



FORWARD CONCEPTS®

Electronics Market Research

1462 East Grandview Street. • Mesa, AZ 85203 • U.S.A.

Tel: 480-968-3759 • Fax: 480-968-7145 • E-mail: info@fwdconcepts.com

www.fwdconcepts.com

Table of Contents

CELLULAR HANDSET & TABLET CORE CHIP TRENDS '12

Market Analysis of Baseband, Application Processor, RF & Power
Management Chips

Author:

Carter L. Horney

Editor & Contributor:

Will Strauss

**Report No. 1210
February, 2012**

About the Author

Carter L. Horney, a recognized authority on microprocessor and DSP implementation in telecommunications, is the author of this report. Mr. Horney is an independent consultant and Forward Concepts Associate specializing in semiconductor product strategy and market planning. He was formerly Division Planner for Rockwell International's Digital Communications Division and earlier Strategic Marketing manager for Rockwell's Semiconductor Products Division. Mr. Horney was responsible for the product planning, which led Rockwell (now Conexant Systems) to dominate the worldwide FAX and high-speed modem chip market. He was appointed a Rockwell Engineering Fellow and received many commendations for outstanding achievement in Computer Architecture, Engineering, Technical Marketing, Product Planning and Customer Relations. Mr. Horney has a B.S. in Mathematics and Physics and an M.S. in Mathematics from Western Illinois University.

About the Editor

Will Strauss, President of Forward Concepts, is the editor and significant contributor for this report. Mr. Strauss is internationally recognized as the leading authority on markets driven by digital signal processing (DSP), and wireless is the largest DSP market.

Copyright © 2012 by Carter L. Horney for the exclusive use of Forward Concepts Company. All rights, including that of translation into other languages are specifically reserved. No part of this publication may be reproduced in any form, stored in a retrieval system or transmitted by any method or means, electrically, mechanically, photographic or otherwise, without the express permission of Carter L. Horney, (d/b/a Teletronix) P.O. Box 487 San Clemente, California 92674. (Tel 949-492-8885; Fax: 949-361-8885). Personal E-mail: chorney@cox.net



FORWARD CONCEPTS and the stylized FC Logo are registered trademarks of Forward Concepts Co. ® Reg. U.S. Patent & Trademark Office.

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY.....	1
A. Overview	1
B. Market Drivers.....	1
C. Baseband Processors	2
D. Application Processors.....	8
E. RF Chips.....	10
F. Power Amplifier Modules & FEMs	10
G. Analog Baseband & Power Management Units	11
II. BASEBAND PROCESSORS	13
A. Overall Baseband Processor Market Shares	14
B. Digital Baseband Processor Forecast by Air Type	18
C. Announced LTE Baseband Chips.....	21
D. Early LTE Aircard/USB Modems.....	22
E. Early Multimode 3G/4G LTE Smartphones	23
F. LTE Operator Status and the Bands of Deployment	24
G. LTE Forecasts by Major Regions	28
H. Digital Baseband LTE Forecast	30
I. LTE Supplier Market Share	31
J. Voice over LTE Transition (SRVCC).....	32
K. LTE Baseband Supplier Profiles.....	33
1. Altair Semiconductor Ltd.	36
2. Broadcom (4G LTE UE Class 4 Baseband).....	37
3. Cavium Networks (LTE, 3GPP Rel 8 baseband)	38
4. Innofidei (LTE baseband chip)	38
5. MAXIM-GenAsic Design Systems Inc (LTE transceiver)	39
6. Intel-Mobile Communications (LTE RF and 3G/LTE basebands).....	39
7. Leadcore Technology (LTE/TD-SCDMA Platform)	40
8. GCT Semiconductor and LG Electronics	40
9. MediaTek (TD-LTE + TD-SCDMA Com-processor)	41
10. NVIDIA-ICERA (LTE and 21 Mbps HSPA+ platform).....	41
11. Qualcomm (LTE/3G multimode platform).....	42
12. Renesas Mobile Corp. (LTE+3G DC-HSPA+ baseband Platform)	43
13. Samsung (LTE and WiMAX Baseband)	44
14. Sequans Communications (LTE and WiMAX Baseband Chip only)	44
15. Spreadtrum (LTE/TD-SCDMA/GSM baseband platform).....	45
16. ST-Ericsson (LTE 4/3G Platform – DBB, ABB and RF devices)	46
L. WCDMA Baseband Market & Vendor Shares.....	47
M. WEDGE, HEDGE, HEDGE+ Supplier Positioning	49
1. Texas Instruments.....	49
2. ST-Ericsson.....	49

