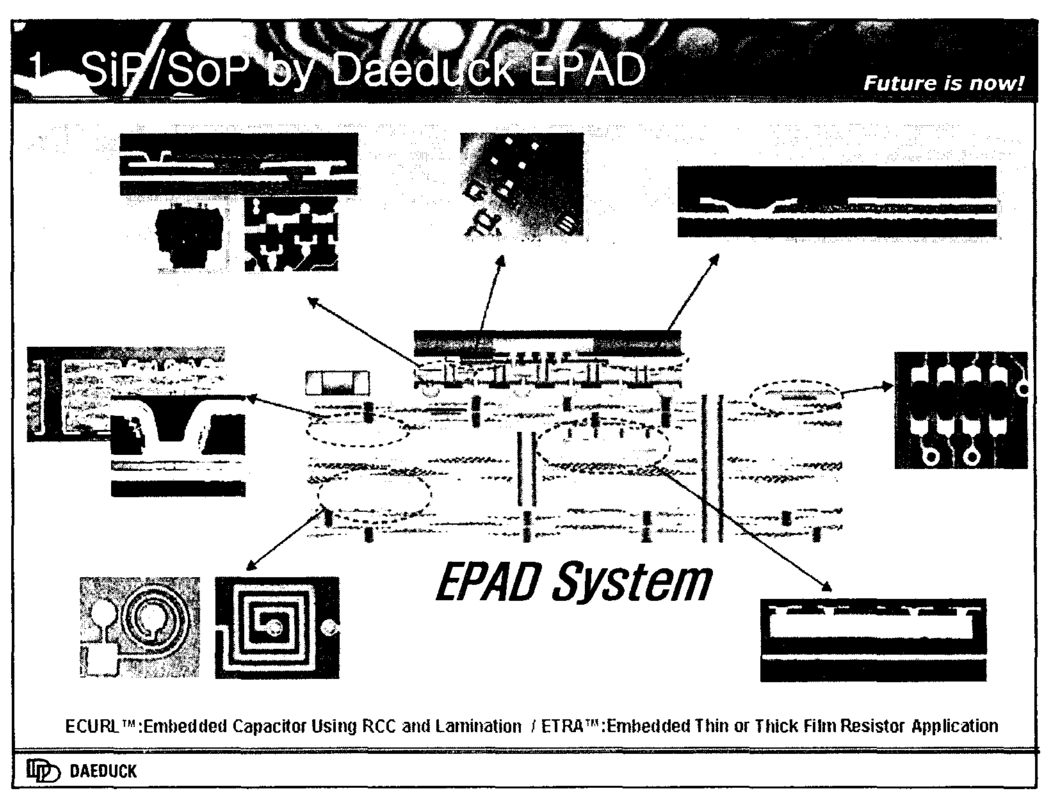
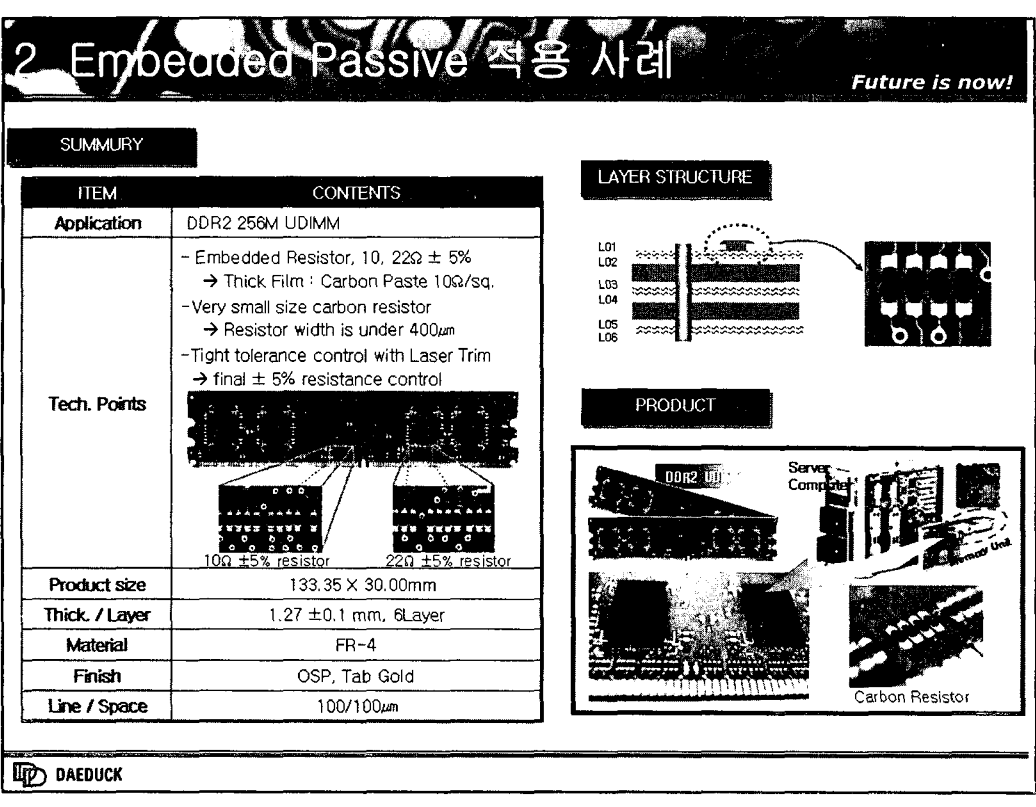
다층PCB 기판에 구현한 High-Q 임베디드 패시브 고주파 모듈 제작사례

