

Simulation and Design of Printed Circuit Boards Utilizing Novel Embedded Capacitance Material

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emc 2010
Navigating EMC

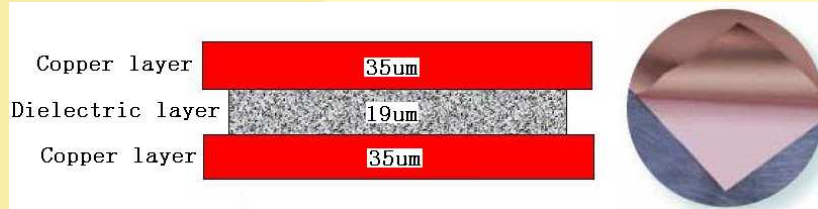


Outline

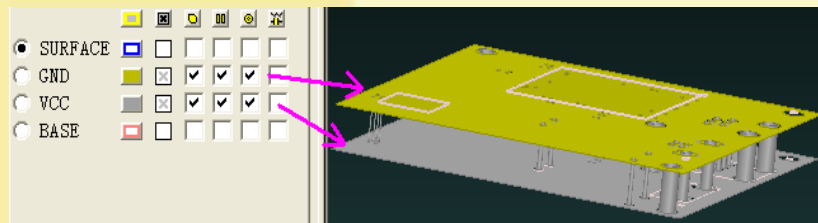
- *Embedded Capacitance Material Introduction*
- *Impedance Simulation Comparison for boards with ECM or FR-4 Power/Ground Core*
- *Comparison of the power noise measurement*
- *In Board Interference Analysis for ECM and FR4 Board*
- *ECM Impact to Signal Integrity*
- *Board Level EMC Performance Comparison – Simulation*
- *Board Level EMC Performance Comparison – Test Result*
- *The Application Prospect of the Embedded Capacitance Materials*
- *Questions*

Embedded Capacitance Material Introduction

- Planar sandwich structure ECM
- Higher capacitance density than thin core FR4
- Higher decoupling bandwidth than discrete MLCC caps
- 3M C-PLY19
 - 19um filled insulation
 - >6nf/sq inch C/A



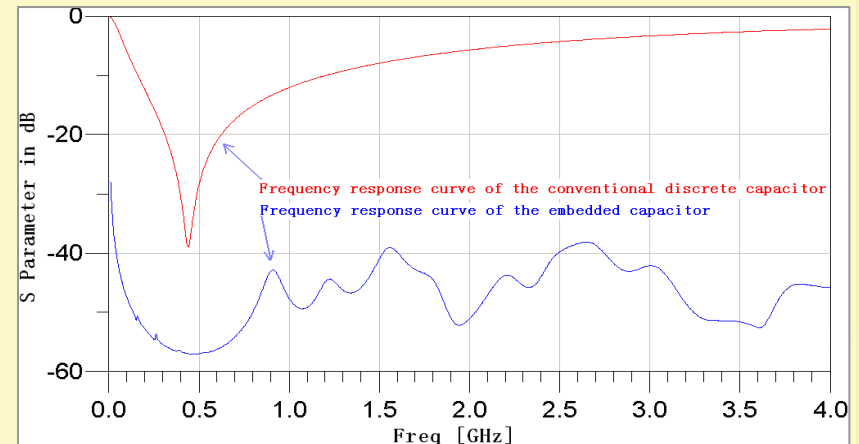
Schematic illustration of 3M C-PLY19



Schematic illustration of PCB plate capacitor

Materials name	FR-4	3M C-PLY19
Parameters	(PCB plate capacitor)	(Embedded capacitor)
Composite	FR-4	Epoxy/Ceramic filler
Dielectric constant (DK)	$\cong 4.0\sim 4.5$	21
Dielectric consumption (DF)@1GHz	$\cong 0.02$	0.03
Dielectric thickness (um)	≥ 68	19
Capacitance density (nF / inch ²)	≤ 0.3	6.2