TABLE OF CONTENTS

3.	Qualcomm	50
4.	Renesas Mobile.....	51
5.	Marvell.....	51
6.	Broadcom	51
7.	Intel Mobile	52
N.	WCDMA/HEDGE Standalone Baseband Chip Profiles	54
1.	Broadcom (7.2Mbps HSDPA / HSUPA Basebands).....	55
2.	NVIDIA/Icera Semiconductor (21 Mbps HSPA+ Baseband).....	56
3.	Intel (Release 7 diversity HSPA+ 21/11 Mbps Baseband Platform).....	57
4.	MediaTek (Othello WEDGE Platform).....	58
5.	Qualcomm (Up to 42Mbps DC-HSPA+ Platforms)	59
6.	Renesas Electronics (SH-MobileG3 HUSPA/GSMM).....	62
7.	ST-Ericsson (7.2 and 21 Mbps HSPA+ Connect Platforms).....	63
O.	CDMA Baseband Market & Vendor Shares	66
P.	CDMA2000 Baseband Supplier Profiles	67
1.	VIA Telecom.....	68
2.	Qualcomm (CDMA2000 1x Advanced Chip Set)	68
3.	Qualcomm (CDMA2000 EV-DO Rel. 0 and Rel. A)	69
4.	Qualcomm (Tri-mode CDMA1x EV-DO Rev. A, HSPA+/EDGE)	70
Q.	TD-SCDMA Baseband Supplier Profiles.....	70
1.	Leadcore Technology (TD-HSDPA IP)	72
2.	MediaTek (TD-SCDMA/GSM Baseband & RF)	73
3.	Marvell (TD-HSPA Baseband, Apps Processor).....	73
4.	Spreadtrum (TD-HSPA DBB & RF, CMMB receiver, Triple-SIM)	74
5.	Spreadtrum (LTE and TD-HSPA-SCDMA Baseband)	76
6.	ST-Ericsson- (TD-HSPA Baseband, RF, ABB)	77
R.	TD-SCDMA Baseband Market & Vendor Shares	78
S.	GSM/GPRS & EDGE Baseband Market & Vendor Shares	80
T.	GSM, GPRS & EDGE Baseband Supplier Profiles	82
1.	Broadcom (Monolithic EDGE BB/RF Transceiver)	83
2.	Intel (Class 12 EDGE BB, RF & PMU Platform)	83
3.	MediaTek (GPRS/EDGE Class 12 52-104 MHz ARM7EJ Platform)	84
4.	MediaTek (MT623x 208 and 312MHz ARM9 EDGE Platforms).....	84
5.	MStar Semiconductor (GSM/GPRS & EDGE ARM926 EJ).....	85
6.	ST-Ericsson (Quad GPRS or EDGE-RX monolithic modem)	86
U.	Dual-SIM, GPRS & EDGE Baseband Supplier Profiles.....	87
1.	Intel (EDGE Dual-Active Standby)	88
2.	MediaTek (MT6253 ULC GSM/GPRS, dual standby, single talk)	89
3.	ST-Ericsson (GSM/GPRS ULC, dual standby, single talk)	89
4.	Spreadtrum (GSM/GPRS triple SIM, triple standby, single talk).....	89
V.	EDGE Baseband Market & Vendor Shares.....	90
W.	PHS & iDEN & Vendor Shares.....	91
X.	PHS Chipset Supplier Profiles	93
1.	Atheros Communications	93
2.	GCT Semiconductor (CMOS PHS Xceivers)	93
3.	OKI (W-OAM Enhanced PHS Baseband)	93
III.	STAND-ALONE APPLICATION PROCESSORS.....	95

