



RFMOD

RFMOD

RF Module & Optical Design Ltd

www.rfmod.com



Company

- RF Module & Optical Design Ltd (RFMOD) was established in October '04.
- We are a privately held company based in Cambridge, UK.
- Our core business is in the development of effective microelectronics packaging technology solutions for high volume portable radio products, such as mobile phones
- Our target customers are leading OSATS and IDMs supplying leading OEMs
- We are a new, independent Intellectual Property (IP) resource for the \$8Billion semiconductor packaging industry
- Our revenues are derived from a mixture of licensing and production royalties
- Our technologies are currently global - patent-pending



Target Markets

- Portable Wireless (Mobile phone)
 - RF Power Amplifiers
 - RF “Front-ends” and RF System-in-Package (SiP) solutions
 - Transceivers for WiFi™ / Bluetooth™ Zigbee™ ...
 - Power Management
 - Discrete blocks - VCO, LNA
- Image Sensors (Camera Modules)
- Biometrics (Finger print ID, Lab-on-a-chip)
- MEMS (Pressure sensors)
- RFID
- Power (MOSFET)



Worldwide Packaging Trends

WORLDWIDE IC PACKAGING DEMAND FORECAST
(Billion Units)

		2002	2003	2004	2005	2006	2007	2008
Thru hole	DIP	5.22	5.04	5.14	4.99	4.79	4.74	4.74
	SIP/ZIP	1.65	1.67	1.69	1.64	1.55	1.54	1.54
	PGA	0.42	0.43	0.48	0.46	0.43	0.43	0.43
	Others	0.19	0.18	0.17	0.16	0.15	0.15	0.15
	Total	7.48	7.33	7.48	7.24	6.93	6.86	6.86
SMT	SO	40.17	46.09	60.38	64.60	68.48	67.80	71.86
	QFN	1.35	2.54	6.48	11.98	13.78	13.92	15.17
	PLCC	1.60	1.68	1.85	1.87	1.77	1.74	1.72
	PQFP	11.79	14.98	18.28	19.74	20.72	20.31	21.33
	SM Cer.	0.26	0.29	0.32	0.32	0.33	0.31	0.31
	Others	0.23	0.24	0.26	0.27	0.28	0.28	0.25
	Total	55.40	65.82	87.56	98.79	105.37	104.35	110.64
DCA	TAB	0.96	1.12	1.25	1.33	1.42	1.41	1.42
	COB	3.49	3.89	4.67	5.13	5.44	5.28	5.23
	Total	4.45	5.01	5.92	6.46	6.87	6.69	6.65
Area Array	BGA	2.14	3.56	4.34	4.65	4.88	4.78	4.97
	CSP	4.13	4.70	5.97	6.51	6.90	6.83	7.24
	WCSP	0.11	0.18	0.37	0.50	0.55	0.56	0.56
	FCOB	2.01	2.27	3.34	3.74	4.04	4.04	4.16
	Total	8.39	10.71	14.02	15.39	16.37	16.20	16.93
3D	Stacked	0.83	1.42	2.84	3.98	4.17	4.17	4.38
Grand Total		76.55	90.29	117.82	131.86	139.70	138.28	145.47

