The Bluetooth Platform Solution from Motorola System Overview

1 Executive Summary

As the Bluetooth™ marketplace continues to expand, market requirements demand products that are ever smaller in form factor, more cost-effective, and delivered to market quickly. To enable Bluetooth product developers to meet increasingly aggressive time-to-market requirements, Motorola offers a complete and comprehensive RF-to-applications Bluetooth platform solution with the Bluetooth Platform Solution from Motorola.

We know our customers demand leading-edge technology and we offer it in our platform solution. The platform is based on Motorola's third-generation P3 Bluetooth architecture. Our platform comprises the following products:

- V1.1 compliant baseband with Bluetooth standard HCI interface (MC71000) and RF IC (MC13180) (Bluetooth Class 2)
- Optional V1.1 compliant power amplifier (MRFIC2408) (Bluetooth Class 1)
- V1.1 compliant embedded Bluetooth protocol stack and profiles
- Optional power management IC for headset and phone accessories (MC13181)
- Development kit and associated tools for rapid prototyping and development

Featuring fully integrated hardware, software, and associated development tools, the platform solution enables the rapid development and deployment of cost-effective Bluetooth products. Motorola is one of an elite group of nine Bluetooth SIG promoters and has years of experience in developing Bluetooth applications from RF ICs, to the Bluetooth stack, to end products, and deploying this technology on a world-wide basis to over 26 countries so far. By choosing the platform solution from Motorola, developers have a wealth of options to implement fully integrated, tested, qualified, and interoperable components thus avoiding many common component integration and interoperability problems. The platform solution

from Motorola greatly simplifies technical support. With one phone call, a developer can obtain support on any part of the complex Bluetooth architecture. This avoids the frustration and time wasted trying to fix compatibility and interoperability problems between multi-vendor components.

The Bluetooth Platform Solution from Motorola is designed to:

- Give your products leading-edge radio performance that includes special 802.11b coexistence capabilities.
- Provide industry-leading noise performance using Motorola patent-pending JD/MLSE technology with superior rejection of interference with ISM-band devices such as cordless phones and microwave ovens.
- Assure outstanding audio quality with a special Bluetooth Audio Signal Processor (BTASP).
- Lower overall production costs with an optimized dual-IC architecture for baseband and RF transceiver functions.
- Facilitate the interoperability that is crucial in a Bluetooth environment through a fully tested comprehensive platform, participation in all Bluetooth UnPlugFests, and a leadership role in the Bluetooth SIG.

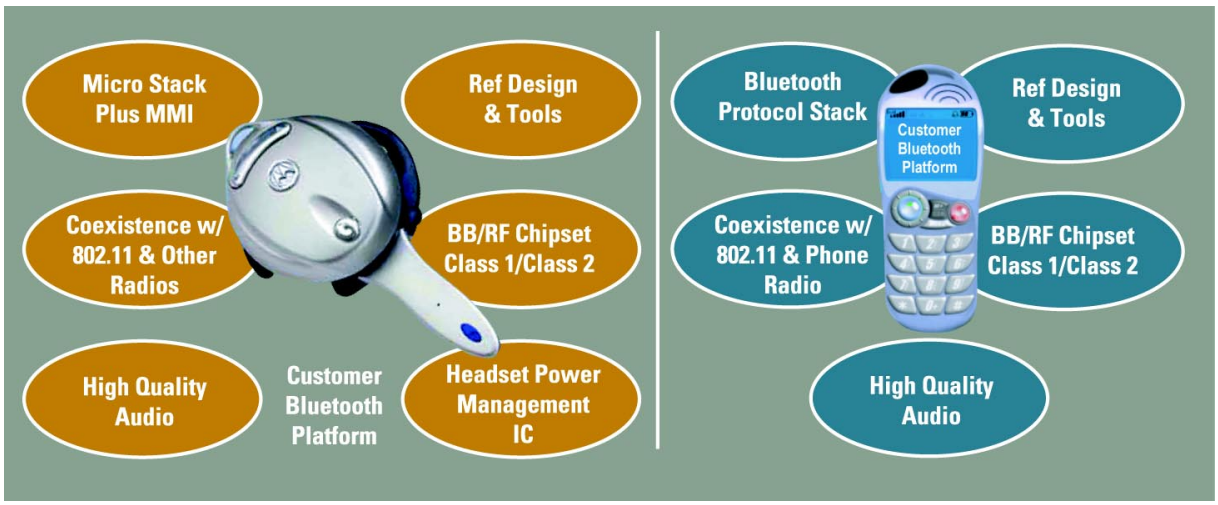


Figure 1. The Bluetooth Platform Solution from Motorola

2 Platform Key Benefits

The Bluetooth Platform Solution from Motorola significantly reduces both time-to-market and the effort and cost of developing Bluetooth products. Table 1 summarizes the platform's key benefits.

Table 1. Key Benefits of the Bluetooth Platform Solution from Motorola

Feature	Benefits	Value Proposition
High-performance radio that includes Motorola's patent-pending JD/ MLSE technology	• Improved coexistence with 802.11b and other ISM-band devices. • Better range, increased capacity, more robust performance. • Easier integration into cell phone platforms.	• Much improved Bluetooth user experience, thus perceived product quality, by providing a high degree of link availability and lower power consumption. When co-located with 802.11b users, they can also enjoy a much improved experience. • The fewer integration headaches, the faster the time-to-market. Motorola engineers have taken great care to make our solution highly compatible with cell phone radios from GSM, to CDMA, to the latest GPRS/EDGE and 3G architectures.
Special Bluetooth Audio Signal Processor (BTASP)	• High-quality voice connections.	• Fewer annoying clicks and pops, and lower power consumption during voice connections.
Comprehensive platform solution	• One-stop shopping. Less support confusion – you get all the help you need with one call. • Lower risk of interoperability problems. Spend less time analyzing and worrying whether the various pieces and parts you've selected will really work together in your product as well as communicate with other Bluetooth products.	• Minimizes design risks because there are fewer technical unknowns. Less confusion when trying to isolate problems between components. This all results in a faster time-to-market with fewer surprises. • Much improved Bluetooth user experience with fewer problems connecting in the real world, heterogeneous, multi-vendor environment.
Optimized two-chip architecture	• Avoids compromises between cost and performance. Get the best of both.	• Enables the lowest system cost while still achieving the optimal level of performance. Each IC can be implemented in its most ideal process and follow their respective optimal process cost-curve.

