Critical Choices In Wireless RS-232

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As the practical limits of using wired RS-232 systems are reached, designers have looked toward wireless technologies to extend transmission range and provide networking for their embedded systems. High-data throughput technologies, such as, Ethernet, WiFi (802.11b) and Bluetooth allow designers to leverage existing infrastructures (via base stations and access points), utilize high-bandwidth flexibility in transmission schemes, and provide adequate networking within RS-232 systems up to 300 feet of range. For some applications, the transmission range is too limited and the added cost and complexity make these solutions undesirable.

For certain applications, proprietary wireless RS-232 systems that specialize in long range and low data throughput can be very cost effective. Wireless RS-232 systems can also provide ease-of-use, extended range capabilities, flexible integration, rapid installation and extended product lines.

Related costs, engineering experience, and plans for deployment influence the path a designer will take when designing wireless RS-232 into their projects. Selecting the appropriate wireless RS-232 solution for connecting low-bandwidth electronic devices requires several considerations. These considerations should include:

- Radio frequency (RF) hardware options
- Time-to-market issues
- Transmission range related issues
- Power requirements
- Optimum transmission bands
- Interference immunity

RF Hardware

Most designers consider modules (circuit boards populated with all essential RF components needed for a wireless link RF), transistor-based components (discrete radio designs), and chipsets (integrated circuits) as hardware options for implementing wireless communication into their designs. Modules offer the greatest ease-of-use and deployment by providing a completed wireless solution that can be plugged into a product or system design. Transistors and chipsets offer the lowest hardware costs to a designer. These options require extensive RF hardware engineering and significant RF firmware development to implement the solution appropriately into a product or system. Table 1 lists RF experience, development time and time-to-market expectations for a designer to consider before choosing to develop with a transistor, chipset or module.

Table 1. Designer Needs for Implementing Various Wireless Solutions

Designer Needs	Discrete Radio Design (Transistors)	RF Integrated Circuits (Chipset)	Wireless Transceiver Module
RF Experience	Expert	Moderate	Little to none
Development time	Months to years	Months to years	0 to 6 months
Time-to-market	Very long	Long	Short

Time-to-Market

When time and RF engineering experience is of abundance, a designer may opt to use chipsets to save on RF component costs. Using transistors or chipsets, the designer actually develops the hardware and software workings of the product. While transistors or chipsets offer functionality, the designer must dictate how those chips will work in concert with the software the designer will develop. This task is not for the faint of heart, as completed designs must also pass rigid FCC, ETSI and other agency requirements for deployment in the various regions of the world. The regulatory approval process can add months or years to development.

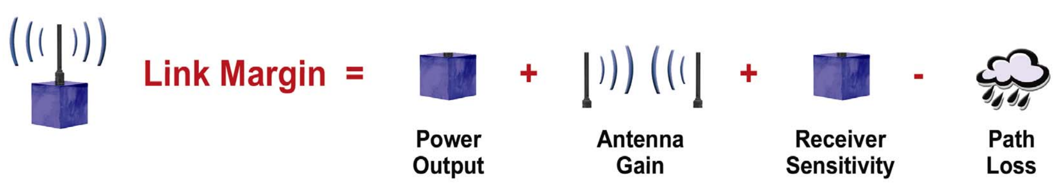
Wireless transceiver modules offer a faster time-to-market alternative to transistors or chipsets that allow designers at all levels of RF experience to integrate a completed wireless system into their products. Many modules are manufactured as a drop-in solution where designers create a compatible interface on their processor board and supply serial data to the appropriate pins. Modules offering the easiest integration allow the designer to send raw UART data into the module and expect that same data out on the receiving end of the wireless link.

Modules may carry FCC, ETSI and CE and other approvals allowing the designer to deploy products in various regions of the world with minimal additional approvals. The completed RF design and agency approval of many wireless transceiver modules make them a popular choice in the fast-paced world of wireless product design.

Achieving Long Range

Transmission range in a system is determined by link margin calculations. Figure 1 shows the overall link margin of a system includes transmission power output, antenna gain, receiver sensitivity and path loss (due to cable and antenna attenuation, air content and obstacles preventing line-of-sight conditions). Achieving long range with wireless transceiver modules requires an effective combination of output power, antenna gain and receiver sensitivity. Each of these specifications can have dramatic affects on the link margin of a wireless link path.

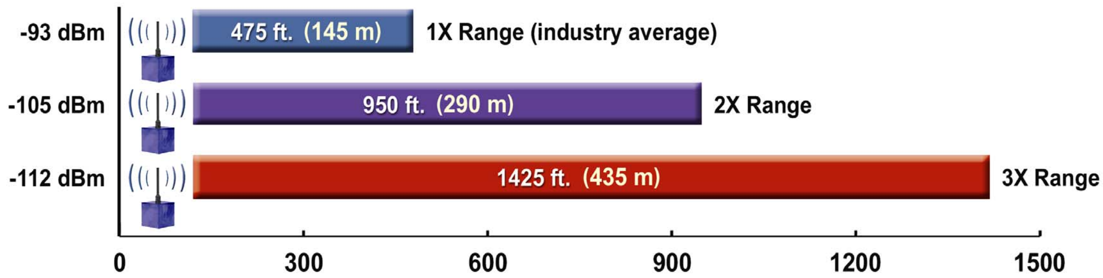
Figure 1. Link Margin



It would be simple to boost the output power and employ high-gain antennas to acquire the desired range. However, many regulatory agencies in the world place limits on transmission power output and total antenna gain allowed in a wireless link. In addition, many applications require compact size, portability, low power consumption and low cost from their wireless solutions. Improving receiver sensitivity has proven to be a cost effective means for increasing range with out the overhead of high-powered and/or cumbersome antenna solutions.

