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King Yuan ELECTRONICS CO.,LTD

Silicon Valley TEST Conference & Expo San Jose Nov. 8-9, 2010 www.svtest.com

RF IC testing yield enhancement by EMI detection

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Task team members

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Introduction

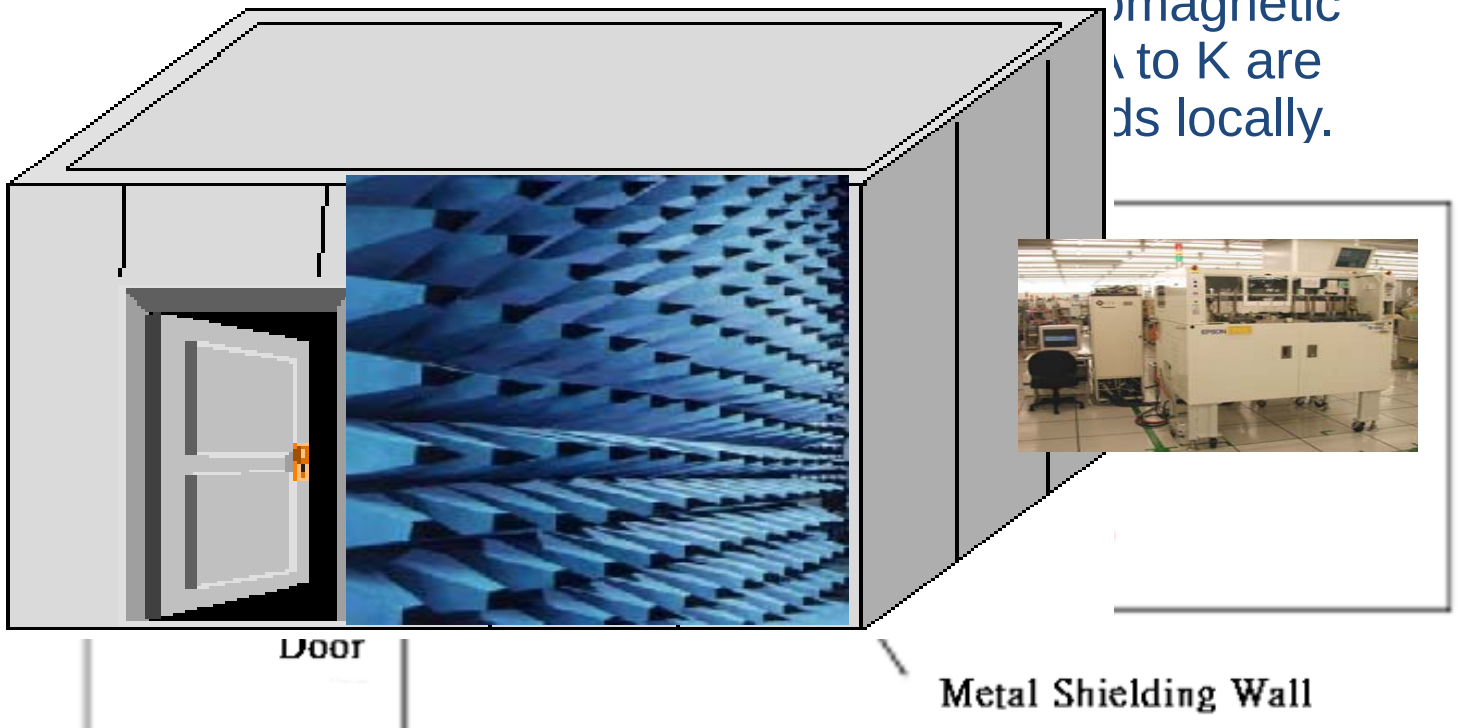
- ***Introduces RF Performance degradation owing to EMI issue***
- Propose active ATE test concept to Improve EMI yield loss with simulation model for theoretical validation
- Actual low yield case study on a production line and experiment result
- Conclusion

RF Performance degradation owing to EMI issue

- SoC and SiP with highly integrated multi-standards of wireless communication systems in a single DUT.
- External EM waves are coupled to transmission lines on PCB and packaging structure.
- Controlled EMI environment is expensive and acceptable for limited samples tested, but not suitable for open-sides mass-production-line environment.

Traditional EMI isolated approach and drawbacks

- Surrounded by Metal shielding wall
  - Electromagnetic fields are isolated as much as possible.
  - To survey the isolation quantity of the electromagnetic [illegible] A to K are [illegible] fields locally.



Drawbacks

- Electromagnetic noise caused by either outside interference signals or the switch transition noise of the system are time-variant in nature.
- Therefore, RF performance measurements and detecting noise must be synchronized to achieve a correlation between the results obtained and the measurement error due to system noise interference.
- The optimal number and locations for the test points are difficult to obtain.
- Yield loss occurs when interference can not be isolated to an acceptable level.

