Lecture #11

10/17/2016

Last Class

- Near-Far Problem
- Convolutional Codes

Today

- Decoding Convolutional Codes
- Phone Teardowns
- 3G, 4g and Beyond

Next Class

Announcements

- Homework Due Friday
- Exam #1 Monday

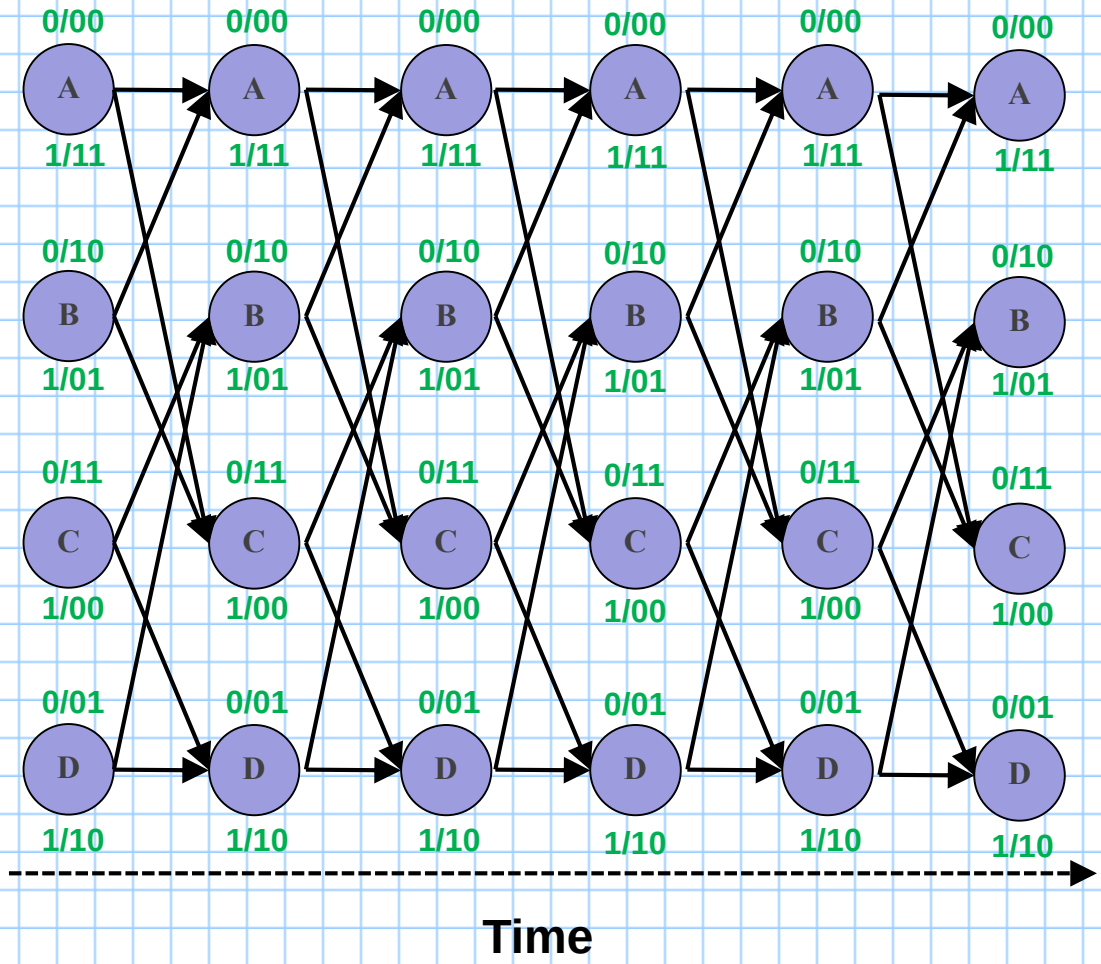
Convolutional Code Decoding (Trellis View)

We can now think about what the decoder needs to do in terms a trellis

Viterbi convolutional decoders find the maximum likelihood path through the Trellis

The Hamming distance between received and expected values can be used as a metric to evaluate paths

EX: After transmission through a noisy channel, the received encoded sequence is 11 10 11 00 01 10 (Bit Errors Highlighted)



CDMA / IS-95 Summary

To make CDMA work in real settings requires a lot more functionality!

We assumed synchronicity, what happens if mobiles begin transmissions at different times?

How should the best transmit power-level be determined and how often should it be adjusted?

What code rate/length should be used to maximize data rate while minimizing bit-error rate (BER)?

