

PLAN

- **UTE EMC task force and program history**
- **ICEM model technical basis, technical reminders**
- **ICEM implementation in IBIS database**
- **ICEM validation**
- **ICEM cookbook**
- **Conclusion**



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UTE EMC TASK FORCE

AND PROGRAM HISTORY



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UTE TEAM

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	MAURICE Olivier	VALEO
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	SAINTOT Pierre	ST MICRO ELECTRONIQUE
	SOUBEYRAN Amaury	EADS CRC
University	SICARD Etienne	INSA
	RAMDANI Mohamed	ESEO

History

- 1994 : WORKING GROUP UTE/CEF 93GT5 EMC
- 06 / 1997 : IEC 93 / 67 NP
- 1998 : DATE 98 / INTERNATIONAL TASK FORCE
- 2000 : DATE 2000 / IEC INTERNATIONAL EXPERTS MEETING
- 03 / 2001 : IEC 62014 - 3
CDV proposal sent to IEC
for standard approval



		93/146/CDV	
		DRAFT TECHNICAL REPORT	
Project number		62014-3/TR/Ed.1	
IEC/TC or SC		Secretariat	
TC 93		U.S.A.	
Distributed on		Voting terminates on	
2001-11-30		2002-05-03	
Also of interest to the following committees		Supersedes document	
Functions concerned			
<input type="checkbox"/> Safety	<input checked="" type="checkbox"/> EMC	<input type="checkbox"/> Environment	<input type="checkbox"/> Quality assurance
<p>THIS DOCUMENT IS STILL UNDER STUDY AND SUBJECT TO CHANGE. IT SHOULD NOT BE USED FOR REFERENCE PURPOSES.</p> <p>RECIPIENTS OF THIS DOCUMENT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.</p>			
Titre: CEI 62014.3: CEM des composants – Partie 3 : Modèle électrique des circuits intégrés (ICEM)		Title: IEC 62014-3: EMC for Component – Part 3: Integrated circuits Electrical Model (ICEM).	

- 03 / 2001 : DATE 2001 MUNICH IBIS SUMMIT MEETING

PROGRAM STATUS

- **IEC 62014-3 DOCUMENT COMPLETION AND IEC APPROVAL.**
- **SANTA CLARA PRESENTATION (End of JANUARY 2002)**
- **COOK BOOK UNDER CONSTRUCTION**
- **DATE 2002 PARIS IBIS SUMMIT MEETING**

ICEM and cookbook documents available on the UTE web:
www.ute-fr.com

ICEM MODEL

Integrated Circuits

Electromagnetic Model

TECHNICAL BASIS

TECHNICAL REMINDERS

ELECTROMAGNETIC AND HF NOISE SOURCES

- **Power supply lines emission :**

Switching activity in different modules (Internal/peripheral)

High frequency current through package connections

- **I/O connections noise emission :**

Noise due to output fast signals and package characteristics

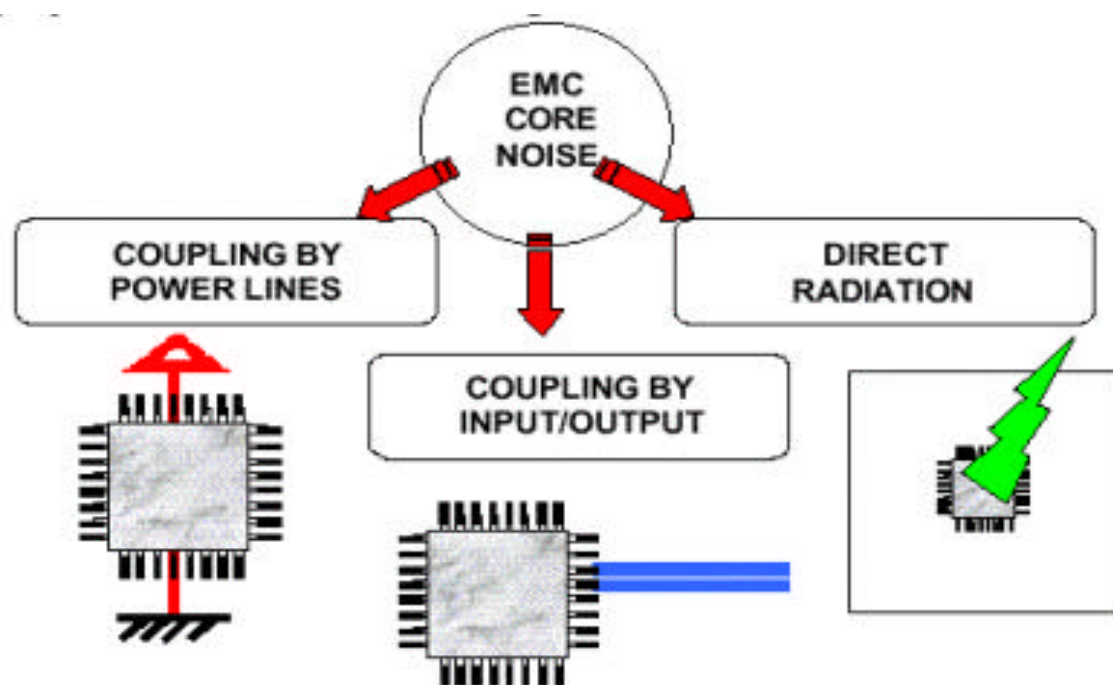
Noise coupling through package to the other I/O pins

