Part 15.247 Bluetooth

QUESTION 1.
Please note that the radiated emissions data on pages 16 through 19 and 43 through 47 of the report do not indicate if all factors associated with the measurement have been considered. There does not appear to be any indication that the cable factor, antenna factor or preamp factor (if used) have been considered in the final data. Since the emissions above 1GHz also appear to be at the noise floor, it may be necessary to include a preamplifier to make proper measurements. The report does not been clearly explained if this was done or not. Please note that 2.1033 (b)(6) states, "…The report **shall include** sample calculations showing how the measurement results were converted for comparison with the technical requirements." Please provide the required sample calculations and please show evidence that all factors associated with final data have been considered. If these factors are part of the analyzer setting, please show how the analyzer treats each of these factors (e.g. a sample calculation)

RESPONSE 1.
Please note that the plots attached are for indication purposes only. The limit line is calculated based on a worse case scenario, that is, a peak detector has been used with the average limit line. If the sweep was done using an average detector then the indicated race would have dropped by approximately 9.5 dB taking the noise floor 20dB below the limit. FCC states that spurious below 20dB down on the limit do not require reporting.

I can confirm that all antenna factors and cable losses are contained within the analyzers transducer table. The test engineer manually enters these at the time of test. The spectrum analyzer adds the cable loss and antenna factor to the raw result and indicates the corrected figure on screen.

Lvl = R + Cl + AF

Where Lvl is the final Result.
R is the raw data.
Cl is cable loss.
AF is the antenna factor.

QUESTION 2.
Please note that the reported plot on page 17 of the report shows a video bandwidth lower than the resolution bandwidth. Please note that the video bandwidth in all but averaging mode is typically to be equal to or greater than the resolution bandwidth. While the setting used may not affect the readings by more than a fraction of a dB if at all, the analyzer video bandwidth should be equal to or greater than the res bandwidth. Please also note that this plot shows failing data but there is no indication if the tabular data on the preceding page of the report is associated with this failing data or not. Please explain why an incorrect video bandwidth was used and please explain why failing data is provided without clear reference to subsequent passing data.

RESPONSE 2.
Please note that these plots are pre-scans only and do not indicate final results. They are used solely for the purpose of identifying emissions that require further attention.

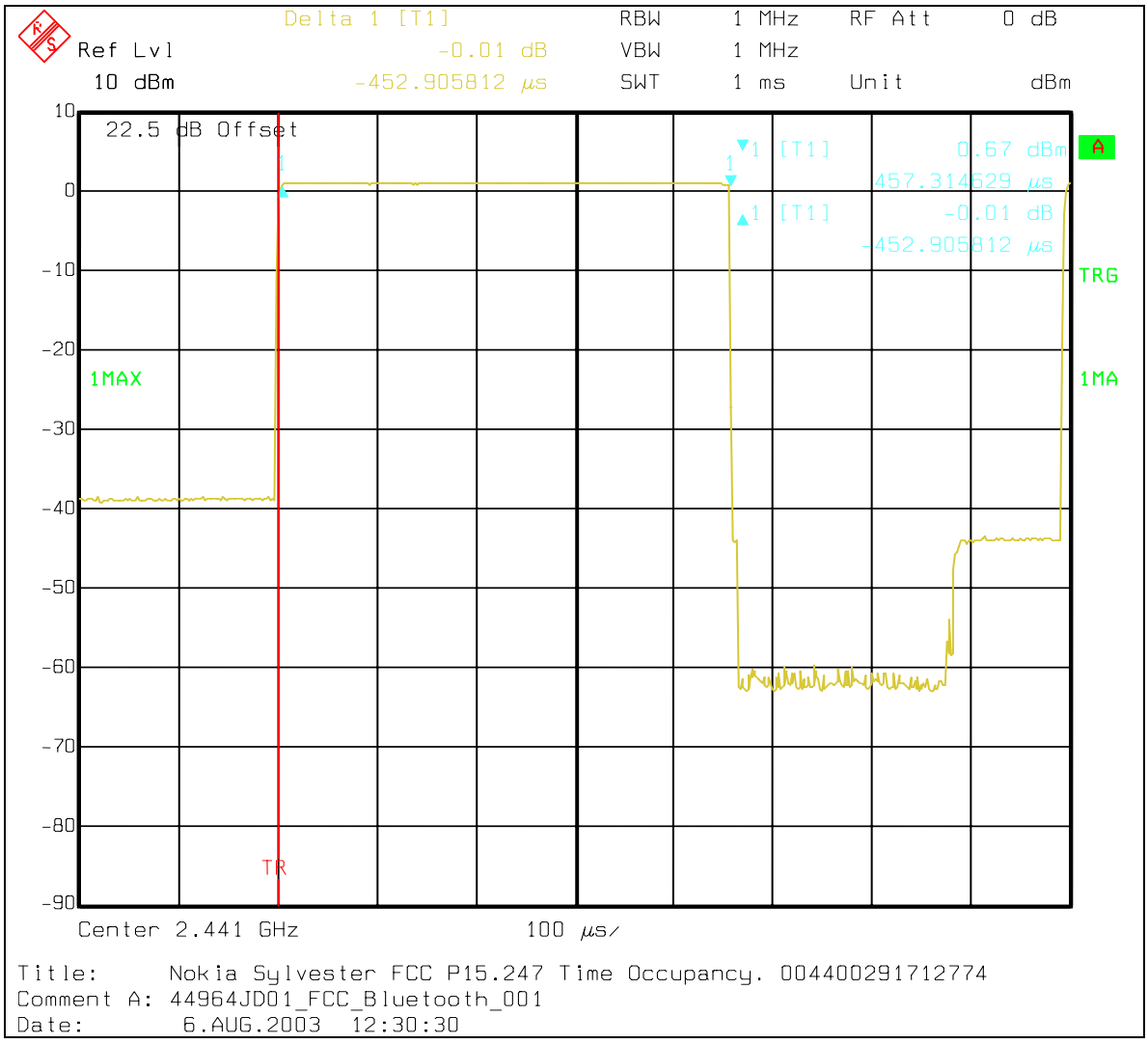
The response that is shown to be over the limit has been finally measured using a QP CISPR detector. The result is held within the associated table. Not the plot marker frequency of 66.9MHz the corresponding table entry is 66.4MHz. The slight difference in frequency is brought about by the lack of instrument resolution when making large sweeps. The table shows the exact frequency of the emission.