TABLE OF CONTENTS

A. Overview	95
B. Smartphones.....	96
C. Computing Tablet Forecast and Market Shares	100
D. Coprocessors vs. Application Processors	103
E. Communication Processor Market Impact.....	106
F. Application Processor Market & Vendor Shares	109
G. Application Processor Forecast	112
H. Stand-alone Application Processor Suppliers.....	113
1. Freescale (1.2 GHz Single Core Cortex A8).....	118
2. Freescale (1.2 GHz Single, Dual and Quad Core Cortex A9)	118
3. Fuzhou Rockchip Electronics.....	119
4. Huawei (HiSilicon K3, MW-Mobile 6.5 Professional)	120
5. Intel (32nm single-core, hyper threaded processor)	120
6. Marvell (55nm ARMADA Applications Processors)	124
7. Marvell (Triple-Core Processor)	125
8. Nufront (Dual A9 Standalone Applications Processor)	125
9. NVIDIA (Tegra2 Dual A9 Standalone Applications Processor)	125
10. NVIDIA (Tegra3 First Quad Cortex A9 Application Processor)	127
11. Qualcomm (APQ8060A and APQ8064 S4 dual-core Krait)	128
12. Renesas (40nm EMMA Mobile Dual Cortex-A9 Engine).....	129
13. ST-Ericsson (Nova dual Cortex-A9s and A15)	133
14. Renesas Electronics (40nm dual-core A9 APE5R Processor)	134
15. Samsung (SCS3C2442 Low-Cost MCP Application Processor)	135
16. Samsung (45nm SC36410 MCP Application Processor)	135
17. Samsung (S5PC110 1 GHz Cortex-A8 Application Processor)	136
18. Samsung-Apple A5 (1.2 GHz Dual Cortex-A9+ SGX543MP2 GPU)	137
19. Samsung (1.2 GHz Dual Cortex A9+ Mali400 GPU)	137
20. Samsung (2.0GHz Dual Cortex A15+ Mali-T6044GPU)	138
21. Telechips (1.2 GHz Single Core Cortex A8).....	138
22. Texas Instruments (OMAP3 Applications Processors).....	139
23. Texas Instruments (1.5 GHz OMAP4470 Dual A9+2 M3 Processor).....	142
24. Texas Instruments (OMAP5 dual-core 2GHz Cortex-A15 Processor	144
25. VIA Technologies.....	145
I. Image & Video Co-Processor Supplier Profiles.....	147
1. Broadcom (VideoCore Graphics Processor).....	147
2. MtekVision (Camera Signal Processor)	149
3. ST-Microelectronics (Image Signal Processor).....	149
4. Texas Instruments (720P Video Co-Processor)	150
5. CoreLogic (Image & SD-D1 Co-Processors)	151
6. Vimicro (JPEG/M 1.3Mp Image Co-Processor)	151
7. Renesas (12 MP Camera Processor)	152
J. 3D Video Co-Processor Supplier Profiles.....	152
1. Movidius	153
2. Texas Instruments (OMAP 4440 and OMAP5).....	153
3. NVIDIA (Tegra 2 3D).....	154
IV. COMMUNICATION PROCESSORS.....	155
A. DBB Com-Processor Forecast by Air Type	162