KY860704

Source: BPA Consulting

QFN has the highest growth rate in history



RFMOD

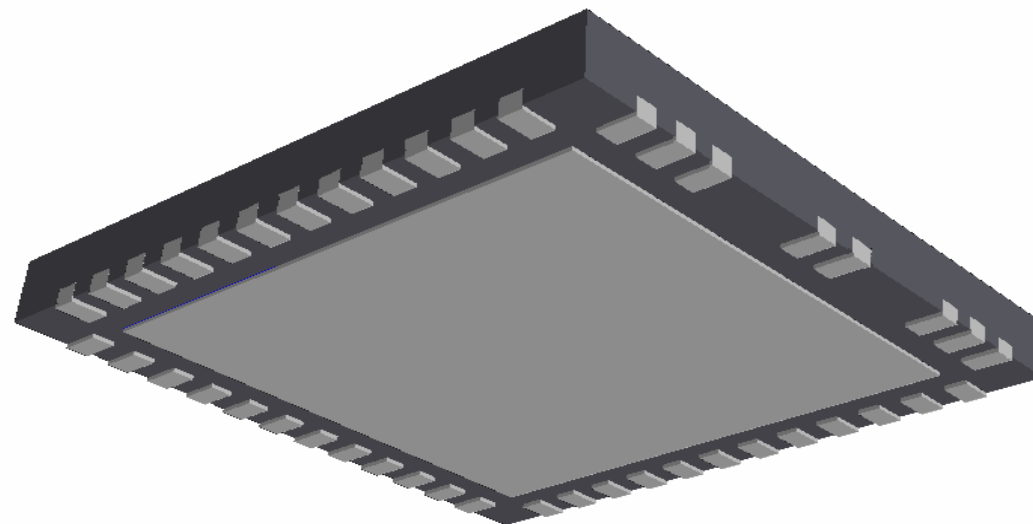
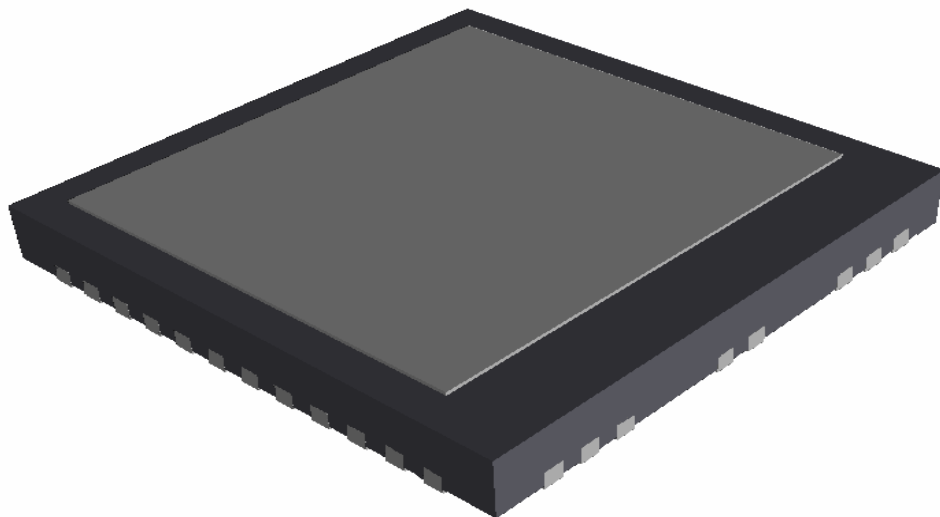
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Technology

