



# SAS-2 SSC Investigation (06-064r2)

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(SAS FTF - 5/9/2006)

## Revision History

Rev 0 – Initial Release

Rev 1 – Added pages 13 to 16

Rev 2 – Added pages 17 to 23



# SAS-2 SSC Investigation – Objectives

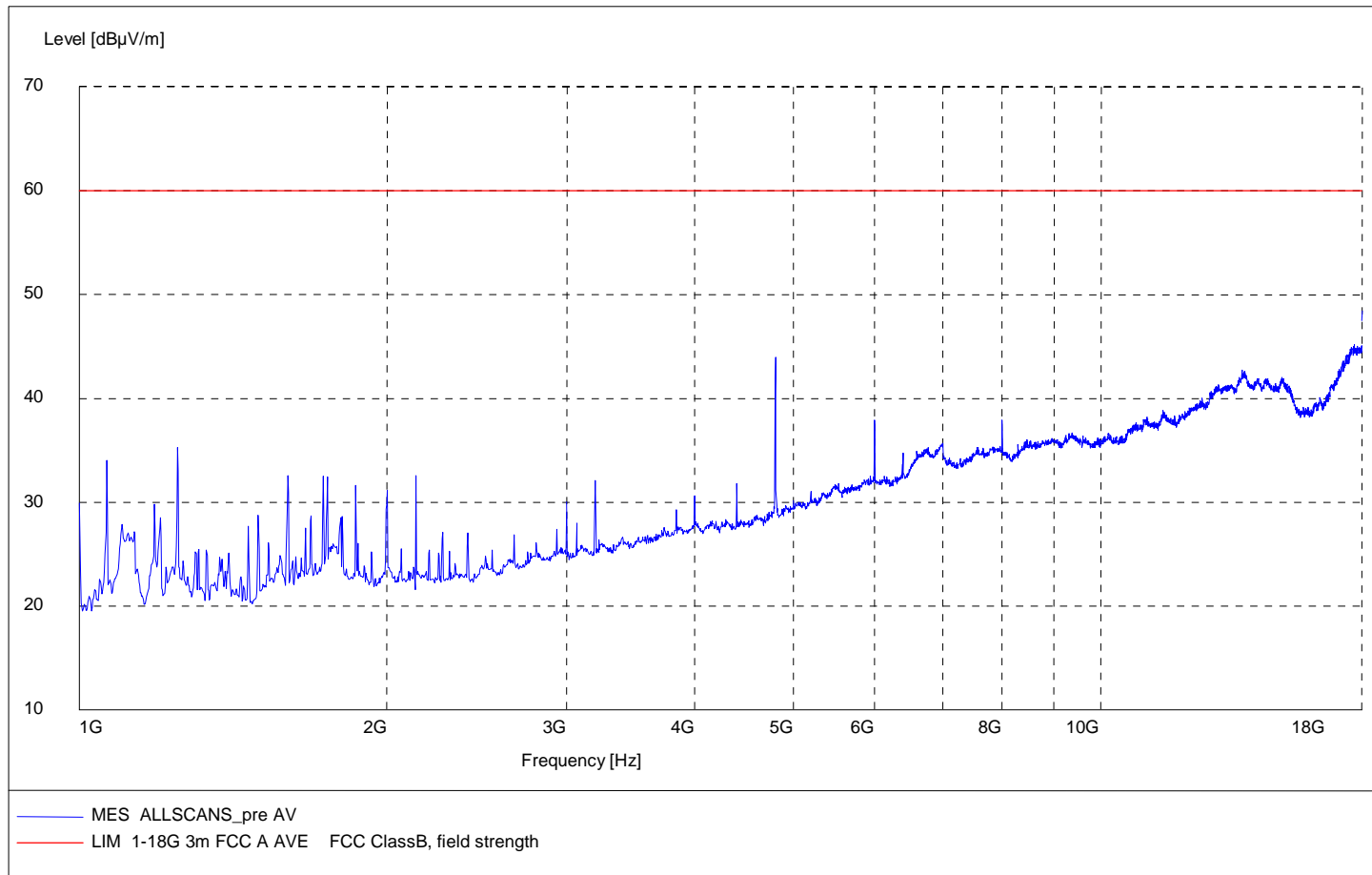
- At the last face-to-face, hp was requested to provide data demonstrating that SSC lowers emissions levels
- Discuss issue with hp's EMC test experts. Understand how tests are performed and get opinions on level of noise reduction to be expected.
- To compare results with and without SSC, calculate the difference in dB. This number is a ratio of the noise levels and is an indicator of the effectiveness of SSC. Also note that it is independent of the absolute noise level.