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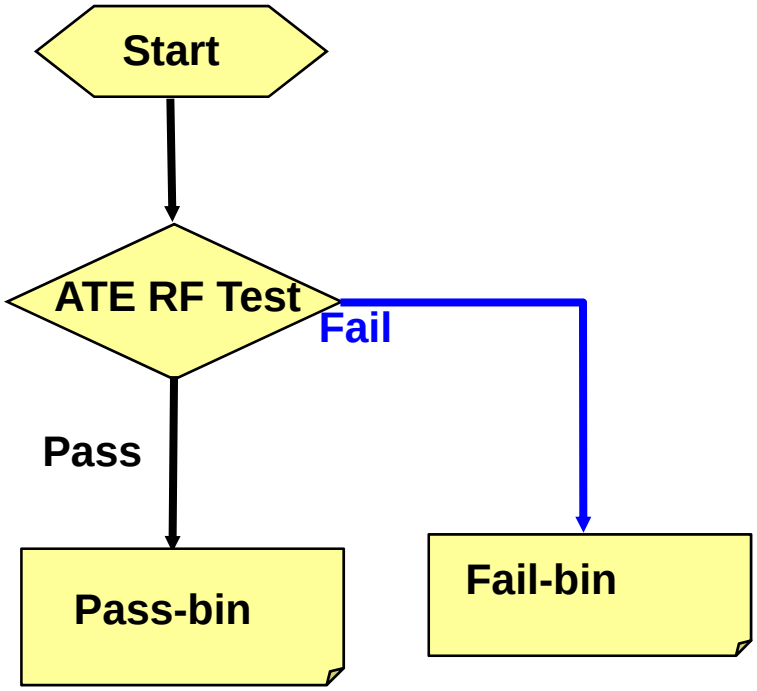
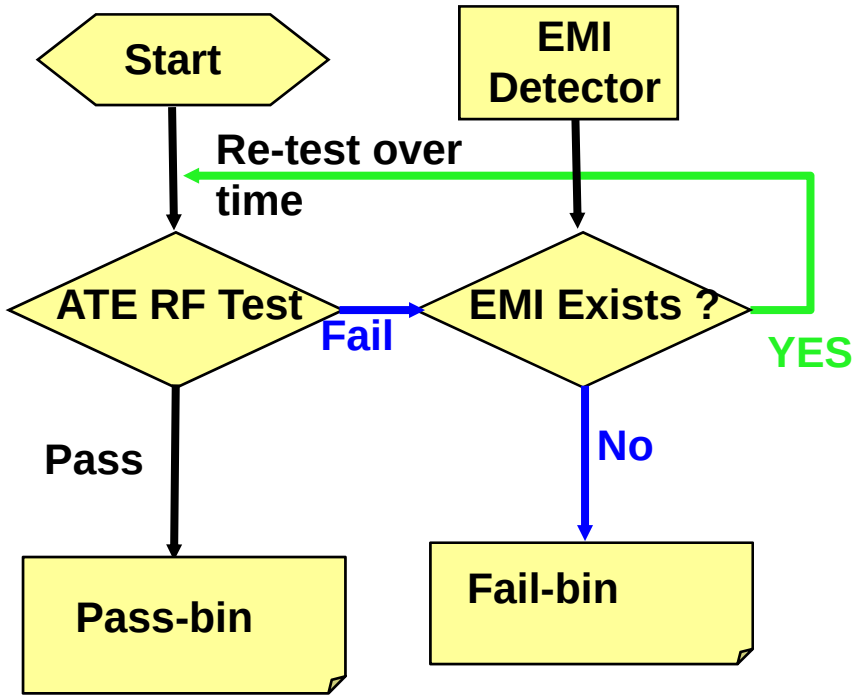
Active EMI detection Approach for ATE testing

