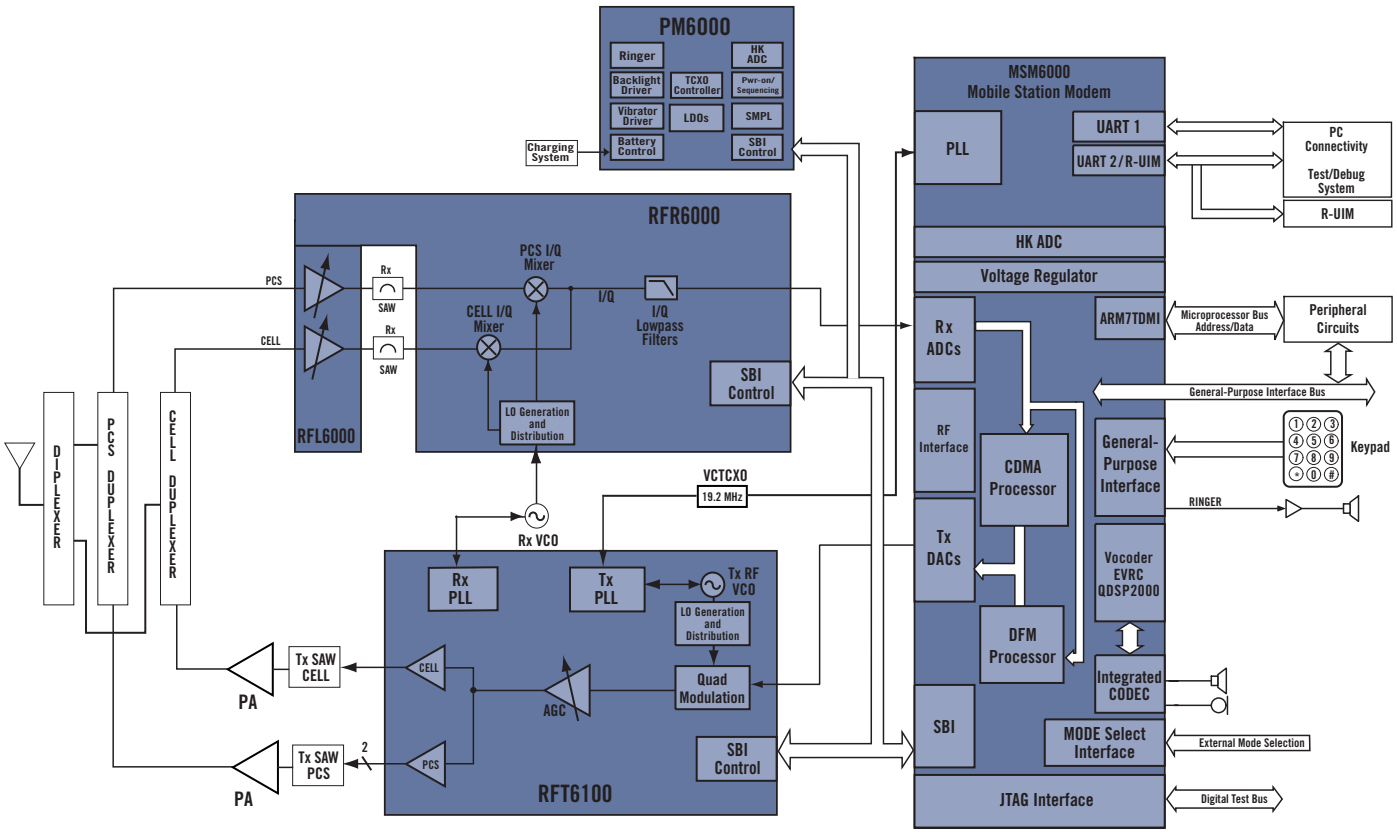

MSM6000 Chipset Architecture Using QCT's radiOne Zero Intermediate Frequency (ZIF)

Overview

At QUALCOMM CDMA Technologies (QCT), we strive to constantly improve the indispensable communication tools we 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 MSM6000™ 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 Revision 0 of the CDMA2000® 1X standard. The MSM6000 chipset, including the radioOne RF components, reduces the total number of radio components by half, shortens handset development and test times and enables higher handset production yields. These features contribute to reducing overall handset design and manufacturing costs, as well as shortening time-to-market.

The MSM6000 chipset solution consists of the MSM6000 baseband processor and radio frequency (RF) solutions to support multiple configuration, including the direct conversion RFL6000™, RFR6000™ and RFR6120™ receive devices and direct conversion RFT6100™ and RFT6120™ transmit devices, as well as PM6050™ and PM6000™ power management devices, and a compatible power amplifier device. These devices, perform all of the signal processing and power management in the subscriber unit.