윤 상 근 과장
(대덕전자)

다층 PCB 기판에 구현한 High-Q
임베디드 패시브 고주파 모듈 제작 사례


1. SiP/SoP by Daeduck EPAD
Future is now!
EPAD System
ECURL™:Embedded Capacitor Using RCC and Lamination / ETRA™:Embedded Thin or Thick Film Resistor Application
DAEDUCK

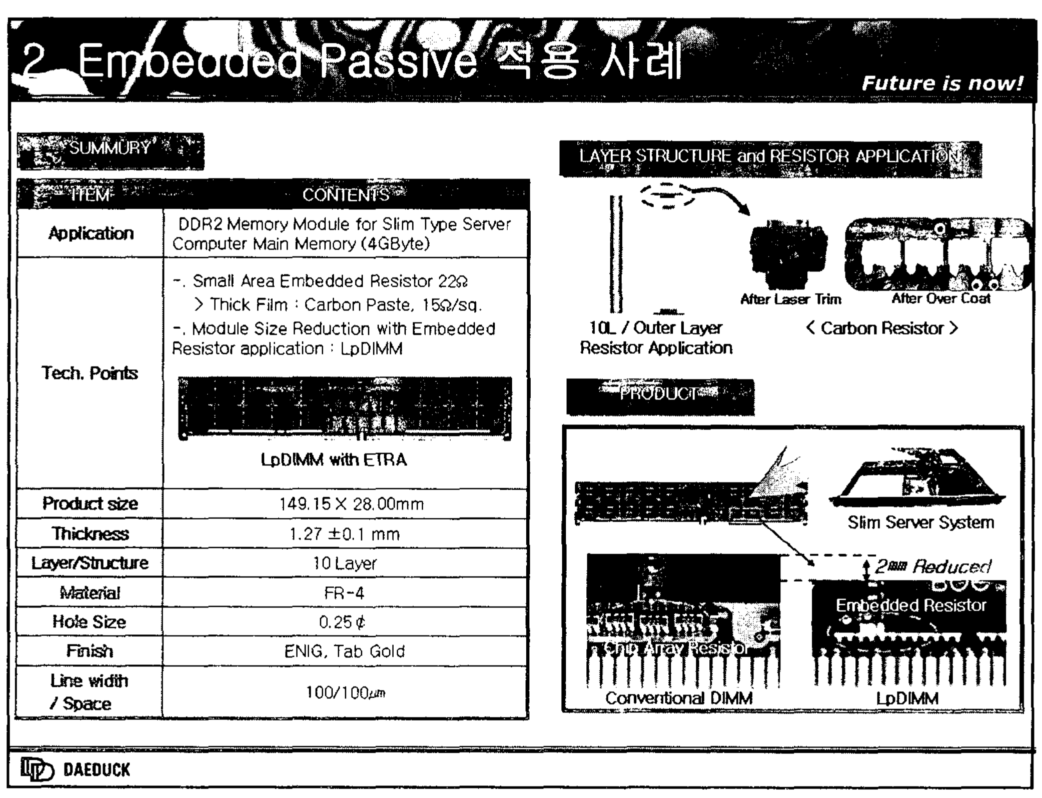


2. Embedded Passive 적용 사례

Future is now!

SUMMURY

ITEM	CONTENTS
Application	DDR2 256M UDIMM
Tech. Points	- Embedded Resistor, 10, 22Ω ± 5% → Thick Film : Carbon Paste 10Ω/sq. -Very small size carbon resistor → Resistor width is under 400㎛ -Tight tolerance control with Laser Trim → final ± 5% resistance control 10Ω ±5% resistor 22Ω ±5% resistor
Product size	133.35 X 30.00mm
Thick. / Layer	1.27 ±0.1 mm, 6Layer
Material	FR-4
Finish	OSP, Tab Gold
Line / Space	100/100㎛

