Global and China Mobile Phone RF (Radio Frequency) Industry Report, 2008-2009

Mobile phone RF system consists mainly of transceivers, power amplifier (abbreviated as PA thereafter) and antenna switch. PA might be set in the Front-End-Module or FEM. In 2G, the cost of RF system was only about US $1.5, while In 3G, the cost was increased to between US$6.0 and US$8.0, and the cost will further increased to about US$8.0 to US$10.0 in 4G, obviously, FR system had the highest cost growth during the upgrading of mobile phones.

The receiver is a part of the mobile phone platform. Generally the mobile phone baseband vendors also provide the receivers, however, Nokia's baseband was from Texas Instruments, but its receiver was from ST Microelectronics or Infineon. ST Microelectronics has further enhanced its baseband ability through the consolidation between NXP and Ericsson mobile platform.

PA (Power Amplifier) is the most key component in a mobile phone, which decides the voice quality, connection time, standby time and signal strength. PA has been produced by compound semiconductor manufacturers all along, including RFMD, Skyworks, Triquint, Anadigics, Avago and Renesas. Renesas still relies on the previous products form Hitachi Semiconductor, launched none of any new products.

RFMD has always been the NO.1, but the gap between RFMD and Skyworks is shrinking gradually. RFMD relies much on Nokia and Motorola. 75% sales of RFMD are contributed by those two. On the other hand, above 90% PA of Nokia is from RFMD. Skyworks's main clients are Sony Ericsson, Motorola, LG and Samsung. The world's first 4G FEM containing PA was from Skyworks.

As the world's largest GaAs OEM, Triquint is good at high-integration PA, as well as the PA packaging. The GSM PA with the smallest footprint and the world's first FC packaged PA were both produced by Triquint. The main clients of Triquint are Samsung, LG, RIM and Apple.

Anadigics has a close relationship with Qualcomm, which is focused on the PA development for CDMA and WCDMA. Especially it has a high market share in CDMA market. Since its establishment, Anadigics has been expanding continuously, but during the past five years, only one year is profitable.

Avago was previously the semiconductor department (Agilent) of HP. Avago was the first one engaged in the WCDMA development. Though its sales did not look good initially, with the increasing popularity of WCDMA, the sales turned to increase rapidly.

In 3G era, RF system becomes more complex. Some smart mobile phones have as many as five PAs, one is for all GSM frequency bands, one is for WLAN and the other three are for three 3G frequency band separately. Considering the high integration is the further development focus for PA, Skyworks and

Triqunit have the biggest potential. 4G has much higher requirements to PA such as higher T/PR and higher efficiency. No matter in 2G or 3G, PA sector is always monopolized by compound semiconductor manufacturers; the traditional silicon semiconductors have no chances. PA was usually GaAs HBT in 2G , in 3G, new entrants tend to InGaP HBT, Skyworks had already acquired the PA department of Freescale. In 2009, Skyworks launched the world's first model FEM (SKY77445) focus on LTE/EUTRAN. Anadigics also has two models of PA for LTE/EUTRAN, both of them adopted InGaP.

Six Typical PA Models in 3G

Vendor	Model	Base	Technics	Wave	Packaging	Launching time
Freescale	MMM6032	GaAs/SiGe	HBT	1.2	MCM	Jun.2005
RFMD	RF5184	GaAs	HBT	1.2.5.8	QFN	Sep.2008
Avago	ACPM-7881	GaAs	pHEMT	1	SMT	2006
Triquint	TQM676021	InGaP	HBT	1	LGA	Feb.2009
Anadigics	AWT6281	InGaP	HBT	2	SMT	Feb.2009
Skyworks	SKY77158	InGaP	HBT	1	MCM	Mar.2008

Antenna switch is also has high entry barriers. Although its price is rather lower than PA and receiver, usually requiring SiP packaing and LTCC underlay. Globally, antenna switches are mainly supplied by Japanese vendors such as MURATA, Renesas and New JRC etc.

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