TABLE OF CONTENTS

B. Communications Processor Market Shares	164
C. Communications Processor Forecasts.....	169
D. Communications Processor Supplier Profiles	170
1. Broadcom (7.2 Mbps HSDPA Baseband-Processor)	174
2. Broadcom (65nm 7.2/5.8 Mbps HSUPA Baseband-Processor)	174
3. Broadcom (40nm 7.2/5.8Mbps HSUPA Android DBB-Processor).....	175
4. Broadcom (40nm 21 Mbps HSPA+ Cortex A9 Com-Processor)	175
5. MediaTek (MT6516 GSM/EDGE ARM926 Com-processor)	176
6. MediaTek (65nm MT6573 7.2/5.8 HSUPA Com-Processor)	177
7. Marvell (65nm WEDGE/TD-SCDMA Com-Processor)	178
8. Renesas-NEC (HSDPA Cat8 /GSM Com-Processor)	179
9. Renesas Electronics (HSPA+/LTE Dual-A9 Com-processor).....	180
10. Renesas Mobile Corporation (LTE/DC-HSPA+ Com-Processor).....	182
11. Qualcomm (Multi-chip HEDGE & EV-DO Multimedia Platforms)	183
12. Qualcomm (HD Snapdragon HSPA Com-Processor)	187
13. Qualcomm (ARM11 HSDPA/HSUPA Low Def Platform)	190
14. Spreadtrum Communications (1GHz Cortex A5 + TD-SCDMA)	192
15. ST-Ericsson (Hybrid U6715 ARM926EJ-S HSPA Com-Processor).....	192
16. ST-Ericsson (Hybrid U5500 DualA9 HSPA Com-Processor)	194
17. ST Ericsson (Hybrid U8500 DualA9 HSDPA+ Com-Processor)	195
V. RADIO TRANSCEIVERS.....	197
A. Overview	197
B. Radio Technology Evolution.....	197
C. Overall RF Transceiver Market Shares.....	200
D. GSM/GPRS Transceiver Market Shares	201
E. EDGE Transceiver Market Shares	203
F. CDMA Transceiver Market Shares.....	204
G. WCDMA/UMTS Transceiver Market Shares	205
H. PHS, PDC, TDMA, iDEN Transceiver Market Shares	206
I. Radio Transceiver Forecast.....	206
J. 2G/3G RF Transceiver Supplier Profiles	209
1. AKM (Tri-band WCDMA/HSDPA Xceiver)	210
2. MediaTek (TD-SCDMA and WCDMA Xceiver	210
3. MediaTek (CMOS quad GSM/GPRS Xceiver).....	211
4. Broadcom (Polar EDGE Xceiver & EDGE ULC).....	211
5. Broadcom (65nm Bands I-X WCDMA/HSPA Xceiver & EDGE).....	211
6. Fujitsu (90nm 10-band HSPA/ EDGE RF Subsystems)	212
7. GCT Semiconductor (CMOS 800 MHz CDMA2000 Xceiver)	213
8. Intel/Infineon (130nm CMOS WEDGE & LTE Xceivers).....	214
9. ST-Ericsson (3GPP Rel 6 WCDMA/HSPA Xceiver)	215
10. ST-Ericsson (Cat 7/8 GSM/GPRS/EDGE/WCDMA Xceiver)	216
11. ST-Ericsson (130nm dual-band CMOS TD-SCDMA Xceiver).....	216
12. Qualcomm (CMOS Diversity WEDGE Xceiver + GLONASS GPS)	216
13. RDA Microelectronics (CMOS TD-SCDMA, GPRS Xceivers).....	217
14. Renesas (SOI BiCMOS 8-band HEDGE & EDGE Xceiver)	218
15. Skyworks Solutions (WEDGE & EDGE Xceivers)	220
16. Icera (CMOS 7-band WCDMA/HEDGE Xceiver)	221

TABLE OF CONTENTS

17.	Sony Semiconductor (SiGe BiCMOS WCDMA/HSPA Xceiver)	221
18.	Spreadtrum (7-band CMOS WEDGE, TD-SCDMA Xceiver).....	221
K.	4G LTE RF Transceiver Chip Suppliers	223
1.	Altair Semiconductor (1.9-2.7 GHz CMOS Transceiver)	225
2.	FCI/Silicon Motion (CMOS LTE Transceiver)	226
3.	Fujitsu Semiconductor (LTE FDD1-17, TDD-34, 38 Transceiver)	226
4.	Fujitsu Semiconductor (Simultaneous LTE/3G Transceiver).....	227
5.	Fujitsu Semiconductor (Multiband, multimode LTE/3G/2G Xceiver)	227
6.	GCT Semiconductor (R8 FDD Multiband +700 MHz).....	228
7.	Huawei-Option's M4S (Reconfigurable RF Transceiver)	228
8.	Icera/NVIDIA (multi LTE/HSPA+).....	229
9.	Intel/Infineon (LTE/3GPP Rel. 7/8, 1-IX band Transceiver).....	230
10.	Maxim-GenAsic (2.3-2.7 GHz WIMAX/TD-LTE Transceiver).....	230
11.	Maxim (2.3-2.7 GHz WIMAX/TD-LTE Transceiver).....	230
12.	Huawei Technologies (M4S SAW-less reconfigurable transceiver)	231
13.	Renesas (LTE Software Reconfigurable Radio).....	232
14.	ST-Ericsson (LTE 4 band RF bundled platform)	233
VI.	LOW-COST INTEGRATED BASEBAND & RF CHIPS	235
A.	ULC Modem Market Size & Vendor Shares.....	236
1.	Dual-SIM, Dual-Standby Trend not addressed by ULC Chips.....	240
B.	ULC Modem Market Forecast.....	241
C.	Ultra-Low-Cost (BB/RF) Modem Supplier Profiles	245
1.	Broadcom (65nm Monolithic EDGE Modem, H.264)	248
2.	Intel (65nm Monolithic GSM and EDGE, MPEG4).....	249
3.	MediaTek, Inc. (65nm Monolithic Low Cost GSM/GPRS)	250
4.	ST-Ericsson (Monolithic GSM/GPRS and EDGE DSDS)	251
5.	Qualcomm (WCDMA/HSDPA Single-Package Modems).....	253
6.	Qualcomm (WCDMA/HSUPA 10Mbps/5.76 Single-Package Modems).....	254
7.	Qualcomm (CDMA 1x Single-Chip & MCP Modems).....	255
8.	Atheros (PHS baseband/RF)	256
VII.	CELLPHONE POWER AMPLIFIERS.....	257
A.	Overview	257
B.	Cellphone Power Amplifier Market Share Leaders.....	258
C.	Cellular Power Amplifier Segmentation	259
D.	Mobile Power Amplifier Five Year Forecast.....	265
E.	Cellular PA Supplier Profiles	268
1.	Anadigics.....	269
2.	Avago Technologies.....	271
3.	Black Sand Technologies.....	272
4.	Maxim Semiconductor (CDMA, PDC and AMP)	272
5.	Mitsubishi Electronic Devices (GaAs Hybrid CDMA and WCDMA)	273
6.	Renesas Technology Corp.....	274
7.	RF Micro Devices	274
8.	RDA Microelectronics (Quad GSM & TD-SCDMA 1800)	276
9.	Skyworks	277
10.	TriQuint Semiconductor	280
F.	LTE PA Supplier Profiles.....	282
1.	Anadigics (FDD 1, 2, 7, 8, 20, 3/4/9/10, 5/6/18/19, 12/17, 13/14; TDD 38, 40).....	282