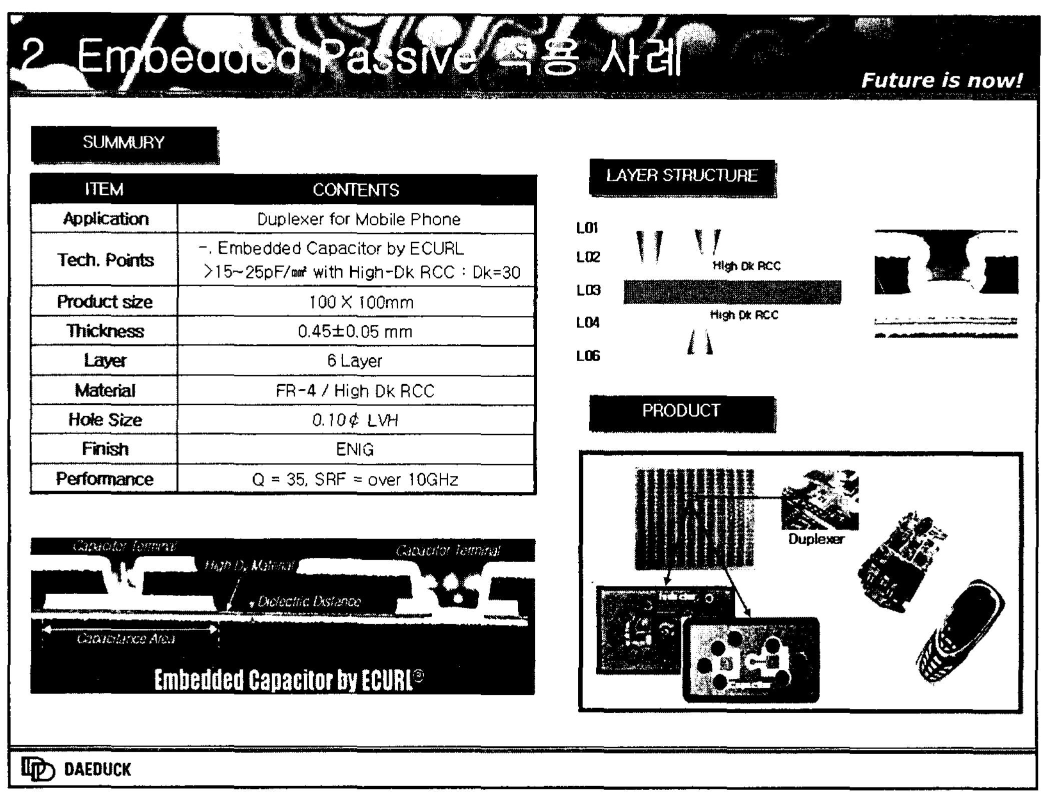


2. Embedded Passive 적용 사례

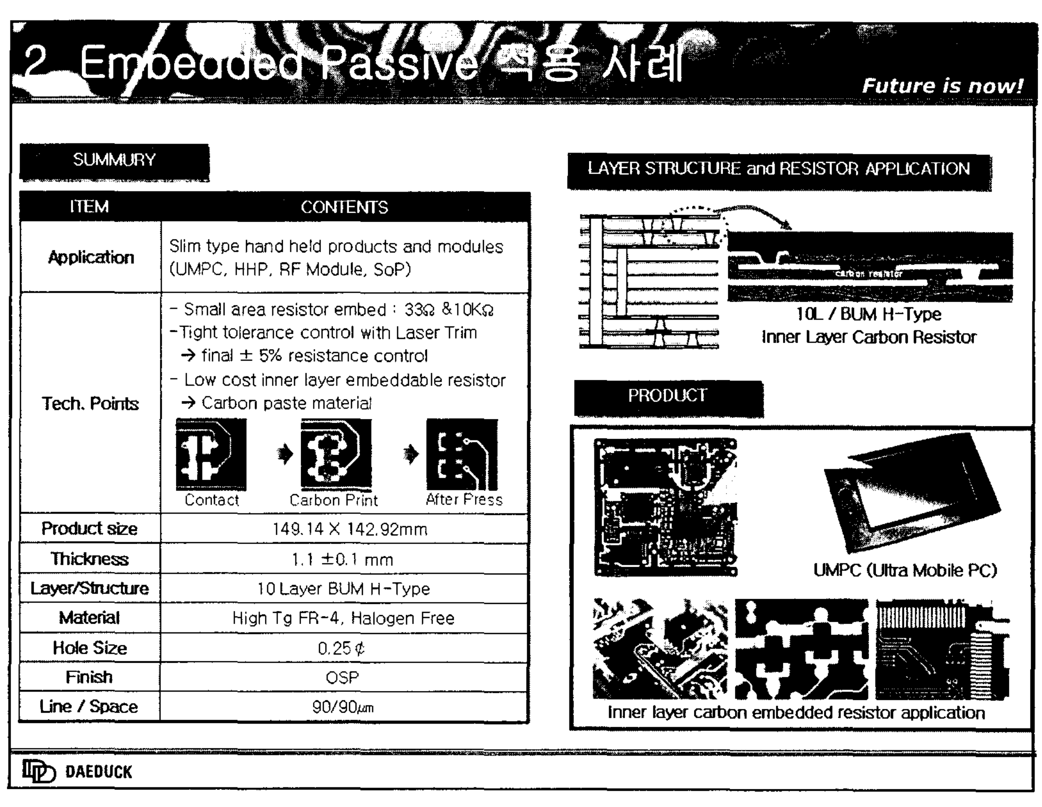
Future is now!