Electrical parameters comparison
FR4 plate capacitance vs ECM (3M C-PLY19)



Frequency response comparison , MLCC vs ECM

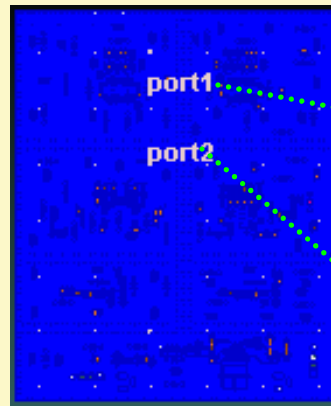


Impedance Simulation Comparison for boards with ECM or FR-4 Power/Ground Core

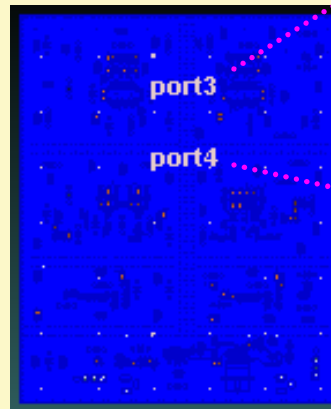
- Same board stack up and layout
- Only difference in Pwr/Gnd core material
- Impedance port set on same position in simulation
- Much lower impedance of ECM from 10MHz~6GHz than FR4
- Much more resonance in FR4 curve, higher impedance and power noise

Layer name	Layout figures	Layout explanation
L1		TOP (GND)
L2	pp(FR4)	SIGNAL
L3	core(FR4)	POWER
L4	pp(FR4) or 3M c-ply19	GND
L5	core(FR4)	SIGNAL
L6	pp(FR4)	BOTTOM (GND)

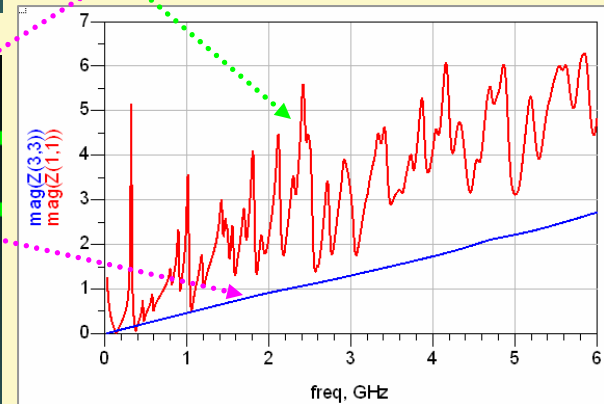
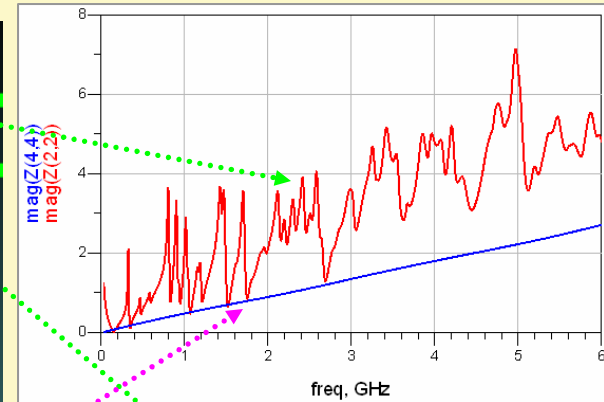
Sample board Stack up