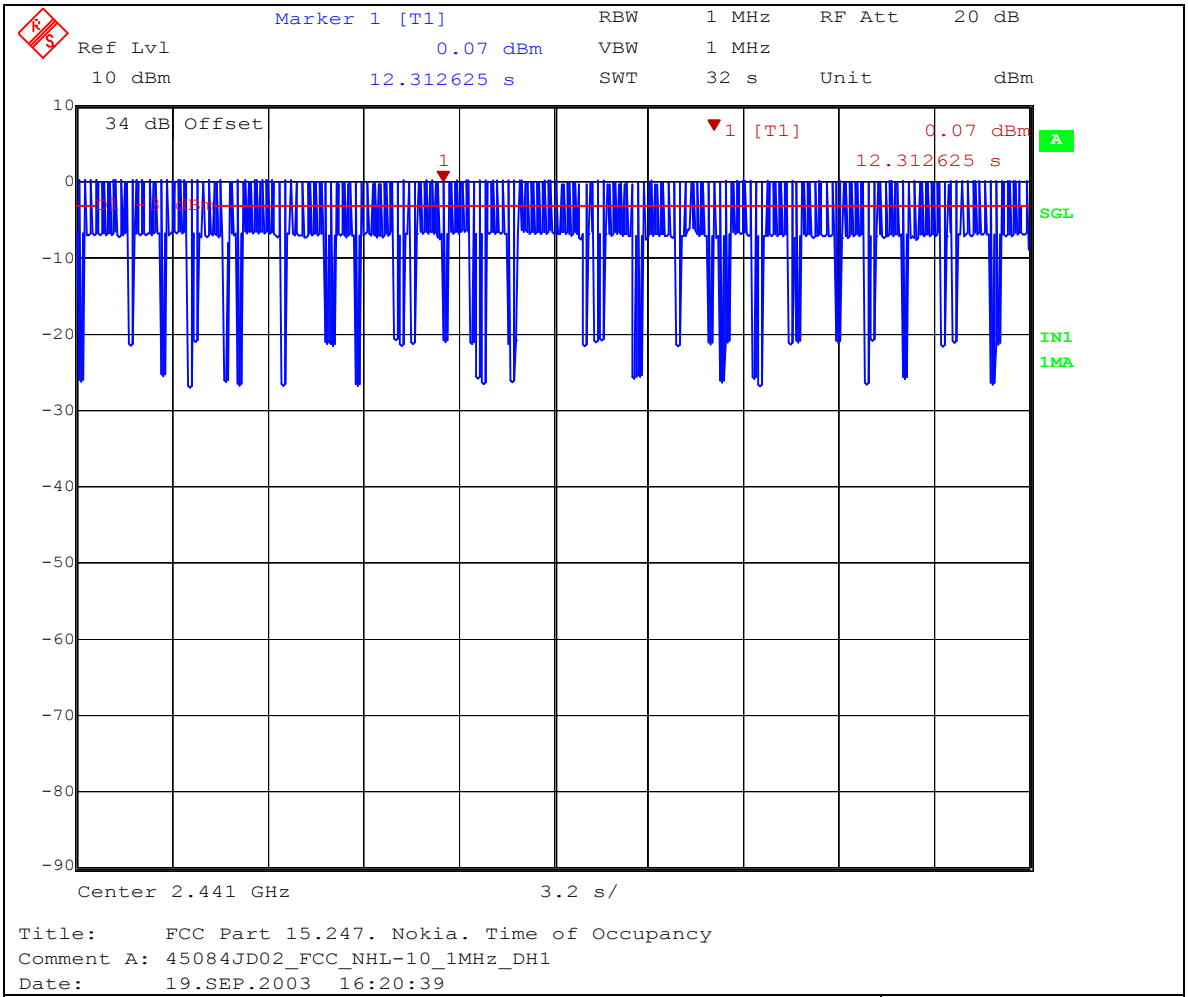
I can confirm that the indicated resolution bandwidth (RBW) is the instruments 6dB IF bandwidth and the video bandwidth (VBW) is the instruments 3dB bandwidth. The equivalent 6dB VBW is 120kHz. The reason it was not selected is that it is not an available option. The Rohde & Schwartz spectrum analyzer used is designed to use a 3dB VBW only.