SUMMURY

ITEM	CONTENTS
Application	DDR2 Memory Module for Slim Type Server Computer Main Memory (4GByte)
Tech. Points	-. Small Area Embedded Resistor 22Ω > Thick Film : Carbon Paste, 15Ω/sq. -. Module Size Reduction with Embedded Resistor application : LpDIMM LpDIMM with ETRA
Product size	149.15 X 28.00mm
Thickness	1.27 ±0.1 mm
Layer/Structure	10 Layer
Material	FR-4
Hole Size	0.25¢
Finish	ENIG, Tab Gold
Line width / Space	100/100㎛



ITEM	CONTENTS
Application	Duplexer for Mobile Phone
Tech. Points	-. Embedded Capacitor by ECURL >15~25pF/㎟ with High-Dk RCC : Dk=30
Product size	100 X 100mm
Thickness	0.45±0.05 mm
Layer	6 Layer
Material	FR-4 / High Dk RCC
Hole Size	0.10¢ LVH
Finish	ENIG
Performance	Q = 35, SRF = over 10GHz



ITEM	CONTENTS
Application	Slim type hand held products and modules (UMPC, HHP, RF Module, SoP)
Tech. Points	- Small area resistor embed : 33Ω &10KΩ -Tight tolerance control with Laser Trim → final ± 5% resistance control - Low cost inner layer embeddable resistor → Carbon paste material Contact → Carbon Print → After Press
Product size	149.14 X 142.92mm
Thickness	1.1 ±0.1 mm
Layer/Structure	10 Layer BUM H-Type
Material	High Tg FR-4, Halogen Free
Hole Size	0.25¢
Finish	OSP
Line / Space	90/90㎛

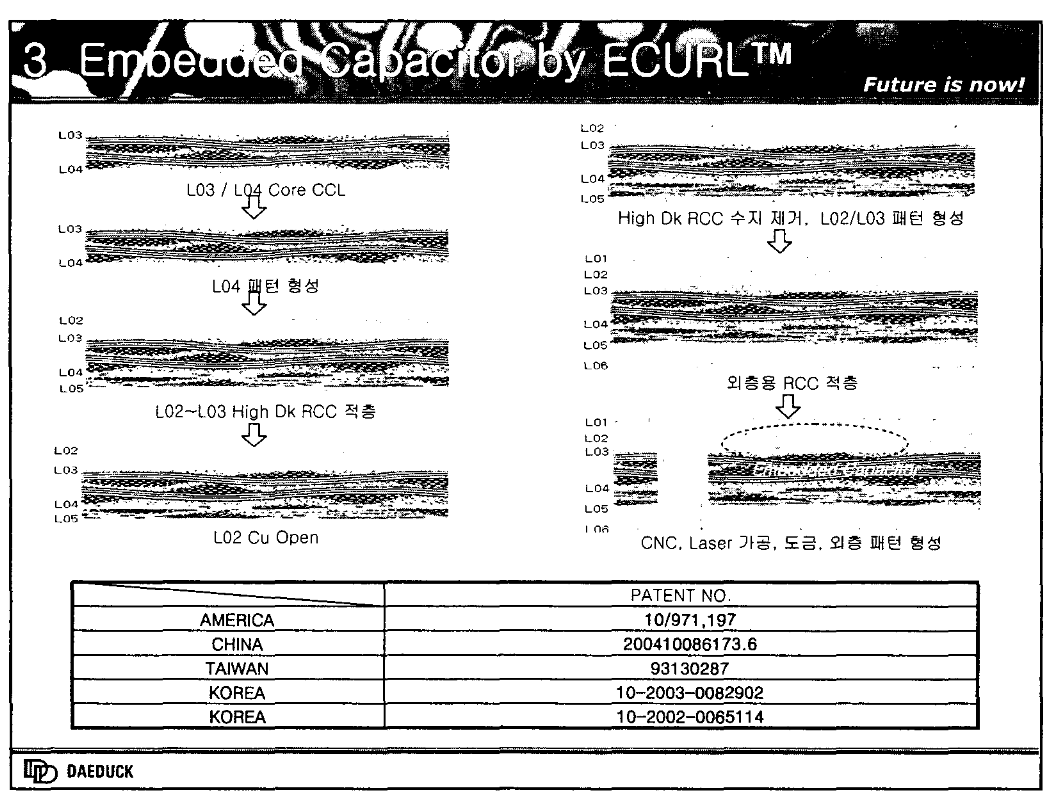
3. Embedded Capacitor by ECURL™

Future is now!