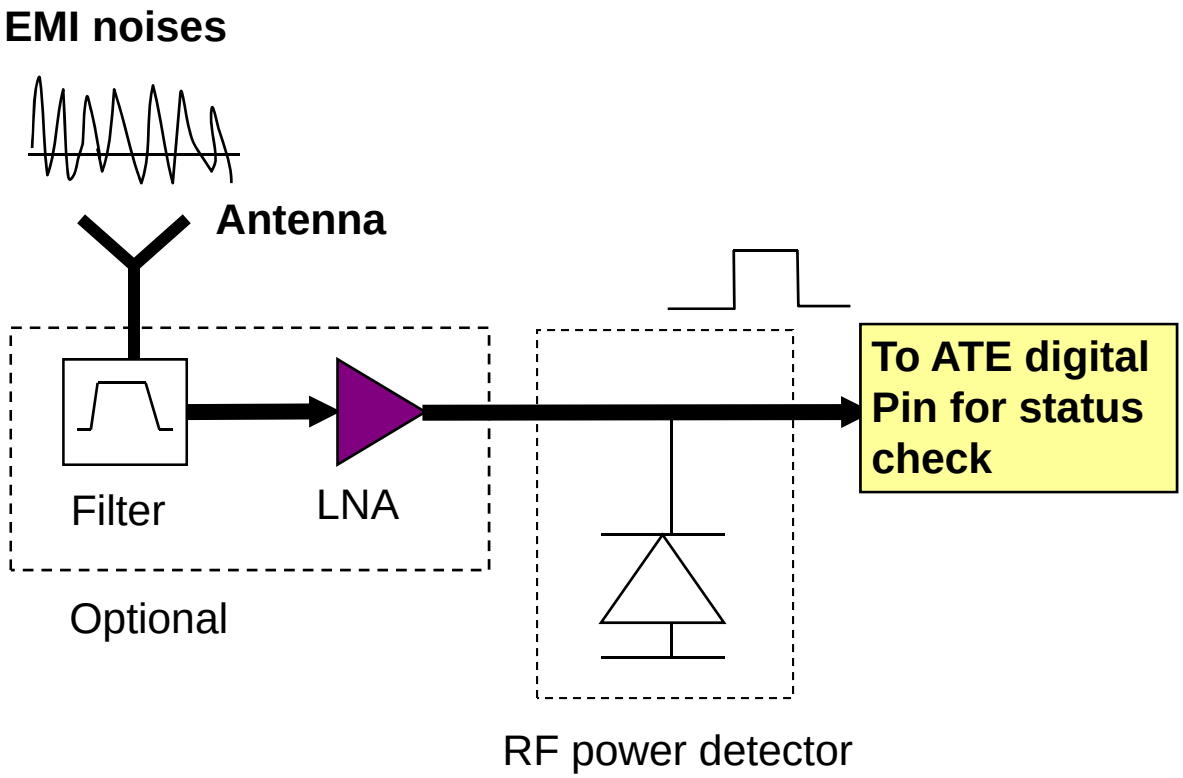
Original Approach



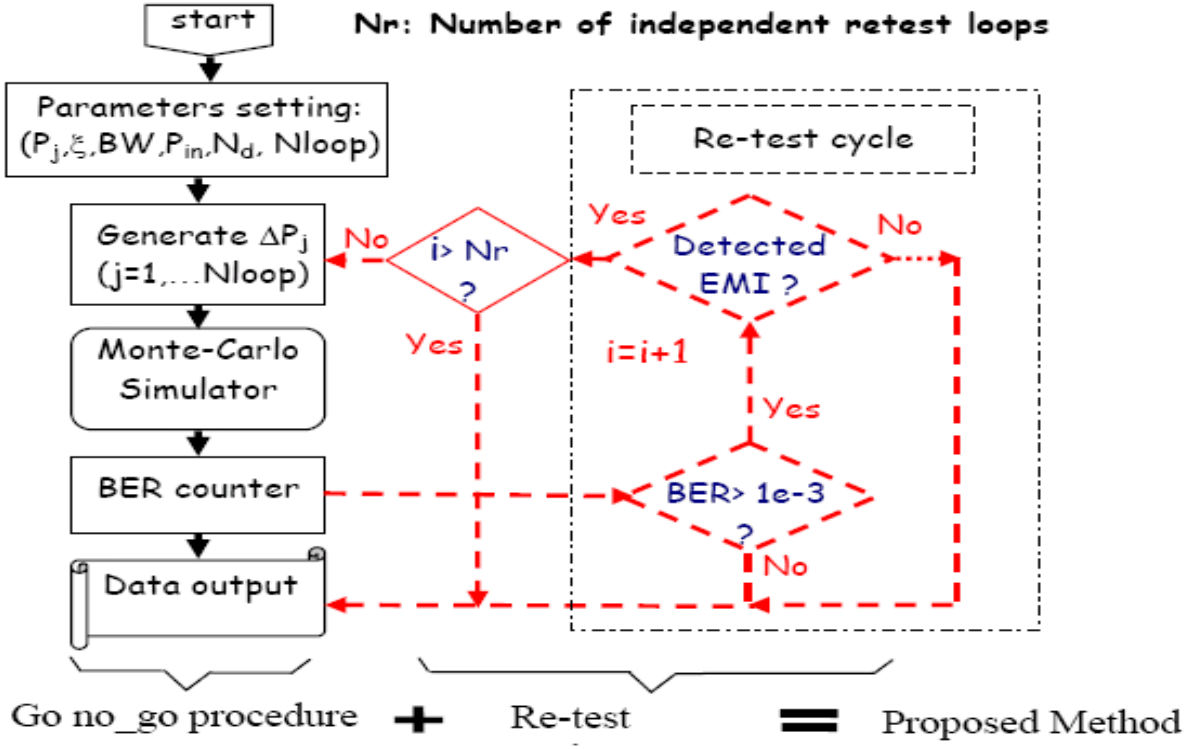
Novel Approach



Novel approach with Hardware Implement

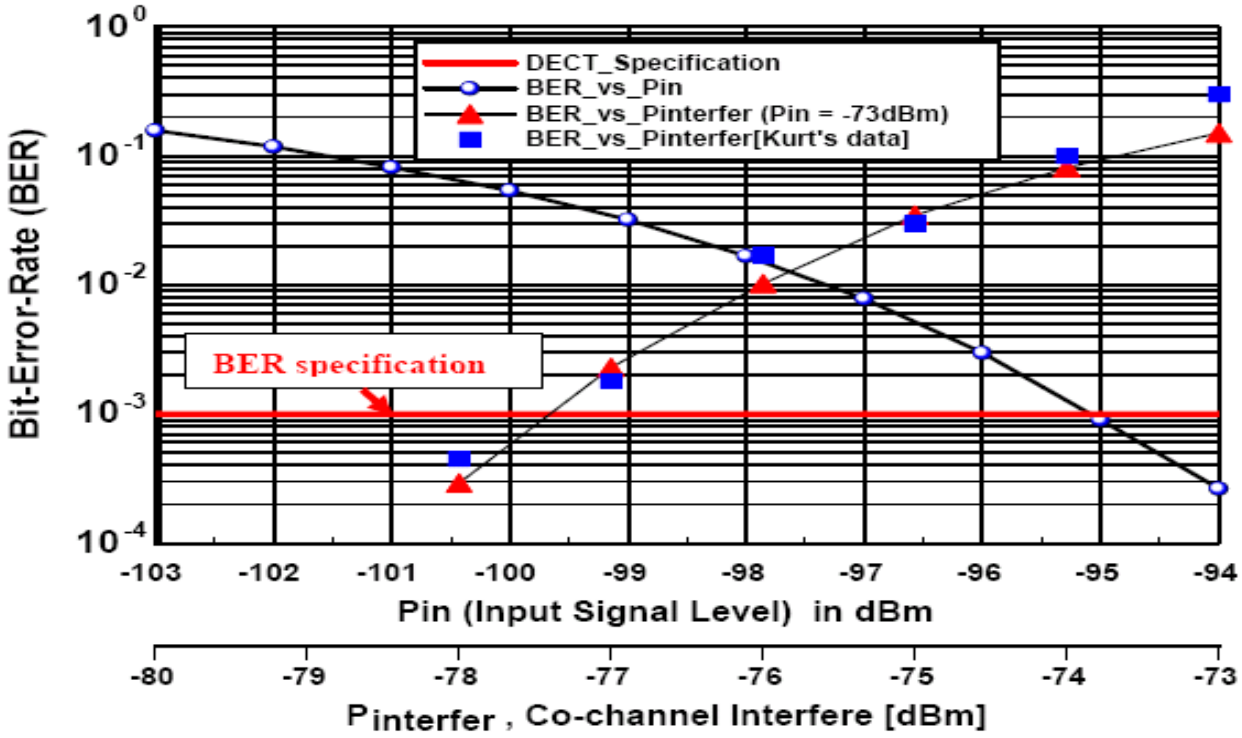


Simulation flow



Monte-Carlo simulation flow (Nloop = 3) simulates BER based on go no-go (without dash-line) and proposed (with dash-line) test procedure

BER vs. Co-channel interfere



Simulated BER versus input signal level (Pin) and simulated BER versus a co-channel interference with power level of Pinterfer, when input signal level is -73 dBm

