MSM6050 Chipset Solution Architecture Using QCT's radioOne Zero Intermediate Frequency (ZIF)

Overview

At QUALCOMM CDMA Technologies (QCT), we strive to constantly improve the indispensable communication tools we all use every day. QCT creates state-of-the-art chipsets, system software, development tools and products – such as the Launchpad™ suite of technologies and software – that support the most advanced digital wireless features and functionality available for wireless devices and base stations – while continually reducing complexity, cost and board-space requirements.

The MSM6050™ solution, part of QCT's MSM6xxx™ Mobile Station Modem™ (MSM™) family of chipsets and system software, uses QCT's revolutionary radioOne™ Zero Intermediate Frequency (ZIF), or direct conversion, architecture and supports data rates of up to 153 kbps on the forward and reverse links (FL and RL). The MSM6050 chipset, including the radioOne RF components, reduces the total number of radio components and shortens handset development time for multi-band handsets. These features contribute to reducing overall handset design and manufacturing costs as well as shortening time-to-market.

The MSM6050 chipset solution consists of the MSM6050 baseband processor, direct conversion RFL6000™ and RFR6000™ receive devices, the direct conversion RFT6100™ transmit device, PM6050™ power management device and a compatible power amplifier device. These devices perform all of the signal processing and power management in the subscriber unit.

MSM6050™ CHIPSET SOLUTION

radioOne Technology

radioOne is a revolutionary technology for CDMA transceivers that uses Zero Intermediate Frequency (ZIF), or direct conversion, architecture for the wireless handset market. This direct conversion eliminates the need for large IF Surface Acoustic Wave (SAW) filters and additional IF circuitry, which reduces the handset BOM, resulting in facilitating multi-band and multimode handsets that can be produced in smaller form factors.

Using advanced techniques developed by QCT to enable high-dynamic-range receivers, radioOne solves the problem of stringent interference specifications with which CDMA phones must comply. The radioOne technology also incorporates the frequency synthesis and passive elements used in converting baseband signals to and from RF. A single external local oscillator is used for the CDMA receiver, which will provide the capabilities needed to operate on systems around the world and will simplify the procurement of parts and the cost of designing CDMA handsets.

MSM6050 Device Description

The MSM6050 CDMA2000® 1X solution is optimized to support voice and key data capabilities while enabling CDMA2000 network benefits. It provides a seamless migration path from 2G to 3G services and applications, and the increased voice capacity of a CDMA2000 network. The MSM6050 solution will enable manufacturers to quickly develop handsets meeting specifications for worldwide cdmaOne™ and CDMA2000 1X systems. The MSM6050 device reduces radio bill-of-materials (BOM) costs and improves handset standby and talk times over current solutions. A key enhancement to the MSM6050 chipset over the previous generation is the integration of QCT's gpsOne™ position location technology. With the adoption of location-based services and the FCC E911 mandate for safety applications, the new generation of handsets based on the MSM6050 chipset will be able to provide cost-effective high accuracy position location capabilities.

The MSM6050 chipset integrates functions that support Quad Mode (Tri-Mode + GPS) CDMA/FM handset operation. Subsystems within the MSM6050 baseband processor device include a CDMA processor Digital FM (DFM) processor, QCT's latest generation of DSP, the QDSP4000™ core, for voice coding and applications support, PLL and an ARM7TDMI® microprocessor. Also integrated in the MSM6050 device are analog functions such as a wideband mono codec and analog interfaces for the radioOne RF ASICs. Controllers for a Universal Serial Bus (USB), device controller for a R-UIM (CDMA SIM), GPIOs, and peripheral interfaces complete the system integration. QCT provides a complete software suite, Dual-Mode Subscriber Software™ (DMSS™), for building handsets around the MSM6050 chipset. DMSS software is designed to run on a Subscriber Unit Reference (SURF™) phone platform, an optional development platform optimized to assist in evaluating, testing and debugging DMSS software. The MSM6050 device is offered in a 208-ball Fine-Pitch Ball Grid Array (FBGA) production package.

gpsOne Technology

QUALCOMM is introducing a new generation of its breakthrough gpsOne position location technology in the MSM6050 solution. Re-designed from the original MSM3300™ IS-95A/B solution to provide a more optimized implementation, the gpsOne technology merges Global Positioning System (GPS) satellite and network information to provide a high-availability solution with industry-leading accuracy and performance to a new class of mainstream CDMA2000 1X handsets. This solution not only meets the FCC E911 mandate under the most challenging conditions, but also provides a ubiquitous platform for location-based applications and services. The Mobile Station (MS) collects measurements from the GPS constellation and the cellular/PCS network, then sends the information to the Position Determination Entity (PDE), which optimizes the position location calculation based on existing information. gpsOne technology will enable consumer-priced, position capable CDMA handsets. The block diagram on page 1 illustrates the baseline architecture for the MSM6050 and CDMA/GPS terminal devices.