The benefits of CDMA outweigh the implementation woes, making it the technology of choice for 3G and beyond

Greatly improves capacity

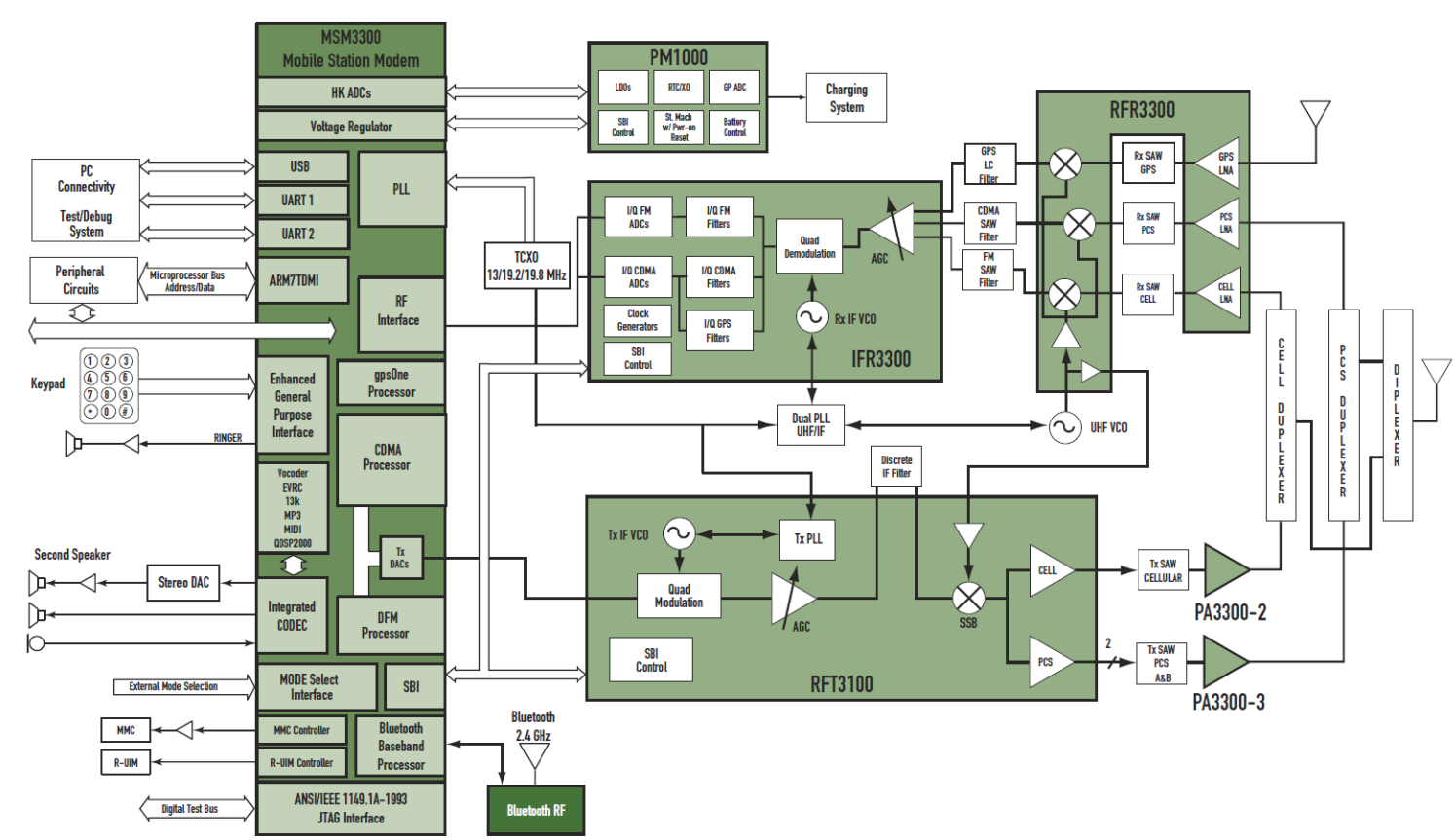
Able to take advantage of cell phone “silent time”, further increasing the number of simultaneous calls possible

Universal frequency reuse, eliminates frequency planning

Facilitates soft handoffs (eliminating hard handoffs)

2G CDMA Phone Teardown

2G CDMA Phone Teardown



QUALCOMMS' CDMA Mobile Device Architecture

2G CDMA Phone Teardown

QUALCOMM CDMA TECHNOLOGIES

RFR3300™

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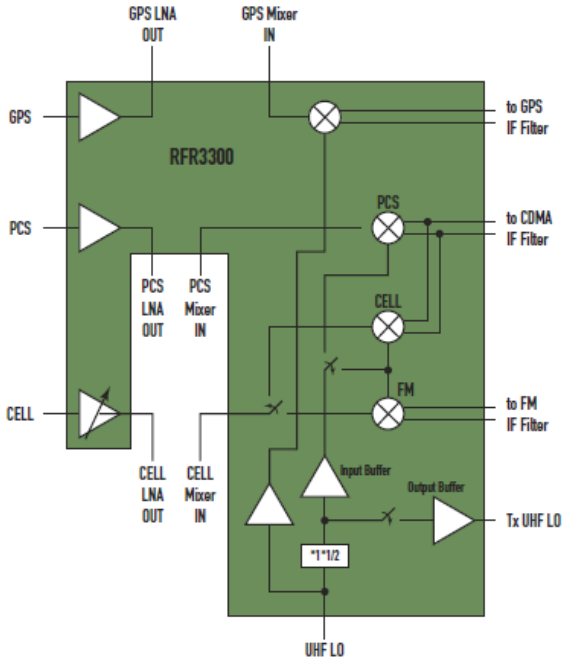
OVERVIEW