FR-4 PCB



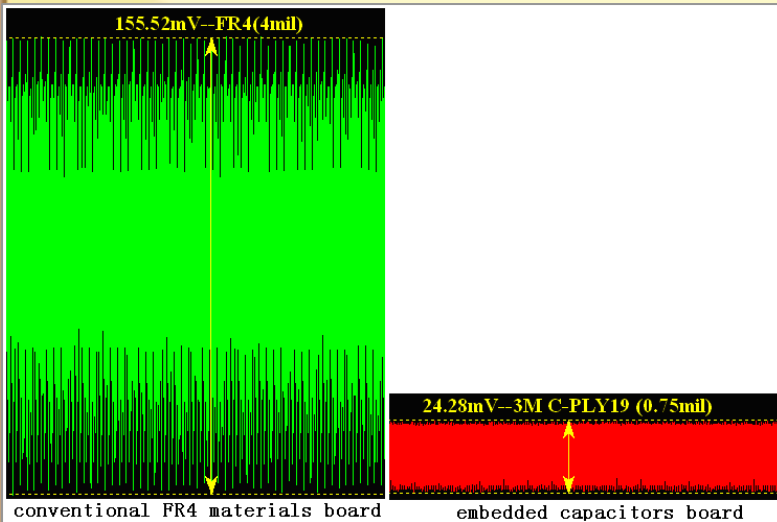
3M C-PLY19 PCB



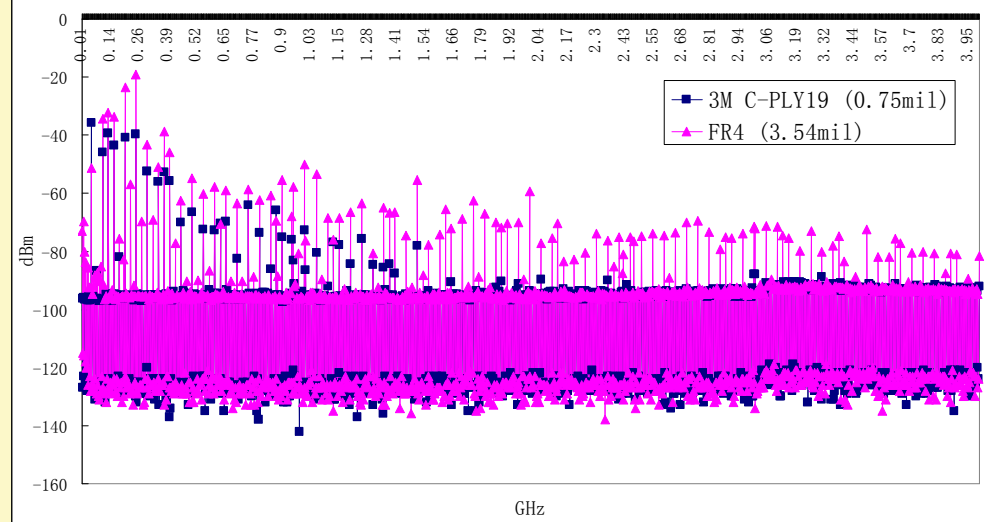
Impedance Comparison
Blue for ECM
Red for thin core FR-4 plate capacitor