CLAM-LP™



CLAM-LP™

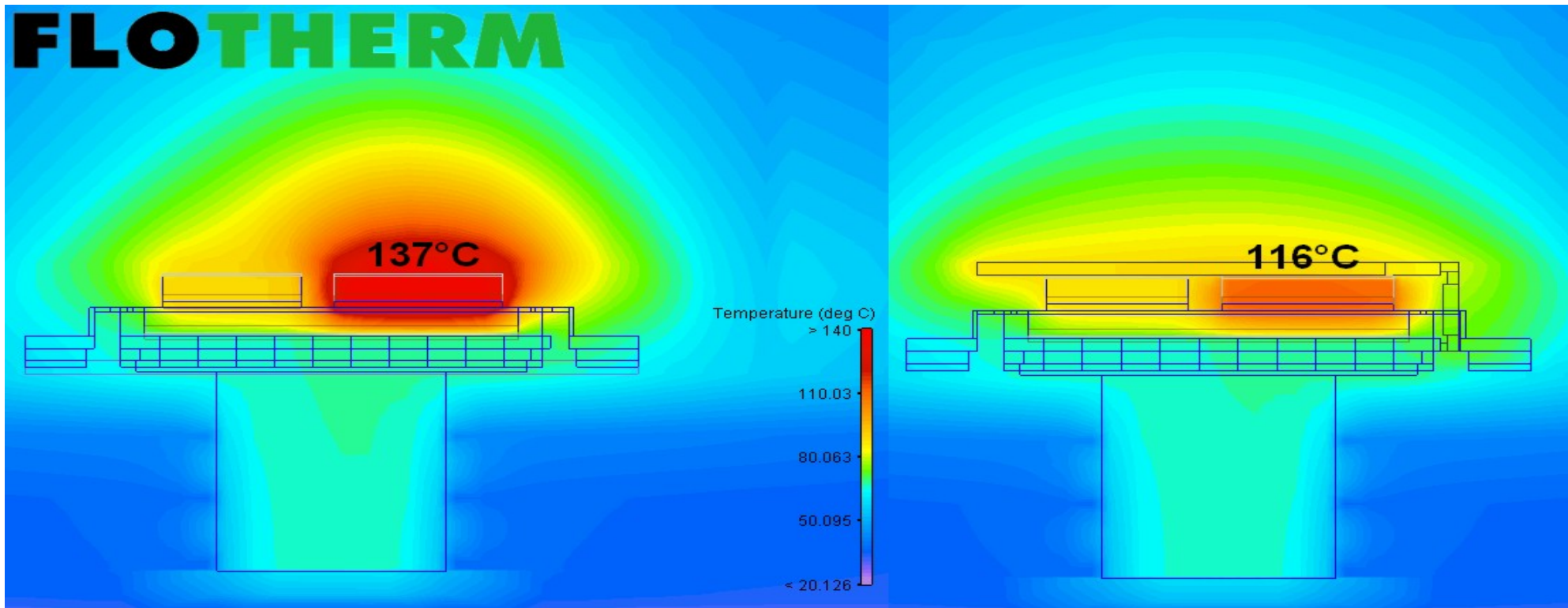


**The worlds first QFN package
with upper and lower grounded pads**



Features

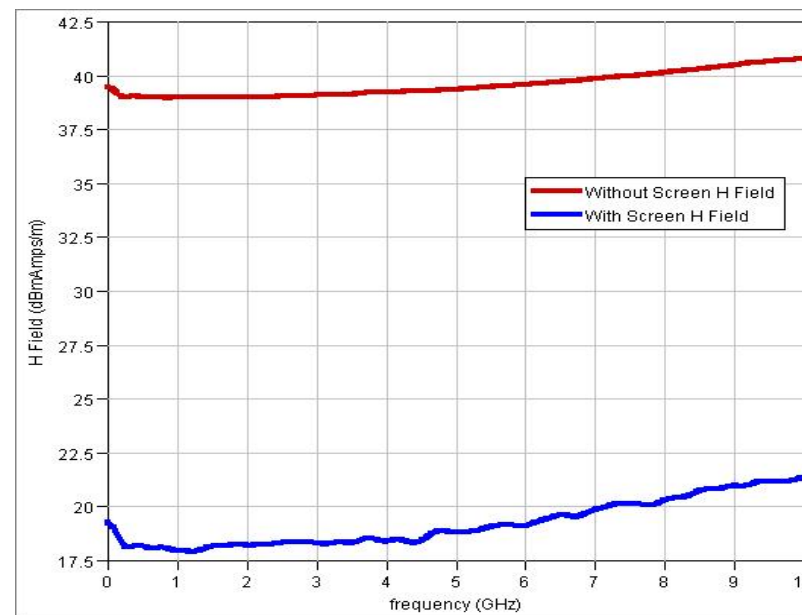
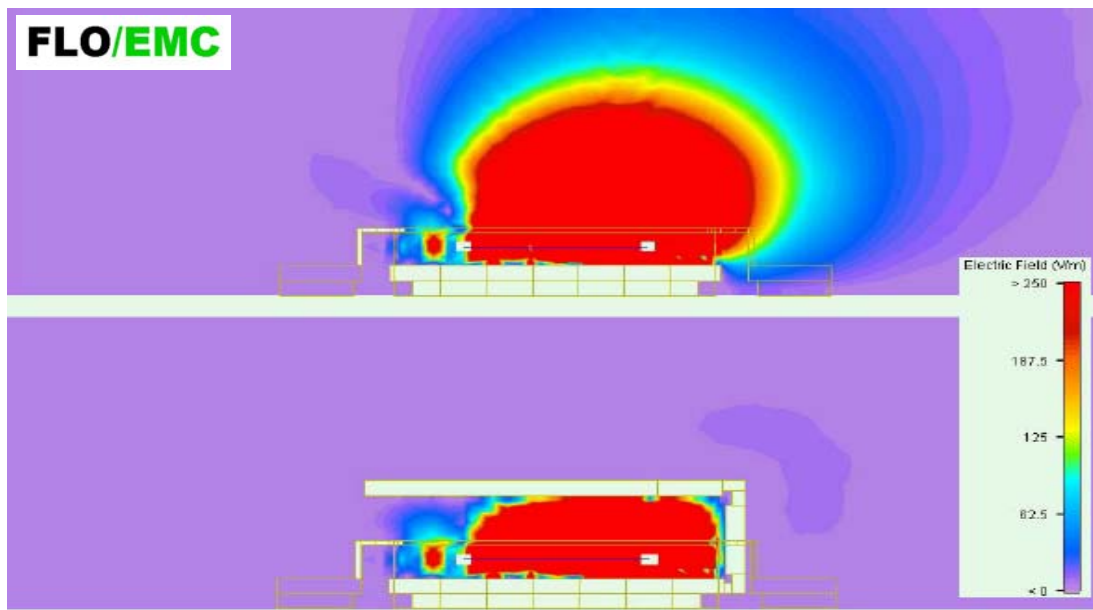
- Integrate EMI / EMC shield
- Interconnected Double Pad Heatsink
- Integrated Inductor / Antenna Option
- Inherent Low-cost of QFN
- Suitable for single chip or System-in-Package (SiP)
- Size range from 3x3 to 12x12mm (JEDEC M0220 and M0229)
- Low profile - Standard 0.9, 0.75 and 0.5mm
- Suitable for Quad (QFN) Dual (DFN), & Array I/O
- Standard Wire bond, Flip-chip-onto-leadframe or Stacked die
- Uses existing leadframe processing
- Uses same assembly line infrastructure and materials
- Options for Camera Module (Image Sensor and Glass / Lens mount)