The RFR3300 device, successor to the RFR3100™ chip, integrates dual-band Low Noise Amplifiers (LNAs) and mixers for downconverting from RF to CDMA and FM IF, and contains a dedicated LNA and mixer designed for downconverting Global Positioning System (GPS) signals from RF to IF. The RFR3300 receiver operates in the 832 MHz-894 MHz cellular band, 1840 MHz-1990 MHz PCS band and 1575 MHz GPS band. The RFR3300 device meets cascaded Noise Figure (NF) and Third-Order Intercept Point (IIP3) requirements of IS-98 and JSTD-018 for sensitivity and two-tone intermodulation. Together with QUALCOMM's MSM3300™ Mobile Station Modem (MSM™) chipset and IFR3300™ baseband receiver, the RFR3300 device offers the most cost-effective and high-performance solution for CDMA dual-band or tri-mode phones with gpsOne™ capability.

The cellular LNA in the RFR3300 device offers gain control capability for improving dynamic range and performance in the presence of high levels of interference. Reducing the gain in the LNA also improves power consumption. Band selection and gain modes as well as enhanced features, including selective power-down modes which permit optimized power savings and extended stand-by time performance, are controlled directly from the MSM3300 device and system software.

The RFR3300 device is fabricated on an advanced silicon germanium BiCMOS process, which facilitates low-noise, low-power, high frequency analog circuits. The RFR3300 device is designed for voltage ranges from 2.7 V to 3.15 V and is available in a low profile 5 millimeter by 5 millimeter 32-pin BCC++ plastic package.

Figure 1. RFR3300 Functional Block Diagram



RFR3300 DEVICE FEATURES

- Performs downconversions from RF to IF
- Applications
  - CDMA: PCS and cellular
  - FM
  - GPS
- Designed to comply with NF and IIP3 requirements for IS-98 and JSTD-018
- Cellular LNA features three gain modes to provide improved dynamic range and performance in the presence of high level interferers
- Selective power-down modes for extended standby-time performance
- UHF LO divide by 2 circuit for flexible frequency planning
- Compatible with IFR3000™ or IFR3300 devices for IF-to-baseband processing
- Supply voltage from 2.7 V to 3.15 V
- 32-pin BCC++ plastic package (5 mm x 5mm x 0.8 mm)
- SiGe BiCMOS process

RFR3300 INTERFACES

The RFR3300 device interfaces with QUALCOMM's MSM3300 Mobile Station Modem device. The combination of MSM3300, RFR3300, IFR3300, RFT3100™, PA3100™ and PM1000™ devices form the core of the portable CDMA/FM subscriber unit.

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IFR3300™

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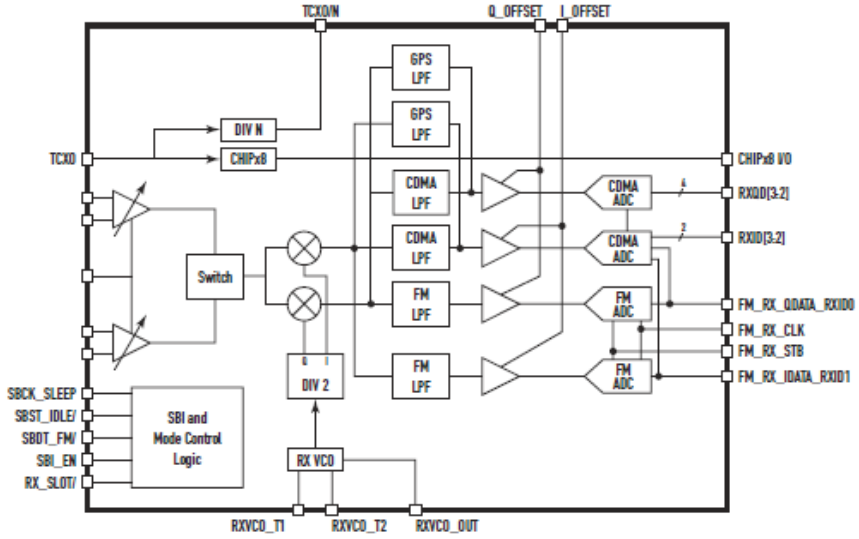
Figure 1. IFR3300 Processor Functional Block Diagram



OVERVIEW

The QUALCOMM IFR3300 Rx IF-to-baseband processor offers significant advantages in size, cost and power. It integrates the Automatic Gain Controls (AGCs), I/Q demodulators, low-pass filters and Analog-to-Digital Converters (ADCs) into a single Application-Specific Integrated Circuit (ASIC). It performs the same IF-to-baseband processing as the IFR3000™ processor, but adds GPS capability. The integrated GPS functionality provides the most cost-effective GPS and IS-95B IF receiver solution. The IFR3300 processor is offered in a 48-pin BCC+ package.

