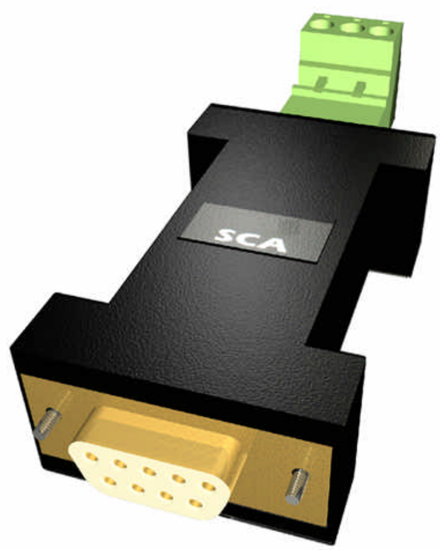
Serial Communication Adapter

RS-232 to RS-485 Converter



Communicate Up to 4000 Feet
Powered by the PCs' Serial Port
Optically Isolated
Easy to Use

Ideal for Industrial Control

The Serial Communication Adapter (SCA) is a port-powered RS-232 to RS-485 converter that allows a PC (or any other asynchronous serial device) to communicate over long distances via RS-485. The SCA has a Standard DB-9 (female) serial connector that connects directly to a PCs' serial port and a detachable terminal block connector on the RS-485 side. See Figure 1.

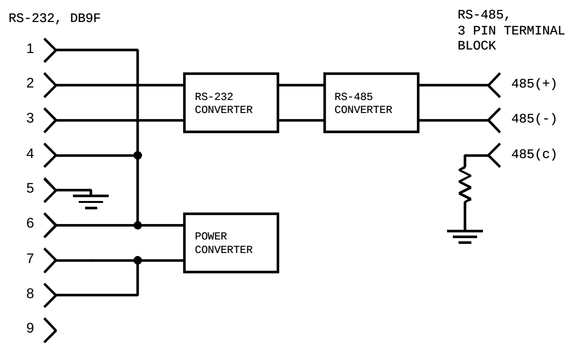


Figure 1.

RS-485 Basics

RS-485 is a reliable 2-wire, half-duplex serial communications system. Cables can be up to 4000 feet in length and up to 32 Unit Loads (devices) can be connected to the network. The signals are balanced (See "Balanced vs. Unbalanced") making it nearly immune to electrical noise. RS-485 Tranceiver chips require single +5V supply making them simple to integrate into your project. RS-485 is ideal for applications ranging from simple communication experiments to industrial control systems.

RS-232 vs. RS-485

RS-232 is a point-point system with a maximum specified range of 75 feet. Since there is no addressing, only 2 devices can communicate. Speeds of over 115 KBaud are possible. High speeds are often problematic at longer distances but low speeds are quite reliable, even at several times the specified maximum range. Signaling is done using a minimum of 3 Lines (TXD, RXD, GND) and uses ±12VDC levels (0-5 VDC for TTL). RS-232 is not suitable in electrically noisy environments, even with shielded cables.

RS-485 is a Point-to-Multipoint (also referred to as multidrop) system that can address up to 32 nodes over a distance of up to 4000 feet.

Data rates of up to 10 Mbit/sec. are possible. Only 2 wires are required and inexpensive unshielded twisted-pair can be used.

Regardless of which method you use, data is sent by varying the voltage levels on a wire. “TTL RS-232” uses 5 VDC (2.4V to 6.0VDC is valid) to represent a logic 1, and 0V (up to 0.4V is valid) to represent a logic 0. By comparison, True RS-232 uses +12V for logic 0 and -12V for logic 1.

RS-485 uses a different approach to indicating logic levels. Instead of measuring voltage levels on one line with reference to ground, it uses the voltage *difference* between 2 lines called “A” and “B”. The line that is more positive is assumed to be line B and then less positive is line A. The signal or logic level is the result of subtracting line A from line B. Put another way, if Line B is greater then Line A then logic level is 1; if Line A is greater then Line B, the logic level is 0.

If an RS-485 reciever sees line A is 0.2V more positive then line B it is logic 1. If line B is 0.2V more positive then line A it is logic 0. If there is less then 0.2V difference recieved the logic is undetermined (Figure 2).