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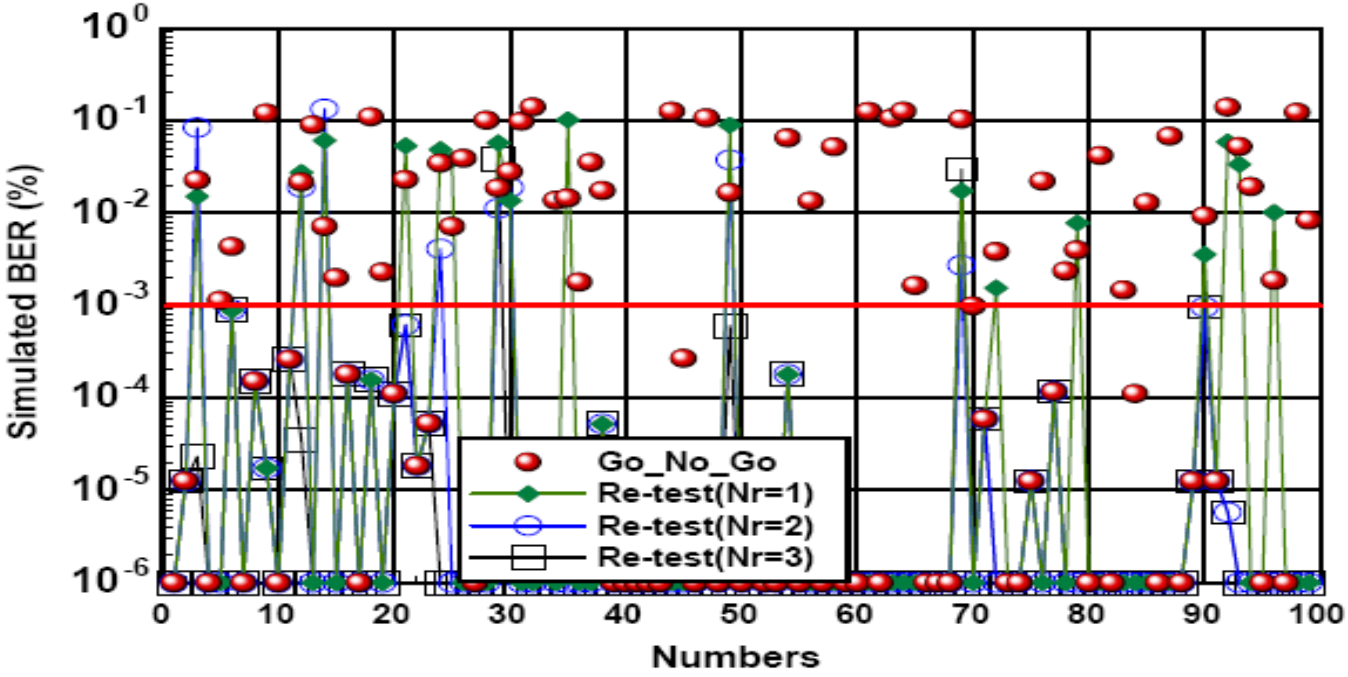
Simulation Result



The comparison between the simulated BER computed using go no_go procedure and proposed retest method, showing the failed evens reduced from 27/50 to 10/50, 7/50, and 1/50, corresponding to the number of retest cycle of Nr = 1, 2, and 3, respectively

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Low yield on a production line case I (2008 OCT)

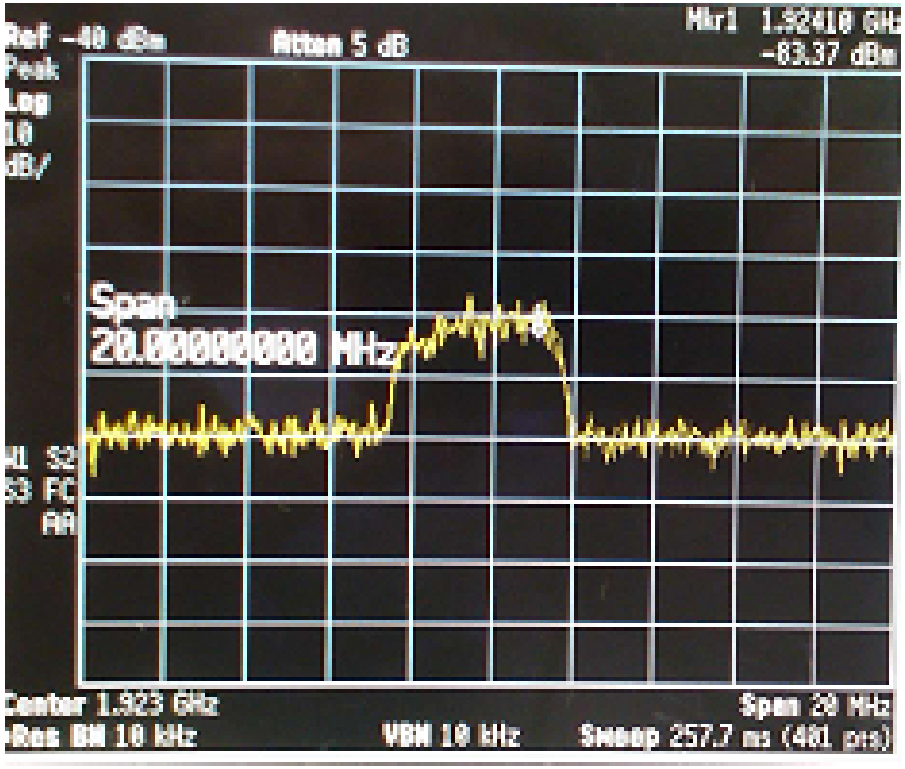
- **DUT is a DECT transceiver**
- **Operator was unnoticed since no continue fail alarmed**
- **EMI issue might account for the low yield, but no visible evidence was shown**

	Bit-Error-Rate (BER) failure rate		
	Low-band channel	Mid-band channel	High-band channel
Day 1 (Day-time)	0.28%	0.99 %	42.91%
Day1 (Night-time)	0.59%	4.22%	0.25%
Day 3 (Day-time)	0.2%	1.41%	36.4%
Day 3 (Night-time)	0.55%	2.45%	0.52%

