Some new technologies in future mobile terminal

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Abstract
This article is going to introduce some new idea and technologies which can be used in future mobile terminals (phones). it covers RF semiconductor , data transmission, and image capture area. In this paper, new trends of wireless terminal is summarized at first, then followed by introduction of FBAR (film bulk acoustic resonator) E-PHEMT power amplifier technologies, date transmission technologies (IrDA Vs blue tooth), image capture solution for video phone. Some of these technologies are already applied in modern mobile phone models and some of them are still under developing, just for designer's referrence.

1. Trend of Mobile Terminal

With the development of mobile communications, voice service is not the only needs of a subscriber, the mobile terminal of 3G will hopefully have all the multi media functions. it will have a big color display, motion picture, high speed data transmission, video capture. As we know, to realize the function that we want to have, we must make components in mobile terminal as small as possible, and consume very low power, that is the reason why many new technologies is used in mobile communication field.

2. New RF Technologies

FBAR Filter

Maybe 3 years ago, few people knew what FBAR is . but today , FBAR is not a strange word. FBAR (Film Bulk Acoustic Resonator) is a breakthrough of resonator technology being developed by Agilent Technologies. FBAR Duplexer won Awards of "EDN Magazine's Innovation Of The Year prize "and "2000 Technology Award From Wireless Design & Development Magazine " in 2000. This technology can be used to create the essential frequency-shaping elements found in modern Wireless systems, including filters, duplexers, and resonators for oscillators.

When compared to ceramic-based products, FBAR-based solutions offers significant advances in miniaturization. Products can be realized in less than10% of the volume of present ceramic-based solutions. The electrical performance of FBAR prototypes is already within a few decibels of the performance of the current generation of CDMA PCS ceramic duplexers, and it is expected that FBAR-based products will offer equivalent performance to ceramic-based products .

When compared to SAW devices, FBAR devices can offer improvements in electrical performance, including the potential for lower insertion loss, steeper filter "side walls" , and better power handling. Additionally, while the difficulties of obtaining high power handling characteristics in fine-pitched interdigitated structures presently limit SAW-based duplexers to the cellular bands, FBAR technology extends easily to PCS frequencies, and can be used to create resonators that operate to frequencies above 10 GHz. FBAR technology is compatible with both Silicon and Gallium Arsenide (GaAs)wafer processing, opening the door for integrated radio solutions that include both active elements and filtering within the same semiconductor package, and eventually on the same chip. SAW devices are commonly constructed on Lithium Tantalate (LiTaO3) or Lithium Niobate (LiNBO3), higher-cost substrates that are likely limited to integration into multi-chip modules. The relatively large size of ceramic technology devices makes these devices inappropriate for integration. The comparison of FBAR, SAW and Ceramic duplexer is as below :

Item	Ceramic	SAW	FBAR
Size (PCS duplexer)	875 mm^3	140 mm^3 cellular band	98 mm^3 going to 45mm^3
Electrical (I.L., roll-off)	Excellent	Good	Excellent
Power handling	Best (>35dBm@2GHz)	Fair(31dBm@900MHz)	Good(>32dBm @2GHz)
Temperature Coefficient	0 to -6 ppm/C	-22 to –44 ppm/C	-20 to –30 ppm/c
Frequency Range filters: Duplexers	Cellular /PCS Cellular/PCS	IF-cellular –PCS Cellular/PCS ?	Cellular –PCS -mw Cellular –PCS -mw
Integration	No	Multi-chip module MCM	MCM: future full integration

E-PHEMT PAM

E-PHEMT means Enhancement-mode Pseudomorphic High Electron Mobility Transistor, PHEMTs provide a way to get the high mobility of Indium Phosphide on a Gallium Arsenide substrate, thereby avoiding the breakage problems associated with the very brittle Indium Phosphide wafers. The term "pseudomorphic" - literally "false form" - comes from the fact that the very thin semiconductor layer used to form the junction abandons its customary crystal lattice structure and assumes

the form of the underlying GaAsS substrate, thus creating a mechanically viable structure. The main difference between E-PHEMT and GaAs or HBT is as below :

Item	GaAs HBT	E-PHEMT
Threshold control	Easy	Difficult
Low voltage PAE	Fair	good
On-state breakdown	Degraded by high	Limited by burn out
Temp. Coefficient	Positive	Negative
107 hr MTTF @150oC Tch	no	Yes
Surface effects	Moderate	Severe
Control current	High	Low

In the near few years , E-PHEMT technology is applied to design power amplifier module(PAM) for Handsets , and from the specification comparison of the PAM available in market , we can find that E-PHEMT PAM has much advantages than other kinds of products in both GSM and CDMA field.

Dual-band: E-GSM (880-915MHz) and DCS (1710-1785) PAM comparison						
Manufacturer	PartNumber	Technology	Pkg size (mm)	Duty Cycle	PAE/Pout (%/dBm) [Pin] (dBm) E-GSM	DCS
Agilent	ACPM-7891	E-pHEMT	9x12x1.6	25%	60/35 [0-4]	50/32.5 [0-4]
Agilent	ACPM-7892	E-pHEMT	13.75x11x1.8	12.5%	45/34 [0-4]	40/31.7 [0-4]
Hitachi	PF08109B	MOSFET	11x13.75x1.9	12.5%	53/35.5 [0]	43/32.7 [0]
Philips	BGY280	na	13.75x11x1.7	12.5%	45/35 [0]	30/32 [0]
Hitachi	PF08122B	MOSFET	8x13.75x1.6	12.5%	55/35 [0]	50/33 [0]
RFMD	RF3160	GaAs HBT	8x11x1.5	25.0%	55/35 [6-10]	50/32.5 [6-10]
Conexant	CX77302	GaAs HBT	8.1x11.8x1.5	various	55/34.5 [6-12]	50/31.5 [6-11]
Anadigics	AWT6107	InGaP HBT	9.3x11.6x1.55	12.5%	55/34.5	50/31.5