Source: Flomerics FloTHERM Tools

- Thermal Simulation showing improvement for Tri-Band Cellular PA.
 - PA(1W) and its controller (100mW) are shown flip chip mounted onto an Integrated Passive Die. The IPD provides PA input and Output matching and local supply decoupling.
 - The CLAM-LP's unique structure assists dissipation of the PA's thermal energy by spreading heat through the exposed top pad to air and directly to the PCB through the copper leadframe connection to the grounded die attach pad.

The unique top pad is an effective heatsink ...

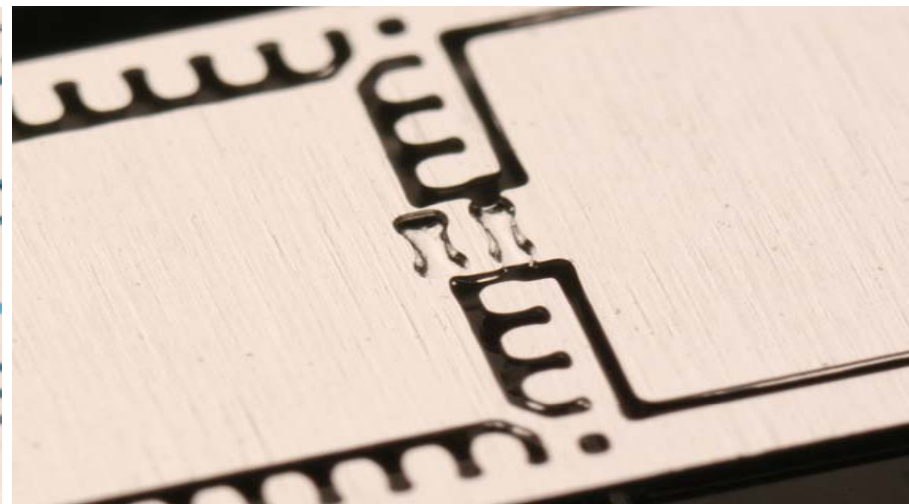
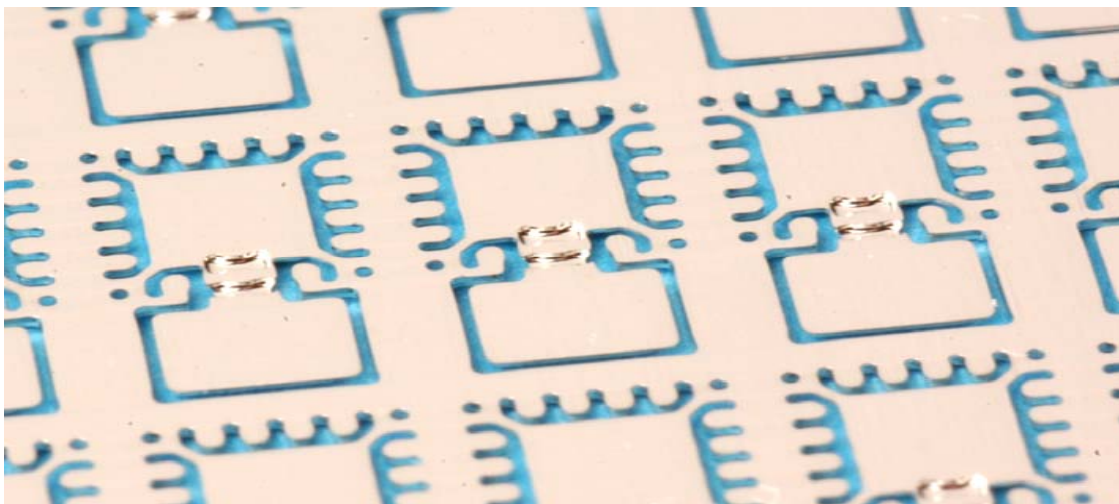