MSM6000™ CHIPSET SOLUTION

MSM6000 Chipset Solution Benefits

- Supports voice and basic data while enabling CDMA2000 1X network benefits
- Offers backward compatibility with IS-95A/B
- Provides a fully integrated solution that reduces board space requirements, resulting in tremendous savings in bill-of-materials (BOM) costs
- Allows personal information and data features to be transferred to new devices without additional programming

MSM6000 Device Description

The MSM6000 CDMA2000 1X solution is fully backward compatible with IS-95A/B and is optimized to support voice and basic data capabilities. While providing CDMA2000 network benefits, it enables a seamless migration path to 3G services and applications, and improved voice capacity in the CDMA2000 network.

An entry-priced solution, the MSM6000 device reduces bill-of-materials (BOM) costs and improves handset standby and talk times.

The MSM6000 device interfaces directly with QCT's new radioOne RF ASICs. Subsystems within the MSM6000 device include a CDMA processor, a DFM processor, QCT's QDSP2000™ digital signal processor (DSP) for voice coding, PLL and an ARM7TDMI® microprocessor. Also integrated in the MSM6000 device are an audio voice codec and analog interfaces for the radioOne RF ASICs. Controllers for an R-UIM (CDMA SIM), GPIOs and peripheral interfaces complete the system integration.

The MSM6000 solution supports two-way short messaging service (SMS) data rates of up to 14.4 kbps and, it is compliant with CDMA2000 Revision 0, which addresses key attributes of network voice capacity improvements and significantly extended handset standby times. The MSM6000 device is offered in a 208-ball fine pitch ball grid array (FBGA) production.

QCT provides a complete software suite, Dual-Mode Subscriber Software™ (DMSS™), for building handsets around the MSM6000 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.

Additionally, the MSM6000 solution supports QUALCOMM's BREW® application programming interface (API) development platform.

MSM6000 Device Features

- QUALCOMM radioOne interface
- CDMA2000 1X Revision 0, IS-95A/B CDMA air interfaces
- Tri-mode
- 2-way short message service (SMS)
- Embedded QDSP2000 digital signal processor core
- EVRC Vocoder
- Supports peak rates of 14.4 kbps data in forward and reverse links simultaneously
- 3.0 V memory interface
- R-UIM (CDMA SIM) interface
- Integrated narrowband mono voice codec
- 208-pin FBGA package

radioOne Technology

As with all members of the MSM6xxx family of chipset solutions, the MSM6000 solution features QUALCOMM's radioOne Zero Intermediate Frequency (ZIF) architecture, which eliminates the need for Intermediate Frequency (IF) components. With radioOne technology, the MSM6000 chipset requires less printed-circuit-board area than previous generations and reduces time-to-market development and BOM costs.

RFL6000 Device Description

Integrated into the RFL6000 device are two low noise amplifiers (LNAs): a cellular LNA and PCS LNA. 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, reducing component count, space and cost
- Two integrated LNAs with programmable gain steps
  - Cellular LNA supports CDMA
  - Operates in cellular bands in China, Japan, Korea and the United States
  - Individual gain setting for CDMA and FM modes
  - PCS LNA supports PCS CDMA operation
  - PCS bands of operation in China, Korea and the United States
- Programmable mode control to reduce DC power consumption
- High-reverse isolation
- Efficient three-line QCT 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 ZIF down converter. The device has three mixers which, when combined with the RFL6000 device, provides full RF-to-baseband down conversion for the cellular, PCS and GPS bands. The local oscillator (LO) generation block produces all LO signals, so that only one external single-band voltage control oscillator (VCO) is required for all CDMA frequency bands of operation.

Included on 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 transmit 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 device.

The device is designed to operate with 2.7 to 3.0 V power supplies and is compatible with single-cell Li-Ion batteries. Compatibility to the digital reference voltage (1.8 to 3.0 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 ZIF chipset that eliminates the entire IF, reducing component count and space
- Single- or multiband operation: cellular, PCS and GPS
- Single- or multimode operation: cellular CDMA, PCS CDMA, cellular FM and GPS
- Full downconversion — RF to baseband
- Receive path circuitry
  - GPS LNA
  - Stepped gain control
  - Three sets of quadrature downconverters
  - 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 extends handset standby time
  - Selective circuit power-down
  - Gain and bias controls
- Low-power supply voltage (2.7 to 3.0 V), low-power dissipation
  - Digital reference voltage is compatible with lower MSM voltage (1.8 to 3.0 Vdd)
- Available in small, thermally efficient package (40-pin BCC++)

MSM6000™ CHIPSET SOLUTION

RFT6100 Device Description

The RFT6100 device is a direct conversion chipset that integrates all the upconversion and modulation functionality necessary for AMPS- and CDMA-mode phones operating in cellular and PCS bands. This transmit chip consists of two I/Q modulators, one for cellular and one 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 phase locked loop (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

- Reduction in component count, space and cost via radioOne chipset eliminates receiver and transmitter IF
- Single- or dual-band operation: cellular and PCS
- Single- or multimode operation: cellular CDMA and PCS CDMA
- Full direct upconversion from analog baseband to RF
- Transmit signal path:
  - Baseband amplifier
  - Two sets of quadrature modulators/upconverters
  - RF AGC amplifier, switch network, driver amplifier
- Integration of LO generation circuit
- Requirement of only one external VCO 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 three-line QCT SBI
- Power supply voltage (2.7 to 3.0 V)
- Small, thermally efficient package (40-pin BCC++)

RFR6120 Device Description

The RFR6120 chip, optimized specifically for single-band cellular receive operation, includes an integrated CDMA LNA/mixer and UHF VCO. The integrated UHF VCO covers both cellular and J-CDMA bands, and is controlled by the Rx PLL integrated in the RFT6120 chip. The RFR6120 is offered in a 6 mm x 6 mm 40-pin Quad Flat No-Lead (QFN40) package.