2.1 Coexistence with 802.11b and Robust RF Performance

The P3 architecture draws upon Motorola's 70 years of experience in designing leading-edge radios. The P3 architecture carefully factors in many RF performance issues to:

- Facilitate coexistence with 802.11b WLAN radios.
- Establish and maintain a robust link in the presence of other ISM-band interference sources like microwave ovens, cordless phones, and other ISM-band radios.
- Facilitate integration into the mobile phone environment.
- Establish and maintain a robust link when there is a high-density of Bluetooth networks.

Some of the RF performance features include:

- Selection of internal clock frequencies to avoid desensing of a mobile phone.
- Patent-pending joint detection/maximum likelihood sequence estimator (JD/MLSE) bit detector and clock recovery mechanism. This enables a unique combination of superior sensitivity and in-band/out-of-band blocking performance. For more information, see *Motorola's Bluetooth Solution to Interference Rejection and Coexistence with 802.11 Application Note* (AN2211/D).
- Pad slew rate control and minimum voltage levels to limit transient RF energy that can desense a mobile phone radio.
- Fractional-N synthesizer to allow reuse of the mobile phone frequency reference and remove the interference associated with a dedicated crystal.
- Motorola's MC13180 RF transceiver is implemented in Motorola's unique CDR1 BiCMOS process. This enables a high-performance radio while still maintaining the Bluetooth low-cost objective.

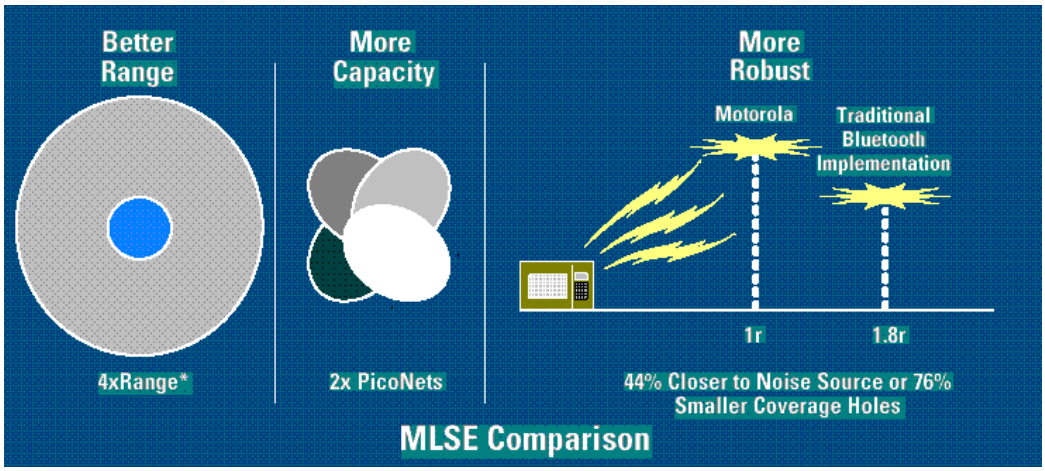
2.1.1 Patent-Pending JD/MLSE Technology and Coexistence with 802.11b

Motorola, since the beginning of its Bluetooth development, has been aware of the challenging issues of interference rejection and coexistence with 802.11b. Thus, Motorola put a heavy emphasis on interference rejection performance into its design plan. The platform solution incorporates:

- A maximum likelihood sequence estimator (MLSE) that rejects possible interference and is designed to give your Bluetooth products excellent noise performance.
- Adaptive frequency hopping is designed to combat interference. It benefits other radios, like 802.11b, as much as other Bluetooth radio networks. For more information, see *Enhancing ISM Band Performance Using Adaptive Frequency Hopping Application Note (AN2212/D)*.
- The joint detector increases the reliability of the access code detection. This minimizes unnecessary re-transmissions that might interfere with other devices operating in the ISM band, such as 802.11b devices, and lowers power consumption.

The results are a much improved Bluetooth user experience. Not only does Motorola's patent-pending MLSE technology enable a robust link around 802.11b WLAN radios—and around other ISM-band devices, such as microwave ovens and cordless phones—but it also provides better range, more capacity, and improved quality versus traditional bit slicing radios. The better range not only allows improved service availability, but also increases the service coverage area by up to 16 times[1]. The additional capacity means throughput is maintained in high-density Bluetooth environments like airports. The improved quality is provided by Motorola's interference rejection that allows fewer service outages when strong interference like microwave ovens or other radios are nearby.

1. Compared to a Bluetooth Specification V1.1 compliant bit-slicing radio.



* Compared to a Bluetooth Specification V1.1 compliant bit slicing radio

Figure 2. User Experience of the Performance Gain from MLSE versus Traditional Slicing Detector

2.2 High-Quality Voice

A key feature of Bluetooth technology is its native quality-of-service supporting audio at both the link and application levels. The Bluetooth platform solution from Motorola builds upon the Bluetooth native audio capability to deliver quality audio. A key component of Motorola's approach to delivering high-quality audio over the Bluetooth channel is the Bluetooth Audio Signal Processor (BTASP) that has been designed into the MC71000 Bluetooth Baseband Controller. The MC71000 engineering team drew upon a strong Motorola heritage of voice and data radio systems to ensure that robust and quality audio is delivered using Motorola's platform solution. The BTASP and Motorola's high-performance radio architecture work in tandem to result in audio that has noticeably fewer pops, clicks, and hisses, especially in high-interference radio environments.

The Bluetooth Audio Signal Processor (BTASP) is a dedicated module that handles all computation-intensive audio functionality in a Bluetooth system. This offloads this power-hungry work from the ARM7 core, and puts it into a much more power-efficient BTASP. The result is improved talk time for users enjoying the audio performance of Bluetooth technology. The BTASP supports voice links compressed with either log-PCM (A-law or μ-law) or CVSD. See *Using the Bluetooth Audio Signal Processor (BTASP) for High-Quality Audio Performance Application Note (AN2210/D)* for more information.

2.3 Interoperability

Interoperability is a major concern of the Bluetooth community. In real-world implementations, a multitude of Bluetooth products, likely from different vendors, will be called upon to interoperate transparently. The sheer complexity of the Bluetooth architecture means a careful, methodical approach is required for such interoperability to be achieved. The engineers at Motorola who developed the platform placed a high priority on interoperability is why Motorola has implemented a five-pronged interoperability strategy:

- Comprehensive platform solution
- Sophisticated development test framework based on TTCN
- UnPlugFest participation
- Bluetooth SIG standards participation
- Informal testing

2.3.1 Comprehensive Platform Solution

The first step to interoperability is a complete, comprehensive platform solution. With our comprehensive implementation, Motorola offers all the key components that are qualified with each other to reduce the chance of interoperability problems due to component mismatch.