SE = over 40dB at 10GHz

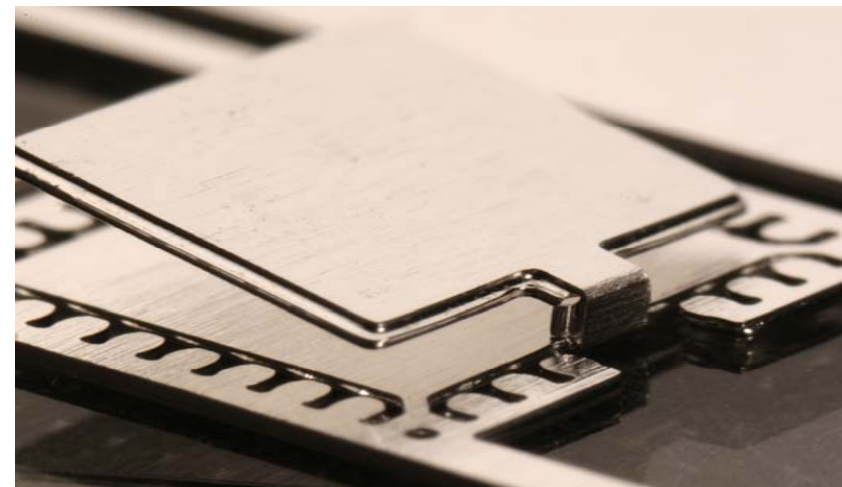
Source: Flomerics FloEMC Tools

- EMI Simulation showing E Fields at 2.4GHz
 - The CLAM-LP's unique structure contains emitted E and H fields at the package level.
 - The Top pad is grounded internally
 - The simulation above shows a minimum SE of approx. 20dB up to 10 GHz for max die size in 3x3x0.9mm package
 - Simulations for larger die in larger package 7x7x0.9mm have demonstrated a SE of approx. 40-50dB up to 10 GHz

... and EMI shield



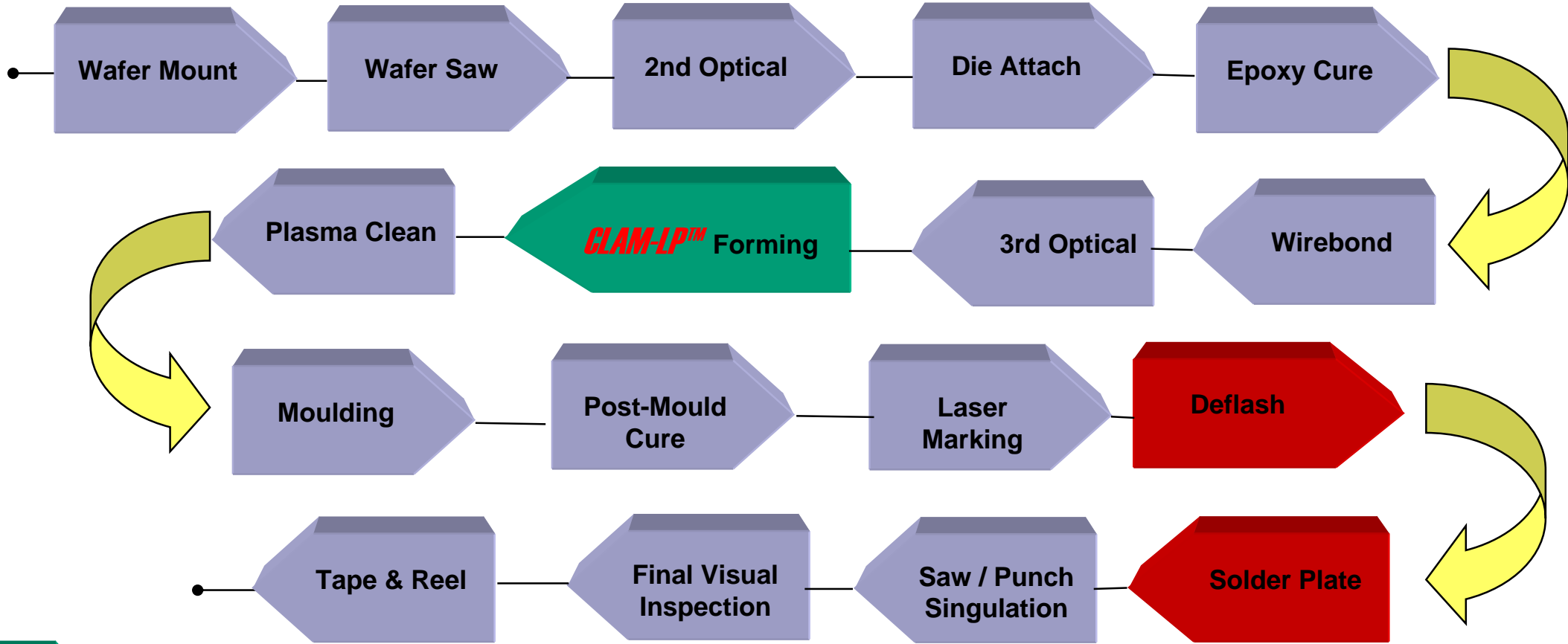
Our patent-pending design uses standard “half-etch” processes to define “bend points”