The IFR3300 Rx IF-to-baseband processor is designed for use in dual-mode CDMA and FM portable cellular phones or single-mode plus gpsOne™ enabled phones. It interfaces at RF with the RFR3100™ or RFR3300™ Rx front-end and at baseband with the MSM3300™ Mobile Station Modem (MSM™) device.

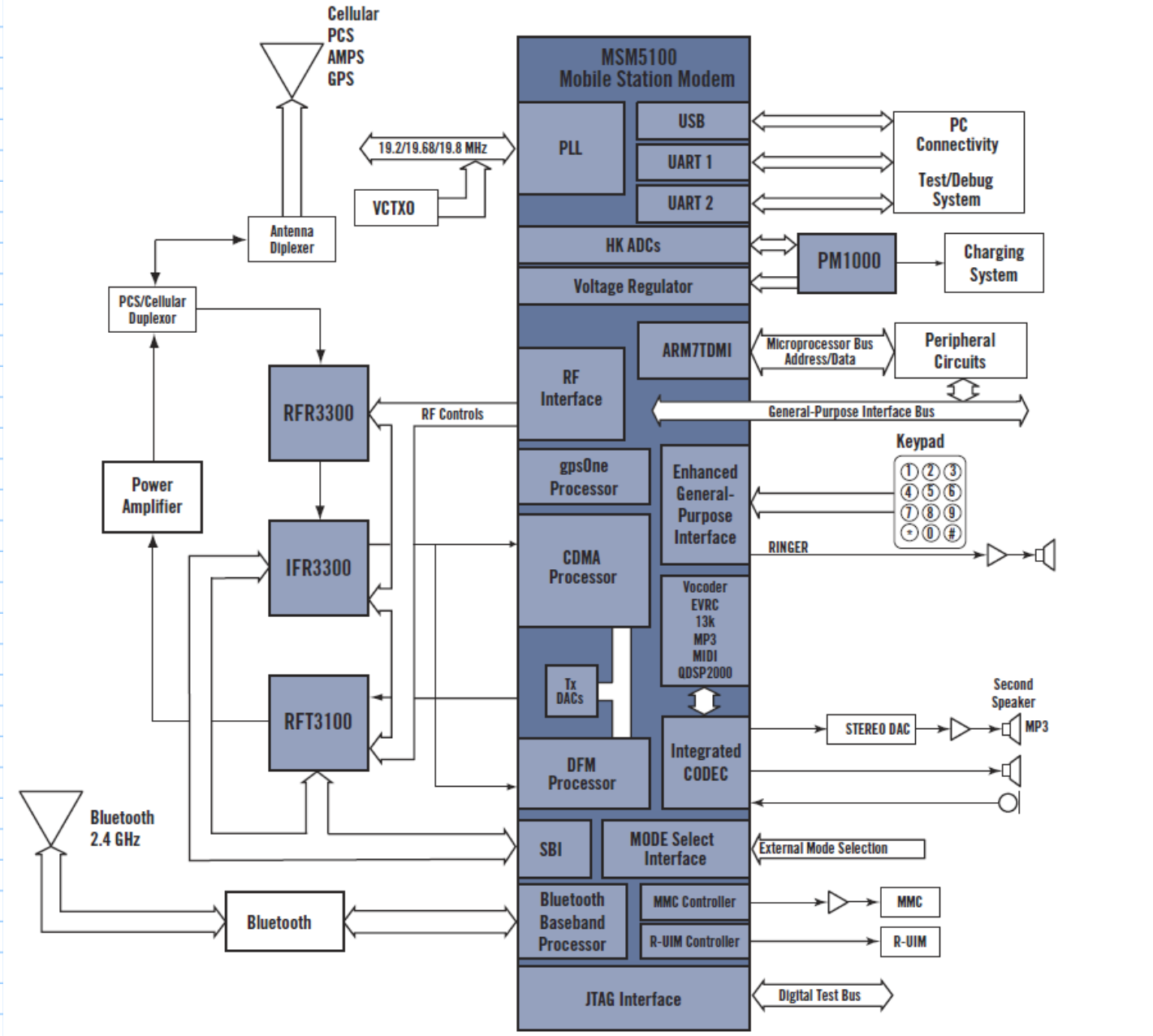
SMALLER PACKAGING

Even with the added capability of GPS, the IFR3300 device maintains the package size and pin compatibility with the IFR3000™ device. The result is a more economical solution for performing CDMA, FM and GPS IF-to-baseband processing.