Noise coupling through package to other powers supplies

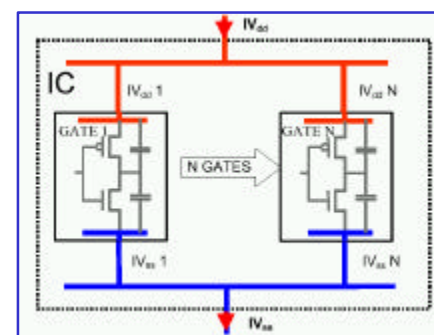
- **IC Direct emission :**

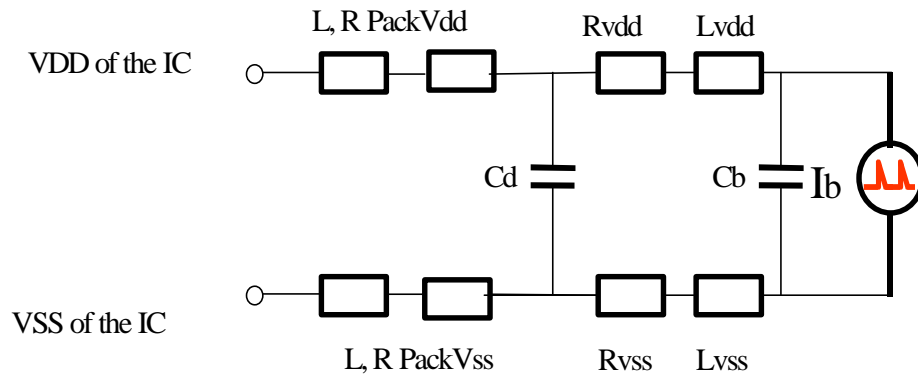
Package Bonding and metal die connections