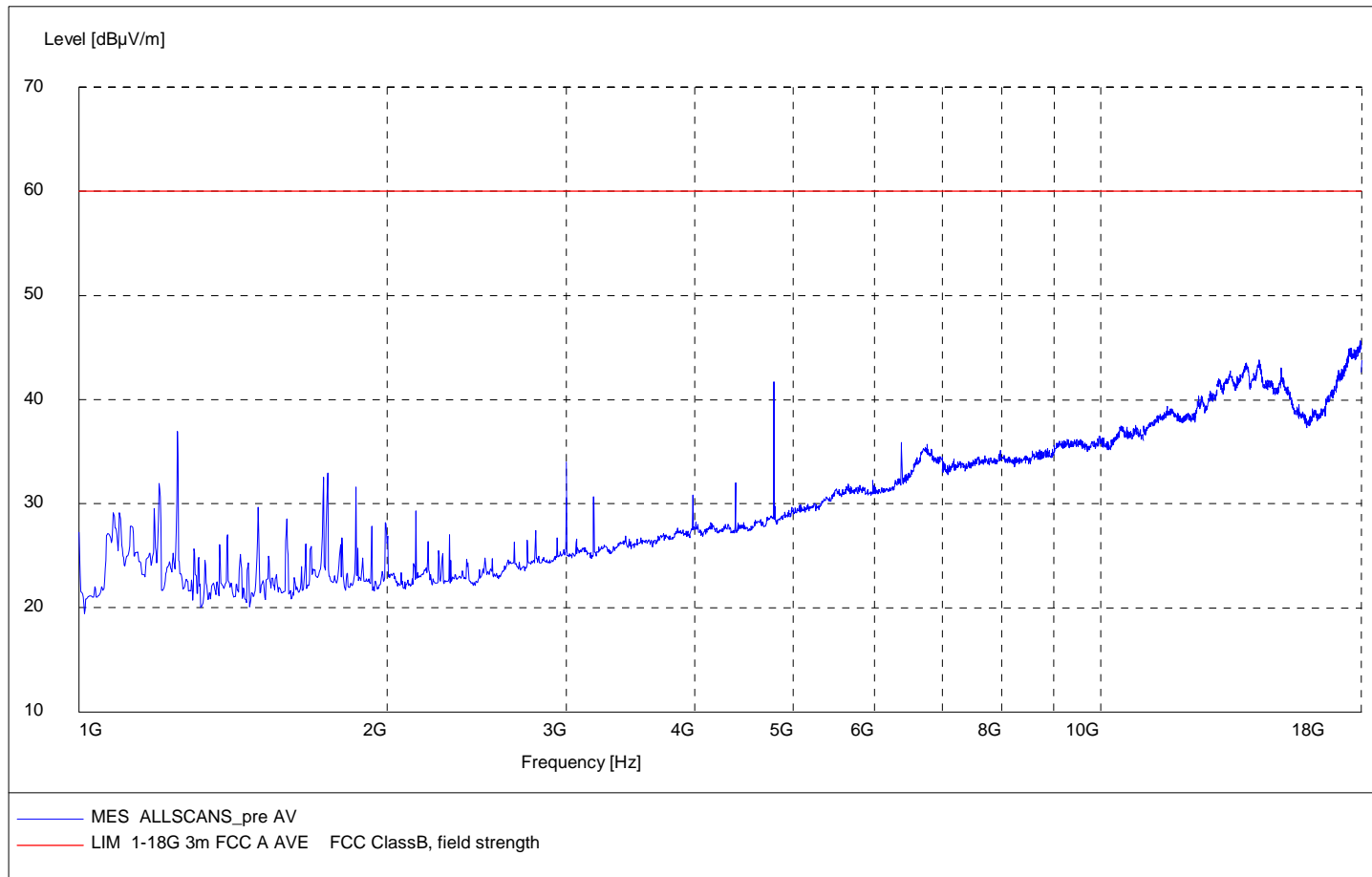
# SAS-2 SSC Investigation – Test Platform #1