2.3.2 Development Test Framework Based on TTCN

Motorola's commitment to testing includes a TTCN-based formal test framework. We use the TTCN formal test scripting language to exercise the solution at the HCI-and-below level. This framework is used to verify compliance with the Bluetooth specification, for performance stress testing, and for interoperability testing with other vendor's products. Employing this level of testing ensures a highly consistent, robust, and solid implementation of the Bluetooth protocol. The Bluetooth Platform Solution from Motorola can be expected to give you the highest level of interoperability available—anywhere.

2.3.3 UnPlugFest Participation

At the SIG-sponsored UnPlugFests around the world, Motorola is there—testing platform components for interoperability and making sure the components can function seamlessly in any environment.

2.3.4 Bluetooth SIG Standards Participation

As a Bluetooth SIG promoter, Motorola has access to all aspects of the Bluetooth standard activities. We know that a clear, precise standard is key to interoperability. So we expanded our leadership position on the Bluetooth SIG by becoming a promoter, not only to clarify and evolve Bluetooth features, but also to make possible the earliest and most frequent testing of reference implementations.

2.3.5 Informal Testing

Finally, Motorola meets regularly with leading Bluetooth developers to clarify implementation questions and verify interoperability. This extra effort is yet another means to deliver and ensure a high degree of interoperability.

2.4 Power Advantage

Mobile device users place a premium on long battery life. A key advantage of the Bluetooth technology is its very low-power characteristics while still remaining active in a Bluetooth environment (for example, hold and sniff modes). This makes Bluetooth technology ideal for mobile devices. Motorola's platform builds upon inherent Bluetooth low-power features by employing power-efficient architectures plus Motorola's proprietary IC manufacturing processes that are optimized for low power.

To achieve the best power performance, Motorola engineers chose to optimize the RF and digital parts into two different IC processes. For lowest power, the Class 2 MC13180 RF transceiver is implemented in Motorola's proprietary CDR1 BiCMOS IC manufacturing processes. For the less power-challenged baseband, Motorola has chosen a bulk CMOS process that provides low static and active power consumption.

2.5 Low Cost

Motorola engineers have chosen a two-chip path to achieve the lowest cost Bluetooth solution. The reasoning is simple. Digital and RF IC process technology nodes rarely become available in a synchronized manner. Placing the baseband and RF transceiver ICs in their most cost-efficient processes allows each to individually follow their respective optimal cost-curve. A one-chip approach is continually forced to make a sub-optimal compromise between cost and process technology.

2.6 Assured Supply of Product

Those people with years of experience in the high-volume semiconductor industry know that supply and demand cycles are a fact of life. Motorola Semiconductor Products Sector (SPS) and our customers have weathered 50 years of semiconductor industry cycles. These cycles have established Motorola SPS as a reliable, quality, and long-term supplier of components to customers who ship some of the highest unit volumes in world. In times when manufacturing capacity is pushed to the limit, Motorola will be there to provide our customers assured supply of product.

3 Chipset Overview

The platform chipset provides a low-power, low-cost, single-supplier system solution. The key components that compose the chipset are:

- MC71000 Bluetooth Baseband Controller IC
- MC13180 Bluetooth Low Power Wireless Data Transceiver IC
- Optional MC13181 Wireless Power Management IC for Headset and Phone Accessory Applications
- Optional MRFIC2408 External Power Amplifier IC for Class 1 Applications

Motorola's platform solution gives developers the option of using popular third-party stacks or custom stacks.

The development kit for the Bluetooth Platform Solution from Motorola contains everything needed for an engineer to easily and quickly set up and start demonstrating a Class 1 or a Class 2 Bluetooth solution. The solution also provides a Bluetooth engineer with an efficient reference layout of the MC71000 and MC13180 on an FR4 PCB substrate. The development kit is a turnkey solution that contains all the hardware, application software, software utilities, and documentation to quickly get an engineering team up the Bluetooth learning curve. The development kit was developed with the following in mind:

- Engineers evaluating the Motorola platform chipset and its features
- Engineers porting a Bluetooth stack to the Motorola platform
- Engineers wanting to quickly prototype a host device enabled for Bluetooth technology

- Engineers wanting a reference design that allows a fast layout of a Bluetooth solution based on the Bluetooth Platform Solution from Motorola

Figure 2 is a simplified block diagram of the Class 2 implementation.

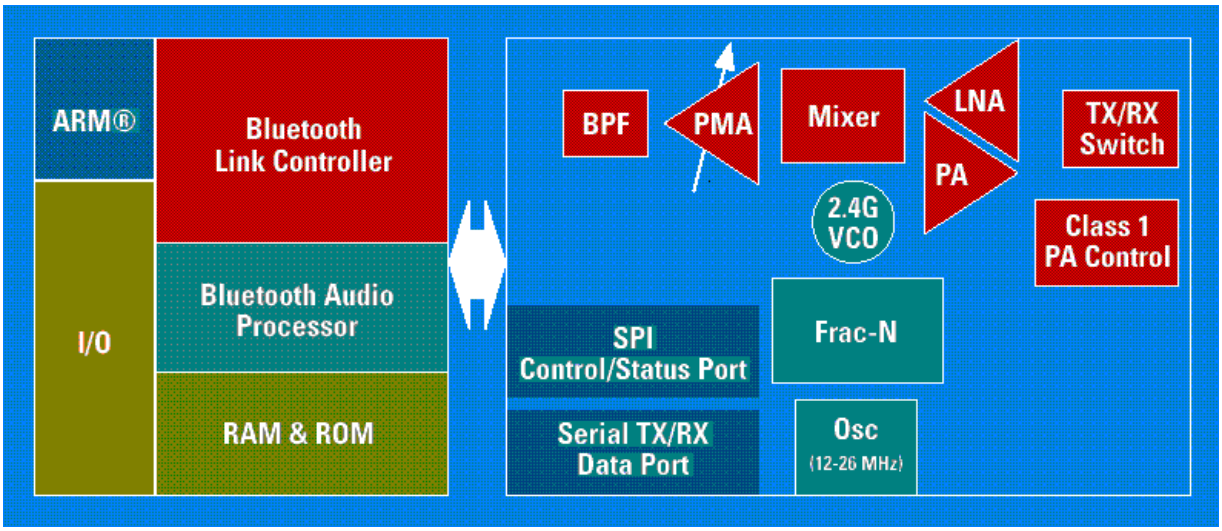


Figure 3. Class 2 Solution Block Diagram

4 Chipset Key Features

The key features of the platform chipset are as follows:

- **MC71000 Bluetooth Baseband Controller IC**
  - — Bluetooth Specification 1.1 Compliant
    - – Supplied software stack is full implementation of Bluetooth technology up to and including HCI layer
  - — ARM7 Platform
    - – Designed to run up to 32 MHz
  - — Bluetooth Link Controller
    - – Low-level baseband processing engine
    - – Dedicated SPI controller to RF front-ends
  - — Bluetooth Audio Signal Processor (BTASP)
    - – Filters and interpolation for superior audio quality and sample rate synchronization
    - – Support for 8, 16, 32, and 64 kHz sample rate CODECs
  - — Two General Purpose Counters/Timers
    - – Configurable to perform pulse width modulation
  - — High-Speed UART (up to 2 Mb/sec @ 24 MHz)
  - — High-Speed SSI (up to 2 Mb/sec @ 24 MHz)

- — Dual High-Speed SPI (up to 2 Mb/sec @ 24 MHz)
- — Power Management
  - – Operating core voltage: 1.65 to 1.95 V
  - – Low park, hold, and sniff mode current consumption
- — 27 GPIO pins grouped into 2 ports
- — Memory Sub-System
  - – SRAM (64 Kbytes)
  - – ROM (256 Kbytes)
- — JTAG Test Interface Controller (JTIC)
- — Packaging: 100-pin MAPBGA, 7 mm x 7 mm

- **MC13180 Bluetooth Low Power Wireless Data Transceiver IC**
  - — Power Supply Range: 2.5 to 3.1 V
  - — Low Current Drain in Transmit (29 mA Peak) or Receive (37 mA Peak) Mode
  - — Sleep Mode for Power Conservation
  - — Minimum External Components
  - — Low IF Receiver with On-Chip Filters
  - — Fully Integrated Demodulator with A/D
  - — Direct Launch Transmitter
  - — Multi-Accumulator, Dual-Port, Fractional-N Synthesizer
  - — RSSI with A/D
  - — Crystal Independent (12 to 15 MHz) Reference Oscillator or 12 to 26 MHz clock if supplied externally
  - — Packaging: 48 QFN, 7 mm x 7 mm
- **Optional MC13181 Wireless Power Management IC for Headset and Phone Accessory Applications**
  - — Low-Battery Detector
  - — Three LDO Voltage Regulators
    - – 2.55 V, 65 mA for RF/IF
    - – 1.85 V, 30 mA for Baseband
    - – 3.0/3.3 V, 60 mA for CODEC and other circuitry
  - — Integrated Pass Device
  - — Independent Enable Lines
  - — Optimized for Low-Cost Bypass Capacitors
  - — Microprocessor Supervisor Circuit
  - — General Purpose Inverter, OR Gate, and Comparator
  - — Maximum V_{CC} Rated up to 7.0 V
  - — Voltage-Robust, Level-Shifted Logic Inputs to V_{CC} (7.0 V)

  - Seamless Integration with Motorola's Bluetooth Chipset
  - Packaging: 24 QFN, 4 mm x 4 mm
- **Optional MRFIC2408 External Power Amplifier IC for Class 1 Applications**
  - Power Supply Range: 2.5 to 3.6 V
  - Power Amplifier Enable/Disable Function
  - Over 20 dB of Power Control
  - Low-Power Shutdown Mode
  - Seamless integration with the Motorola Bluetooth chipset
  - Packaging: 9 QFN, 3 mm x 3 mm

5 Chipset Functional Description

The following subsections provide individual descriptions of each main component in the platform's chipset. Each subsection includes a detailed functional block diagram of the particular component.

5.1 MC71000 Bluetooth Baseband Controller IC

The MC71000 Bluetooth Baseband Controller is a part of the Bluetooth chipset from Motorola that provides a complete, low-power Bluetooth radio system. The design is based on Motorola's third-generation Bluetooth architecture that has set the industry standard for interoperability, complete functionality, and compliance with the Bluetooth specification.

The MC71000 Bluetooth Baseband Controller implements the baseband and host controller interface (HCI) of the Bluetooth protocol. It operates with a core voltage of 1.8 V and I/Os between 1.8 V and 3.3 V. The MC71000 is the ideal solution for low-power, short-range Bluetooth applications and includes superior performance features like the dedicated Bluetooth audio processor module and on-chip memory. Debug and production test are fully supported through the joint test action group (JTAG) interface. The MC71000 provides a zero-glue logic interface for the companion MC13180 Bluetooth Low Power Wireless Data Transceiver (IC), allowing the implementation of a two-chip Bluetooth Class 2 radio. The addition of the MRFIC2408 External Power Amplifier provides a Class 1 solution.

See Figure 4 for a detailed block diagram of the MC71000 and Table 3 on page 12 for list of on-chip peripherals, modules, and special cells that are included to support the operation of low-power Bluetooth applications.