Mechanisms for parasitic emission covered by ICEM model

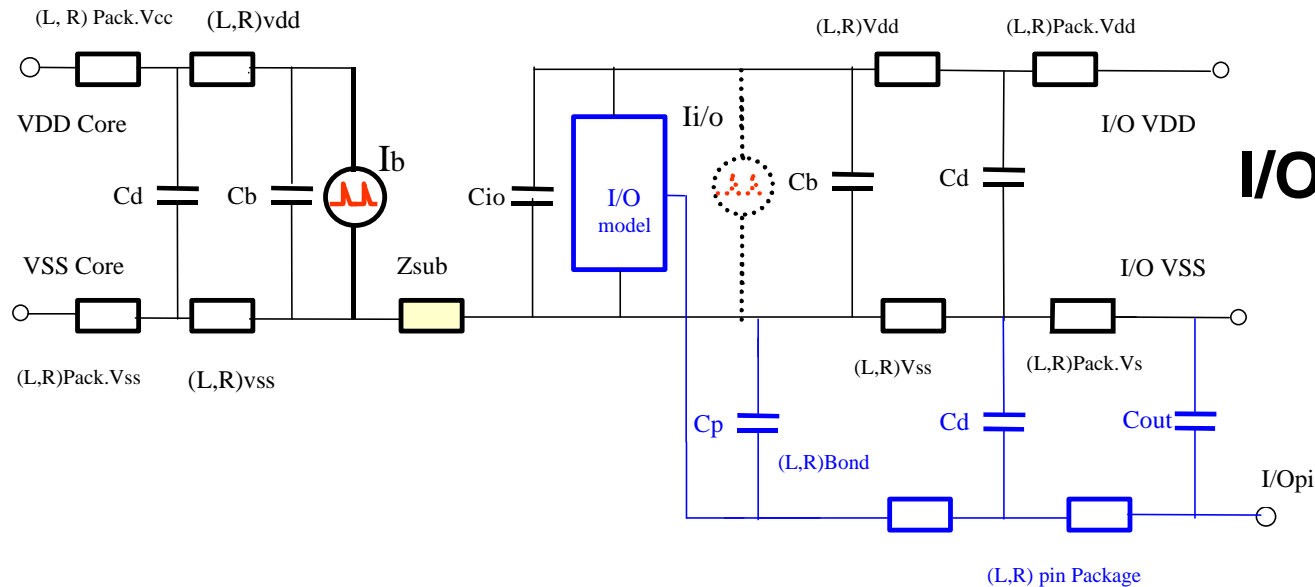


Origin of parasitic emission in CMOS: gate switching





Power lines contribution



I/Os contribution



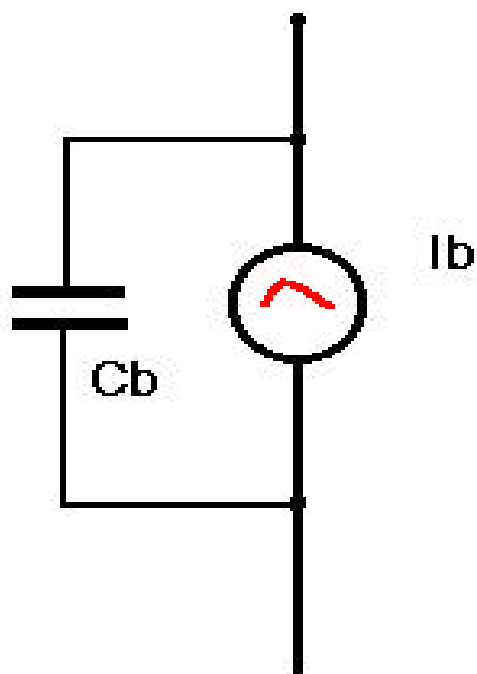
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ICEM IMPLEMENTATION

IN IBIS DATABASE

CURRENT GENERATOR DESCRIPTION



[Ib generator]

[Cb capacitor]

Variable	Typ	Min	Max
C_pkg	2.045e-13	8.363e-14	3.75e-13

[Vdd Vss Pin]

[Ib current]

Variable

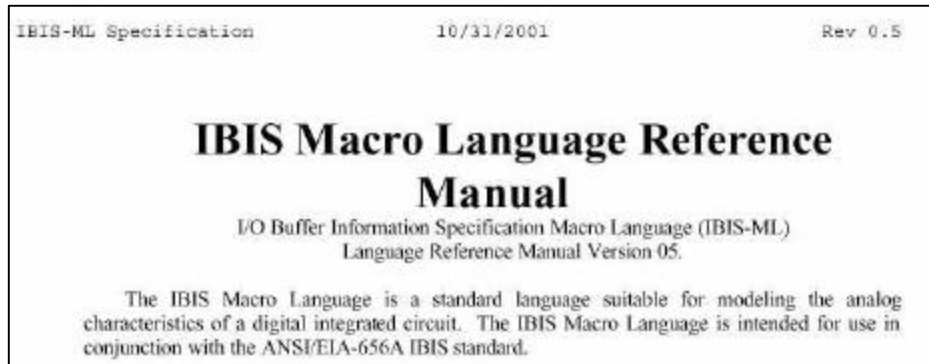
Ib (mA)	1	10	50	100	80	60	40	20
t (nS)	.5	1	1.5	2	2.5	3	3.5	4

[Frequency]