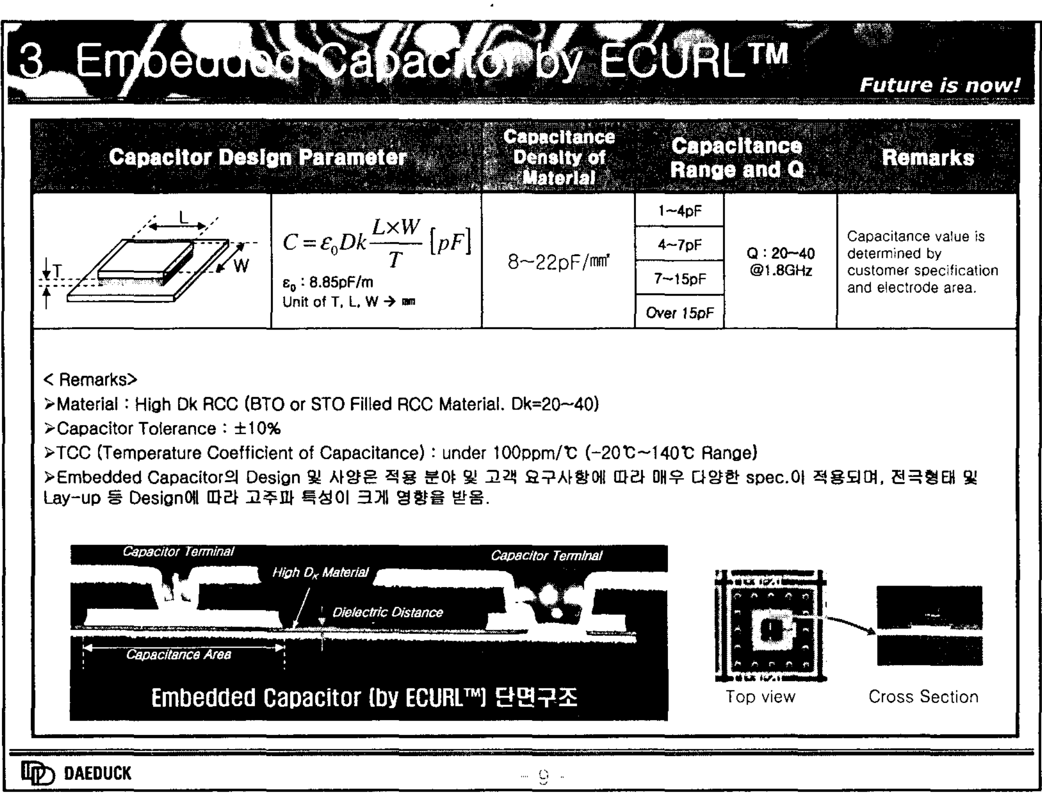
ITEMS	ZBC2000	ECURL™	MEZZANINE
MAKER	SANMINA	DAEDUCK	MOTOROLA
CAPACITOR MATERIAL	FR-4	RCC / HIGH Dk RCC	CFP
Dk (@1GHz)	4	3.5~40	20
Tan δ (@1GHz)	0.02	0.02	0.03
THICKNESS (um)	50	10~45	12
CAPACITANCE (nF/in²)	0.5	0.5~22	10
CAP. LAYER PROCESS	DEVELOP+ETCH	LASER DRILL+ETCH	DEVELOP+ETCH
KEY TECHNOLOGY	THIN CORE LAMINATION	LASER ABLATION	PHOTO DIELECTRIC
APPLICATION	NETWORK BOARD	NETWORK BOARD/ RF MODULE/SIP	RF MODULE/SIP

- ECURL™ : Embedded Capacitor Using Rcc & Lamination

DAEDUCK



	PATENT NO.
AMERICA	10/971,197
CHINA	200410086173.6
TAIWAN	93130287
KOREA	10-2003-0082902
KOREA	10-2002-0065114



3. Embedded Capacitor by ECURL™

Future is now!

Capacitor Design Parameter		Capacitance Density of Material	Capacitance Range and Q		Remarks
L, W, T	$C = \varepsilon_0 Dk \frac{L \times W}{T} [pF]$ ε_0 : 8.85pF/m Unit of T, L, W → ㎜	8~22pF/㎟	1~4pF	Q : 20~40 @1.8GHz	Capacitance value is determined by customer specification and electrode area.
			4~7pF		
			7~15pF		
			Over 15pF		

< Remarks>

➢Material : High Dk RCC (BTO or STO Filled RCC Material. Dk=20~40)

➢Capacitor Tolerance : ±10%

➢TCC (Temperature Coefficient of Capacitance) : under 100ppm/℃ (-20℃~140℃ Range)

➢Embedded Capacitor의 Design 및 사양은 적용 분야 및 고객 요구사항에 따라 매우 다양한 spec.이 적용되며, 전극형태 및 Lay-up 등 Design에 따라 고주파 특성이 크게 영향을 받음.

