Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Facilitate the Use of Cellular Telephones and other Wireless Devices Aboard Airborne Aircraft	))))	WT Docket No. 04-435

COMMENTS OF MOTOROLA, INC.

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Motorola, Inc. ("Motorola") hereby submits these comments in response to the *Notice of Proposed Rulemaking* in the above-captioned proceeding.[1] In this proceeding, the FCC requests comment on the relaxation of its ban on airborne usage of 800 MHz cellular handsets, as well as comment on other significant issues, all aimed at facilitating wireless handset use on aircraft. Motorola supports the initiation of this proceeding to determine the best means for further promoting the development of consumer-based airborne communications. In revising its rules, however, the Commission must address many complex issues. Many of these issues overlap with issues administered by the FAA, and in that regard we encourage the continued close coordination of the two agencies in any subsequent Rulemaking to ensure safe use of RF emitters onboard commercial aircraft. A paramount consideration in determining whether to allow use of 800 MHz cellular systems onboard aircraft must be the need to adequately protect existing terrestrial-based systems from harmful interference. The Commission should not lift the ban on use of cellular onboard aircraft absent a clear framework for ensuring such protection.

[1] *Amendment of the Commission's Rules to Facilitate the Use of Cellular Telephones and other Wireless Devices Aboard Airborne Aircraft*, Notice of Proposed Rulemaking, WT Docket No. 04-435, FCC 04-288 (Feb. 15, 2005).

I. INTRODUCTION AND SUMMARY

The proliferation of wireless devices in the US and worldwide is increasingly evolving into a societal dependence on ubiquitously available wireless services that will ultimately provide seamless mobility for content and services to people when they want it, wherever they are, and regardless of the access pipe. Deployment of wireless systems on commercial aircraft could greatly benefit the general public by extending service during periods of travel, and holds the potential for increasing the utility of wireless services to the consumer. Motorola is committed to developing and deploying products and solutions that realize our Seamless Mobility vision by providing consumers the ability to move seamlessly across all communications networks. Widespread consumer acceptance and the derivation of maximum societal benefits of such a vision will require the availability of highly reliable networks capable of delivering high value content without disruption.

Accordingly, a key factor in whether cellular use should be permitted on aircraft is that it must be implemented in a way that does not cause harmful interference to existing terrestrial networks. It is not reasonable, or in the public interest, to allow implementation of a service that results in the deterioration of the current primary access mechanism for millions of mobile users. Any implementation of cellular use onboard aircraft must be done in a way that does not negatively impact terrestrial systems. This is especially true given the variety of alternative access mechanisms, such as WiFi or Bluetooth, that are now being integrated into mobile phones, are widely available in portable computing devices and are beginning to be deployed on airplanes around the world. Given such alternatives for consumers to access data and even voice, there is no reason to rush to permit use of other technologies aboard aircraft until it has been demonstrated that it can be done without negatively impacting licensed terrestrial networks.

II. THE COMMISSION SHOULD COMPREHENSIVELY CONSIDER ALL WIRELESS COMMUNICATION AND DATA TECHNOLOGIES IN SUBSEQUENT RULINGS.

The FCC has proposed to lift the current ban on "cellular" transmitters on commercial and/or private airplanes and is considering additional changes in anticipation of mobile phone deployments operating via onboard (*e.g.*, picocell supported) systems.[2] Given the current prohibition against using cellular and Specialized Mobile Radio ("SMR") services onboard aircraft, a focus of this proceeding is on whether to lift those prohibitions. While there is no prohibition against using Personal Communications Services ("PCS"), under Part 24 of the Commission's rules, or Wireless Communications Services ("WCS") under Part 27, the interference issues and concerns are the same as for the cellular and SMR services.

Accordingly, if the Commission determines that airborne use of cellular services can be done in a way that does not cause harmful interference to terrestrial networks, it should extend whatever framework is adopted to also cover the PCS, WCS and iDEN/SMR services so as to maintain a unified set of policies applicable to all relevant commercial wireless technologies, including cellular (Part 22), broadband PCS (Part 24), and iDEN/SMR (Part 90). The rules with respect to use of various CMRS services are not uniform and the exclusion of particular technologies from this modification would not only limit market competition, but might precipitate even more problematic issues with respect to the safe and practical deployment of onboard communication systems.

The uniform inclusion of technologies in all CMRS bands, such as those governed by Parts 22, 24, 27 and 90, will provide additional flexibility for the deployment of consumer-based

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[2] These onboard systems would presumably be backhauled by either an air-to-ground link, or alternatively via an air-to-satellite-to-ground link, to a cellular switching station and out to conventional communications networks.

services on commercial aircraft. Decisions to deploy single, combinations of, or all existing technologies, including technologies that operate on an unlicensed basis, such as WiFi or Bluetooth, onboard a given aircraft should ultimately be made based upon careful consideration of technical feasibility, compatibility with aircraft electronics, interference risk to terrestrial communication networks, cost-efficiency, consumer demand, and various human factors including the practical implementation of in-flight procedures to assure compliance with airline policy. Both single and multiple technology deployments will be associated with a unique set of challenging complexities that must be addressed. Ultimate solutions should be developed based upon safe and practical in-flight operations, realistic engineering solutions, and market forces and not because of an uneven application of regulations.[3]