Variable	Typ	Min	Max
F(MHz)	13	6	50

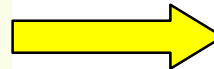
ICEM in IBIS-ML

IBIS mark-up language (IBIS-X) makes ICEM implementation very easy



Call of the user-defined model:

```
[begin header]
[ibis-ml version] 0.5
[filename] mpc755.ibs
[data] Nov 27, 2001
[model] ICEM
[end]
```



```
[define model] ICEM
| on chip capa
capacitor c_dec (vcc vss) C=5fF
| Serial supply resistor
resistor r_vdd (vcc vcc_int) R=10
resistor r_vss (vss vss_int) R=10
...
| current
Ib (vcc_int vss_int) I=It(TIME)
[It]
time I(typ)
0.0 0.3e-3
0.1e-9 0.3e-3
0.2e-9 0.5e-3
0.3e-9 0.8e-3
...
[end It]
[end define model] ICEM
```



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ICEM VALIDATION

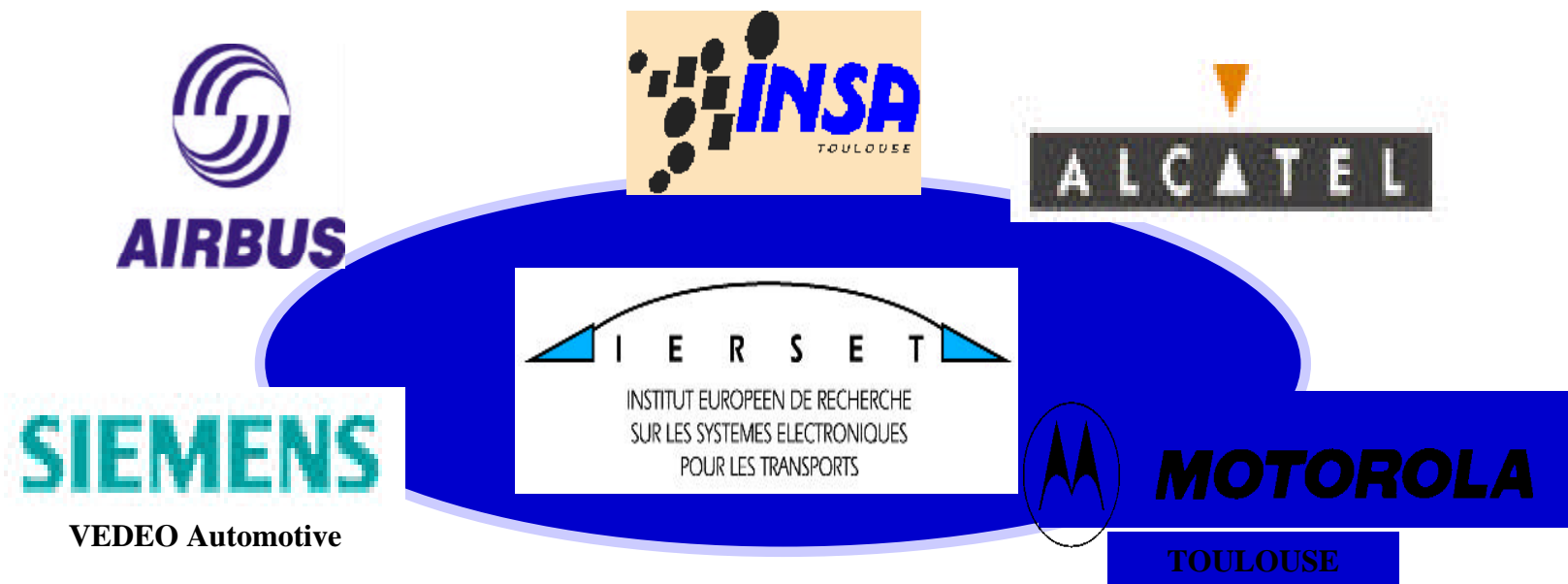


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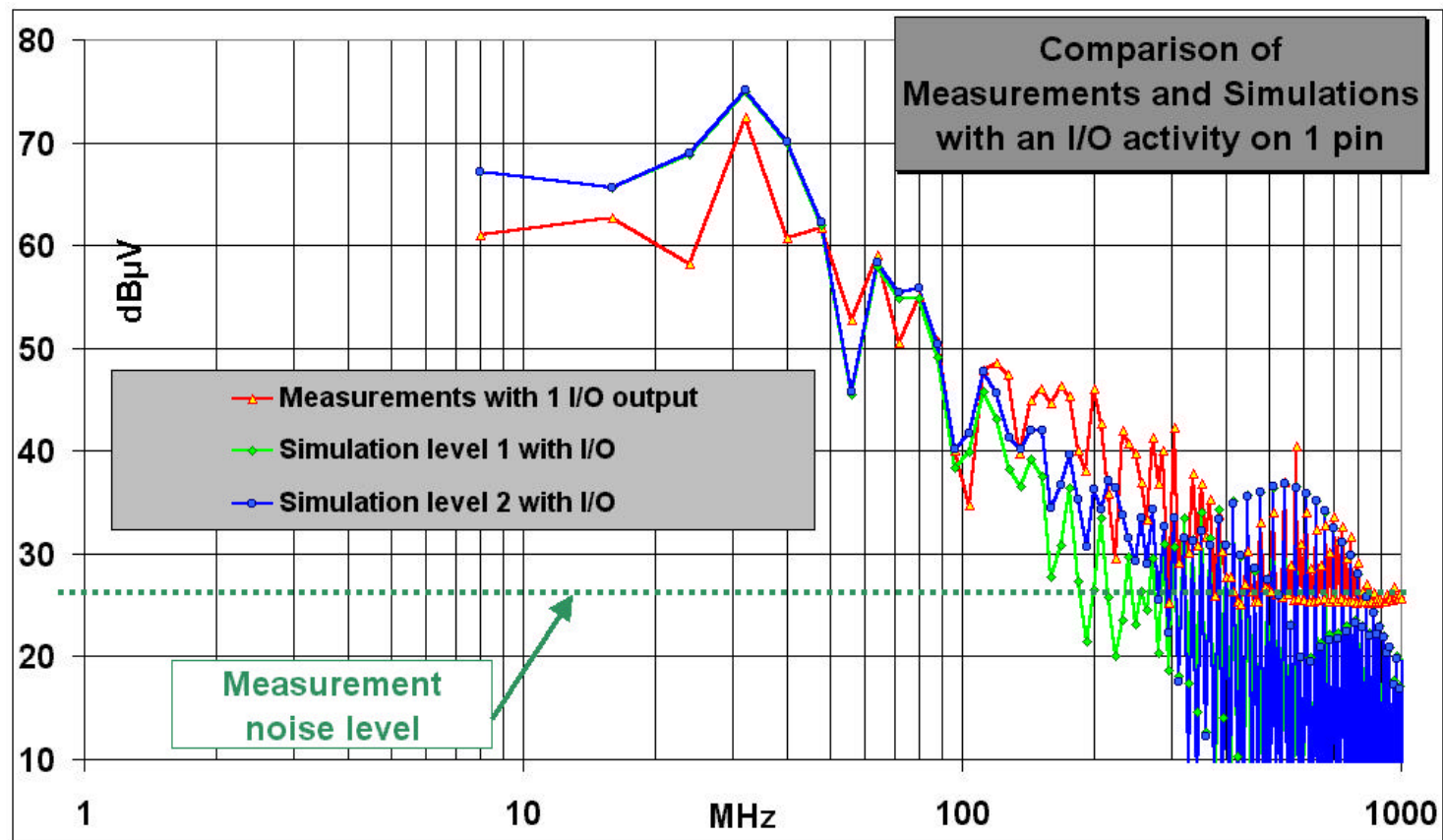