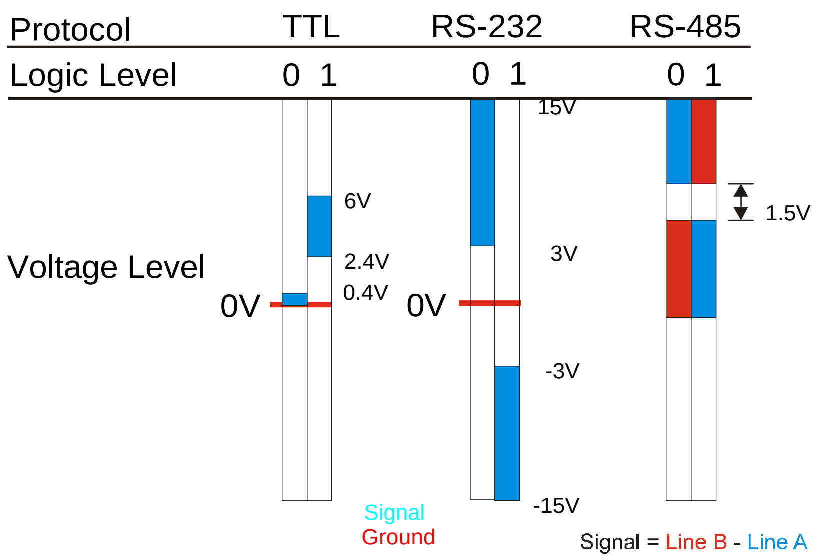


Figure 2.

An RS-485 driver chip only needs to drive a minimum voltage difference of 1.5V. This reduces the requirement for a stable ground, lowers current consumption and reduces component cost.

Noise

The term “noise” refers to electrical interference that is caused by induced voltages. These voltages result when a varying magnetic field passes through a conductor such as the wire you are using to communicate over. This results in unexpected changes in the voltage levels on the serial lines, and can alter or obliterate your data.

TTL RS-232 communications operate over very short distances. The shorter the conductor the less chance there is for induced voltages. True RS-232 deals with moderate distances and environments where induced voltages aren’t as likely. RS-485 operates on cable lengths as long as 4000 feet and in environments where induced voltages are common.

Noise immunity in the RS-485 protocol is the result of the induced voltage levels being subtracted away. Any noise will be present on both signal lines (A and B). When the reciever chip measures the signals it calculates the difference between the lines -not their absolute voltage levels. This is why RS-485 is referred to as a balanced system.

Another inherent advantage is that as each signal line has a peak voltage of 3 Volts, that when you subtract the 2 lines, the resultant signal has a peak-peak voltage of 6 Volts (see figure 3). The larger the voltage used to represent a bit, the less likely it is to be damaged or destroyed by noise.

Balanced vs. Unbalanced

An unbalanced transmission medium is one in which an induced voltage can affect one line more than another. RS-232 is unbalanced as it references ground and an induced voltage will alter the signal line, but not ground.

A balanced transmission medium is one where any induced voltages affect all signal carrying lines in the same way. With RS-485, the information being sent is detected by the difference in voltage on the signal lines; if an induced voltage affects both lines equally, then the net voltage difference between the 2 lines remains unchanged and the information remains intact.

Protocol or Standard

RS-485 is the common name for the TIA/EIA-485 standard. This a guideline describing the voltage levels for signals, cable impedance,

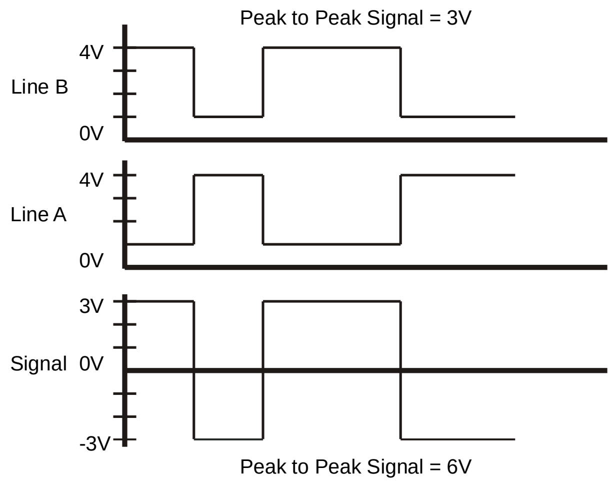


Figure 3.

load capacity and other details. It does not specify how to communicate with your equipment; nor does it tell you how to address your nodes, acknowledge reciept or rejection of data, or perform error checking.

Since EIA-485 is basically a specification for driver, receiver and tranceiver chips, the manufacturer of the equipment needs to specify cabling, grounding, termination and connectors. RS-485 is a Standard an example of a protocol that can be used over RS-485 is S.N.A.P (described in the examples section) .

Duplex

RS-485 is a half-duplex system, meaning that only one node can transmit at once. A simple example would be a system with two nodes; where Node 1 is transmitting while Node 2 is receiving. Similary, if Node 2 needs to transmit, Node 1 must switch to receive. In a system where there are mutliple nodes, preventing conflicts requires some kind of protocol.

The easiest protocol to implement for half duplex communications is called Master/Slave. With this arrangement, one node is designated as the Master and tells all the other Slave nodes when they can transmit. A more complicated version of this is “Token Ring”, where the master is defined as the node that has the token. The Master can transfer the token to another node when needed. Note that both options require that each node have a unique address.