- Intel based server with SSC on the memory bus.
- Frequency of interest is 4.8 GHz
- FCC test method is two part process
  - Perform automated preliminary scan and graph results
  - Perform manual scan to locate physical position and orientation with highest peak value

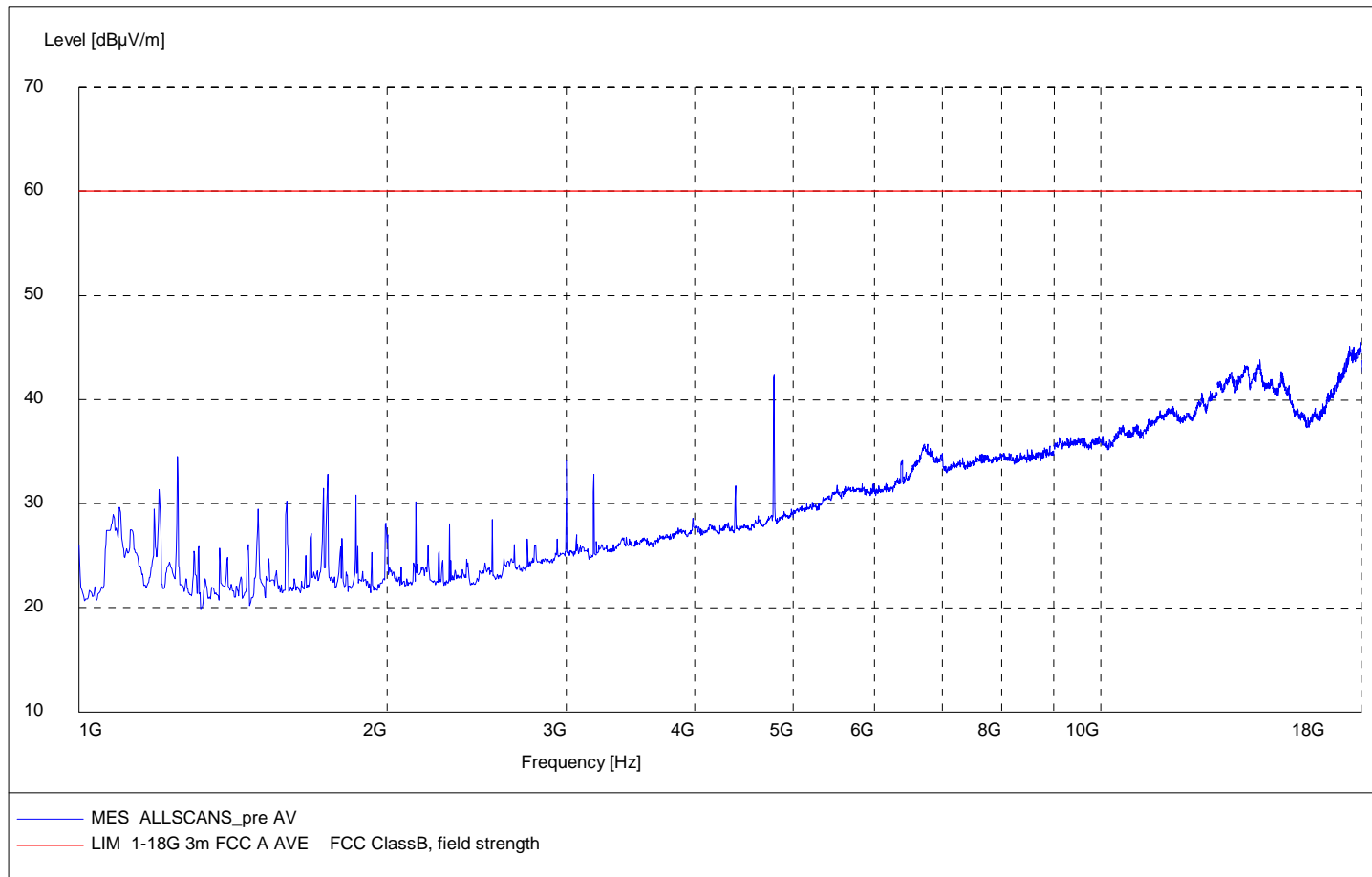
# SAS-2 SSC Investigation – Platform #1 – Memory SSC Disabled