MODEL VERIFICATION

IERSSET VALIDATION

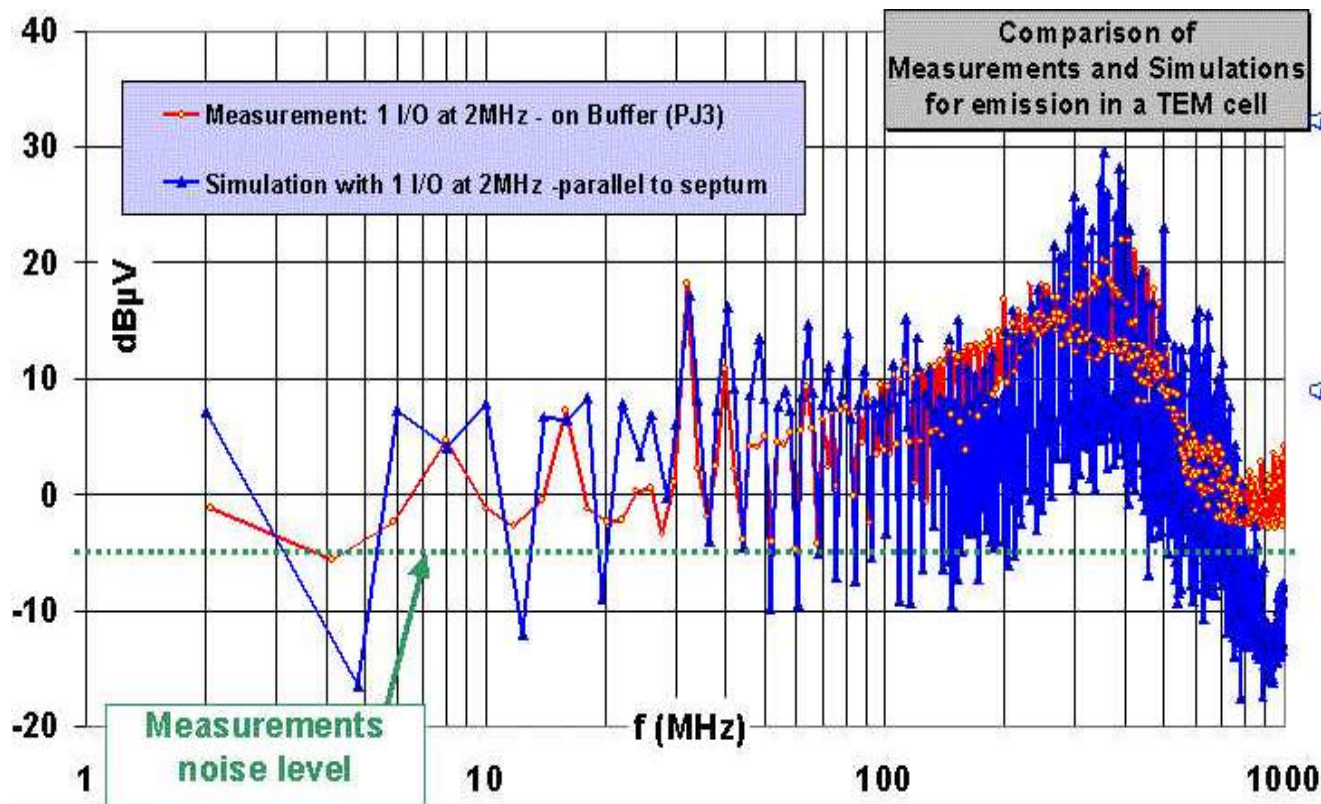


Emission Model with IOs



Emission in TEM cell

Validation for the core & IOs