Comparison of the power noise measurement



Power ripple noise comparison in time domain

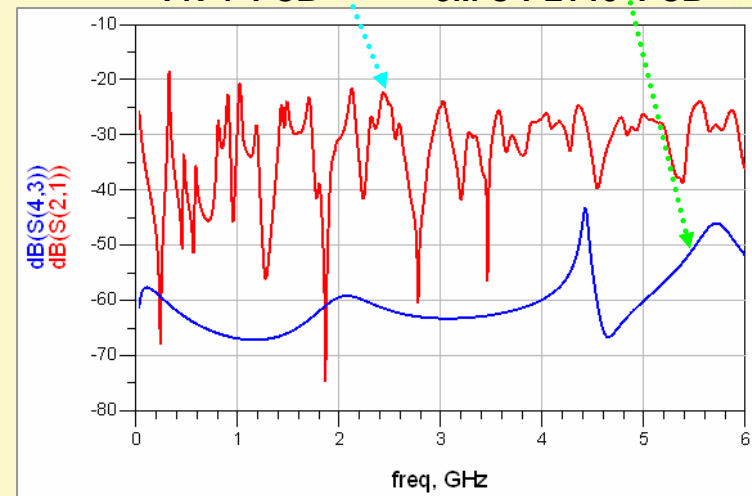
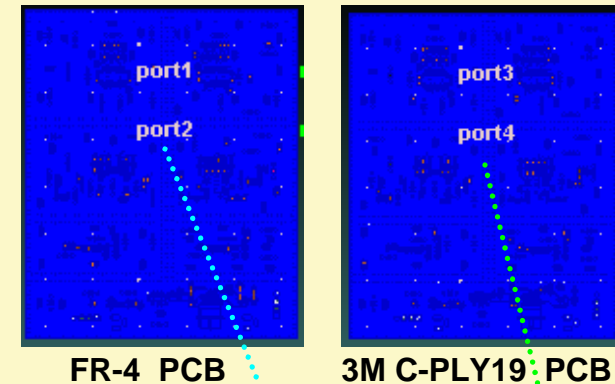


Power noise frequency spectrum comparison

- Power noise ripple of FR4 board is much higher than that of ECM board.
- ECM board shows superiority over FR4 on noise reduction in entire bandwidth 10MHz-4GHz.
- ECM board noise close to white noise of Spectrum Analyzer in higher frequency over 1.5GHz.
- Very promising for ECM to improve power supply quality, digital /analog interference in board & board level EMI.

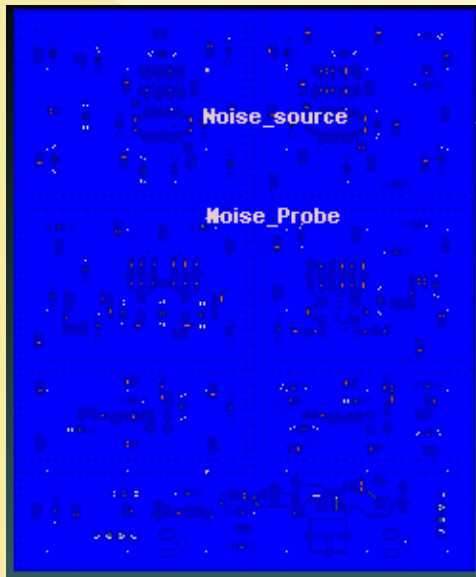
In Board Interference Analysis for ECM and FR4 Board

- Port set on same connectors position on FR4 / ECM board
- Transmission coefficient between same ports of ECM board is much lower than that of FR4 board
- ECM board minimized risk for interference from shared power distribution system within board