Note: No low yield alarm for day 2

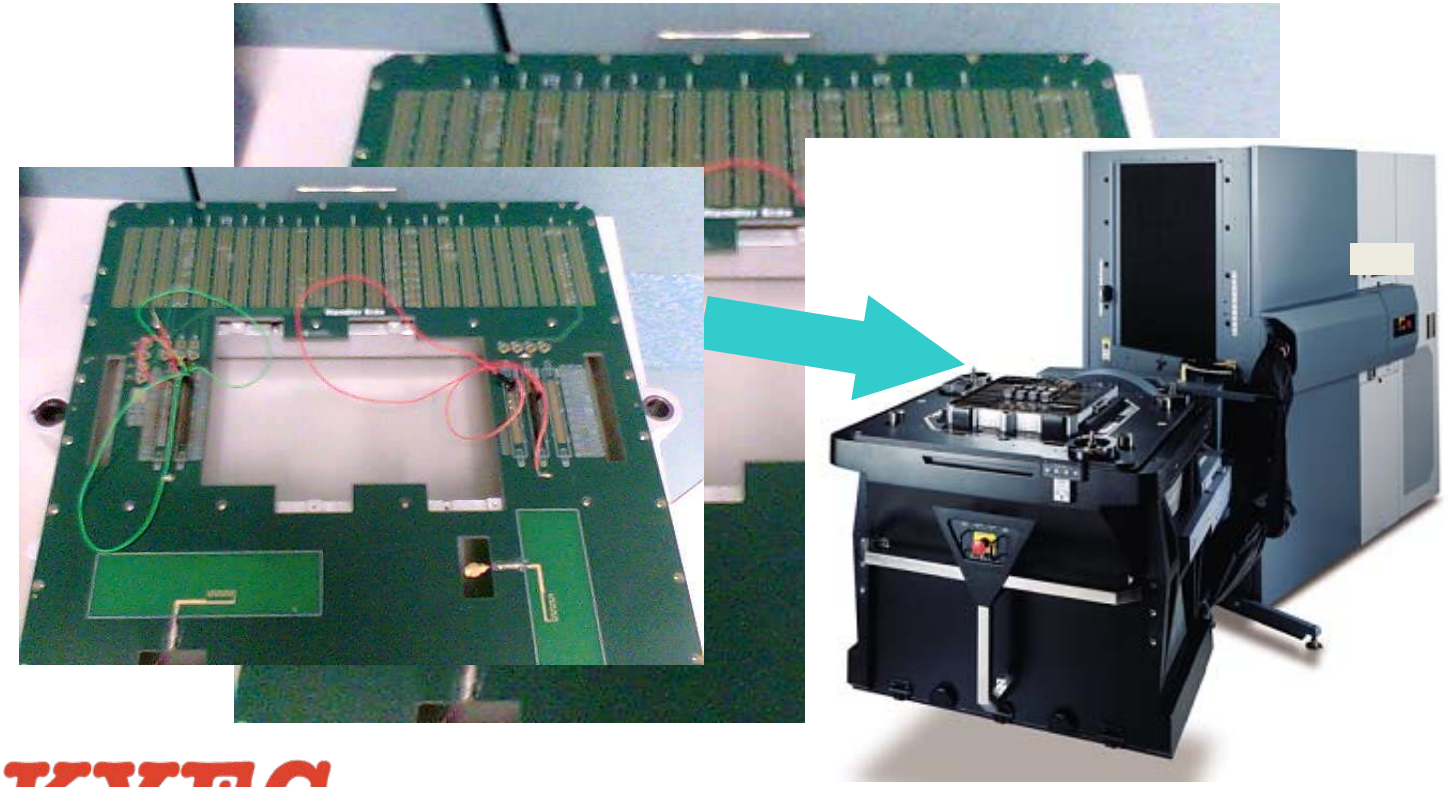
Low yield on a production line case II (2010 Feb)

We detected a cellular phone operation company was testing a base station during the daytime continually one week.