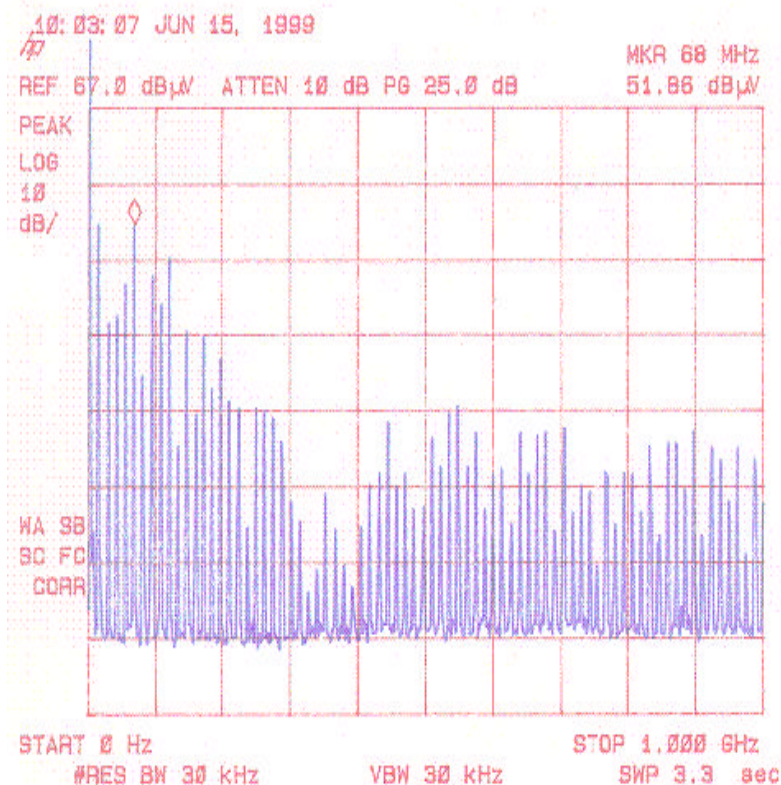


Model fits correctly up to 800MHz

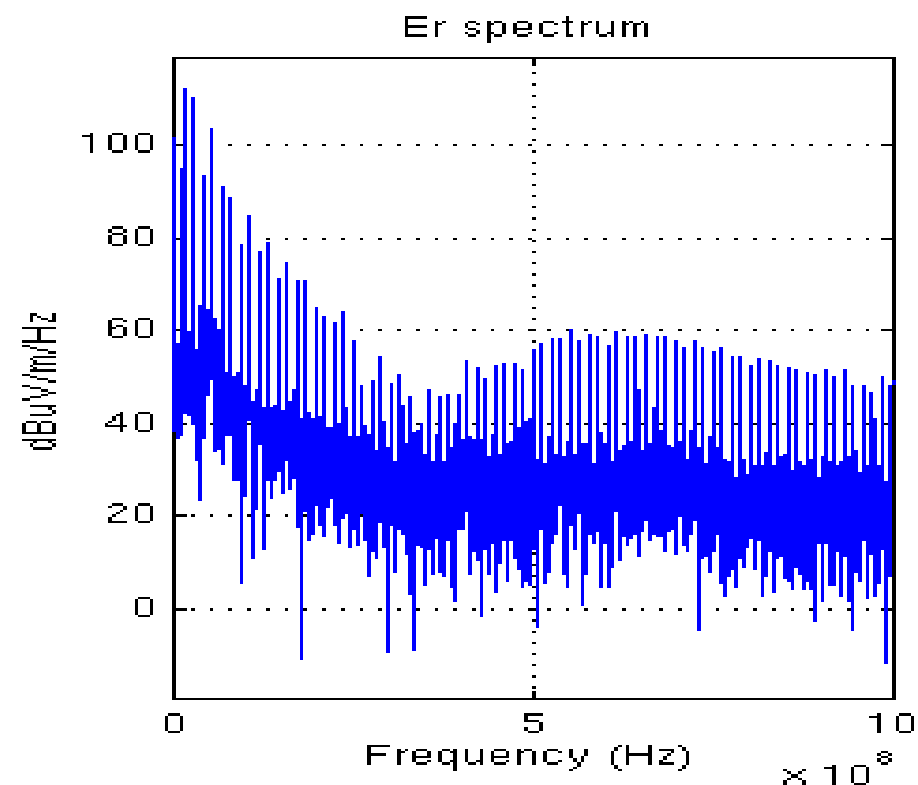
At high frequencies, IO effects dominate