# SAS-2 SSC Investigation – Platform #1 – Memory SSC Enabled (0.04%)



# SAS-2 SSC Investigation – Platform #1 – Memory SSC Enabled (0.15%)





# SAS-2 SSC Investigation – Platform #1 – Manual Scan Results

- Although the automated scan shows minimal improvement the manual scan shows a large improvement
- With SSC disabled the 4.8 GHz component is 63.0 dB $\mu$ V/m
- With SSC enabled and an SSC span of 0.04% of the center frequency (Serial ATA is 0.25%), the 4.8 GHz component is 54.3 dB $\mu$ V/m
- With a span of 0.15%, the 4.8 GHz component is 45.8 dB $\mu$ V/m
- Reduction in emissions is 17 dB $\mu$ V/m



# SAS-2 SSC Investigation – Test Platform #2

- Intel based motherboard in business class PC with one Serial ATA Gen II drive
- Host chip set has SSC enabled for all tests
- System level tests performed with SSC enabled and SSC disabled
- Disk drive SSC is the only variable
- Frequencies of interest are 3 GHz and 6 GHz





# SAS-2 SSC Investigation – Platform #2 – Manual Scan Results

- With SSC disabled, the 3 GHz component is 37.8 dB $\mu$ V/m and the 6 GHz component is 44.3 dB $\mu$ V/m
- With SSC enabled, both components fell to below 30 dB $\mu$ V/m
- Reduction is at least 8 dB $\mu$ V/m for 3 GHz and 14 dB $\mu$ V/m for 6 GHz



# SAS-2 SSC Investigation – Other Points

- Measured data correlates with hp's EMC experts position that 10 to 20 dB reduction is typical
- CISPR (European) specifies no levels above 6GHz. FCC class A is 54 dB $\mu$ V/m
  - New CISPR requirements will be 6dB tighter than FCC
- Experts say shielding apertures need to be no more than 1/20 of a wavelength to be effective.
  - This is 2.5mm for 3GHz and 1.25mm for 6GHz



# SAS-2 SSC Investigation – Other Points

- Server market continues to migrate to lower cost designs with packaging similar to a PC
  - See IDC Market Analysis Report, “Worldwide and U.S. Server 2005-2009 Forecast”

# SAS-2 SSC Investigation – Conclusions

- Measured data correlates with experience of EMC experts
- Feedback from OEM's at last face-to-face demonstrate that emissions are a serious issue
- SSC has provided 10 to 20 dB reduction in manual scan of emissions where used
- With increasing speeds and tighter emissions specs the problem is getting worse