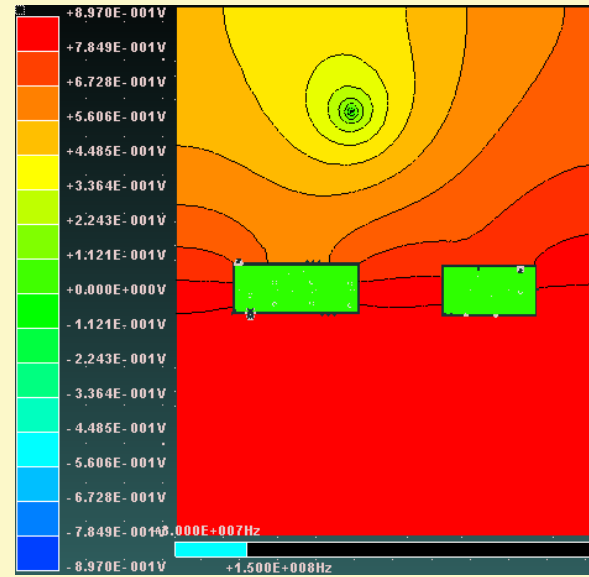


Transmission coefficient comparison
Red for FR4, Port1,2 ,Blue for ECM, Port3,4

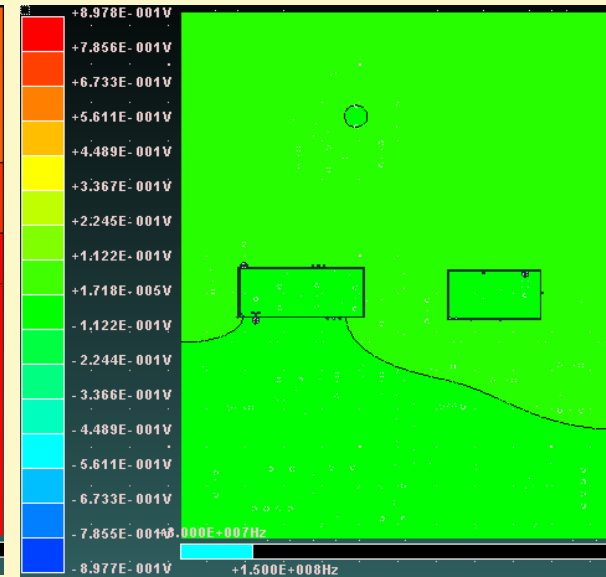
In Board Interference Analysis for ECM and FR4 Board