IFR3300 FEATURES

- Supports IS-98 (CDMA) and IS-19 (AMPS) standards for dual-mode operation
- 2.7 V to 3.15 V supply voltage
- Low current: 26 / 21 mA in CDMA Rx / FM Rx modes
- Rx power control through 90 dB dynamic range AGC amplifier
- IF mixer for down-converting IF to analog baseband for CDMA, FM and GPS
- Low-pass filtering for CDMA, FM and GPS I- and Q-component baseband signal demodulation
- 4-bit ADCs convert CDMA or GPS I and Q analog baseband components to digital baseband
- 8-bit ADCs convert FM I and Q analog baseband to digital baseband
- Clock generators for CDMA/AMPS/GPS operation
- VCO for generation of Rx LO mixing signal
- I- and Q-channel DC offset control inputs drive baseband DC voltage offset to zero in CDMA, FM and GPS signal paths
- CDMA and FM mode compatible with the MSM3000 and MSM3100 devices
- GPS mode select through 3-line serial bus interface (SBI) from the MSM3300 device
  - Slotted FM mode
  - Selective power-down
  - Mode selection
- Pin compatible with IFR3000 processor
- 48-pin BCC+ package

2G CDMA Phone Teardown



2G CDMA Phone Teardown

RFT3100™

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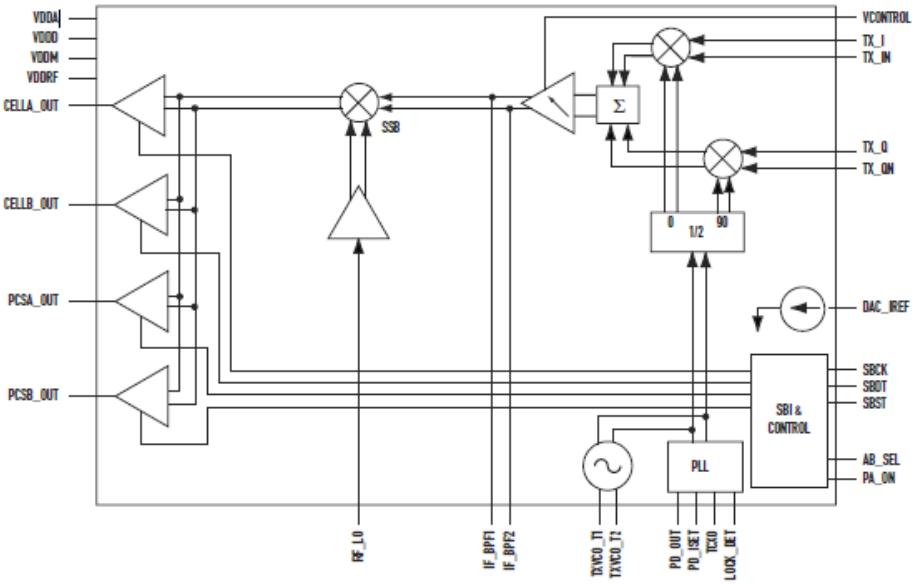
RFT3100™ QUALCOMM CDMA TECHNOLOGIES

Figure 1. RFT3100 Processor Functional Block Diagram



RFT3100 OVERVIEW

The RFT3100™ Baseband-to-Radio Frequency (RF) Transmit Processor performs all transmit (Tx) signal processing functions required between the analog baseband and the Power Amplifier (PA) for IS-95 Code Division Multiple Access (CDMA) cellular, JSTD-018 PCS, and ARIB-53 (Japan) single-band and dual-band applications. The RFT3100 device incorporates the previous-generation functionality of the IFT3000™ Baseband-to-Intermediate Frequency (IF) Processor together with RF upconversion and driver amplifiers. In addition to offering the most advanced and integrated CDMA Tx solution available, providing a board area savings of more than 65 percent over previous generation chipsets, the RFT3100 device minimizes power consumption for extended talk-time performance.

The RFT3100 device is available in three configurations: dual-band cellular and PCS (RFT3100-1), cellular-only (RFT3100-2), and PCS-only (RFT3100-3).

Utilizing an analog baseband interface, the RFT3100 device connects directly to QUALCOMM's MSM3100™ and MSM3300™ chipsets. The baseband quadrature signals are upconverted to the cellular or PCS frequency bands and amplified to provide signal drive capability to the PA. The RFT3100 device includes an IF mixer for upconverting analog baseband to IF, a programmable Phase Locked Loop (PLL) for generating Tx IF frequency, single-sideband upconversion from IF to RF, two cellular and two PCS driver amplifiers (dual-band version), and Tx power control through an 85 dB variable gain amplifier (VGA). The single-sideband upconversion also eliminates the need for a bandpass filter normally required between the upconverter and driver amplifier, providing overall board area and cost savings. RFT3100 functionality is specifically controlled from the MSM device via the three-line serial bus interface (SBI).