RFR6120 Device Features

- Compatibility with all CDMA2000 1X members of the QUALCOMM MSM6xxx family of chipsets
- Full direct downconversion — RF to baseband
- Supports full international cellular band operation such as for Japan, China, India, Latin America, Korea and the United States
  - Supports CDMA and AMPS modes
- Receive path circuitry includes:
  - High dynamic range baseband filter
  - Cellular LNA and mixer
  - On-chip UHF VCO
- Integrated LNA with programmable gain steps
  - Two LNA AMPS gain settings
  - High-reverse isolation
- Individual circuit power on/off controls
- Power reduction feature control extends handset standby time
  - Selective circuit power-down
  - Gain and bias controls
- QUALCOMM's efficient three-line SBI
- Low-power supply voltage (2.7 to 3.0 V)
- Compatible with lower MSM voltage (1.8 to 3.0 Vdd)
- Available in small, thermally efficient package (QFN40)

RFT6120 Device Description

The RFT6120 chip, tailored specifically for single-band cellular transmit operation, consumes lower current than its quad-mode predecessor, the RFT6100 device, and is offered in a 5 mm x 5 mm 32-pin Quad Flat No-Lead (QFN32) package.

RFT6120 Device Features

- Compatibility with all CDMA2000 1X members of the QUALCOMM MSM6xxx family of chipsets
- Full direct upconversion — baseband to RF
- Supports full international cellular band operation such as for Japan, China, India, Latin America and the United States
- Supports full international CDMA2000 1X cellular band*
- Transmit path circuitry includes:
  - Baseband amplifier
  - One set of quadrature modulators/upconverters
  - RF AGC amplifier
  - Driver amplifer with on-chip RF matching
- Integration of LO generation circuit
- Entire transmit synthesizer on chip (transmitter PLL and VCO)
- On-chip receiver PLL to control UHF VCO
- 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
- QUALCOMM's efficient three-line SBI
- Low-power supply voltage (2.7 to 3.0 V)
- Available in small, thermally efficient package (QFN32)

MSM6000™ CHIPSET SOLUTION

PM6050 Device Description

The MSM6000 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 MSM6000 system software and generates all the regulated voltages for the MSM and radioOne chipset. The PM6050 device offers 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 terminals
- Fully compatible with QUALCOMM's radioOne ZIF 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 on chip RC assures MSM sleep clock
- Real-time clock for tracking time, calendar functions, programmed durations, and for 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 SBI 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

PM6000 Device Description

The MSM6000 device interfaces directly with QCT's PM6000 power management chip, which provides battery management and charging functions, general housekeeping and various functions supporting user interfaces. The PM6000 device is optimized for handset system control with the MSM6000 system software and generates all the regulated voltages for the MSM and radioOne chipset.

The PM6000 device integrates 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. The PM6000 chip contains all of the primary power management functions, making it ideal for more basic terminals.

PM6000 Features

- Complete power management, housekeeping and user interface functions for CDMA terminals
- Fully compatible with QUALCOMM's radioOne ZIF 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
- Current monitoring for over-current protection
- Voltage and current control loops to support unregulated external supplies
- Automated recovery from sudden momentary power loss
- Seven low-dropout regulator circuits with programmable output voltages
- Six of seven 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 on-chip RC assures MSM sleep clock
- TCXO circuits control TCXO warm-up, and synchronize and buffer the TCXO signal
- Two programmable current sinks for driving backlights and LEDs
- Driver circuit compatible with 1.3 or 3.0 V vibrator motors
- Ringer/buzzer driver
- MSM-compatible three-line SBI for efficient initialization, status and control
- Ten 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

The Launchpad Suite of Technologies

The Launchpad suite of applications technologies offers wireless operators and manufacturers a cost-effective, scalable and timely solution for providing advanced wireless data services. This seamlessly integrated solution enables advanced next-generation applications and services that incorporate multimedia, position location, connectivity, customized user interface and storage capabilities. Launchpad features are available for each QUALCOMM chipset, closely matching the specific functionality and cost-target objectives agreed upon in joint product planning with manufacturers and wireless service operators worldwide.

QUALCOMM's BREW Solution

The MSM6000 includes support for QUALCOMM's BREW solution. BREW is a complete product and business system for the development and over-the-air deployment of data services on wireless devices. The BREW solution provides the necessary tools and value-added services to developers, device manufacturers and wireless operators for application development and distribution, device configuration, and billing and payment.

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.

* For CDMA with AMPS requirement RFT6100 is recommended.

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