CLAM-LP™ Leadframe



CLAM-LP™ Manufacturing Process



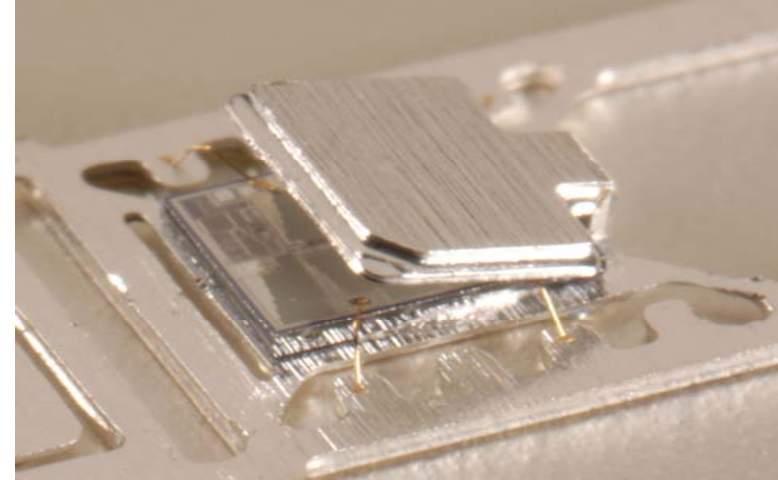
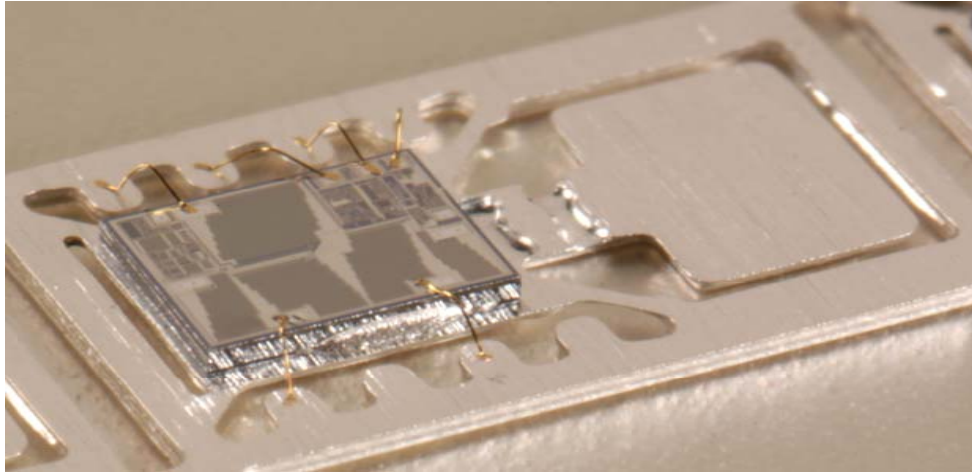
- Extra Forming Step