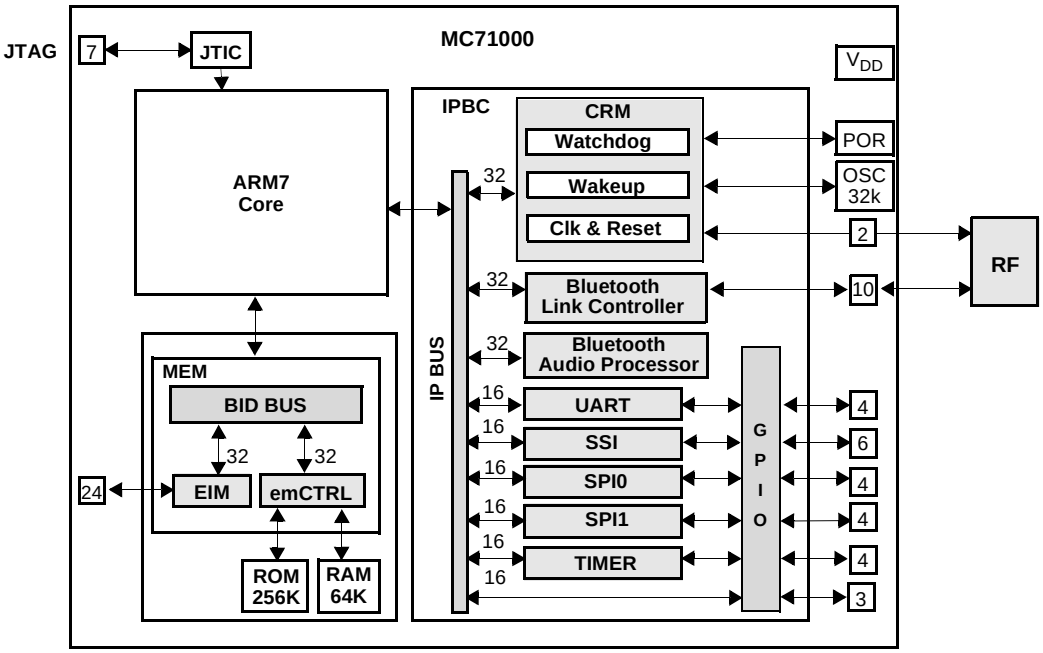


Figure 4. MC71000 Bluetooth Baseband Controller IC Functional Block Diagram

5.1.1 ARM7 Platform (A7P)

The MC71000 architecture is based on the 32-bit ARM7TDMI microprocessor. It is an industry-standard processor recognized for its efficient MIPS/WATT benchmark, along with excellent code efficiency when working in the 16-bit THUMB mode. The architecture is based on RISC principles and supports both the 32-bit ARM instruction set and the 16-bit THUMB instruction set.

The ARM7 platform implements the following modules:

- The reduced ARM high-performance bus (R-AHB) is the ARM7 platform's internal bus.
- The ARM7 interrupt controller (AITC) supports up to 32 interrupt sources from other modules.
- The core bus arbitration (CARB) module arbitrates between the ARM7 processor and test interface as the bus master.
- The ARM high-speed bus multiplexer (AHBMUX) module supports 8-, 16-, and 32-bit transfers and covers the full 4 Gbytes of address space.
- The AHB to IP bus bridge interface (AIPI) module interfaces the R-AHB to the external IP bus and supports up to 31 peripherals, which are all attached to the AIPI.

5.1.2 Memory Sub-System

Program information in the MC71000 is stored in ROM. The MC71000 has the following internal memory configuration:

- SRAM (64 Kbytes)
- ROM (256 Kbytes)

The MC71000 includes a sophisticated BIOS that allows key portions of ROM code to be patched. The ROM patching mechanism allows blocks of the ROM to be updated in products that are already manufactured. The BIOS also allows the replacement of existing drivers, like the UART transport layer driver, and supports the loading of other initialization and run time code. Some example uses are the loading of key information, radio tuning parameters, unique IDs, and so on. This information may be loaded from the host system or from an optional external Serial Electrically Erasable Programmable Read Only Memory (SEEPROM).

5.1.3 Peripherals Sub-System

The peripherals sub-system contains the following modules:

- A Bluetooth link controller module (BTLC) handles all link controller-specific functions. Embedded in the BTLC are also the dedicated Bluetooth timers, which maintain an accurate estimate of time in both the native and the remote module. A small, dedicated Bluetooth serial peripheral interface controller handles all serial communication with the MC13180 Bluetooth Low Power Wireless Data Transceiver.
- A dedicated, hardwired Bluetooth audio signal processing (BTASP) module gives users high-quality audio performance. With a minimum of processor intervention, this module handles all filtering, interpolation, and encoding/decoding (aLaw, uLaw, and CVSD).
- The universal asynchronous receiver/transmitter (UART)) module provides one of the main interfaces to the MC71000 IC. The generated baud rate is based on a configurable divisor and input clock. It can be configured to send one or two stop bits as well as odd, even, or no parity. The UART transmit and receive buffer sizes are 32 bytes each.

  After power on reset, a default UART HCI transport driver is loaded from ROM. This driver can be replaced with either a host loaded driver or a driver stored in the optional external SEEPROM.
- The MC71000 contains two configurable serial peripheral interface (CSPI) modules, CSPI0 and CSPI1. Both CSPI modules are master/slave configurable, equipped with 16-byte data out buffers (transmit and receive FIFOs), and allow the MC71000 to interface with external CSPI master or slave devices. Incorporating the $\overline{\text{SPIRDY}}$ and $\overline{\text{SS}}$ control signals, it enables fast data communication with a fewer number of software interrupts.

  In the lowest cost Bluetooth applications, the host will load radio initialization and run time information into RAM. Optionally, such information can be stored in a SEEPROM connected to the CSPI port. The MC71000 IC has a sophisticated BIOS that simplifies the process of a host loading information to the radio and to the EEPROM. The MC71000 CSPI supports direct connection to a variety of popular SEEPROMs.
- The synchronous serial interface (SSI) module is a full-duplex serial port allowing digital signal processors (DSPs) to communicate with a variety of serial devices, including industry-standard CODECs, other DSPs, microprocessors, and peripherals.

  After power on reset, a default SSI HCI transport driver is loaded from ROM. This driver can be replaced with either a host loaded driver or a driver stored in the optional external SEEPROM.
- The dual timer (TMR) module is a general-purpose module, used for timing control and application-specific tasks. The TMR contains two identical 16-bit counter/timer groups, each supports counting, prescaling, comparing, loading, capturing, and holding options.
- A 16-bit periodic interrupt timer (PIT) that provides precise interrupts at regular intervals with minimal processor intervention.

- Dedicated clock and reset module (CRM) for handling all clock, reset, and power management features. The CRM is designed to make full use of the facilities supplied by the Bluetooth standard to conserve power, while still maintaining a Bluetooth link.

The MC71000 supports a maximum of 27 GPIO lines grouped together in two ports. Port B contains 14 lines and Port C contains the other 13. These ports can be configured as GPIO pins or dedicated peripheral interface pins. The GPIO is used for application-specific tasks.

5.1.4 Test

The JTAG Test Interface Controller (JTIC) interface offers full JTAG and boundary scan capabilities for debug and production test purposes, as well as access to the JTAG interface on the ARM core.

5.2 MC13180 Bluetooth Low Power Wireless Data Transceiver IC

The MC13180 is a single chip, low-IF RF data transceiver intended for Bluetooth applications in the 2.4 GHz ISM band. When combined with the MC71000 Bluetooth Baseband Controller IC, a complete Bluetooth solution can be realized. The device's receiver features a low-noise amplifier, high/low image reject mixer, complete on-chip VCO, post mixer amplifier, self-adjusting channel filter, limiting amplifier, demodulator, and A/D block. The transmitter includes a direct launch VCO controlled by a dual-port, fractional-N synthesizer, LPA (0 dBm), and T/R control function. The device supports 1.0 Mb/sec GFSK data in 1.0 MHz channels. A 3-wire interface allows read/write access to internal functions and a 4-wire, bi-directional port is used for RX and TX data transfer. This device is targeted for exclusive use with the MC71000 Bluetooth Baseband Controller. See Figure 5 for the functional block diagram.