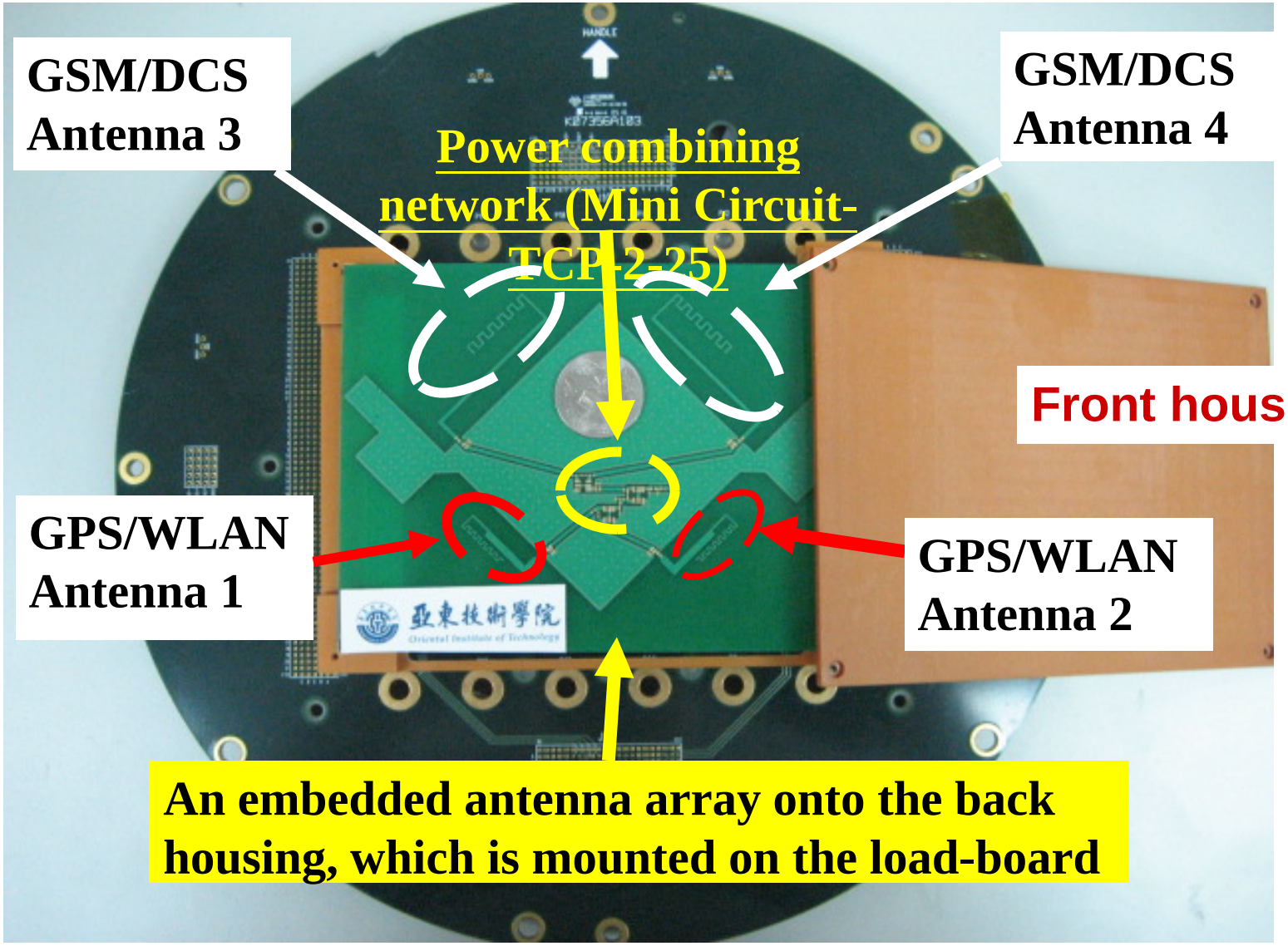


Embedded PCB Antenna

- Embedded PCB antenna built on load board for ATE testing

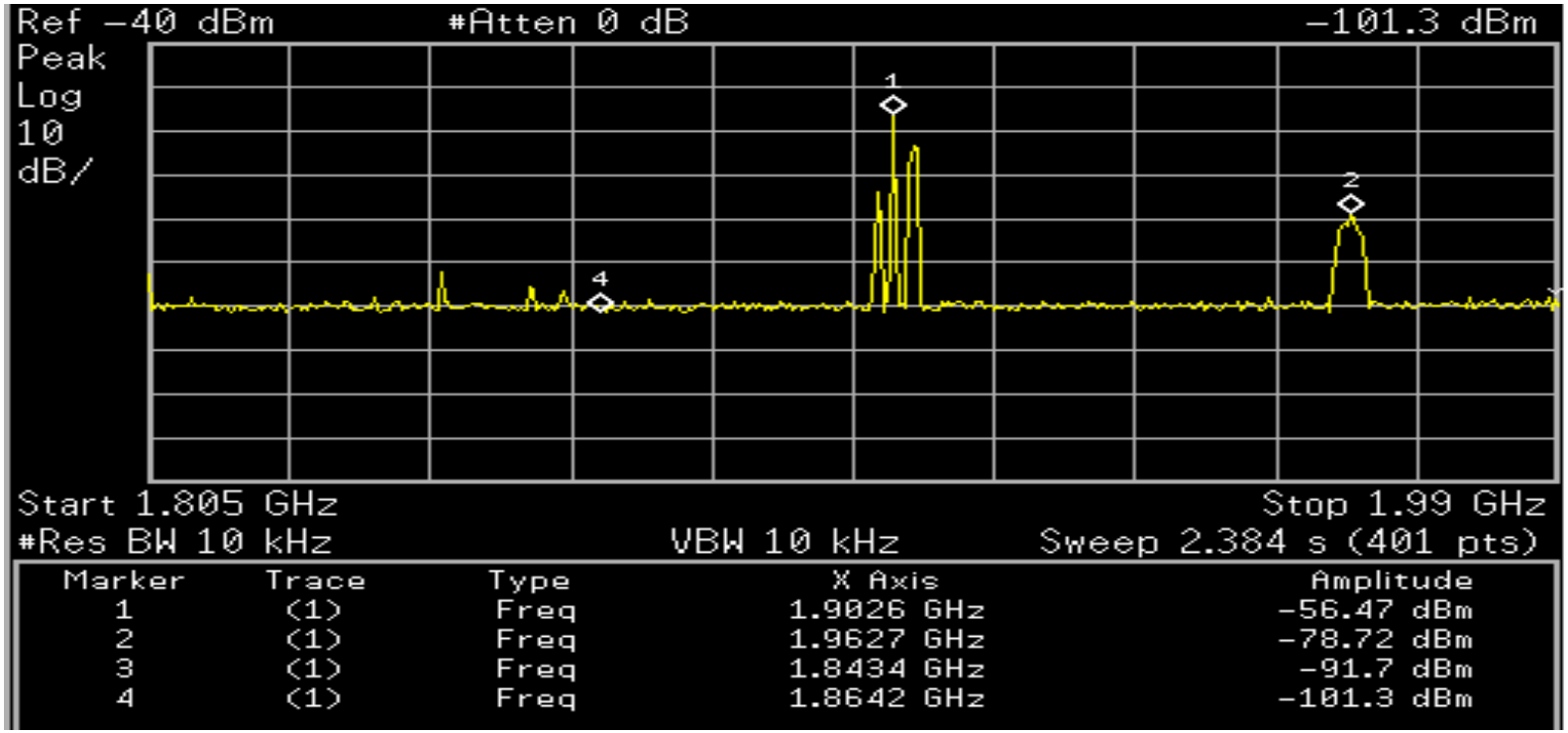


Embedded PCB Antennae Array



Experimental Results

Validation of EMI sensor

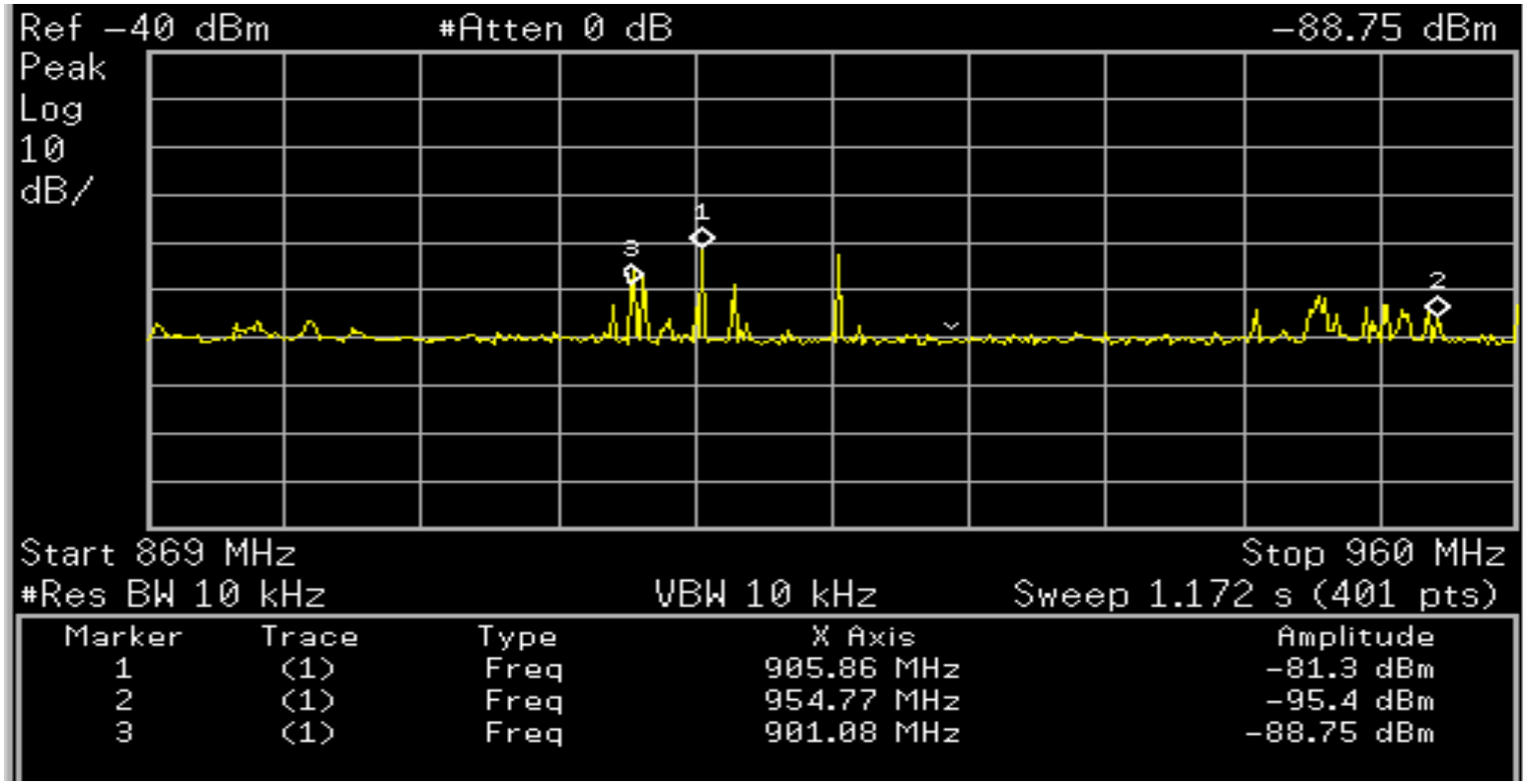


Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	1.9026 GHz	−56.47 dBm
2	(1)	Freq	1.9627 GHz	−78.72 dBm