Simulation setup



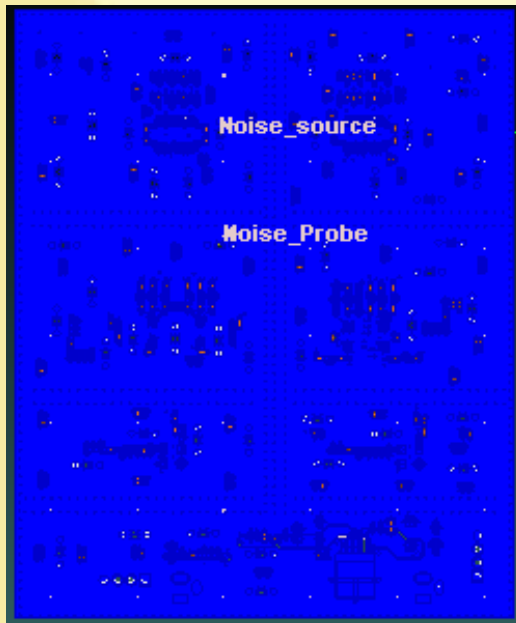
power noise distribution on FR-4 board



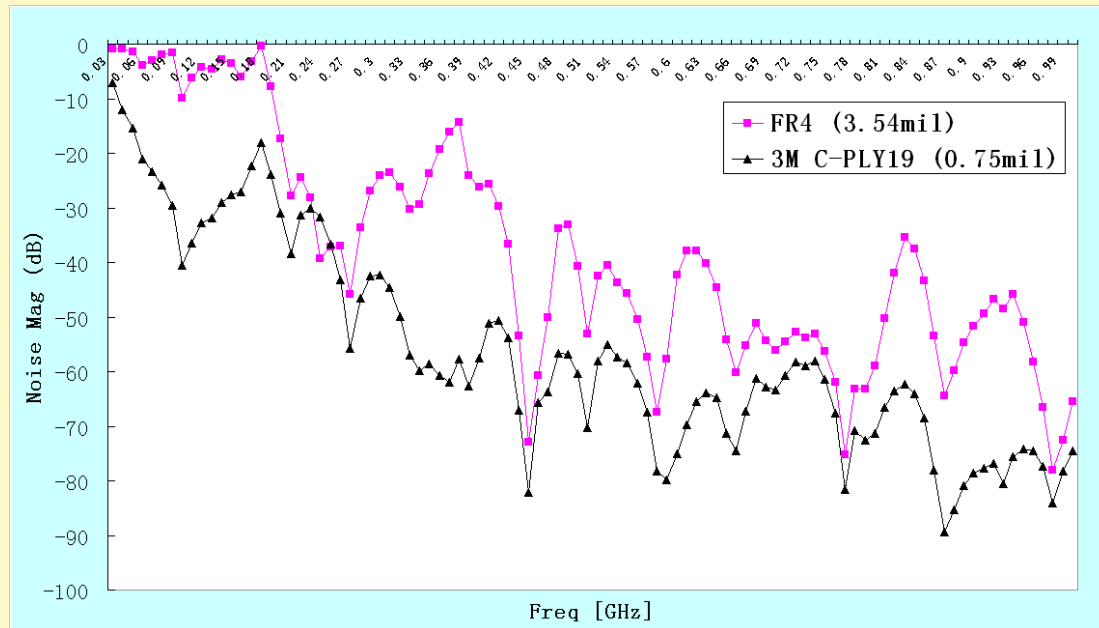
power noise distribution on ECM board

- Set noise source and noise probe on same position of FR4 / ECM board
- Same noise source input
- smaller noise distribution area and lower noise amplitude on power plane for ECM board

In Board Interference Analysis for ECM and FR4 Board



Simulation setup

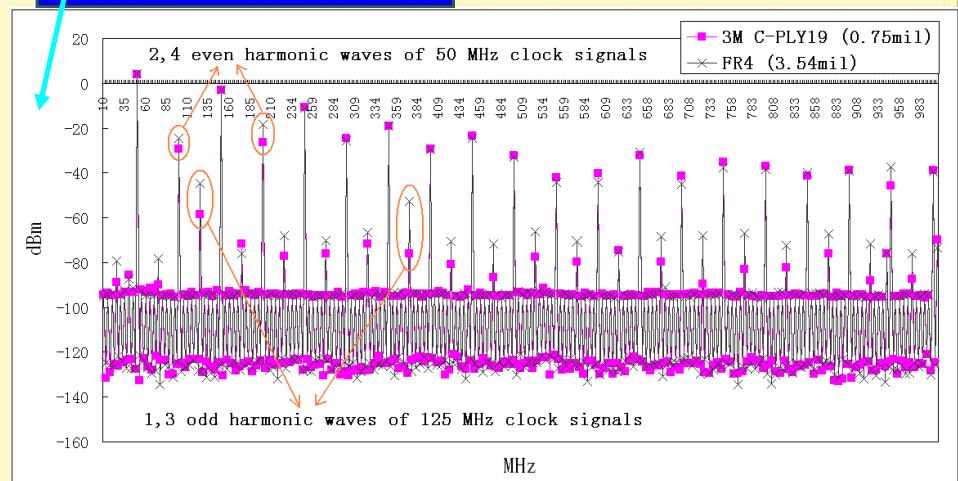
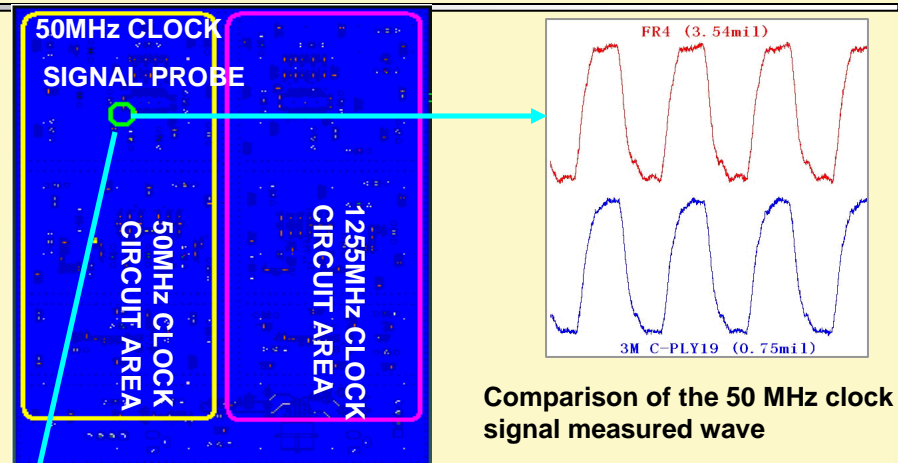