DIRECT IC RADIATION

CORRELATION BASED ON TEM CELL MEASUREMENT



TEM CELL



Simulation



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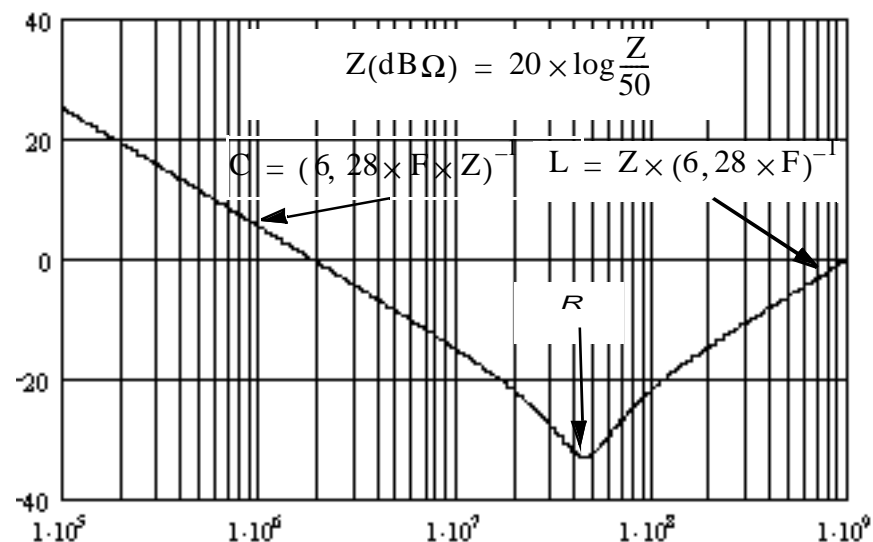
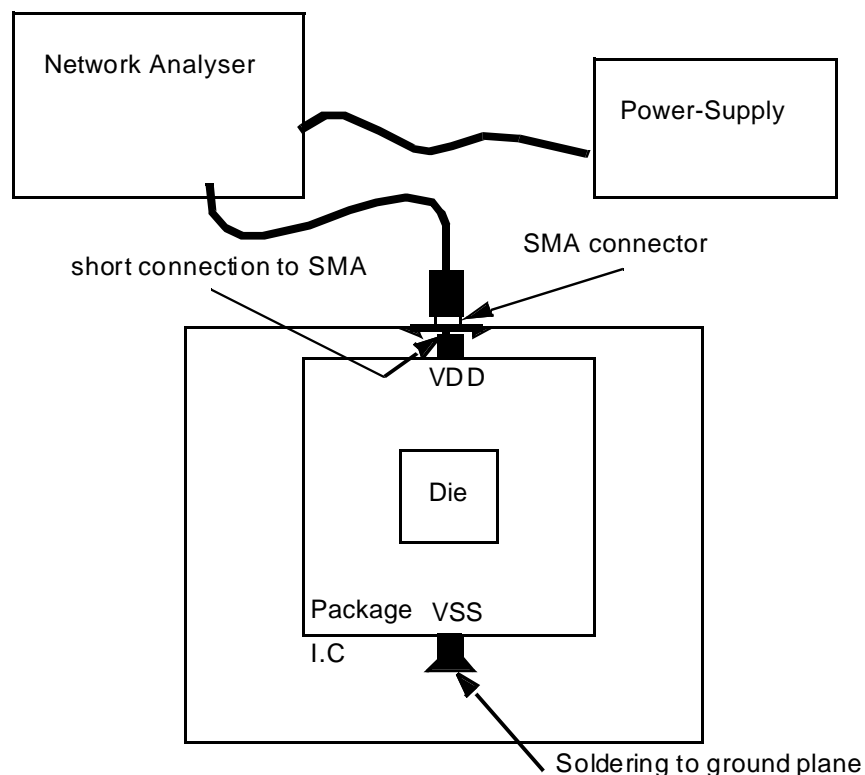
ICEM'S COOKBOOK

COOK BOOK STATUS

- **UTE TEAM WORKING ON COOK BOOK
TO BE COMPLETED 1st JULY 2002.**
- **“DIVA” PROJECT IN “MEDEA+” STRUCTURE**
CONTRIBUTORS : EADS CRC, INSA, AIRBUS
 - **APPLY ICEM MODEL TO SIMULATE COMPLEX PCB LAYOUT.**
 - **VALIDATE THE COOK BOOK (PARAMETERS
EXTRACTION BASED ON COOK BOOK PROCESS)**

COOK BOOK STATUS

PARAMETERS EXTRACTION BASED ON MEASUREMENT





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CONCLUSION

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- **ICEM** gives a capability to simulate EMC due to internal activity and of I/Os noise coupling
- **ICEM** model is easy to add as a modification or add in the files of usual standards like IBIS
- **ICEM** model parameters can be obtained by measurement (cook book) if data are not available from ICs manufacturers.
- **ICEM** can be easily implemented in commercial simulation software