TABLE OF CONTENTS

2.	Mitsubishi Electric.....	283
3.	Skyworks (FDD 1, 4/9, 5/6, 7, 8, 9, 13/14, 12/17 and TDD 38/40)	284
4.	RFMD (Single bands 12/13 or 7)	284
5.	TriQuint Semiconductor (band 13, 17 of the USA 700 MHz).....	285
VIII.	POWER MANAGEMENT UNITS.....	286
A.	Overview	286
B.	PMU Audio Codec/Speakerphone Drivers	289
1.	AKM Semiconductor (CMOS 24-bit Audio)	290
2.	Cirrus Logic (CMOS Audio Codec)	291
3.	Texas Instruments (Audio Codec+ USB and miniDSP)	291
4.	Maxim (Stereo Audio Codec)	292
5.	Wolfson Microelectronics (Stereo Codec with SPKR drivers and Class W headphone) 293	
C.	PMU Market Shares	294
D.	PMU Five-Year Forecast.....	298
E.	PMU Company Profiles	300
1.	Anpec Electronics (Battery charge management)	301
2.	Broadcom	301
3.	Dialog Semiconductor (CMOS PMU/Audio subsystem)	301
4.	Infineon (RF-Baseband Power Management)	303
5.	Linear Technology (Energy Management).....	303
6.	Maxim Integrated Products	304
7.	MediaTek (Baseband).....	305
8.	Micrel (BiCMOS, discrete specific PMUs).....	306
9.	National Semiconductor	307
10.	Qualcomm (Cellular Power Management).....	307
11.	Ricoh Electronic Devices (7 channel PMU + white LED driver)	308
12.	ST-Ericsson (Application Processor PMU)	309
13.	Texas Instruments (Processor PMUs).....	310
14.	Wolfson Microelectronics (Audio Codec, MEMS Mics)	311
IX.	APPENDIX.....	313
A.	WIRELESS ACRONYMS & ABBREVIATIONS	313