Designed to meet the requirements for global CDMA markets, the RFT3100 device will operate over the following Tx frequency ranges:

Cellular band
824 MHz - 925 MHz
PCS band
1750 MHz - 1910 MHz

The range of supply voltage for the RFT3100 device is from 2.7 V to 3.3 V, which provides operating compatibility for platforms utilizing a single-cell Li-Ion battery design. RFT3100 operating modes are controlled by the MSM and include selective power-down, gain control, and punctured CDMA transmission (gated Tx power) for optimal power savings and talk-time improvement.

The RFT3100 device is fabricated on an advanced BiCMOS process, which accommodates both precision high-frequency analog circuits and low-power CMOS functions, and is available in a 32-pad BCC++ plastic package.

2G CDMA Phone Teardown

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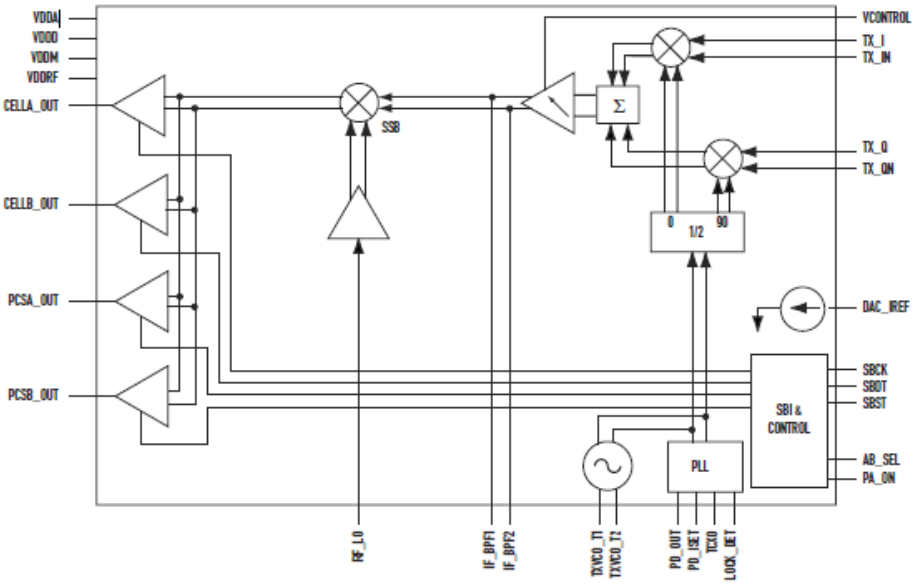

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EPCOS COMPONENTS
YOUR DIRECT LINK TO EPCOS
Direct Link 0929

SAW-Komponente

Oktober 2004

Je kleiner, desto feiner

PROFILE | DUPLEXERS

EPCOS ist Weltmarktführer bei OFW-Komponenten. Bei Duplexern für Mob
wendungen bietet EPCOS derzeit die weltweit kleinsten Bauelemente mit A
gen von nur 3,0 × 2,5 × 0,6 mm³

Duplexer sind Schlüsselbauelemente der meisten Mob

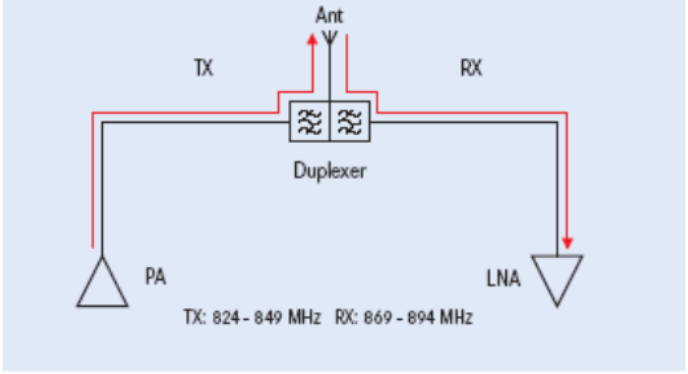
mechanischen Uhr auch dann zu hören, wenn ein Düsenflugzeug direkt über il

Der Duplexer sitzt schaltungstechnisch direkt hinter der Antenne. Er führt die S
Noise-Amplifier (LNA) des Mobiltelefons zu und unterdrückt dabei alle Frequer
Gleichzeitig verbindet er den Ausgang des Leistungsverstärkers (PA) des Mob

In → 1 ist die Verschaltung eines Duplexers zwischen Antenne, PA und LNA s
Darstellung ersichtlich wird, erfüllt der Duplexer folgende Hauptaufgaben:

- In der Sendeeinheit des Mobiltelefons transportiert er die Sendesignale mit
  Leistungsverstärker (PA) zur Antenne.
- In der Empfangseinheit des Mobiltelefons überträgt er die Empfangssignale
  Verlusten von der Antenne zum Kleinsignalverstärker (LNA).
- Gleichzeitig schützt er den empfindlichen LNA vor den relativ hohen Spann
- Außerdem verhindert er, dass das Breitbandrauschen des PA den Empfan