Getting Started

Using the SCA is as simple as connecting the device to an available serial port on your PC and the twisted pair to the SCA. If you have an existing RS-485 network, then you're pretty much done. If you're new to RS-485, then we offer the following example that uses the SCA to communicate with 2 BASIC Stamp II devices via RS-485.

A quick and easy way to get an RS-485 network running is to use the SCA with the Scaleable Node Address Protocol (S.N.A.P). This free protocol is simple and yet surprisingly flexible. You can choose the type of addressing, data packet size and type of error checking. Using S.N. A.P. Lab and the BASIC Stamp example software provided, you should be able to have data streaming back and forth between nodes and your computer in no time. The SNAPLab and the Stamp example code are on the included diskette or can be downloaded from the HVW Technologies web site, from the Downloads page: (http://www.HVWTech.com/downloads.htm)

The circuit in Figure 4 uses a BASIC Stamp II and two DS75176 RS-485 transceivers (both available separately from HVW Tech.). Assemble the circuit using a few feet of twisted pair between nodes.

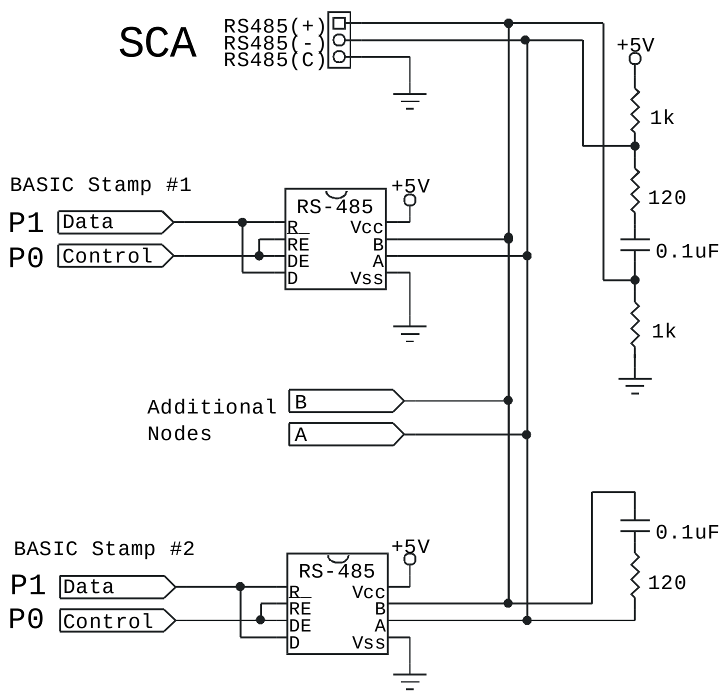


Figure 4.

The first test will see just one Stamp sending data to the PC. Download the “snap_lab_send2.bs2” program into one of the BASIC Stamps This program will send a SNAP packet from address 2 every three seconds. Next, run SNAPLab.exe and under the “Connection” tab set the following:

Serial Port : Select the serial port that the SCA is connected to
Serial Speed: 2400
Flow Control: None.

Click “Connect”.

Select the “Send and Receive” tab, and in the “Send” section, select:

“My address” = 1
“No. of bytes” = 1
“Error detection” = None
“ACK” = No ACK Request
“Set command bit” = Not selected

SNAPLab is setup such that there are 2 windows under the “Recieve” section. The “My Packets” part shows all data sent to the address set in “My Address”; and the “All Packets” windows shows all traffic on the network. In most networks, the “master” is involved in (or controls completely) all data on the network, so the information in the windows should be the same.

NOTE: There is a small bug in SNAPLab (v0.82) that requires that when you setup the address for SNAPLab, you must select “None” for “My Address” and then switch back to the option that allows you to enter an address. You must then re-type “1” and hit ENTER, even though the value 1 appears by default. You will not see any packets in the “My Packets” window until you do this.

You should now see incoming packets from the BASIC Stamp in the “My Packets” and “All Packets” panes of the “Receive” section of SNAPLab.

To take this test one step further, download “snap_lab_send3.bs2” program into the other Stamp and reset both Stamps at the same time. You will now see incoming packets from addresses 2 & 3.

To test the transmit-side of the network, reprogram the Stamps with “snap_lab_receive2.bs2” and “snap_lab_receive3.bs2” respectively then run and configure SnapLab as before. Finally, in the “Send” section of SnapLab, set the “Destination Address” to “2” and in the “Data” window, enter a number between 1 and 127. Click “Send Packet”.

The Stamp with the “snap_lab_receive2.bs2” program in it will receive the packet, double the number you entered and send it back. The returned packet will appear in the “My Packets” window. Try setting “Destination Address” to “3” to test the other Stamp.