TABLE OF CONTENTS

FIGURES

Figure 1 Growth of Mobile Phones & Computing Tablets	2
Figure 2 Global Growth of LTE by Region	5
Figure 3 Baseband Growth by Cellular Standards.....	6
Figure 4 Cellphone Digital Processor Summary Forecast	7
Figure 5 Application Processor and Co- Processor Forecast.....	9
Figure 6 Analog Baseband, RF and Power Amplifier Chip Sales Summary.....	12
Figure 7 All Baseband Sales Distribution by Category: 2011	14
Figure 8 Digital Baseband Vendor Market Shares: 2011	15
Figure 9 Baseband Market Revenue by Cellular Standard 2011	16
Figure 10 3G UMTS Baseband Shipments by Air Standard	17
Figure 11 Forecast Patterns of Handsets by Air Interface '09-'16.....	19
Figure 12 The Global Growth of LTE Mobile Baseband by Major Region	29
Figure 13 The Growth of LTE Baseband Processors in Asia.....	29
Figure 14 LTE Baseband Chip Suppliers market share for 2011	32
Figure 15 WCDMA/HSPA/TD-SCDMA Baseband Vendor Market Shares: '11	47
Figure 16 Renesas G4 Cortex-A8 DBB Com-Processor.....	63
Figure 17 CDMA Stand-Alone Baseband Vendor Market Shares: '11	67
Figure 18 Spreadtrum SC800G TD-SCDMA Baseband Block Diagram.....	76
Figure 19 TD-SCDMA Baseband Vendor Market Shares: '11.....	79
Figure 20 GSM/GPRS Multi-chip Baseband Market by Vendor: '11.....	80
Figure 21 GSM/GPRS/EDGE Multichip Baseband Market by Vendor: '11.....	81
Figure 22 EDGE Baseband Vendor Market Shares: '11	90
Figure 23 PHS & iDEN Baseband Vendor Market Shares: '11	91
Figure 24 Smartphone Growth versus others: 2010 to 2016.....	96
Figure 25 Estimated Smartphone Shipments by Operating System" '11.....	98
Figure 26 5-year Forecast of Smartphones Segmented by Price Levels	99
Figure 27 Tablet Market Share by OS Standard: 2011	101
Figure 28 Estimated Tablet Shipments By Vendor for 2011	102
Figure 29 Slave Coprocessor Market by Type: '11	104
Figure 30 Com-Processor vs. Apps Processor Revenues: '11	106
Figure 31 Baseband Processor Revenues by Type: '10.....	107
Figure 32 Standalone Application Processor vs. Com-Processor Growths.....	108
Figure 33 Integrated Com-processors by Cellular Standard.	108
Figure 34 Standalone Application Processor Vendor Market Shares: 2011	109
Figure 35 Tablet Application Processor Vendor Market Shares: '11	110
Figure 36 Intel's Single-core Z2460 Mobile Application Processor	122
Figure 37 NEC Mobile Application Processor Migration Plan	130
Figure 39 Telechips TCC88xx Application Processor Block Diagram	139
Figure 38 TI OMAP44x Block Diagram.....	142
Figure 39 Block Diagram of OMAP5430 Standalone Application Processor.....	144
Figure 42 VIA Technologies/WonderMedia WM8650 Apps Processor Diagram.....	146
Figure 40 Broadcom High-Def Mobile Multimedia Co-Processor Block Diagram	148
Figure 41 Com-processor Growth by Air-Type over five-year period.	163
Figure 42 Communications Processor Market Shares: '11	164
Figure 43 Baseband-Application Processor vs. Standalone Growth Forecasts.....	165
Figure 44 Com-Processor vs. Standalone Apps Processor Market: 2010.....	166
Figure 45 Com-Processor Sales Revenue by Baseband Standard.....	167
Figure 46 Smartphone Share of Market by Operating Systems for '11	168

TABLE OF CONTENTS

Figure 47 Media Tablet Share of Market by Operating Systems for '11	168
Figure 48 NEC Electronics Medity2 Chipset.....	180
Figure 51 Renesas MP5232 LTE Communication Processor Diagram.....	182
Figure 49 ST-Ericsson U6715 DBB Com-Processor	193
Figure 50 ST-Ericsson U5500 Rel7 HSDPA Smartphone Com-Processor	194
Figure 51 ST-Ericsson U8500 HSPA Smartphone Com-Processor	195
Figure 52 Overall Cellular RF Transceiver Market by Vendor: '11	200
Figure 53 GSM/GPRS RF Transceiver Shipments by Vendor: '11	201
Figure 54 Integrated RF/Baseband Transceiver Market by Vendor: '11.....	202
Figure 55 EDGE RF Transceiver Shipments by Vendor: '11	203
Figure 56 CDMA/1xEV-DO Radio Transceiver Shipments by Vendor: '10.....	204
Figure 57 WCDMA RF Transceiver Shipments by Vendor: '10.....	206
Figure 58 Fujitsu's MB86L01A: Multiband WCDMA/EDGE Radio Block Diagram	212
Figure 59 Cellular Monolithic BB/RF Modem Chip Market by Vendor: '11	237
Figure 60 ULC Cellular Phone Shipments by Technology: '11.....	238
Figure 61 Monolithic Baseband/RF Sales by Cellular Standard for 2011	239
Figure 62 ULC GSM and EDGE Shipments vs. Dual-SIM, Dual-Standby '10-'16	240
Figure 61 ULC Mix of Chip Sales Versus Other Baseband Sales	241
Figure 63 ULC Unit Shipment Growth by Technology: '10-'16.....	242
Figure 25 Monolithic Market Revenue Growth Trends: '10-'16	243
Figure 65 ST-ER G4852 GPRS/EDGE Modem Block Diagram	252
Figure 66 Cellular Power Amplifier Market by Vendor: 2011.....	258
Figure 67 3G/4G Cellular Handset Growth over the Five Year Period	259
Figure 68 Cellular Terminal Growth by Type: '10-'16	264
Figure 69 TI Stereo Audio Codec Block Diagram	292
Figure 70 PMU Market & Vendor Shares: 2011.....	296
Figure 71 PMU Revenue Distribution by Type: 2011	297