- Optional, Dependent upon Mold Tool and use of Pre-plate Leadframe



CLAM-LP™ Forming Step

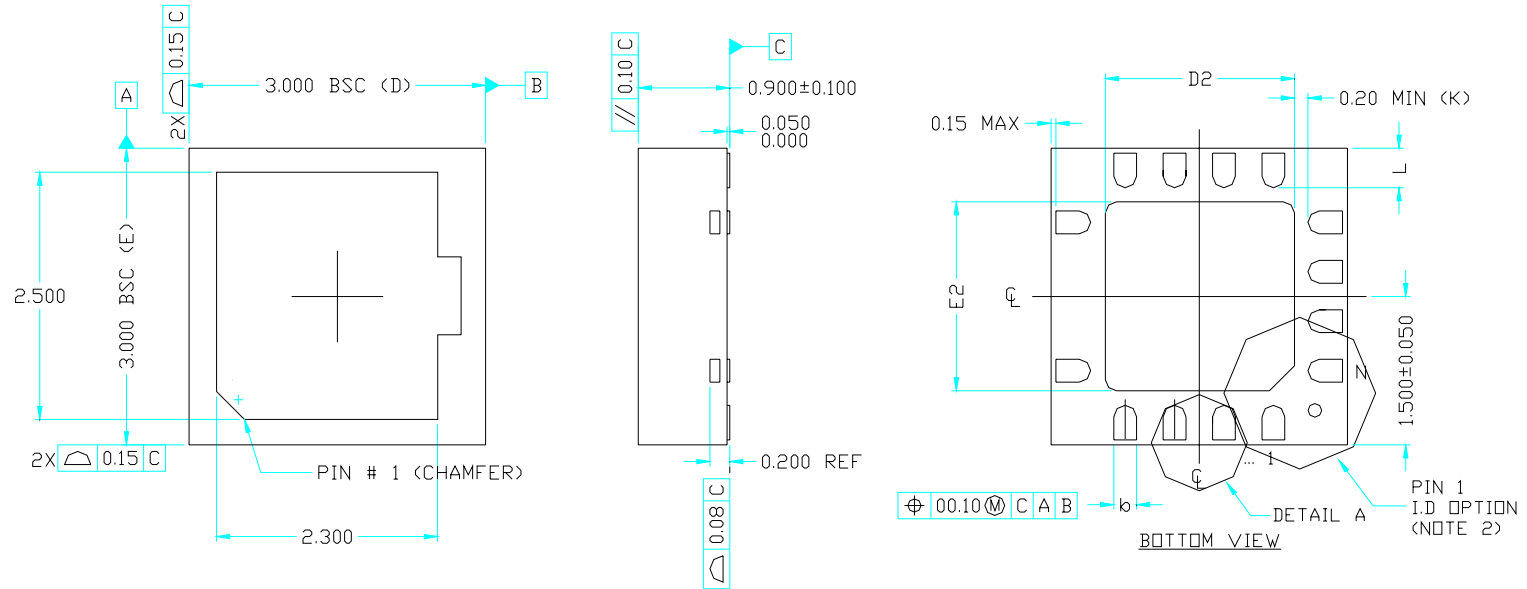


Source: Assembly and Photography - TWI Cambridge

- Top pad is formed over the assembled, wirebonded and inspected die
- Forming phase is completed while still in the leadframe array
- Forming is done prior to plasma clean and mould
- Accurate final positioning of top pad can be achieved by descending mold tool



REV	DESCRIPTION	DATE	BY
A	INITIAL RELEASE	01MAY05	VJR / AGH



NOTE : 1. DRAWING CONFORMS TO JEDEC REFERENCE MO-220 REVISION 1.
 2. PIN 1 I.D. CAN BE A COMBINATION OF DOT AND/OR CHAMFER.

PROJECTION 	UNIT MM	RFMOD TM	RF Module & Optical Design Limited Farfield Innovation Centre Albert Road, Cambridge, United Kingdom T: +44(0)1223 810282 F: +44(0)1223 812400
APPROVAL VJR	DATE 19APR05	TITLE 3x3x0.9 MM CLAM-LP QFN PACKAGE OUTLINE DRAWING	
CHECKED JPC		DRAWING NO. DRG-RFCLMLP-303009-XTP-1	REV. A
APPROVED AGH		SCALE DO NOT SCALE	SHEET 1 OF 2
RELEASED RFMOD-DC			

14 LD 3x3x0.9mm **CLAM-LP**TM QFN



Picture Withheld

4x4x0.9mm **CLAM-LP™** shown with integrated DC Bias Line Inductor
High current, High Q, Serpentine Inductive trace is 200um wide, 200um thick, approx. electrical length 18mm

- **CLAM-LP™** package top pad can be used to fabricate functions such as Power Amplifier DC Bias lines, High Q inductors or Antenna
- A DC inductor could also act as an EMI shield and Heatsink