# SAS-2 SSC Investigation – PPM Variation



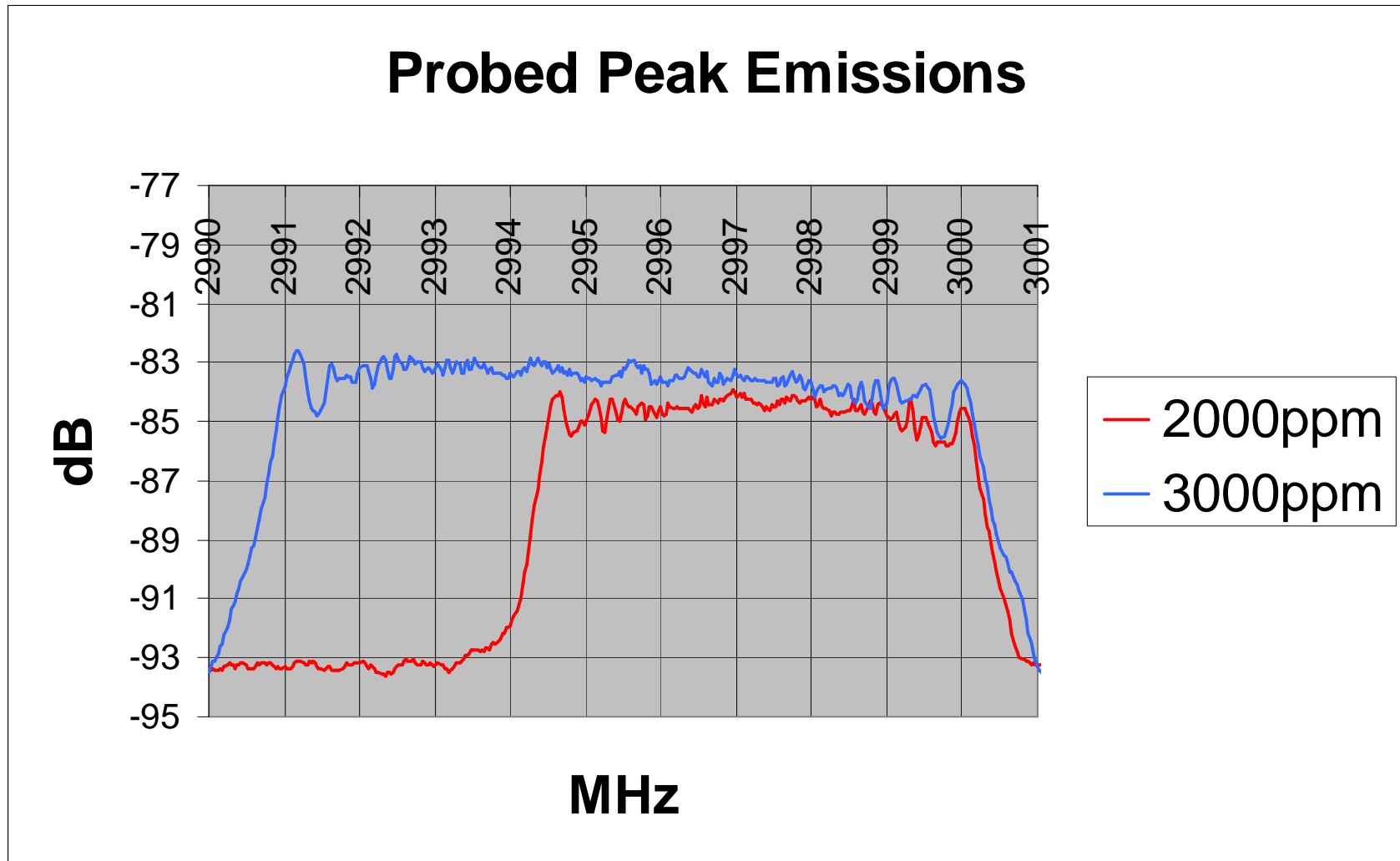
- Objective is to characterize relationship between SSC spread level (specified in PPM) and emissions reduction expected (dB)
- Test matrix to include second generation Serial ATA drives from multiple suppliers with multiple PPM specifications
- Identical PC platform used