3	(1)	Freq	1.8434 GHz	−91.7 dBm
4	(1)	Freq	1.8642 GHz	−101.3 dBm

- **PHS signal from the on call PHS handset**
- **Two interference signals observed at the frequencies of 1930-1990(GSM)/1880-1930(PHS) MHz.**

Experimental Results

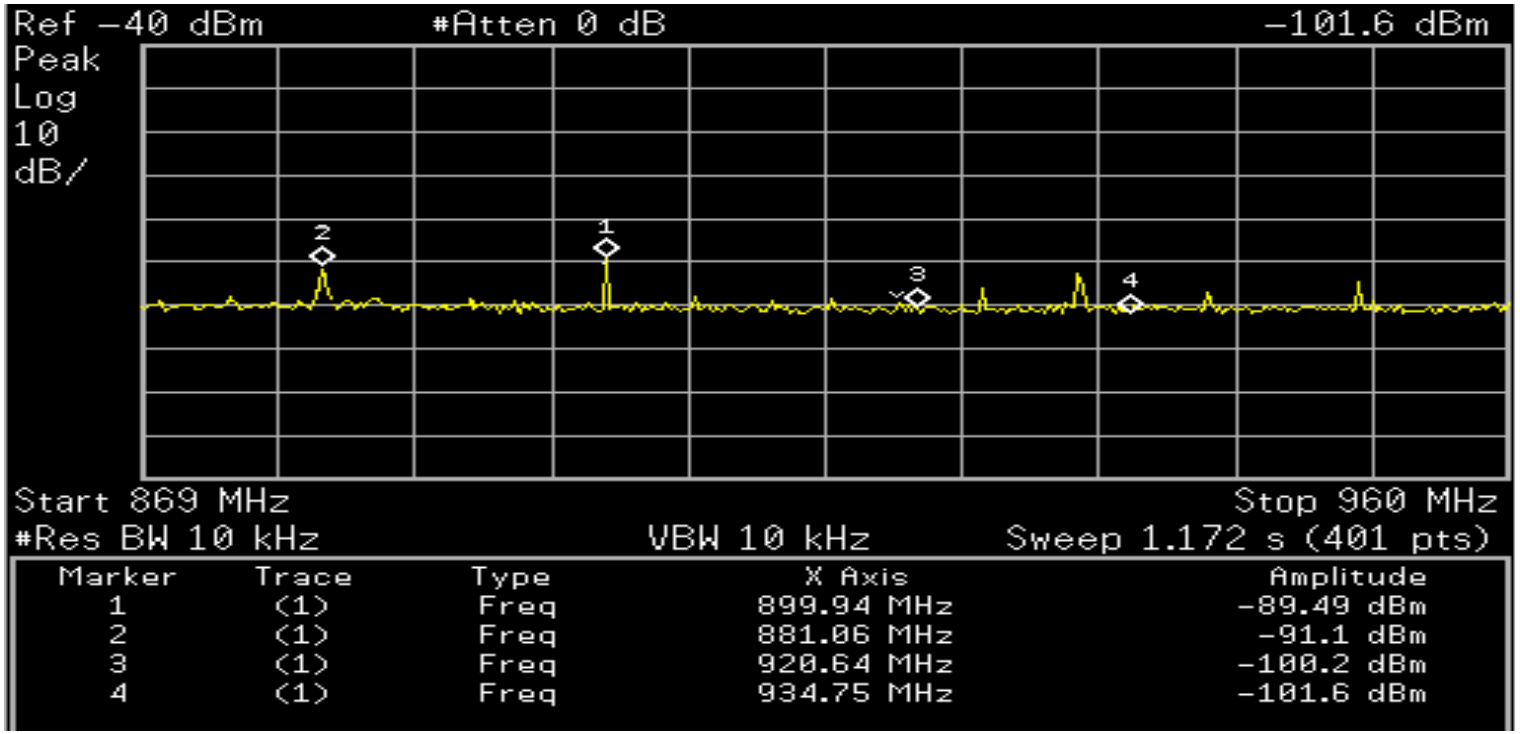
Validation of EMI sensor



- **Measured spectrum context when GSM handset signal is sneaked into test environment, showing GSM UL and DL spectrum**