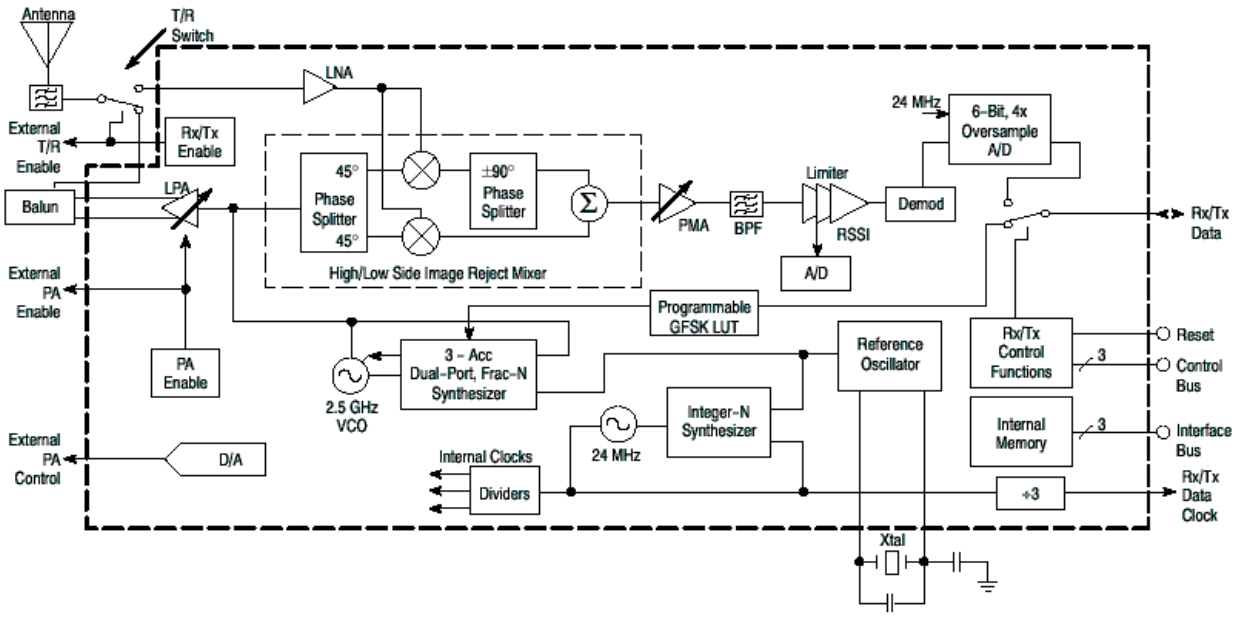


Figure 5. MC13180 Bluetooth Low Power Wireless Data Transceiver IC Functional Block Diagram

5.3 Optional MC13181 Wireless Power Management IC for Headset and Phone Accessory Applications

The MC13181 Wireless Power Management Integrated Circuit (PMIC) is an optional IC designed in conjunction with the Motorola Bluetooth chipset (the MC13180 Bluetooth Low Power Wireless Data Transceiver and MC71000 Bluetooth Baseband Controller). The MC13181 is ideal for devices operating from a 3.6 V single-cell Lithium-ion battery or other energy systems in the 2.7 to 6.5 V range.

The IC features three independently enabled low drop out (LDO) linear voltage regulators for powering baseband, audio, RF/IF, and interface circuitry. A comparator with logic-enabled hysteresis and one scaled input is provided for use as a low-battery detector to protect against excessive battery discharge; it can alternately be used for general system interfacing. A supervisory circuit is integrated to provide a reset signal to the protocol controller indicating valid supply. An over-temperature shutdown function is integrated to protect against excessive power dissipation. A shutdown input line is provided to allow for disabling of all active circuitry to minimize battery loading and to provide single line master disable. Logic inputs accept V_{ih} levels from 1.5 to 7.0 V. See Figure 6 for a detailed block diagram of the MC13181 Wireless Power Management IC.