# SAS-2 SSC Investigation – System Test (FCC)



- Vendor A provided 3 drive samples with varying levels of SSC (Off, 2000 PPM and 3000 PPM)
- At this time, data is not available for the “off” configuration
- The 3000 PPM sample yielded a 4.64 dB reduction over the 2000 PPM sample at 3 GHz
- Results based on energy within a 1MHz window
- Additional data to be provided as samples are available

# SAS-2 SSC Investigation





# SAS-2 SSC Investigation – Comparing FCC to Peak Levels

- Given a triangular SSC distribution, energy density at 3000 PPM is 66% of what is observed using 2000PPM. That ratio implies a 3.5 dB reduction.
- Actual test results obtained a semi-Anechoic chamber were 4.64dB
- Vendor A results appear to correlate



# SAS-2 SSC Investigation – Further Investigation of FCC Test Methods



- FCC Part 15 Radiated Emissions from class B computers is measured using the average detector function
- The class B radiated field strength levels above 960MHz are 500 micro-volts/meter at a distance of 3 meters
- Test results are expressed in units of  $\text{dB}\mu\text{V}/\text{m}$

# SAS-2 SSC Investigation – Primer on Measurement Units



- Instrumentation measures power but displays the results in various forms and units
- Test results are expressed in field strength of  $\text{dB}\mu\text{V}/\text{meter}$
- A signal amplitude of  $0\text{dB}\mu\text{V}$  corresponds to the power level observed when driving a 50-ohm load with a  $1\mu\text{V}_{\text{rms}}$  signal
- A signal amplitude of  $77\text{dB}\mu\text{V}$  ( $7.07\text{ mV}_{\text{rms}}$ ) driven into a 50-ohm load yields  $1\mu\text{W}$

# SAS-2 SSC Investigation – Average vs. Peak (dB $\mu$ V)

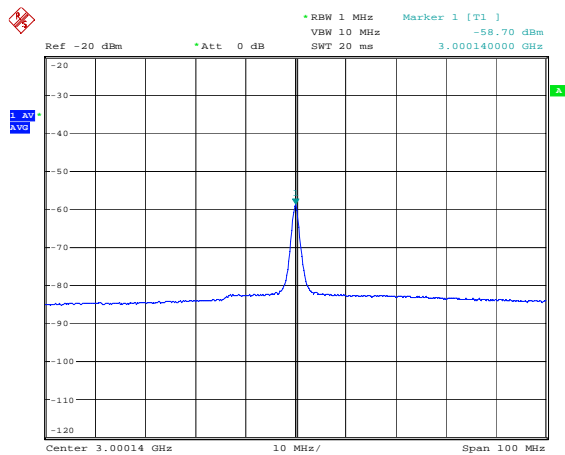


- Measurement bandwidth of 1MHz
- For 3GHz, each 1000PPM increment spreads the power over an additional 3MHz
- Using this ideal SSC model, a spread of 2000PPM (6MHz window) reduces power in the 1MHz measurement window by -15.5dB
- A 3000PPM spread yields -19.1dB (or an additional 3.6dB better than 2000PPM)
- A 5000PPM spread yields -23.5dB