All final measurements below 1 GHz, in idle mode were measured using a QP CISPR detector in line with CISPR 16.1. The QP measurement bandwidth is 120kHz. There is no VBW to consider.

QUESTION 3.
Please note that it appears that you have incorrectly measured channel occupancy. The plot reported shows a span of 83MHz including all channels and a sweep time of 20ms. Please note that this does not match your stated measurement procedure in section 9. The correct measurement is to be done with zero span centered on a single channel and a sweep time of 30 seconds, while the device is in hopping mode. This is to be repeated sufficient number of time to count the maximum occupancy per channel over the specified time limit. Please also note that the dwell (channel occupancy) data reported does not agree with normal and/or typical Bluetooth characteristics. Bluetooth devices typically have three modes of operation including data mode and inquiry mode. Because inquiry mode hops through significantly fewer total channels, inquiry mode may actually be worse case. Please re-measure your channel occupancy following the accepted FCC measurement procedure guideline for channel occupancy found in DA-000705. Please account for the possibility of other than data mode being worse case.

RESPONSE 3.
I can confirm that the data presented was incorrectly presented within the report.





Recorded Pulse Width = 452 uS	
Number of transmission on one channel in 31.6 Seconds = 253	
Total transmission time in 31.6 Seconds = 452uS x 253 = 114.356mS	

QUESTION 4.
Please note that power measurements are better done conducted, however, EIRP is acceptable if performed correctly. Please note that the report section 9 states ERP while the data states EIRP.

The accepted FCC method in accordance with DA-000705 is EIRP. Please correct the confusion between the test procedure listed in section 9 of the report and the data on page 25 section 8.7.2.

Due to the confusion mentioned above, it is not clear from the data that the correct antenna gain information was included. Please provide the calculations using the antenna gain of the substitution antenna used during testing. (See item 1 about the required sample calculations).

RESPONSE 4.
Conducted tests were not performed at the request of NOKIA.

The procedure in the rear of the report incorrectly identifies ERP. I can confirm the indicated radiated power is EIRP. The reference to ERP is incorrect.

The EIRP was measured radiated and thus includes the EUT antenna gain as standard.

The correct procedure is as follows. (Please also see response to the EIRP Part 24 question at the end of this document).

Effective Isotropic Radiated Power (EIRP)

EIRP measurements were performed in accordance with the standard, against appropriate limits.