Noise spectrum comparison on same probe position

- Same noise source and probe setup
- Superior noise spectrum of ECM board in all frequency range

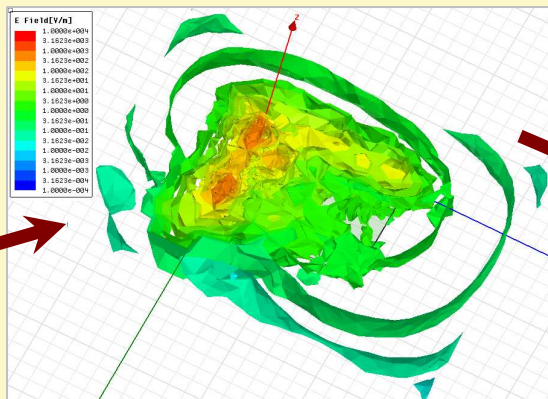
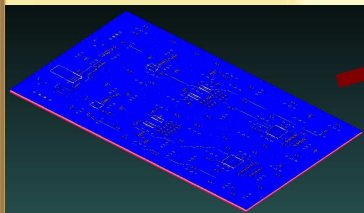
ECM Impact to Signal Integrity

- Same functional circuit on the board for FR4 and ECM board
- 50MHz & 125MHz clock on different zone but with same power
- 125M Clock as aggressor
- 50M clock as victim to see its signal wave and spectrum received
- 50M clock on ECM board less influenced by 125M clock with better jitter and duty cycle

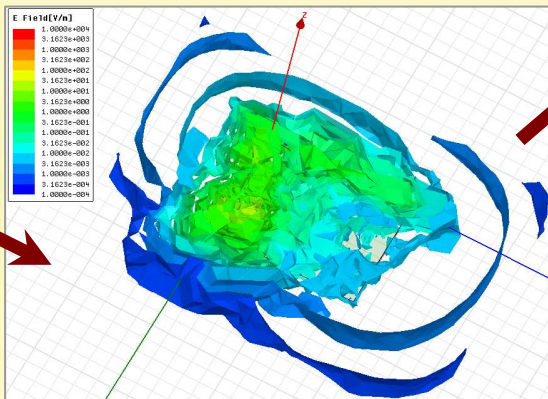
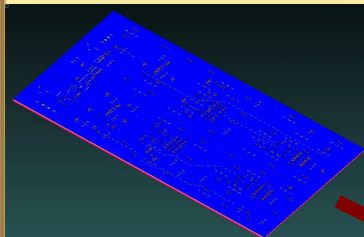


Board Level EMC Performance Comparison -- Simulation

PCB FR4(3.54mil)

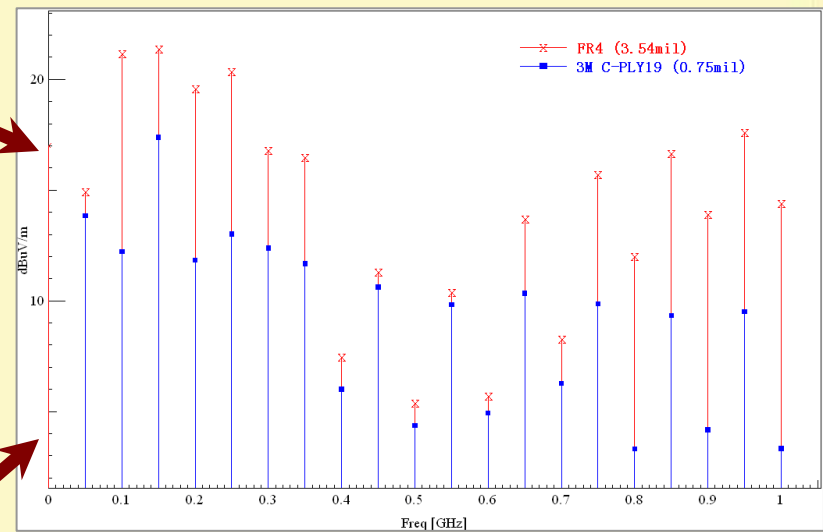


PCB 3M C-PLY19 (0.75mil)