MSM6050 Chipset Features

- Revolutionary radioOne architecture
- gpsOne position location capabilities
- CDMA2000 1X support, offering data rates of up to 153 kbps on both forward and reverse links
- Tri-Mode (CDMA cellular, CDMA PCS, AMPS cellular)
- Vocoders support (EVRC, 13K QCELP®)

- PureVoice Voice Recognition™ (VR)
- Compact Media Extensions™ (CMX™) multimedia software
- Qtunes™ audio decoder
- Moving Pictures Expert Group (MPEG) Layer-3 (MP3) support
- Standard MIDI ringer
- Universal Serial Bus (USB)
- Removable Universal Identity Module (R-UIM) card interface
- Video Decoder
- Integrated wideband mono voice CODEC
- Enhanced Memory support
  - 1.8 V
  - Page Mode NOR Flash
  - NAND Flash memory interface
  - Pseudo SRAM
- 208-pin FBGA package

IS-2000 1X MC Features Supported by MSM6050 Chipset and Software Solution

- Fast 800 Hz forward power control
- Quasi-Orthogonal functions
- Supplemental channel (SCH) support
- CDMA2000 1X Forward Quick Paging channel (F-QPCH)
- Convolutional and turbo codes on SCH
- ITU 144 kbps requirements achieved
- Radio Link Protocol (RLP3)
- Quick paging channel

MSM6050™ CHIPSET SOLUTION

RFL6000 Device Description

Integrated into the RFL6000 device are two Low Noise Amplifiers (LNA): a Cellular LNA and PCS LNA. Both LNAs utilize three gain settings that are programmable through the Serial Bus Interface (SBI).

Operating modes—Sleep, Rx, and Rx/Tx, as well as LNA bias currents, are all automatically adjusted via software to minimize DC power consumption. Depending on handset status, the LNA bias current adjusts automatically to meet RF performance requirements with minimal power consumption.

The device is fabricated using a SiGe BiCMOS process, which is suited for high-performance RF circuits. The RFL6000 device is packaged in a very small 16-pin bump chip carrier (16-pin BCC++).

RFL6000 Device Features

- radioOne chipset eliminates receiver and transmitter IF, thereby reducing component count, space and cost
- Two integrated LNA with programmable gain steps
  - Cellular LNA supports CDMA and FM modes
    - Operates in cellular bands in China, Japan, Korea, and the United States
    - Three CDMA gain settings
    - Two FM gain settings
  - PCS LNA supports PCS CDMA operation
    - PCS bands of operation in China, Korea, and the United States
    - Three CDMA gain settings
- Programmable mode and bias control to reduce DC power consumption
- High reverse isolation
- Efficient three-line Serial Bus Interface (SBI)
- Low power consumption
- Fabricated in SiGe BiCMOS process
- Small package: 16-pin BCC++ (4 mm x 4 mm)

RFR6000 Device Description
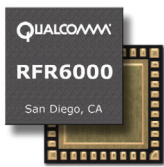
The RFR6000 device is the radioOne zero IF down converter. The device has 3 mixers which, when combined with the RFL6000 device, provide full RF-to-baseband down conversion for the cellular, PCS, and GPS band. The LO generation block produces all LO signals so that only one external single-band VCO is required for all CDMA frequency bands of operation.

Included on the chip is the GPS LNA as well as the entire GPS VCO including resonant components. The Rx PLL, which resides on the transmit companion IC, the RFT6100 device, is switched between the GPS VCO and the external Rx VCO.

Extension of standby time is achieved by selective circuit power down, gain control, and bias current. These features along with all of radioOne chipset functionalities are controlled by QUALCOMM's MSM (Mobile Station Modem).

The device is designed to operate with 2.7 to 3.1 V power supplies and is compatible with single-cell Li-Ion batteries. Compatibility to the lower voltage (1.8 to 3.1 V) is assured when the VDDM is connected to the MSM pad voltage.

The RFR6000 device is fabricated using a SiGe BiCMOS process, which provides high frequency, high-precision analog circuits as well as low-power CMOS functions. Package type is a 40-pin BCC++, which includes a large ground slug for improved grounding, mechanical strength, and thermal conductivity.

RFR6000 Device Features

- Compatibility with QUALCOMM's radioOne Zero IF chipset that eliminates the entire IF, thereby reducing component count and space
- Single- or multi-band operation: Cellular, PCS, GPS
- Single- or multimode operation: Cellular CDMA, PCS CDMA, Cellular FM, and GPS
- Full down conversion – RF to baseband
- Receive path circuitry
  - GPS LNA
  - Stepped gain control
  - Three Quadrature down converter
  - Band-specific low pass filter
  - Baseband amplifiers with DC offset adjustment
- Only one single-band external VCO (Rx VCO) is needed for all CDMA bands of operation for entire radioOne chipset.
- Includes entire on-chip GPS VCO—including resonant circuit
- Individual circuit power on/off controls
- Power reduction feature control and extend handset standby time
- Selective circuit power-down
- Gain and bias controls
- Low-power supply voltage (2.7 to 3.1 V), low-power dissipation
- Compatible with lower MSM voltage (1.8 to 3.0 Vdd)
- Available in small, thermally efficient package (40-pin BCC++)