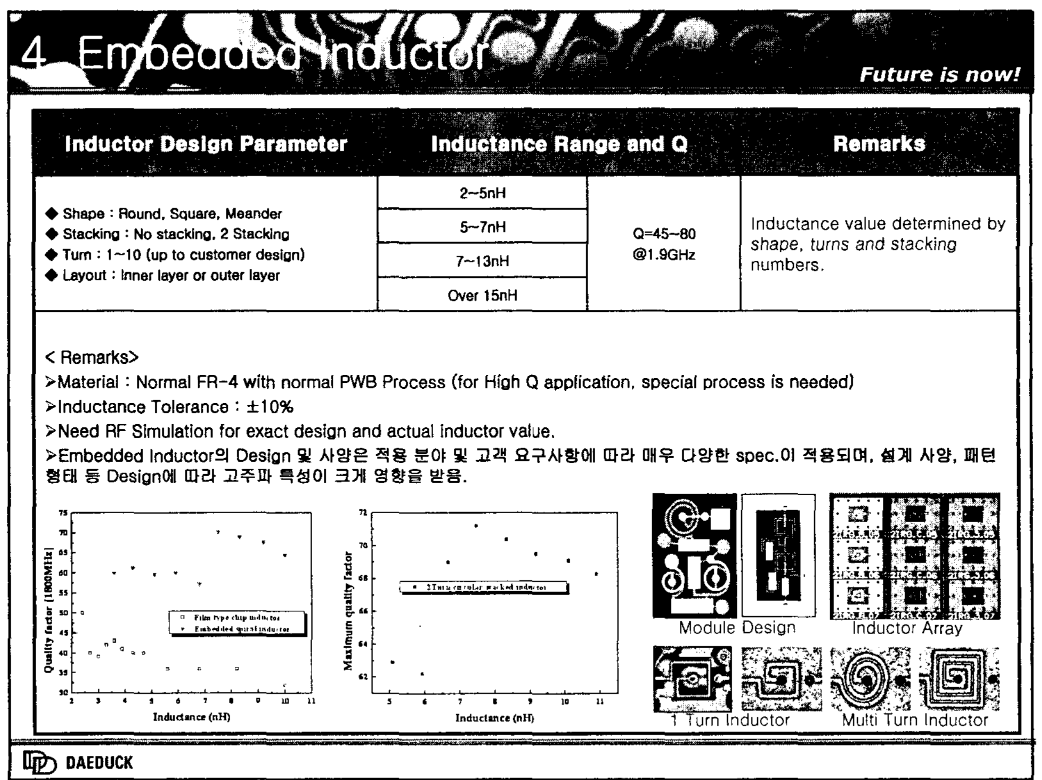
Embedded Capacitor (by ECURL™) 단면구조

Top view

Cross Section

DAEDUCK

- 9 -



4. Embedded Inductor

Future is now!

Inductor Design Parameter	Inductance Range and Q		Remarks
◆ Shape : Round, Square, Meander ◆ Stacking : No stacking, 2 Stacking ◆ Turn : 1~10 (up to customer design) ◆ Layout : Inner layer or outer layer	2~5nH	Q=45~80 @1.9GHz	Inductance value determined by shape, turns and stacking numbers.
	5~7nH		
	7~13nH		
	Over 15nH		

< Remarks>

➢Material : Normal FR-4 with normal PWB Process (for High Q application, special process is needed)

➢Inductance Tolerance : ±10%

➢Need RF Simulation for exact design and actual inductor value.

➢Embedded Inductor의 Design 및 사양은 적용 분야 및 고객 요구사항에 따라 매우 다양한 spec.이 적용되며, 설계 사양, 패턴 형태 등 Design에 따라 고주파 특성이 크게 영향을 받음.

Module Design

Inductor Array

1 Turn Inductor

Multi Turn Inductor

DAEDUCK

FEM (Front-End Module)

❖ FEM : 이동통신 단말기의 RF Front end 단을 집적화 시킨 모듈로서, 이동통신 단말기에서 아날로그 / 디지털 및 초고주파 신호를 처리하는 신호처리용 부품의 회로부분 중 시스템의 고주파 블록의 RF 필터, Duplexer, Diplexer, 스위치, PA (Power Amplifier)등을 집적 기술을 이용하여 소형화 시킨 모듈

❖ FEM은 기본적으로 PAM, SAW 필터, 안테나 스위치 모듈 등 RF 부품과 기판으로 구성되며, 기판은 고집적 실장용 PCB기판 또는 세라믹 기판임

ANT
CDMA RF Full Module
Triple/Dual RF Full Module
Base Band Block
LNA · Rx SAW · RFR · Memory
CDMA/AMPS DPX
PAM · Tx SAW · RFT · LCD
ANT SAW · MSM
PAM · Tx SAW · RFT · Camera Module
PCS DPX
LNA · Rx SAW · RFR · Key Pad
Triple/Dual Tx FEM
GPS · SAW · LNA · RFR · Speaker
A-GPS/S-GPS Quintplexer