1 Verschaltung eines Duplexers



1 Anwendung eines Duplexers beispielhaft dargestellt für ein CDMA-System, das im Cellular-Band operiert.

Die technische Realisierung der Duplexing-Funktion erfolgt, indem zwei Bandp
werden. Das TX-Filter ist auf das Sendeband abgestimmt; das RX-Filter auf da
und dem TX-Filter befindet sich der Antennenanschluss und eine λ/4-Leitung,
der Sendesignale ermöglicht → 2. Gegenwärtig verlangen verschiedene Syste
Simultanbetrieb. In → 3. sind die momentan wichtigsten Systeme und Frequen

3G Cellular

Goal of 3G: Digtal Voice and DATA!

Advancement of technology allows for integration of more sophisticated digital techinques

ITU started planning for 3G in 1992 with goals

Roadmap for 3G was called IMT-2000

2000→ Year to be deployed
2000→ Frequency band (MHz)
2000→ Data bandwidth (kbps)

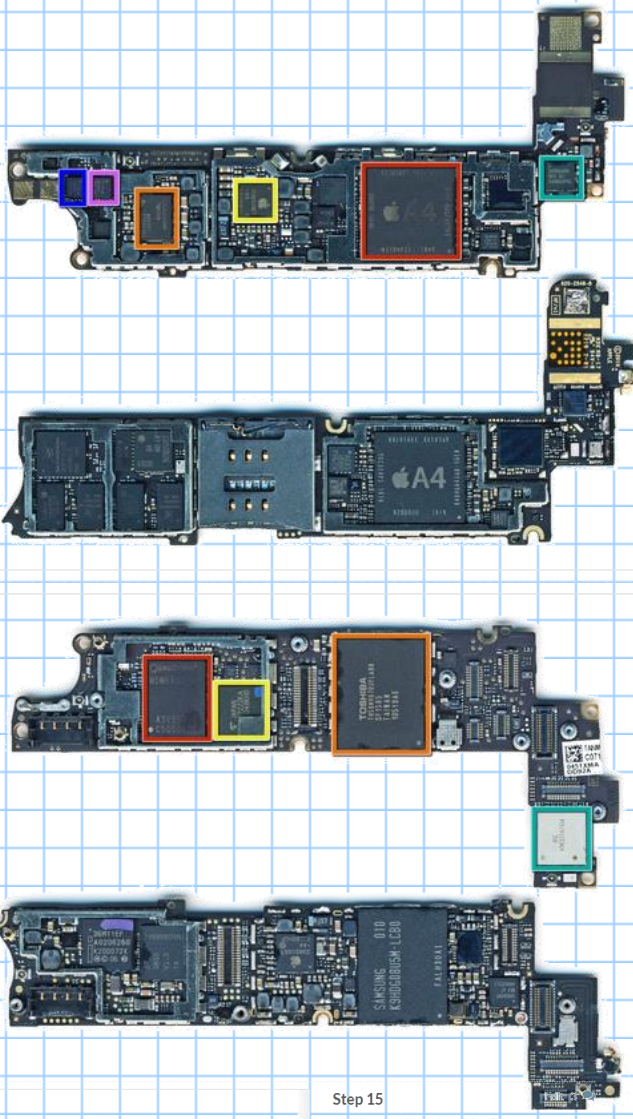
Two proposed standards

WCDMA / UMTS (Wideband CDMA, Ericsson)
CDMA2000 (Qualcomm)
Both are CDMA with wider channel bands (up to 5MHz)

Several proposals made, trouble not engineering, but politics

Europe → GMS backwards compatibility
US → CDMA / IS-95 compatibility

Verizon IPHONE 4 Teardown



Step 13

Edit

Thanks to our friends at UBM Techinsights for providing us with some chip identifications.

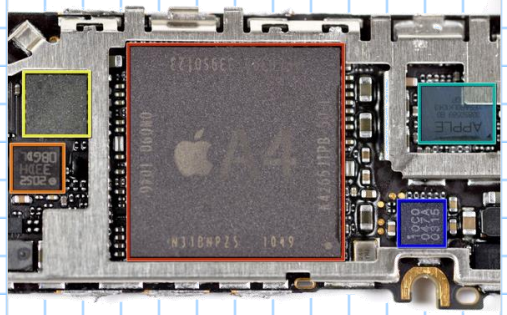
- The front side of the Verizon logic board (on top) contains:
  - Apple A4 Processor
  - Qualcomm PM8028 Power Management
  - Dialog D1815A Power Management IC (Apple branded 338S087)
  - 343S0499 - Texas Instruments Touchscreen controller - Apple/TI, part is #343S0499/#F761586G (an up-rev from earlier # F761586C of the iPhone 3GS)
  - SKY77711-4 - Skyworks poweramplifier module for CDMA/PCS
  - SKY77710-4 - Skyworks power amplifier module for dual-mode CDMA/AMPS

Step 14

Edit

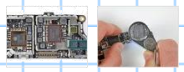
- The back side of the Verizon logic board (on top) contains:
  - Qualcomm MDM6600
  - Toshiba TH58NVG7D2FLA89 16 GB NAND Flash
  - Toshiba Y890A111222KA
  - RS KMOD16104 - The logo on this package appears to be that of Murata's. We suspect that this contains the Broadcom BCM4329 that reportedly provides Wi-Fi/Bluetooth connectivity.