You can now start adding nodes to your network. The SNAP let’s you choose the level of complexity that you feel your network needs. A full discussion of the S.N.A.P. Protocol is beyond the scope of this manual, but we encourage you to read more on this powerful protocol and investigate adding error correction and acknowlegements to your packets to increase the reliability of your network.

Error Correction

Error correction is actually a bit of a misnomer as it cannot correct incorrect data, only advise that the data is incorrect. There are a number of techniques available to detect when received data is different from the data that was originally sent, the most simple of which is simply to send each packet several times and compare the received results. A more elegant approach is called a checksum which is just the sum of the byte values in the packet, which is sent along with the original data.

The problem with checksums is that if two byte values (or the checksum itself) become corrupted, then it is possible to receive data that passes a checksum test, but is in fact, incorrect. Despite this possibility, checksums are a quick and easy way to do basic error checking on non-critical data.

To overcome the potential errors of the checksum, mathematicians devised a system called a Cylical Redundancy Check (CRC) that essentially performs an error check on each byte of the data packet - independently of every other byte in the packet. This way, if 2 bytes get corrupted, the packet will still get flagged as containing incorrect data. A comprehensive dicussion of CRCs (All About CRCs.htm) can be found on the included diskette.

Cables

RS-485 networks are cabled with Unshielded Twisted Pair (UTP) cable; Category 3 (CAT3) or better (CAT5 is commonly used for PC networks and is fine -although more expensive). For extremely noisy environments, Shielded Twisted Pair (STP) may prove beneficial.

Terminations

Using the SCA to communicate to most RS-485 devices does not usually require any termination. A termination is used to match impedance of a node to the impedance of the transmission line being used. When impedances are mismatched, the transmitted signal is not completely absorbed by the load and a portion is reflected back into the transmission line. This reflected signal could cause communication errors especially on long cable runs using a high data rate. If termination is required, the SCA only supports active coupled terminators. When using terminators, one should be installed on each end of a straight cable run. A typical active termination is a 120 Ohm resistor and a 0.1 uF capacitor in series between 485(+) and 485(-).

Failsafe biasing is often used to prevent floating or undetermined states on the lines. When all the nodes are powered down the lines have the potential to float at voltages that might be considered signals. Biasing the line prevents this and improves cable impedance matching. This is shown in the circuit diagram of figure 4. In order to make this as effective as possible you should have your cable selected and cut to the length you are planning on using.

Advanced Topics

No handshaking is required to control the RS-485 driver. The handshake lines from the PC are required only to provide power to the converter. The RS-485 driver is automatically enabled during each spacing state on the RS-232 side. During the marking or idle state, the RS-485 driver is disabled and the data lines are held in the marking state by pull-up and pull-down resistors.

The SCA has an internal connection to prevent data transmitted from the RS-232 port from being echoed back to the RS-232 port. The SCA is used as a two-wire (half duplex) RS-485 converter with a third conductor to be used as signal ground. Using a common signal ground ensures that the common mode voltage between devices falls within the specifications of RS-485. This is especially important for networked devices with opto-isolated RS-485 interfaces.

Links/Resources

- SCA Page: http://www.HVWTech.com.sca.htm
- S.N.A.P Protocol: http://www.hth.com/snap
- Serial Port Complete (an excellent resource on all serial protocols) http://www.HVWTech.com/book_comp_serial.htm
- DS75176 RS-485 Transceiver Chips: http://www.hvwtech.com/misc_comp.htm#serial_drivers

Diskette Index

The included diskette contains the following:
- SNAPLab (SNAPLab.exe)
- BASIC Stamp Example Code (.bs2 programs, see text)
- S.N.A.P Protocol Specifications Document (Snap Protocol.pdf)
- All About CRCs (All About CRCs.htm)
- The Art and Science of RS-485: An article from Circuit Cellar Magazine, July 1999 (Circuit Cellar RS-485.pdf)
- DS75176 Datasheet (DS75176B.pdf)

Technical Support

Technical support is available if you are having problems. If you need help, please provide as much detailed information as possible.

E-mail: support@HVWTech.com
Phone: (403) 730.8603 (Monday - Friday 9am – 5pm Mountain time)

RS 485 Made Easy

Asychronous Serial Communications
Cable Length UpTo 4000 Feet
Upto 32 Nodes
Easy Interface To Microcontroller
Optically Isolated

Other Products from HVW Technologies

Stamp Stack II: The Ultimate BASIC Stamp II prototypng tool. A complete BASIC Stamp II on a board that mounts onto a solderless breadboard. Includes a serial connector, reset switch and a “bullet-proof” power supply. Easy to build, simple to use.

Also: Microcontrollers ☞IR Sensors ☞Compilers ☞PIC Programmers and Proto Boards ☞Schematic/PCB Software ☞Robotics Kits/Parts....
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