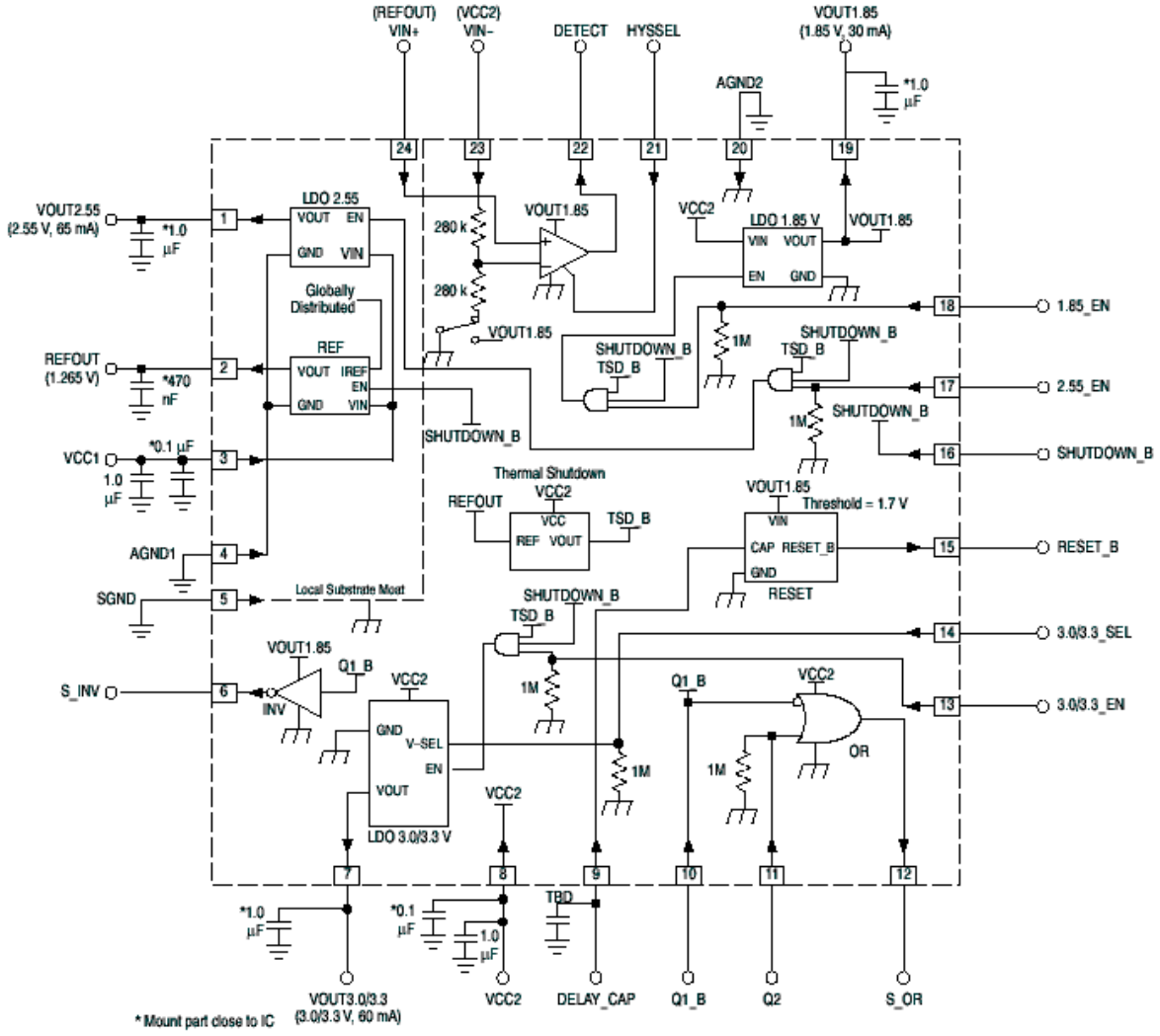


Figure 6. MC13181 Integrated Power Management and Audio Circuit IC Functional Block Diagram

5.4 Optional MRFIC2408 External Power Amplifier IC

The MRFIC2408 is a single chip RF power amplifier intended for Bluetooth Class 1 applications. It is used in conjunction with the MC13180 Low-Power Wireless Data Transceiver IC to implement Bluetooth Class 1 operation and contains power control circuitry. The functional block diagram is shown in Figure 7.

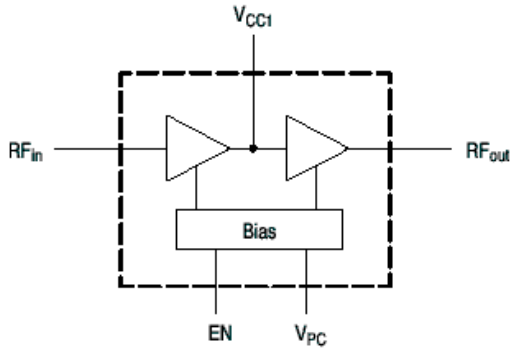


Figure 7. MRFIC2408 External Power Amplifier IC Functional Block Diagram

6 Typical Applications

The following application examples demonstrate a typical design using the Motorola chipset.

6.1 Class 2 Application Example

At the core of all Bluetooth implementations is the baseband and RF transceiver functions that are implemented in the MC71000 and MC13180 products. A low-cost implementation is shown in Figure 8. This implementation assumes the host system downloads all radio initialization information. Optionally, initialization information can be loaded from a SEEPROM attached to the MC71000 IC. The clocks may come from either the host system or be supplied by a dedicated crystal. The solution supports reuse of a wide range of system clocks up to the latest GPRS 26 MHz frequencies. A Class 2 reference schematic is shown on the following page.

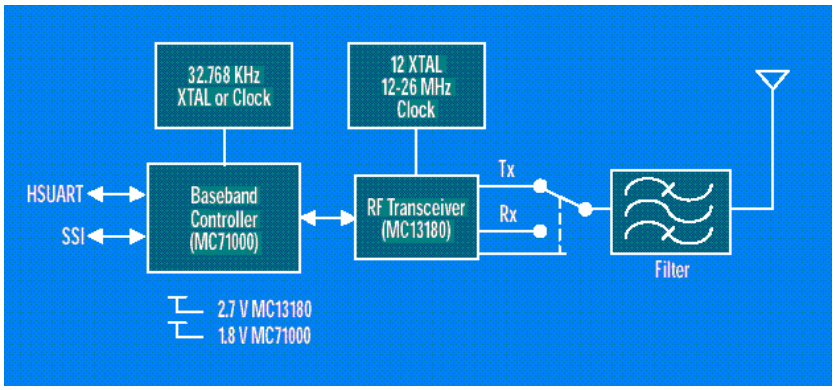
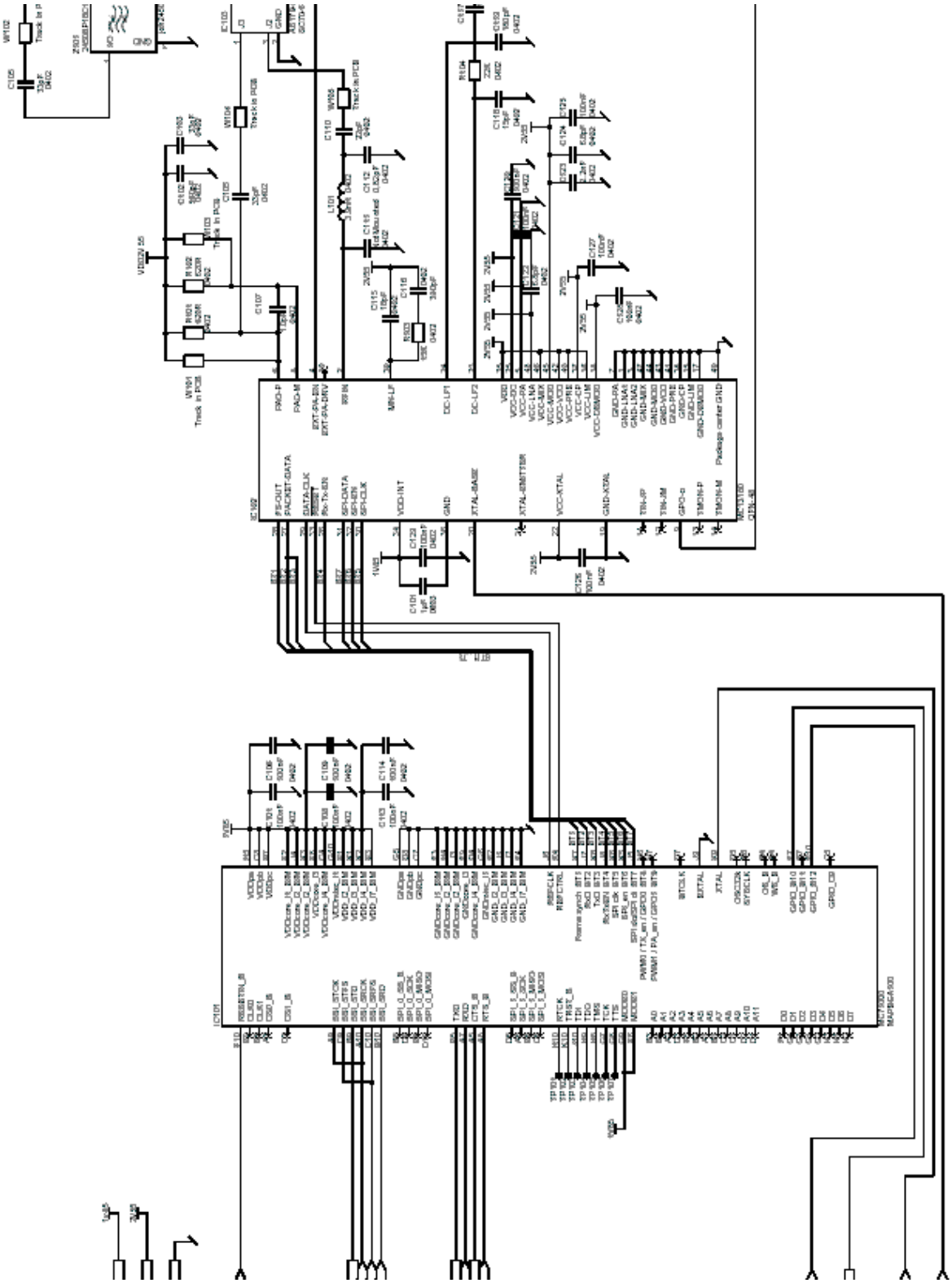