The EIRP was measured with the EUT arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2001 Clause 5.4. The transmitter was fitted with an integral antenna; as such all radiated tests were performed with the unit operating into the integral antenna.

The level of the EIRP was measured using a spectrum analyser.

The test antenna was positioned in the horizontal plane. The EUT was oriented in the X plane. The test antenna was then raised and lowered until a maximum peak was observed. The turntable was then rotated through 360 degrees and the maximum peak reading obtained. The height search was then repeated to take into consideration the new angular position of the turntable. The maximum reading observed was then recorded. This procedure was then repeated with the EUT oriented in the Y and Z planes. The highest reading taken in all 3 planes was recorded. The entire procedure was then repeated with the test antenna set in the Vertical polarity.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a substitution antenna. For EIRP measurements a Horn antenna whose gain was based on an isotropic antenna was used, Any ERP measurements were done using a dipole. The centre of the substitution antenna was set to approximately the same centre location as the EUT. The substitution antenna was set to the horizontal polarity. The substitution antenna was matched into a signal generator using a 6dB or greater PAD. The signal generator was tuned to the EUT's frequency under test.

The test antenna was then raised and lowered to obtain a maximum reading on the spectrum analyser. The level of the signal generator output was then adjusted until the maximum recorded EUT level was observed. The signal generator level was noted. This procedure was repeated with both test antenna and substitution antenna vertically polarised. The EIRP was calculated as:-

EIRP = Signal Generator Level - Cable Loss + Antenna Gain

EIRP is the final calculated Effective Isotropic Radiated Power.

Signal Generator Level is the EUT substituted level.

Cable loss is the loss of the interconnecting cable between the substitution antenna and the signal generator.

Antenna Gain is the gain of the substitution antenna.

All measurements were performed using broadband Horn antennas.

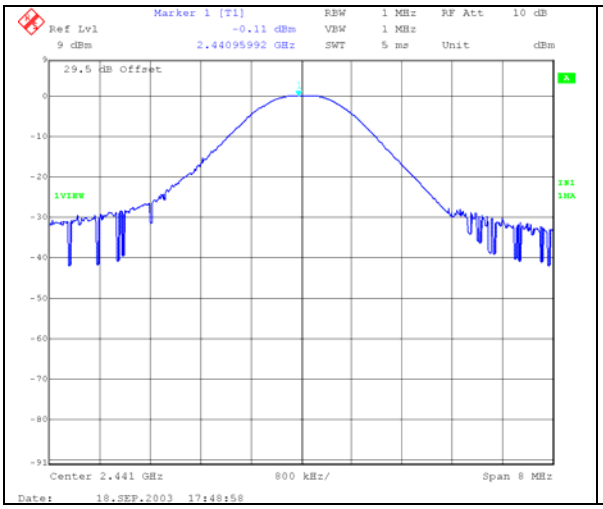
Circumstances where the signal generator could not produce the desired power substitution was performed with the signal generator set to 0 dBm. The radiated signal was maximised as previously described. The level indicated on the measuring receiver was noted. The delta between this level and the maximum level for the EUT was calculated and also noted. The EIRP of the signal generator was calculated using the above formulae. The recorded delta was added to the calculated EIRP to obtain the substituted EUT EIRP.

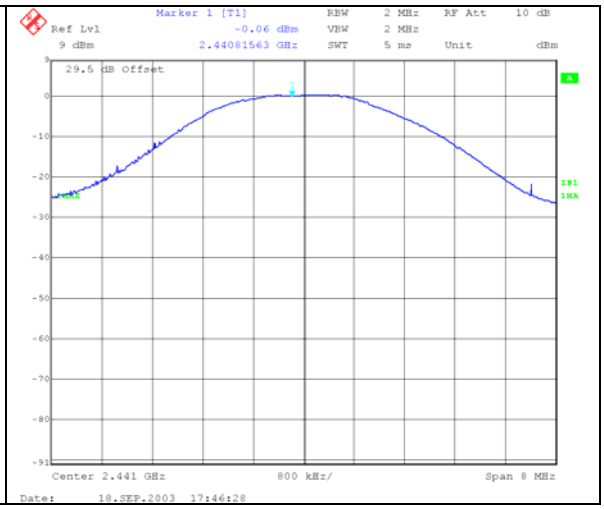
QUESTION 5.
Please note that when using a resolution bandwidth narrower than the displayed device 6dB bandwidth for power measurements, a bandwidth correction factor may need to be employed to account for any error introduced in the measurement by this condition. The displayed device bandwidth shown in the plots show an approximate device 6dB bandwidth of about 1.5MHz and a resolution bandwidth of 1MHz. This means that a resolution bandwidth correction factor of 10log(displayed Bw/ res bandwith) or 1.75dB may have to be included. Please include this correction factor of alternately verify if this is not needed (e.g measuring the power using a res band width of 2MHz; or by conducted measurements using a power meter or diode detector).