Experimental Results

Validation of EMI sensor

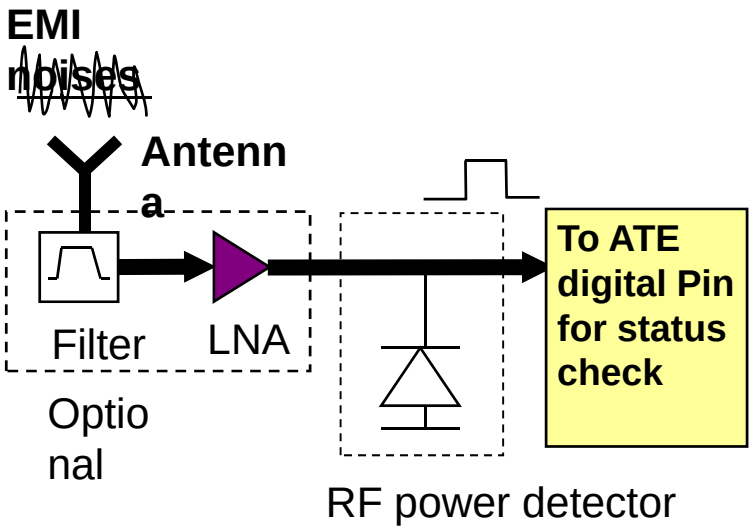


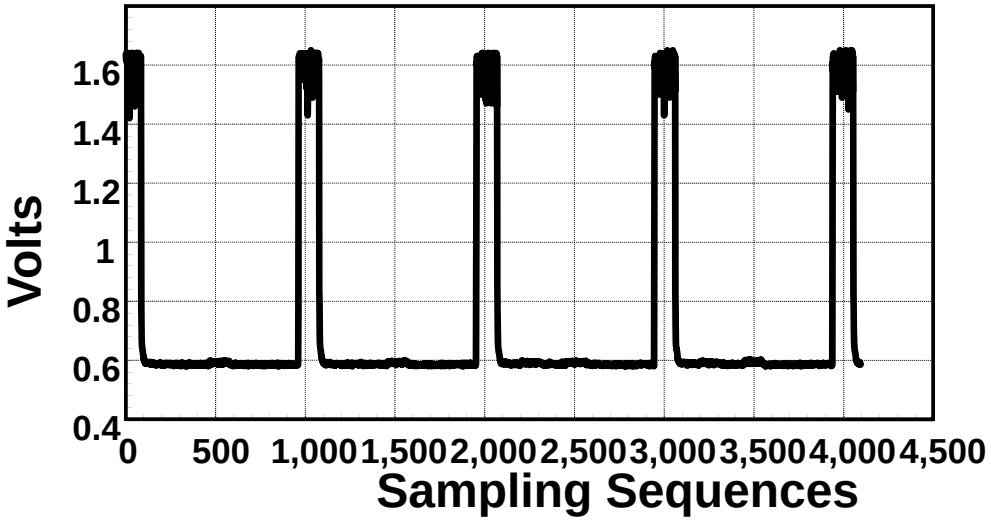
- **GSM TX signal from the nearby tester**
- **Two intentioned tones observed at the frequencies of 899.94 MHz and 881.86 MHz.**

Experimental Results

Validation of EMI sensor

- **Measured DC pulse sequences that are detected by ATE at output port of EMI sensor while the interference of PHS signals exists**





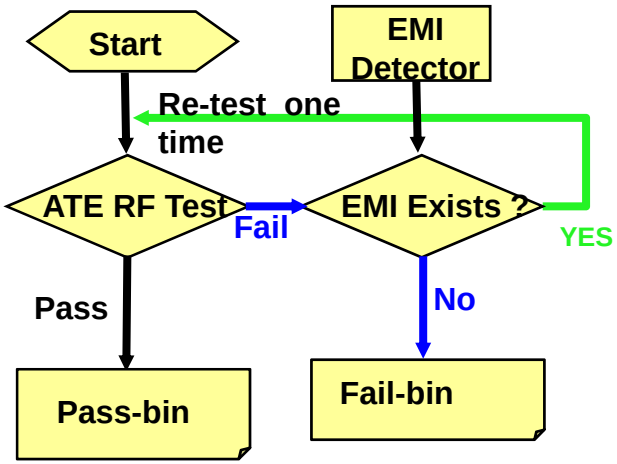
Experimental Results

System Validation:

- **DECT device underwent loop testing while a PHS handset was on call near the tester**

Novel Approach

Test channels	Fail counts with/without retest: 1st Loop testing (30-times)	2nd Loop testing (30-times)	3rd Loop testing (30-times)	Total No./%
Low-band (without retest)	0	0	0	0/0%
Mid-band (without retest)	0	0	0	0/0%
High-band (without retest)	11	7	13	31/ 34%
High-band (one time retest)	2	4	6	12/ 13%



- PHS: 1.880-1.930 GHz (This case PHS: 1.915-1.925 GHZ)
- DECT Low-band 1.790GHz, Mid-band 1.892GHz, High-band 1.923GHz.

- **The extent to which PHS EMI impacts the BER test of DECT RFIC reaches 34% for the high-band channel, which coincide with this low yield result.**
- **An improved yield of about 21% from 34% to 13% with the implementation of retest.**

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The Benefit of EMI detection built on ATE DUT board solution

- **Cost effective:**
  - The low cost of EMI sensor
    - Printing Antenna on PCB of Dot board
  - Digital Pin : buy off by ATE cost
  - Power detector : less than $10
  - Additional test time:
    - Only retest the specified test item that is fail due to the suspected EMI environment.
    - The simulation predict the risk of BER overkill can be reduced to nearly 2% when retested over three times.

- **Production EMI monitor network:**
  - Environment EMI interference can be detected and identified source with location in real time.

Conclusion

- Air pollution degrades the RF testing yield because background EM noises are normally neglected.
- This test method is proposed to enhance yield loss caused by test error due to interference.
- Experimental and Monte-Caro numerical simulation results confirm the performance.