The more link margin that is available, the more range a designer is able to achieve. It is easiest to calculate link margin in dB. As receiver sensitivity becomes more negative it introduces more dB into the link margin. Every -6 dB of receiver sensitivity effectively doubles communication range in line-of-sight conditions (-10dB in urban or indoor environments). The industry's receiver sensitivity average for wireless transceiver modules is -93 dBm. Figure 2 shows an example where a wireless transceiver module with –105 dBm of receiver sensitivity will increase the link margin by 12 dB (more than the industry's average module) allowing the wireless link to communicate at four times the range in line-of-sight conditions and over twice the range in urban or indoor environments.

Figure 2. Receiver Sensitivity vs. Range (calculation based on constant power at 900 MHz)



Long Range with Low Power

Low power consumption can be maintained in a long range system by employing greater receiver sensitivity. For example, a 1 Watt wireless transceiver module has 10 dB more power than a 100 mW module. However, if the 1 Watt wireless transceiver module has a receiver sensitivity of –93 dBm it will have less range than a 100 mW module with a receiver sensitivity of –109 dBm, because the 100 mW module has 6 dB more link margin than the 1 Watt module. This effectively doubles the range while using the current consumption of a 100 mW module.

Transmission Bands

Wireless RS-232 enabled devices typically utilize wireless transceiver modules that operate in the license-free Industrial Scientific and Medical (ISM) radio frequency bandwidths of 900 MHz and 2.4 GHz. Both of these bandwidths can benefit OEMs in different ways.

Wireless transceiver modules operating in the 900 MHz bandwidth offer up to twice the transmission range and penetrate obstacles (i.e. walls, buildings, trees, etc.) better than 2.4 GHz transceivers. While 900 MHz signals outperform 2.4 GHz signals, the 900 MHz band is only available in North America, South America, Australia, New Zealand, and Israel. On the other hand, wireless transceivers operating in the 2.4 GHz band are suitable for license-free communications throughout most of the world.

Designers that want to take advantage of 900 MHz performance, in the approved regions of the world noted above, would best be served by designing a mechanically and software compatible system where 900 MHz and 2.4 GHz transceivers could be swapped based on the country of deployment. Where range is critical, it is disadvantageous to select one transceiver with inferior signal performance (2.4 GHz) for the sake of design consistency. For worldwide deployment of products, OEMs have the option to select manufacturers that offer 900 MHz and 2.4 GHz swappable transceivers.

Interference Immunity

Where transmission obstructions and interference may be encountered in different environments, some wireless transceivers are designed to penetrate obstructions and block interference to acceptable levels. These abilities allow wireless RS-232 to be more flexible than wired systems when used in portable applications.

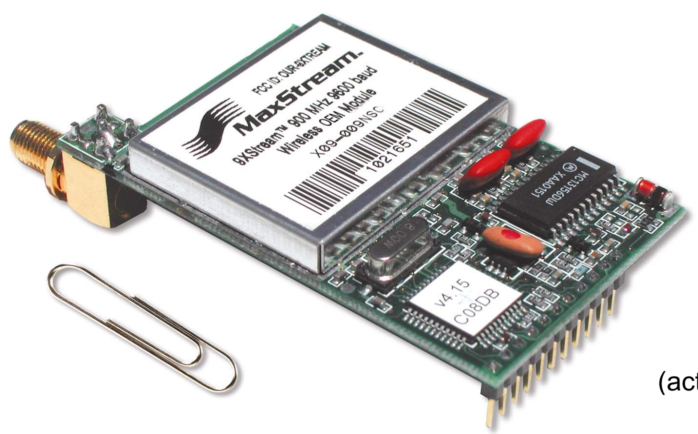
Spread spectrum communications by design carry the added benefit of interference immunity. Some wireless transceiver modules offer additional interference rejection, or blocking, achieved through the use of proprietary filtering and communication across a more narrow band of hopping frequencies.

MaxStream Wireless RS-232 Transceivers

As an example, MaxStream, Inc. (www.maxstream.net) has a line of wireless transceiver modules that meet many of the performance and ease-of-use suggestions discussed in this article. MaxStream modules are all drop-in wireless RS-232 solutions that are FCC and other agency approved for use throughout the world. Integrating these solutions is as simple as connecting a pair of modules between two serial connections (microcontroller UART or serial comm port). MaxStream modules handle all of the complexities of spread spectrum transmission and reception. Of particular note is their ability to communicate at short or long range while consuming low power and maintaining high levels of interference rejection over transparent peer-to-peer, point-to-point, point-to-multipoint and multi-drop networks.

XStream modules set the standard for performance by outperforming many 1 Watt modules, yet MaxStream does this at power levels that cater to battery-powered applications. Also note that 250mW performance is available in products that comply with European emissions. Additionally, MaxStream technology has excellent interference rejection. Interference just 1 MHz away can be 1 million times stronger than the MaxStream signal and only degrade the receiver sensitivity by 3dB.

MaxStream always stands behind its products and is recognized for excellence in customer service and support. For more information, contact MaxStream at 801-765-9885 or www.maxstream.net.



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