Figure 8. Class 2 Motorola Bluetooth Solution Block Diagram

Class 2 Application Example



6.2 Class 1 Application Example

For greater range and more robust link quality, Motorola offers the MRFIC2408 power amplifier. This device enables a seamless interface to the MC13180 using a common power supply and delivered in a very small package. A typical application is shown in Figure 9.

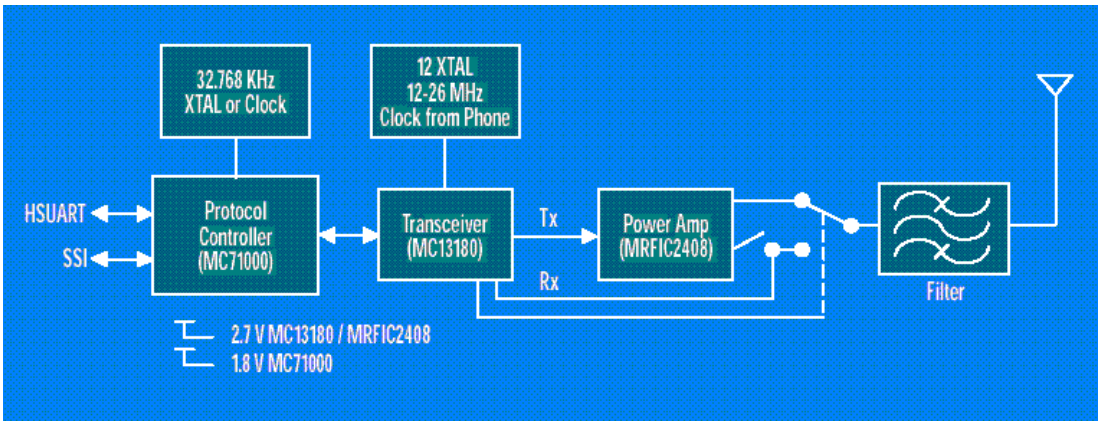


Figure 9. Class 1 Motorola Bluetooth Solution Block Diagram

7 Bluetooth Protocol Stack

The platform solution from Motorola is compatible with popular V1.1 compliant HCI-and-above Bluetooth protocol stacks. The MC71000 implements a Bluetooth V1.1 standard HCI interface. In addition, there is a rich set of extended Motorola-specific HCI commands that provide developers flexibility in how they design and debug the radio. The platform solution gives developers the option to choose from several popular third-party stacks as well as custom stacks.

8 Development Tools

The platform development kit contains everything needed for an engineer to easily and quickly set up and start demonstrating a Class 1 or a Class 2 Bluetooth solution along with interesting applications. In addition, the solution provides a Bluetooth engineer with an efficient reference layout of the MC71000 and MC13180 on a FR4 PCB substrate. The development kit is a turnkey solution that contains all the hardware, application software, software utilities, and documentation to quickly get an engineering team quickly up the Bluetooth learning curve.

The target applications for the development kit are:

- Evaluation of the platform chipset and its features
- Porting of a Bluetooth stack to the platform hardware
- Prototyping of a host device enabled for Bluetooth technology
- Reference design for quick layout of a Bluetooth solution based on the MC71000 and MC13180 chipset

9 Summary

Motorola, via the acquisition of Digianswer, was one of the first companies to ship Bluetooth demo products, V1.0b, and V1.1 Bluetooth products. Motorola's Bluetooth products have achieved governmental certification in over 26 countries around the world. To date, Motorola has qualified over 25 Bluetooth products. This lead has given our engineers numerous cycles-of-learning that have been applied to every component of the Bluetooth Platform Solution from Motorola. Motorola has leveraged this unique experience to develop a platform solution that is comprehensive, robust, meets all of the Bluetooth standard requirements, and has been proven interoperable with a wide variety of other vendor's solutions.

Motorola is one of only nine companies selected as Bluetooth Special Interest Group (SIG) promoters—the highest membership level available. Motorola has dozens of Motorolan's participating in leadership positions in various SIG standards working groups. Motorola will continue to play a major part in the adoption of Bluetooth technology.

Like all winning technologies, Bluetooth development at Motorola will evolve many new features and applications. Motorola engineers have chosen to implement a scalable and flexible architecture with a strong vision of the future of Bluetooth technology. Motorola's solution has performance capacity for future enhancements based on the evolution of the Bluetooth market. There are a variety of improvements under consideration by the Bluetooth SIG. Motorola is a leader in these activities and is working to incorporate these features into future versions of our products.

10 Related Documents

The following documents, available from a Motorola Semiconductor Products Sector sales office, are required for a complete description of the platform's chipset and are necessary to design properly with the platform components:

- *2.4 GHz RF Power Amplifier Technical Brief* (order number MRFIC2408TB/D)
- *Bluetooth Baseband Controller Technical Brief* (order number MC71000TB/D)
- *Development Kit for the Bluetooth Platform Solution from Motorola*
- *2.4 GHz Low Power Wireless Data Transceiver Technical Brief* (order number MC13180TB/D)
- *Wireless Power Management Integrated Circuit Technical Brief* (order number MC13181TB/D)

These documents are available at http://www.motorola.com/semiconductors.

NOTES

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