TABLE OF CONTENTS

TABLES

Table 1 Migration of Baseband Modems from 2G to 4G	4
Table 2 DBB Processor Forecasts by Air Type: '11-'16	20
Table 3 LTE Band Usage and Global Operator Deployment Summary	27
Table 4 LTE Digital Baseband Forecasts: '11-'16	30
Table 5 Comparison of 4G Technologies: WiMAX versus cat 2-LTE	35
Table 6 Five-Year Forecast for Smartphone and Media Tablets	97
Table 7 Smartphone Forecast by Segment from 2010-2016	97
Table 8 Enhancements of Snapdragon S3 CPU 28nm over Cortex A9 Licensees	100
Table 9 Media Tablet Forecast from 2010 to 2016	102
Table 10 Tablet Usage of Application Processors by Vendor	111
Table 11 Application & Co-Processor 5-Year Forecast by Type: '11-'16	112
Table 12 Dual-core Stand-alone Application Processors Slated for 2012	114
Table 13 Stand-alone Application Processor Features & Usage	115
Table 14 Stand-alone Application Processor Features & Usage (continued 1)	116
Table 15 Stand-alone Application Processor Features & Usage (continued 2)	117
Table 16: NVIDIA Tegra 250 Applications Processor Features	126
Table 17 NEC EMMA ARM-based Application Processor Family	132
Table 18: TI OMAP34x, OMAP36x & OMAP44x Applications Processors	141
Table 19 Nokia Captive OS-Based 3G Com-Processors from TI	156
Table 20 O/S-Based 2G Com-Processor Supplier Usage and Features	158
Table 21 Monolithic O/S-Based Com-Processor Supplier Usage & Features	159
Table 22 Communication Processor Forecast '11-'16	170
Table 23 3G DBB Communication Processor Capability	172
Table 24 3G DBB Communication Processor (Continued)	174
Table 25 Qualcomm's MSM Processor Evolution: 2000 to 2008	184
Table 26 Qualcomm MSM7600 Chipset RF Options	186
Table 27: Qualcomm Snapdragon Communication Processors	188
Table 28 Overview of 3G/IMT-2000 Standards	198
Table 29 Radio Transceiver 5-Year Forecast by Wireless technology	208
Table 30 Frequency Bands & Channel Widths for LTE	224
Table 31 Integrated BB/Radio Chip Forecast: '10-'16	244
Table 32 Comparison of Single-Chip GSM, CDMA & EDGE Modems	247
Table 33 Global UMTS-FDD Paired bands and Regions of Coverage	261
Table 34 Cellular Power Amplifier Unit Forecast by Air Technology: '10-'16	265
Table 35 Cellular Power Amplifier Unit Forecast by Handset Type: '11-'16	266
Table 36 Cellular Power Amplifier (PA & PAM) Forecast by Type: '11-'16	267
Table 37 Selected PAM and FEM Suppliers & Popular Handset Sockets	268
Table 38 Anadigics Amplifier Modules for CDMA, GSM & HSPA	270
Table 39 Avago's Lineup of CDMA & WCDMA Power Amplifiers	271
Table 40 Mitsubishi GaAs Hybrid Devices for CDMA & WCDMA	273
Table 41 RFMD's 3G WCDMA/HSPA and CDMA EV-DO Power Amplifiers	275
Table 42 Skyworks' Cellular 2G & 3G PA/FEM Product Line	279
Table 43 TriQuint's Lineup of WCDMA/HSUPA & HEDGE Power Amplifiers	281
Table 44 Cellphone Power Management Unit Forecast by Type: '11-'16	299