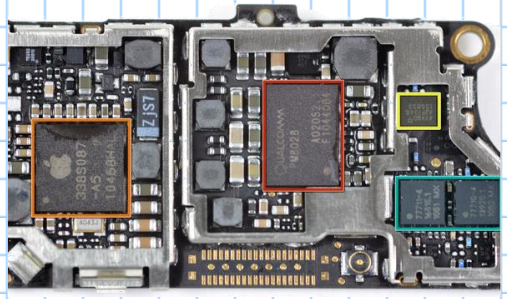
Adding credibility to this statement is the fact that we found this chip last June in the GSM iPhone 4 and that Murata and Broadcom have had RF partnerships in the past.



Step 15

- Here are the brains of the iPhone.
- The A4 markings read N31BNPZ5 APL0398 339S0123, front and center.
- ST Micro's 2052 33DH 0BGDL (three-axis accelerometer)
- ST Micro's AGD8 (L3G4200D 3D gyroscope)
- 10C0 047A 0315
- Cirrus Logic 338S0589 CLI1495B0 Audio Codec (Apple branded)





Step 16

Edit

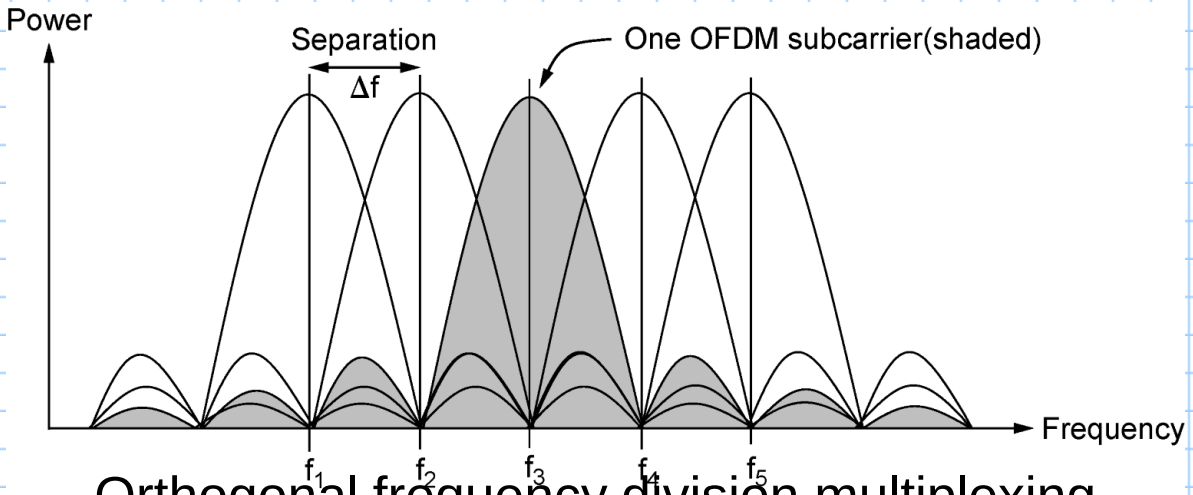
- Like the Apple TV, there is an interesting set of unused solder pads near the edge of the logic board. These are likely used for testing during development.
- The Qualcomm PM8028 chip works in conjunction with the Qualcomm MDM6600 to provide wireless data connection to the phone.
- Dialog D1815A power management IC is in the Apple branded package labeled 338S0876.
- Avago A2FIO46
- Skyworks SKY77711 and SKY77710 power amplifiers

4G Wireless

4G systems / standards operate under the name of LTE (Long Term Evolution)

Goal: High Speed Data

Orthgonal Frequency Division Multiple Access
(also used in 802.11!)



Orthogonal frequency division multiplexing (OFDM).

Wide Channels (1.4MHz to 20 MHz)

Incompatible with 2G/3G networks, requires additional portion of spectrum

(700, 750, 800, 850, 1900, 1700/2100, 2500 and 2600 MHz Bands)

Supports Femtocells (R = 10s of meters)

5G Wireless

5G Networks are expected to be deployed in the 2020's

What will 5G networks / devices look like? What technologies will they use? (And Reuse!!!!)

http://www.futuretimeline.net/21stcentury/2020.htm#.Vh5dEXpVhBc