Triplexer or SP3T (ANT SAW)
□ Triple/Dual FEM
Triple/Dual RF Full Module
□ Quintplexer

5. RF/Module 적용 사례(by ECURL™)
Future is now!

FEM 시장전망

❖ FEM 시장은 단말기 시장의 증가에 비례하여 증가하는 추세

- 2005년 9억불에서 2008년도 16억 달러 수준으로 증가할 전망

- 향후 모토로라, 노키아 등에서의 전력증폭기(PA)를 내장한 Tx 모듈형 채용 증가 전망

- 2006년 현재 Triple Band FEM의 대중화, Quad Band FEM의 단말기 채용 증가 추세에 있음

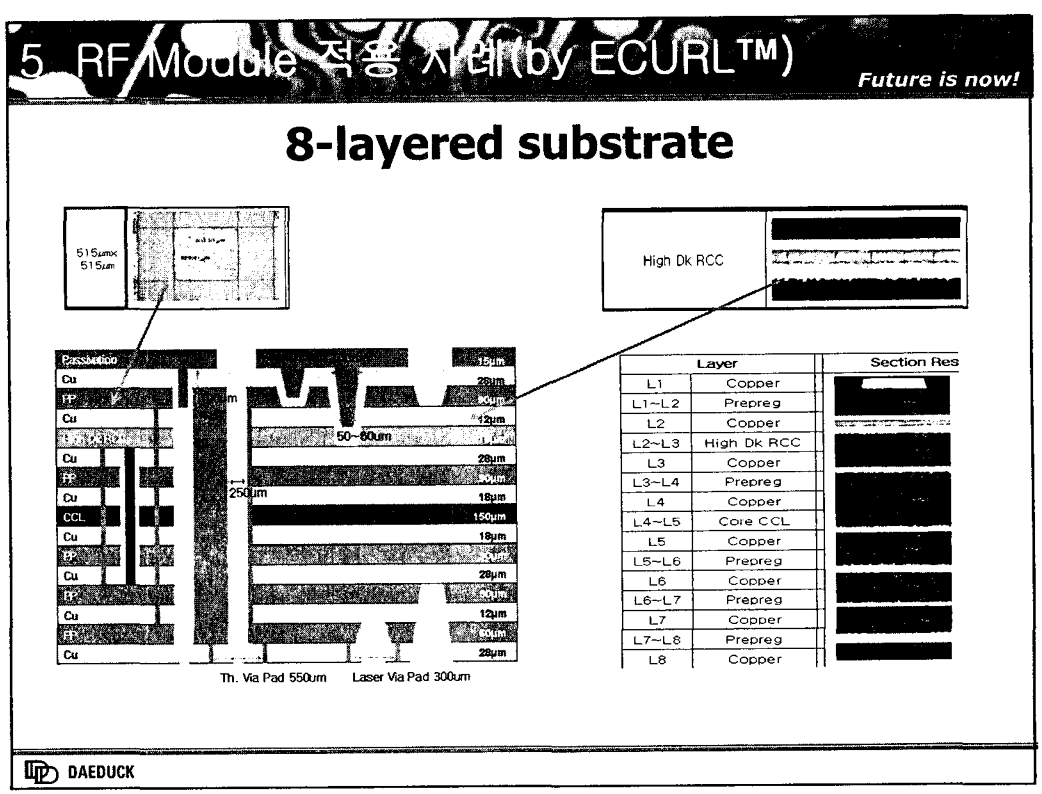
(단위 : 억 달러)

구 분		2004	2005	2006	2007	2008	2009	2010	계
시장 규모	세계시장	9.07	9.84	11.17	13.38	16.09	18.28	20.82	98.65
	국내시장	0.82	0.94	1.16	1.41	2.42	3.47	4.37	14.59
국내 매출액 규모	수출	0.04	0.06	0.09	0.16	0.62	1.17	2.03	4.17
	수입	0.7	0.78	1.02	1.03	1.33	1.21	1.09	7.16
	수입대체	0.12	0.16	0.26	0.38	1.09	2.26	3.28	7.55
	매출계	0.16	0.22	0.35	0.54	1.17	3.43	5.31	11.72

