

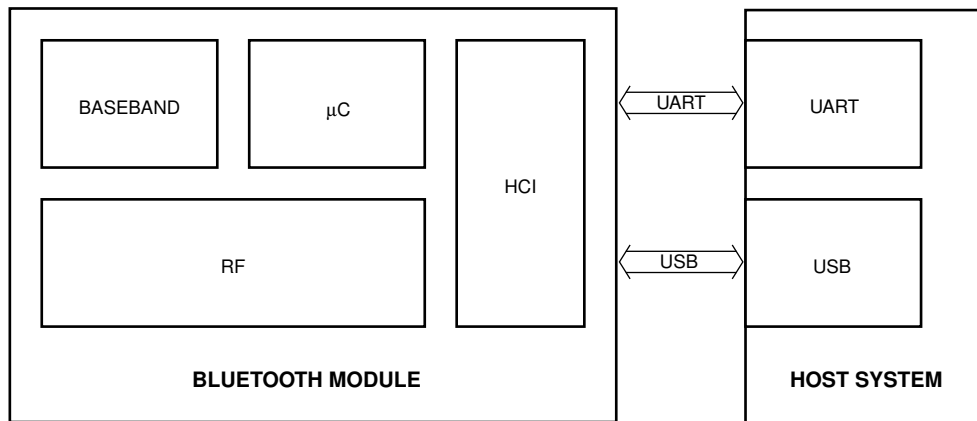
Bluetooth and UART: A Complimentary Coupling

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Bluetooth is a popular standard for wireless communications. Integration of the technology is rapidly expanding in the industry, as it is convenient, easy-to-use, and has the bandwidth to meet the rapidly expanding demands of today's mobile and personal communication applications. According to an In-Stat/MDR report published in April 2004, Bluetooth-enabled applications of the future are expected to include cellular phones, cordless phones, access points, desktop PCs, notebook PCs, memory cards, printers, digital camcorders and cameras, a broad variety of consumer equipment (including games, speakers, set-top boxes and MP3 players), and automotive and industrial applications.

Bluetooth supports wireless point-to-point connections and wireless access to LANs, mobile phone networks, the Ethernet and home networking devices. Bluetooth transmits and receives data wirelessly through these devices. It delivers and receives the data transmitted through a host system and a host controller interface (HCI).

Currently, the most popular HCIs are Universal Asynchronous Receiver and Transmitter (UART) and Universal Serial Bus (USB) links, as illustrated in Figure 1. UART is often preferred, as its performance and data throughput levels are nearly comparable to the USB interface, while its simpler transport protocol enables decreased software overhead and a more cost-effective overall hardware solution.



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Figure 1

It is expected that a large percentage of Bluetooth chips designed for communication applications will include a UART in the host controller. This article will examine the benefits of using UART as a device to bridge the interface between the host and the Bluetooth chipset/module.

An Overview of UART

UART is typically used for communication with serial input and serial output devices. This type of transmission reduces the cost and complexity of the wirings at the expense of speed. For many applications, this tradeoff is ideal.

UART provides serial asynchronous receive data synchronization and parallel-to-serial and serial-to-parallel data conversion for both the transmitter and receiver sections. These functions are necessary for converting the serial data stream into parallel data, which is required by digital systems. Synchronization for the serial data stream is accomplished by adding start and stop bits to the transmit data to form a data character. Data integrity is insured by attaching a parity bit to the data character. The parity bit is checked by the receiver for any transmission errors.

To a host system, the UART appears as an 8-bit input and output port that it can read from and write to. Whenever the host has data to be sent, it just sends it to the UART in byte format (8-bits-wide). And whenever the UART receives data from another serial device, it will buffer the data in its FIFO (again, 8-bits-wide), then it will indicate the availability of this data to the host through an internal register bit or a hardware interrupt signal.

