

MSM6000 Chipset 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 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 Release 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, direct conversion RFL6000 and RFR6000 receive devices,

direct conversion RFT6100 transmit device, PM6000 power management device and a compatible power amplifier device. These devices perform all of the signal processing and power management in the subscriber unit.

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, facilitating multiband 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. 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 greatly reduce the cost of designing CDMA handsets.

MSM6000™ CHIPSET SOLUTION

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 radio bill-of-materials (BOM) costs and improves handset standby and talk times over current solutions.

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™ 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) and data rates of up to 14.4 kilobits per second (kbps), and is compliant with IS-2000 Release 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 Binary Run-time Environment for Wireless™ (BREW™) applications development platform.

MSM6000 Device Features

- radioOne interface
- CDMA2000 1X Release 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
- 3.0V memory interface
- R-UIM (CDMA SIM) interface
- Integrated narrowband mono voice CODEC
- 208 FBGA package

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 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-3.1volt power supplies and is compatible with single-cell Li-Ion batteries. Compatibility to the lower voltage (1.8 to 3.1 volts) is assured when the VDDM is connected to the MSM pad voltage.

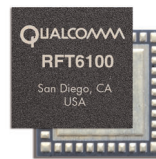
The RFR6000 device is fabricated using a SiGe BiCMOS process, which provide high frequency, high-precision analog circuits as well as low-power CMOS functions. Package type is a 40-pin BCC++, which includes a large ground slug for improved grounding, mechanical strength, and thermal conductivity.

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 downconversion – RF to baseband
- Receive path circuitry
 - GPS LNA
 - Stepped gain control
 - Three Quadrature downconverter
 - Band-specific lowpass 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-Volts), low-power dissipation
 - Compatible with lower MSM voltage (1.8-to-3.0 Vdd)
- Available in small, thermally efficient package (40-pin BCC++)

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, cost
- Single or dual band operation: Cellular and PCS
- Single or multimode operation:
 - Cellular FM
 - Cellular CDMA
 - PCS CDMA
- Full direct upconversion 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 3.00 volts)
- Available in small thermally efficient package (40 BCCP)

PM6000 Device Description



The MSM6000 device also interfaces directly with QCT's new power management chip, the PM6000 device, which provides battery management and charging functions, general housekeeping, and various functions supporting user interfaces. Both devices are optimized for handset system control

with the MSM6000 system software, and include generating all the regulated voltages for the MSM and radioOne chipset.

The PM6000 device 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. 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 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
- 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 serial bus interface 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

QCT's Commitment to Customer Support

As with all QCT products, the MSM6000 solution features the unparalleled customer support you have come to expect from your partner of choice for complete wireless communications solutions. QCT is committed to providing innovative multi mode, multi-network chipsets, system software and development tools that will help ensure your competitive success in the wireless communications marketplace for 3G and beyond.

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