* 자료 : Navian, 'RF Device/modules for Cellular, Gartner, IDC

FEM 업체동향

System	Manufacturer – Domestic	Manufacturer – International	Customer
CDMA	■LG-Innotek **(DPX+PA module+ Tx BPF + Power Detector - PCB)** ■Samsung Electro-mechanics **(DiPX + DPX + PA module + Power Detector + Tx BPF - LTCC)** ■SAWNICS (개발중) **(DPX+PA module+ Tx BPF + Power Detector - PCB)**	■Skyworks **(Tx BPF + PA module + Power Detector + DPX - PCB)** ■Agilent **(PA module + DPX - PCB)**	■ Audiovox ■ Firefly Mobile ■ Hitachi ■ LG ■ Motorola ■ NEC ■ Nokia ■ Samsung ■ Sanyo ■ Sharp ■ Siemens ■ Sony Ericsson ■ Vertu
GSM	■LG-Innotek **(SW+PA module+ Tx BPF + Power Detector - PCB)** ■Samsung Electro-mechanics **(DiPX + LPF + SW + Coupler + Tx BPF - LTCC)** ■PILKOR (in developing) **(SW+PA module+ Tx BPF + Power Detector - LTCC)**	■Philips **(PA module + Power Detection + LPF + SW - PCB)** ■Anadigics **(PA module + harmonic filter + Switch - PCB)**	
Quad-Band (CDMA / GSM)	■LG-Innotek **(CDMA FEM + GSM FEM - PCB)**	■Anadigics **(GSM + DCS/PCS - PCB)**	



5. RF Module 적용 사례(by ECURL™)

Future is now!

Embedded FEM

❖ Embedded FEM
: Tx BPF + PAM + DPX
+ DC bias circuits + Matching circuit

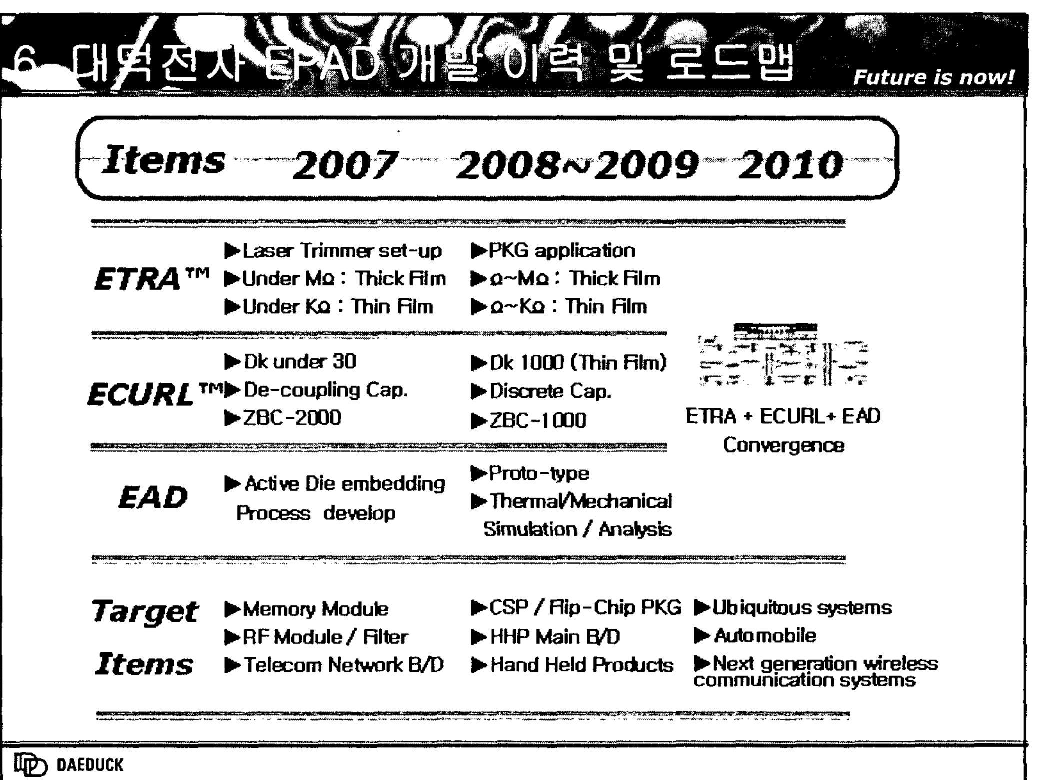
❖ SiP FEM
: PAM + DPX
+ DC bias circuits + Matching circuit

5 mm

5.5 mm

6 mm

DAEDUCK



6. 대덕전자 EPAD 개발 이력 및 로드맵

Future is now!

Items	2007	2008~2009	2010
ETRA™	▶Laser Trimmer set-up ▶Under MΩ : Thick Film ▶Under KΩ : Thin Film	▶PKG application ▶Ω~MΩ : Thick Film ▶Ω~KΩ : Thin Film	
ECURL™	▶Dk under 30 ▶De-coupling Cap. ▶ZBC-2000	▶Dk 1000 (Thin Film) ▶Discrete Cap. ▶ZBC-1000	ETRA + ECURL+ EAD Convergence
EAD	▶Active Die embedding Process develop	▶Proto-type ▶Thermal/Mechanical Simulation / Analysis	
Target Items	▶Memory Module ▶RF Module / Filter ▶Telecom Network B/D	▶CSP / Flip-Chip PKG ▶HHP Main B/D ▶Hand Held Products	▶Ubiquitous systems ▶Automobile ▶Next generation wireless communication systems

DAEDUCK