Free space field distribution

EMI simulation result (3 Meter field)



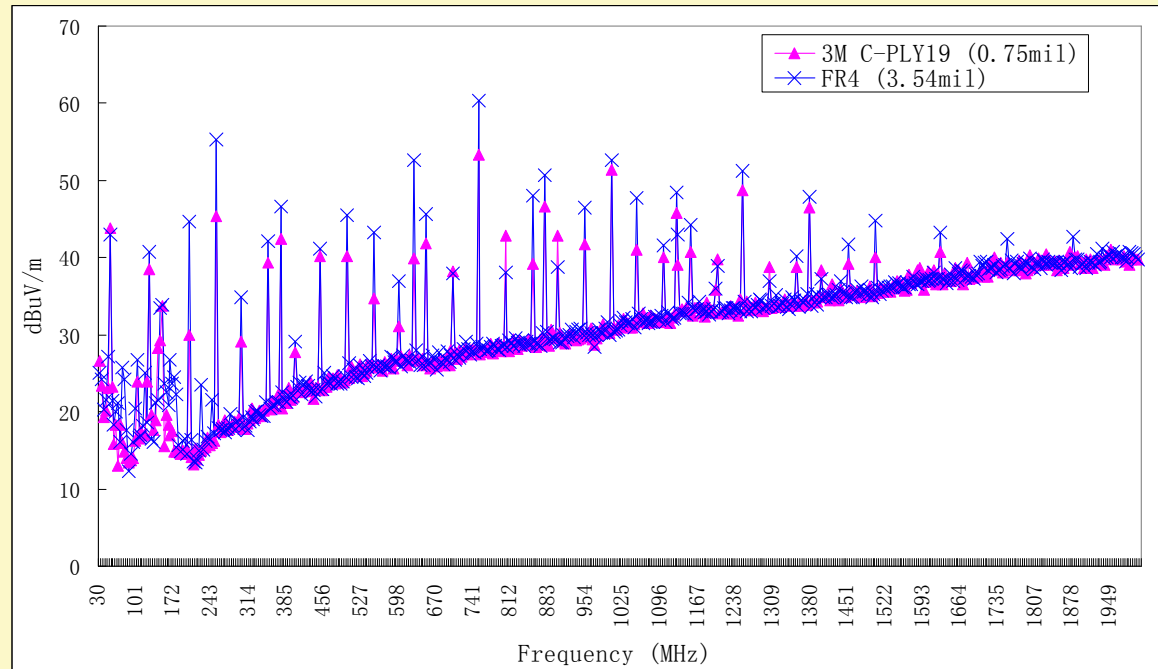
- With same noise source excitation , free space field and 3 Meter field result of ECM board is lower than that of FR4 in all bandwidth simulated



Board Level EMC Performance Comparison – Test Result



Full Wave Darkroom



Radiated Emission Test Result (30MHz - 2GHz)

- Radiated Emission Test in standard full wave darkwave for FR4/ECM board.
- Obvious better performance of ECM board from 30M to 2G (only tested up to 2G)



The Application Prospect of the Embedded Capacitance Materials

Due to excellent performance of Embedded Capacitance Material in SI , PI , EMC, it will be well suitable for application in:

- 1. Digital/analog Interference Design with Digital/analog Mixed Board*
- 2. EMC Design of the Non-shielding Box-type Products with Plastics shell*
- 3. Power Integrity and Signal Integrity Design of the High Speed and High Density Board*

Questions