Single-band: CDMA cellular (824-849MHz)									
Manufacturer	Part Number	Technology	Pkg size (mm)	Pout (dBm)	PAE (%) Pout max (dBm)	Pout/x (dBm)	ACPR (dBc) 0.885MHz (dBc/30kHz)	1.98MHz (dBc/30kHz)	Quiescent Current (mA)
Agilent	ACPM-7812	E-pHEMT	4x4x1.5	28.5	40	9 (16%)	-48	-58	50 (Pout=28.0dBm)
Conexant	CX77126	GaAs HBT(?)	4x4x1.5	28.0	33	5 (13%)	-48	-56	33 (Pout=-5dBm)
LG Innotek	PSC8348	?	4x4x1.7	28.0	37	-	-48	-60	80
RFMD	RF3185	GaAs HBT	3x3x1	28.0	35	-	[illegible]	-56	100
Panasonic	[illegible]	?	6.2x6.2x1.6	28.0	38	-	-	-	-
TriQuint	TQ7131	InGaP HBT	4x4x0.9	28.5	35	-	-48	-56	70

3. IrDA Vs Bluetooth

Communications without cables has made computers with untouched peripheral devices possible . for short range communications in the home or office , two technologies are currently available: Bluetooth and infrared devices , Both have their advantages and disadvantages , but both approaches can also provide complementary solutions for wireless data transfer between devices . the comparison of IrDA and bluetooth is as below :

	Bluetooth	IrDA-Data
General	Up to 10 meters (w/o additional amp) Omni-directional, also through objects Up to 8 devices in a piconet (# 2 units channel sharing) Built-in security Slower connection Supports isochronous & asynchronous services	Max. 1 meter proximity Narrow angle, line of sight Wide range HW & SW platforms Natural security Quicker connection Wide range HW & SW platforms, large installed base
Data Exchange	Uses OBEX Upper layer protocol Electronic business card exchange for specific recipient in group (time consuming discovery, security measures) Penetrate solid objects Mobility	Uses OBEX Upper layer protocol Electronic business card exchange for specific recipient in group (no interference, natural security via short range and angle) Does not penetrate solid objects Must remain stationary
LAN Access	Yes No line of sight needed Generally up to 10 meters Multipoint capability Less Performance Up to 1Mbps (next generation 2 Mbps)	Yes Line of sight Max. 1 meter proximity No Multipoint capability Greater Performance : Up to 4Mbps (16 Mbps soon)
Dial-up Access	Emulate EIA/TIA 232 connection between computer & mobile phone Mobility	Emulate EIA/TIA 232 connection between computer & mobile phone Must remain stationary
Voice Applications	Synchronous voice channels, reserving bandwidth for voice Up to 3 simultaneous, full-duplex in piconet	TC OIV specification for full-duplex voice, uses full 115.2 kbps OK for hands-free mobile phone car cradle
Security	Security at the link level Extra security complicates connections somewhat Can be monitored from any direction(omni directional), however authentication and encryption in baseband protocol	No security at the link level, relies on upper level protocol and applications for authentication or encryption IrDA is simple, no interrogation or recognition needed Directional nature provides low-level security due to line-of-sight, but can be monitored via detecting reflected light
Cost	Beginning at $20 to 30 (future $5)	Complete solutions for [illegible] today
Regulation	RF subject to worldwide regulatory groups Unlicensed use of ISM 2.45 GHz band (except France, Spain, Japan have Bluetooth issues)	Mostly unregulated Eye safety concerns, current IrDA specs are within IEC guideline

IrDA and Bluetooth are complementary solutions which will co-exist .Different consumer device models would offer different cableless connectivity options (eg Ir , Bluetooth) to wireless users , specific solution used in a particular model would depend on target customer usage pattern (eg line of sight, data rates, ...) and price sensitivity .

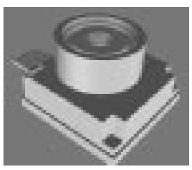
4. CMOS Camera module

Until recently, digital image capture has been dominated by the charge-coupled device (CCD) which relies upon highly specialized silicon processing that is optimized for the conversion of incident photons into charge but is not suited for further processing of the detected signal. Thus, while CCDs have enabled both efficient and low noise image capture, they require significant support electronics external to the sensor along with the associated engineering effort and PC board space for a complete imaging solution. The promise of CMOS is to provide an integrated imaging solution that is small, inexpensive, draws very low power, and is extremely easy to apply. From this point, CMOS image sensor is absolutely better choice for mobile video phone.

The development trend for CMOS imager chips is very steep however. Each new generation of chip design offers higher levels of functionality integrated onto a single chip such that the promise of CMOS technology is rapidly being realized . in addition , the combination of improved analog resulting in steady improvements in captured image quality . and now many companies integrate CMOS sensor and processor into very compact module for mobile phone or PDA .

Embedded Camera module

The picture in the right is an example of embedded camera module , it is an ultra-compact (12 x 12 x 8 mm3) form factor, low power, CIF (352x288, pixel size 4.9µmx4.9µm) resolution digital camera module optimized for embedded


Embedded Camera module

applications. It offers superior image quality in an ultra-compact package with minimal power consumption (48mW active, 8μW standby) , all at very low cost. It fits for mobile phone ,PDA , Video phone or other micro-camera applications .

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