MSM6050™ CHIPSET SOLUTION

RFT6100 Device Description
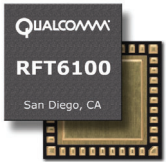
The RFT6100 is a direct conversion IC that integrates all the upconversion and modulation functionality necessary for CDMA and FM mode phones operating in Cellular and PCS bands. This transmit chip consists of I/Q modulators, one for Cellular and the other for the PCS band. The baseband I/Q input from the MSM directly modulates the Cellular or PCS carrier derived from the respective LO generation circuit. Both the Cellular and PCS output drive their own variable gain amplifier (VGA) with a gain control range of 85 dB. A final Cellular driver amplifier provides a modulated RF output. To accommodate split band and filtering, the PCS VGA drives two output amplifiers that can be selected independently or simultaneously via an input selectable switch. All RF outputs have fully integrated 50-ohm matching networks. Integrated on the RFT6100 is the receiver PLL, the transmit PLL, and the entire transmit VCO including resonant components. The VCO drives the LO generation block which in turn generates the required Local Oscillator signal for all CDMA bands of operation.

RFT6100 Device Features

- RadioOne chipset eliminates receiver and transmitter IF, thereby reducing component count, space and cost.

- Single- or dual-band operation: Cellular and PCS.
- Single- or multimode operation:
  – Cellular FM
  – Cellular CDMA
  – PCS CDMA
- Full direct up-conversion from analog baseband to RF.
- Transmit signal path:
  – Baseband amplifier
  – Two-quadrature modulator/up-converter
  – RF AGC amplifier, switch network, driver amplifier
- Integration of LO generation circuit
- Only one external VCO required for all CDMA bands of operation
- Entire transmit synthesizer on chip (Transmitter PLL and VCO)
- Receiver PLL on chip
- Greater than 85 dB transmit power control range
- Power reduction feature via MSM control extends handset talk time
- Optimized for low DC power consumption versus RF output level
- Transmit puncturing
- Selective circuit power down
- Efficient 3-line QUALCOMM Serial Bus Interface (SBI)
- Power supply voltage (2.7 to 3.0 V)
- Available in small thermally efficient package (40 BCCP)

PM6050 Device Description

Additionally, the MSM6050 device also interfaces directly with QCT's new power management chip, the PM6050 device, which provides battery management and charging functions, general housekeeping, and various functions supporting user interfaces. This device is optimized for handset system control with the MSM6050 system software and include generating all the regulated voltages for the MSM and radioOne chipset. The PM6050 offer unparalleled integration of power management functions for CDMA terminals, affording further savings in size and BOM for the handset design. The PM6050 chip supports many additional handset features, such as real-time clock and speakerphone applications, making it the ideal power management solution for feature-rich terminals.

PM6050 Features

- Complete power management, housekeeping, and user interface functions for CDMA handsets, modems, PC cards, PDAs, etc.
- Fully compatible with QUALCOMM's radioOne Zero-IF chipset
- Valid external supply attachment and removal detection
- Supports unregulated and regulated charging systems
- Supports lithium-ion and nickel-based main batteries
- Trickle, constant current, constant voltage, and pulsed charging of the main battery
- Supports coin cell back-up battery (including charging)
- Current monitoring for overcurrent protection
- Voltage and current control loops to support unregulated external supplies

- Automated recovery from Sudden Momentary Power Loss (SMPL)
- Eight low dropout regulator circuits with programmable output voltages
- Seven of eight regulators can be individually enabled/disabled for power savings
- 10-bit ADC for precise voltage and current measurements
- 10:1 analog multiplexer selects the ADC input signal (five wired internally, five accessible)
- Dual oscillators – 32.768 kHz off-chip crystal and onchip RC assures MSM sleep clock
- Real-Time Clock for tracking time, calendar functions, and programmed durations and generating associated alarms
- On-chip adjustments minimize crystal oscillator frequency errors
- TCXO circuits control TCXO warm-up, and synchronize and buffer the TCXO signal
- Four programmable current sinks for driving backlights and LEDs
- Driver circuit compatible with 1.3 or 3.0 V vibrator motors
- Ringer/buzzer driver
- Speaker driver with programmable gain, turn-on time, and muting; single-ended or differential operation (drives external 8-ohm speakers with volume controlled 500 mW)
- MSM-compatible three-line serial bus interface for efficient initialization, status, and control
- 13 functions monitored and reported through real-time and interrupt status signals
- Dedicated circuits for controlled power-on sequencing, including the MSM's reset signal
- Supports and orchestrates soft resets

MSM6050™ CHIPSET SOLUTION

QUALCOMM's Complete Solution — Our Commitment to our Partners

QUALCOMM CDMA Technologies is enabling the future of communications. We work closely with our manufacturer and operator partners to develop solutions that meet market needs today and provide the technology foundation for the wireless communications of tomorrow. Our world-class CDMA engineers create detailed reference designs to accelerate testing and deployment for our partners. And our chipsets and system software are fully integrated and able to bring advanced features and functionality to today's wireless devices. With QUALCOMM CDMA Technologies, manufacturers and operators can offer sophisticated wireless solutions that succeed in the global marketplace.