# SAS-2 SSC Investigation – Average vs. Peak (dB $\mu$ V)

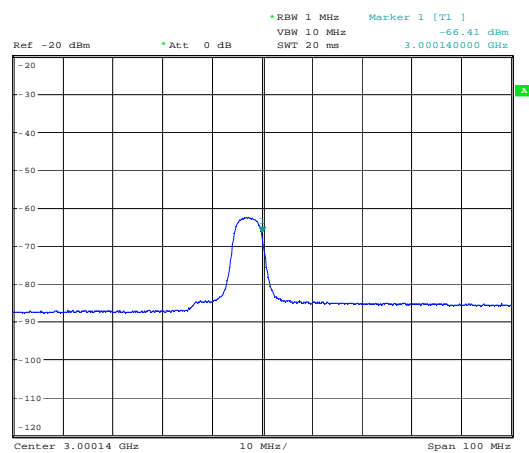


No SSC, AVG,  
-58dB $\mu$ V



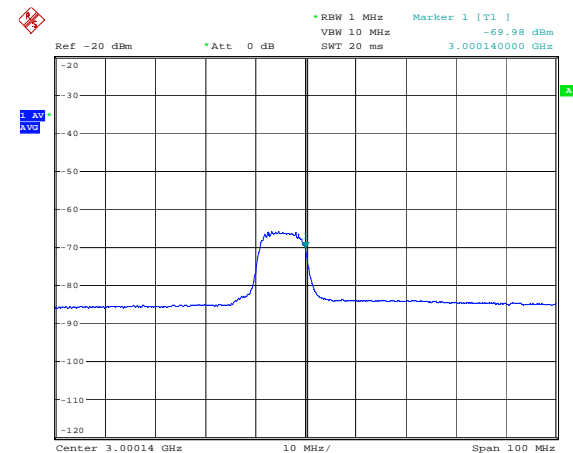
Date: 28.APR.2006 21:58:19

2000PPM, AVG,  
-62dB $\mu$ V



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3000PPM, AVG,  
-66dB $\mu$ V



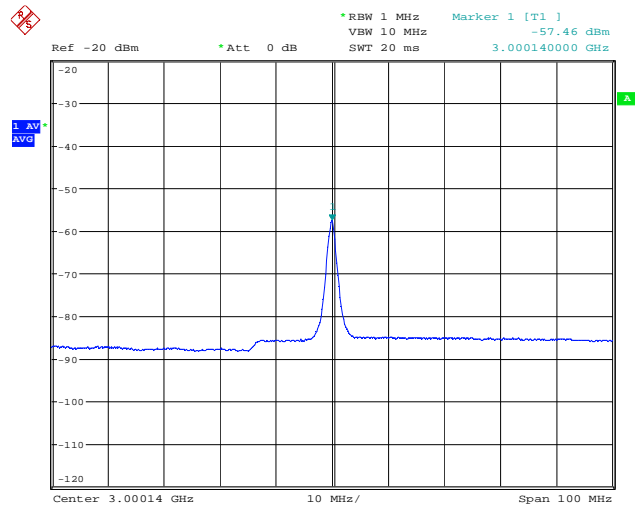
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## Vendor A Samples

# SAS-2 SSC Investigation – Average vs. Peak (dBμV)

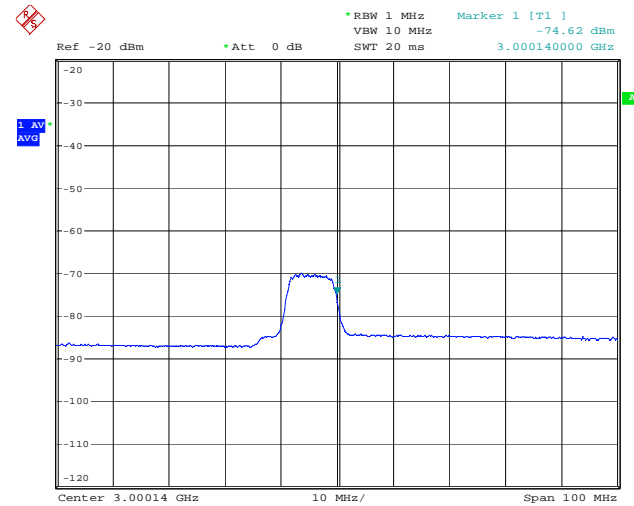


No SSC, AVG,  
-57dBμV



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5000PPM, AVG,  
-70dBμV



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## Vendor B Samples

# SAS-2 SSC Investigation – Chamber Test Results (dB $\mu$ V/m)



## Vendor A Samples

	No SSC	2000PPM	3000PPM
3GHz	45.2	40.9	40.4

## Vendor B Samples

	No SSC	5000PPM
3GHz	53	38
6GHz	57	38

# SAS-2 SSC Investigation – Conclusions



- Exact correlation remains unachievable
- Trends demonstrate increasing levels of SSC reduce emissions