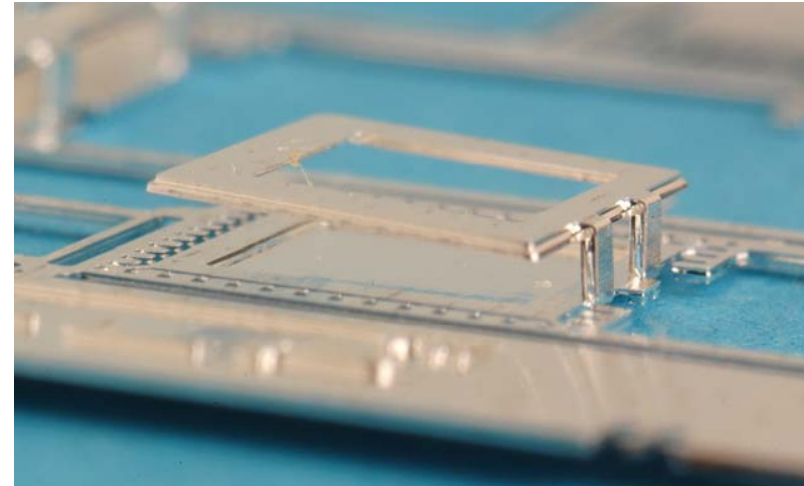
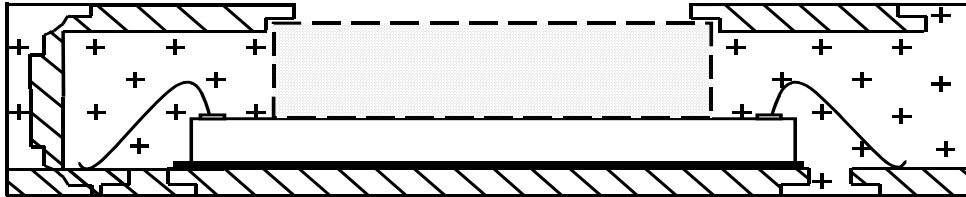
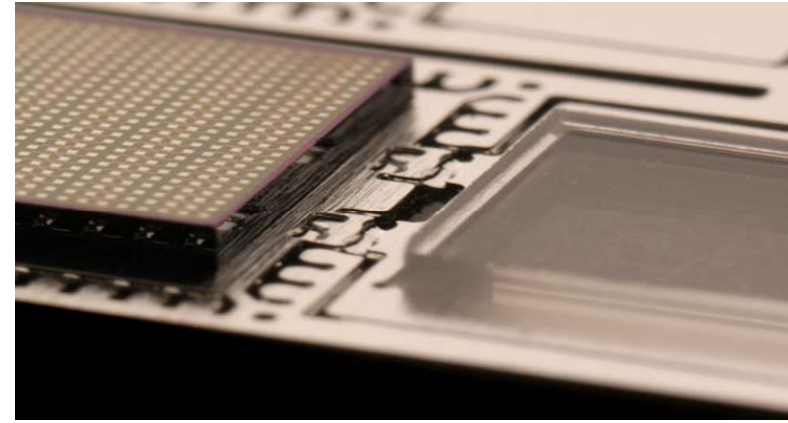
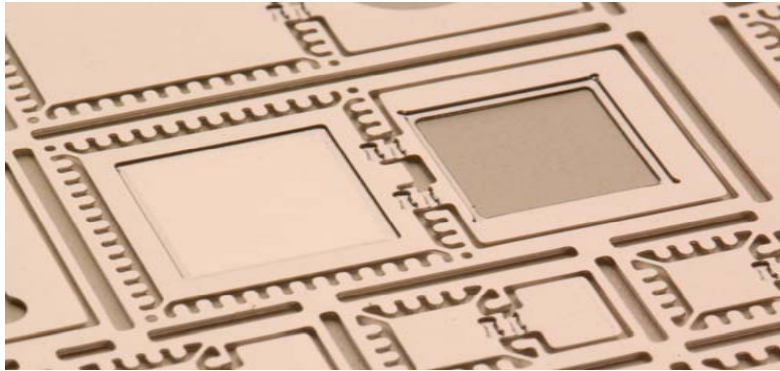


Image Sensor Characteristics:

- Top pad is used as mount for UV Glass
- Image sensor and glass die are assembled on the leadframe while flat
- Thin (0.9mm) construction
- Low cost
- 1st level EMI Protection

CLAM-LP™ Image Sensor



CLAM-LP™ Licensing

RFMOD offer its technology through Supported Licensing programme.

This includes:

- Design Studies
 - Thermal
 - EMI Simulation
 - Area and Cost studies
- Prototype Design and Fabrication
- Technology Transfer
- Partnership in New Product Developments



Summary

- **RFMOD** are a new IP company developing key solutions for the \$8Bn microelectronics packaging industry
- **RFMOD** are addressing the Integration, Thermal and EMI shielding needs of portable wireless systems at the device level
- **CLAM-LP™** technology enhances standard QFN while maintaining the same JEDEC outlines and materials set
- **CLAM-LP™** offers solutions in many applications e.g. image sensors.
- **CLAM-LP™** meets the demands of tomorrows portable wireless products - today
- **RFMOD** offer and support its technology through flexible licencing



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