RESPONSE 5.
It is not understood where the 6dB bandwidth comes from? The procedure outlined in DA00-705 for carrier output power requests that a resolution bandwidth greater that the emissions 20 dB bandwidth be used. 1 MHz is greater than the 20dB bandwidth.

The assumption is correct regarding the effect measurement bandwidths have on a wideband signal, which is why we chose a measurement bandwidth of 1MHz. Your TCB is referring to the wrong measurement bandwidth type. When referring to power bandwidths you refer to its 3dB bandwidth. This is at the point where half the signals power is observed. A Bluetooth device has a 3 dB bandwidth slightly less than 1MHz. This means using any 3 dB bandwidth equal to or greater than 1MHz will have no effect on the emissions amplitude. A 6dB bandwidth could possibly be used when measuring the bandwidth of a voltage based signal. This indicated bandwidth would then be at half the voltage points.

Please see following plots confirming this. There is about a 0.05dB difference. This difference is no as a function of emission bandwidth relative to measurement bandwidth. It is accounted for through measurement uncertainty.





Part 24

QUESTION. 6
Please note that the test methods listed on page 8 of the PCS report list part 15 test methods but do not list licensed device test methods (e.g TIA 603). Please explain.

RESPONSE. 6
Please accept my apologies for omitting this reference. The reference that our secretaries inadvertently dropped from the report was. We do indeed use this standard as a guide for all Part 22/24 and PMR work.

"ANSI/TIA-603-B-2002
Land Mobile Communications Equipment, Measurements and performance Standards."

QUESTION. 7
Please note that while the test procedure in section 9 indicates EIRP measurement methods were done, neither the actual data in the report nor the test procedures indicate how the associated antenna substitution factors have been applied. Please clarify and provide the antenna gain for the substitution antenna used and please show how this factor was applied to the actual results (i.e. entered into the analyzer settings and automatically calculated, calculated by test engineer or other calculation methods).

RESPONSE. 7
I have to disagree with this comment. Our procedure clearly states the substitution procedure used and how substitution level, cable loss and antenna gain are applied.

What we did not include are details of antenna gain and cable loss etc. This was because the EUT was not directly substituted with a horn or signal generator. Instead, the path losses between the EUT and the measurement receiver were determined and the raw EUT EIRP corrected for accordingly. This procedure is detailed in the procedures section of our reports.

The principle is as follows.

Firstly the EUT transmits a level which is maximized through planes X,Y and Z with the measurement antenna being raised through 1 to 4 meters. One the maximum is obtained the EUT is rotated through 360 degrees, further maximizing the level.

Once the maximum level has been obtained. The path loss between the EUT and the measurement receiver is obtained. This is done as follows.

Signal generator set to the frequency of interest with its level being set to an arbitrary level, in this case – 0dBm.

The signal generator is connected to an isotropic horn antenna via a 10dB matching pad and cable. This pad and cable have losses associated with it.

The horn antenna has gain associated with it.

The signal radiated from the horn antenna is then calculated as:-

EIRP = SG- CL – ATT + G

Where SG is the signal generator level.

CL is the cable loss

ATT is the matching pad loss

G is the antenna gain.

The level reported on the measuring receiver is noted and subtracted from the calculated EIRP.

This delta is the path loss between the horn and measuring receiver in dB for the frequency under observation.

Thus path loss is then added to the maximized original raw figure recorded from the EUT. This in turn gives the maximum EIRP for the EUT.

The figures employed for this report were as follows.

SG = 0 dBm, CL = 0.6dB, ATT = 9.9dB, G = 14

The calculated path losses were Bottom = 28.5dB, Middle = 28.8dB and Top = 27.7dB

The raw EUT levels were, Bottom = 3.5dBm, Middle = 3.5dBm and Top = 3.5dBm

The final EIRP figures are Bottom = 32.0dBm, Middle = 28.8dBm and Top = 31.2dBm