In addition to the transmitter and the receiver, some UARTs incorporate additional features to significantly reduce software overhead and increase system efficiency. These features include:

- Hardware and software auto flow control to prevent FIFO overflow conditions automatically. Without automatic flow control, the host software needs to empty the receive FIFO immediately when it is about to be filled up.
- Large FIFOs to reduce the host processor's service time to the UART. This allows the processor more time to do other tasks.
- Faster baud rate and faster bus access to improve the overall system performance. The system can send/receive more data in less time.

UART to Bluetooth Interface: Off-the-shelf Bluetooth Module

One situation in which a UART interface can be beneficial is when it is working with an off-the-shelf Bluetooth module. To illustrate this hardware interface, we'll examine a real-world example revolving around the Free2Move Bluetooth Serial Port Plug (F2M01). Many other products are currently on the market that are similar to the Free2Move plug and, when integrated with UART, similar results should be produced.

The F2M01 integrates a Bluetooth module in very dense packing, which enables the replacement of the most commonly used serial port cable. A class 1 Bluetooth is used, offering a range of approximately 100 meters. No external drivers are needed to use the plug. A user-friendly Windows application is included to program the communication modes as well as the baud rate. The Windows application also enables hardware flow control using RTS/CTS signals. Figure 2 illustrates the interface between the F2M01 and an existing serial port 9-pin connector.

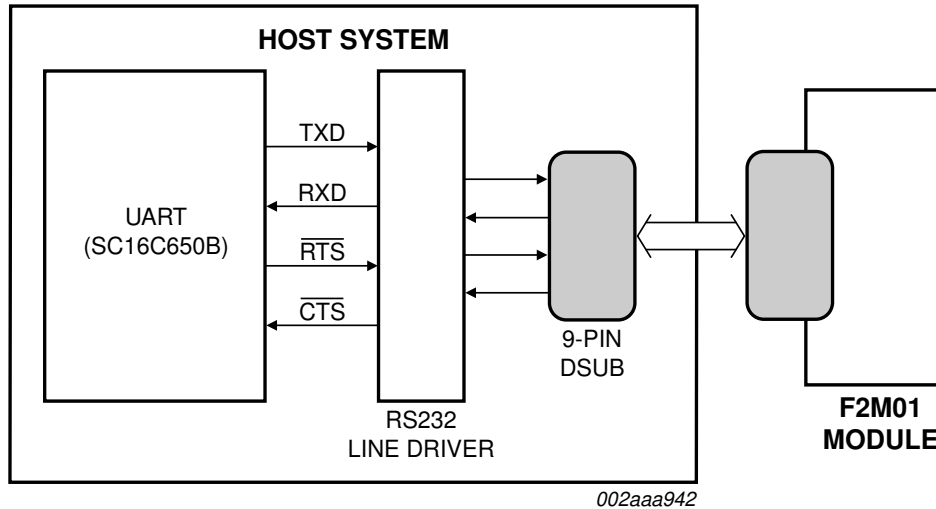


Figure 2

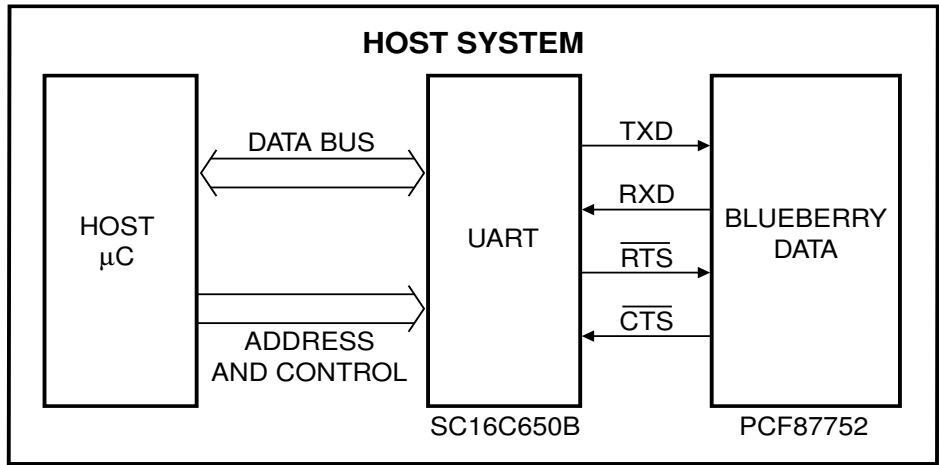
The F2M01 needs to be powered by an external power source of 4-5V DC through a DC connector or a pin 9 of the RS-232 DSUB connector. The module can be connected to any RS-232 serial port interface such as a PC serial port, or to any RS-232 9-pin DSUB connector. The module offers data rates up to 115.2 Kbit/s.

UART to Bluetooth Interface: Bluetooth Chipset

Using UART as a bridge between a host and a device employing a Bluetooth chipset is another situation in which UART proves beneficial. Again, we will use a real-world example to illustrate the interface: the Philips PCF87752. The application of UART with Bluetooth solutions from other manufacturers should run similarly and produce comparable results.

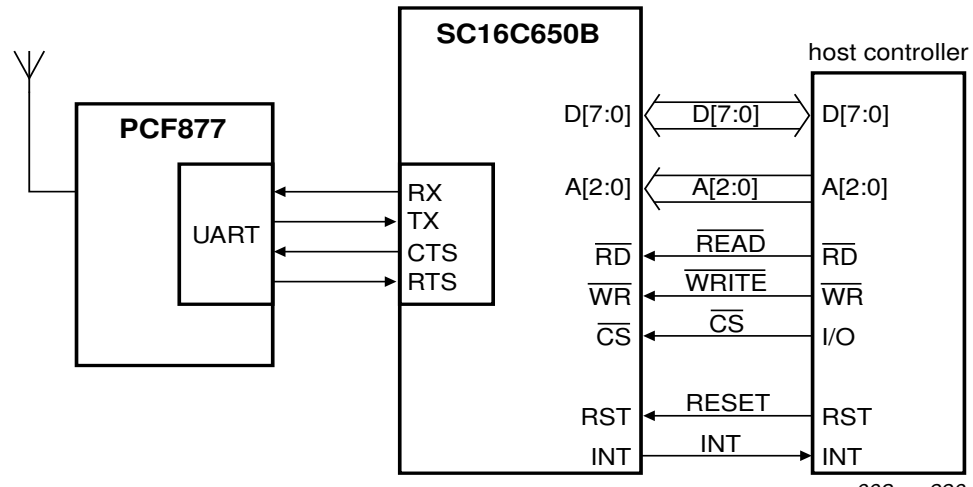
The PCF87752 is the most highly-integrated single-chip baseband solution designed for Bluetooth applications. Known as “Blueberry DATA,” it contains all the necessary elements to provide applications with complete baseband functionality for Bluetooth wireless technology. It is ideal for Bluetooth integration in hosted and some embedded applications like mobile phones and computing devices.

The central processor in Blueberry DATA is an embedded 32-bit ARM7DMI RISC microcontroller, offering very low power consumption per MHz. Several industry-standard I/O interfaces are included in the IC in addition to UART. These include USB, I²C and PCM/IOM. Because of the multiple I/O interfaces available, Blueberry DATA can communicate with a wide range of devices. However, the simple transport protocol of UART results in less software overhead and a more cost-effective hardware solution. Figure 3 illustrates such an interface, while Figure 4 shows a detailed interface between a UART and host controller.



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Figure 3



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Figure 4

It is clear that Bluetooth will be a popular technology deployed for an array of applications in the future because of its performance, convenience and ease-of-deployment. When integrated with UART, the benefits are often amplified. Integrating a Bluetooth module onto a host system through a glueless UART connection can provide designers with an optimal solution to meet the growing demand for faster data rates and flexibility for today and tomorrow's communication applications.