While not an issue that impacts mobile phone manufacturers directly, it would be difficult to envision any onboard wireless solution that would require active surveillance of passenger compliance by the airline flight attendants. Absent some clear distinguishing feature or icon, the ability to distinguish between new and legacy mobile phone handsets, the operating frequency(s) or signal technology(s) used (*e.g.*, GSM, CDMA, iDEN, AMPS, UMTS), or handsets enabled with system-supported features (*e.g.*, WiFi, Bluetooth) or specific software modifications would be impractical.[4] Once any rule facilitating the use of mobile phones on aircraft is adopted, one

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[3] As a caveat, specific technologies should be excluded from this rule change if their use represents an undue hazard to the safe and unobstructed operation of aircraft or terrestrial communications that cannot be sufficiently mitigated by reasonable measures in system design.

[4] Many future user devices will have the capability to disable the radio transmitter to make game and personal organizer features of the device available while the transmit feature is disabled, preventing calls or network registration onboard aircraft, in hospitals, or other places where mobile phone use may be banned. Following the current guidelines, drafted by the CEA Portable Electronic Devices (PEDs) working group, entitled "Recommended Practice: Status Indicator for the Control of Transmitters in Portable Electronic Devices (PEDs)", version 1.0, October 2004, user devices will need to have a clear indicator so that the user and responsible parties can accurately determine that the transmitter is disabled. This technique could be adopted

can only assume the general public is likely to turn on their personal phone, irrespective of technology, to see if it will operate on the airplane system.

III. THE FCC MUST PROTECT TERRESTRIAL SYSTEMS FROM INTERFERENCE.

A paramount concern that the Commission must consider is the potential degradation of existing licensed communications that may result from future aircraft system deployments. It should at the very least be incumbent upon developers of these systems to design against estimates of potential interference to terrestrial communication networks that are agreed to by the incumbent licensees, especially with respect to noise-floor sensitive CDMA technologies (including existing and 3G / UMTS type networks). These estimates will have to be developed through industry consensus.

A. Association of mobile devices with preferred networks

The FCC is considering onboard picocells as a preferred solution to provide service to traditional CMRS handsets. Onboard picocells will likely be able to provide blanket coverage within the cabin of an aircraft using relatively low output power levels, and likewise command handsets that remain under their control to transmit at relatively low power due to existing software mediated dynamic power control. Maintaining low power transmission from handsets, however, requires that they remain associated with the picocell and not attempt links to terrestrial base station sites.[5]

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by airlines to indicate authorized usage onboard aircraft; this is considered only a longer-term solution that could be implemented as newer devices are brought into the market.

5 Clear line-of-sight between terrestrial sites and aircraft produce results in low path loss links that can produce interference to terrestrial networks. Aircraft attenuation is being investigated but low loss situations are certainly possible with cell phones near unshielded cabin windows. Recent data presented to the RTCA by Bill Strauss of Carnegie Melon (June 2004) and Wireless Cabin (December 2004) entitled "*Power and Interference Consideration for*

Existing software in mobile phone handsets usually assigns preference to "home" network sites when roaming or otherwise not linked to the home network. CDMA addresses this issue by using a Preferred Roaming List ("PRL") to establish priorities for which system ID's to seek. The highest priority is normally assigned to the home network for that user, with roaming partners assigned lower priorities. Current technical specifications for GSM and iDEN direct handsets to migrate back to available home network sites if the signal meets the minimum acceptable C/I thresholds. These home network search algorithms are performed at power up, in manual mode, upon loss of the serving network, and during periodic background scans.

While software modifications could theoretically be made to passenger handsets directing them to maintain a link with the airplane's picocell, it is impractical since this would require modification to each mobile device in the field and would require a variety of different software modifications specific to each handset model manufactured. Although some software updates might be performed over-the-air, many legacy handsets and operators will not support this capability. Such a solution would also require a complicated level of surveillance by air flight personnel to ensure compliance.

One approach to address this issue would be to work in the standards bodies for changes in algorithms to specifically accommodate aircraft picocells, but due to the hundreds of millions of legacy handsets on the market this may not be a viable solution in the short term to enable use of mobile devices on aircraft.

B. Airborne jamming devices and interference concerns

While the Commission's NPRM did not mention the use of noise floor lifters

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Airborne Mobile Telephone Systems" suggest that mobile phones are often able to register with terrestrial networks and may make calls in some places.

("jammers"), Motorola has learned from presentations at previous RTCA meetings that many onboard systems under development envision (and may require) the use of wide band jamming technology.[6]

The use of dedicated jammers is not only illegal in the US, but also causes great concern. Obvious and significant dangers of interference from such airborne devices exist for large regions of terrestrial mobile phones and networks. As proposed for use in aircraft, the function of jammers would be two–fold. First, they would be used to disable technologies across all licensed bands that are not supported by the picocell. For a single technology system operating on an aircraft within the US, this would presumably involve spectrum noise across the downlink LMR/iDEN (851-869 MHz), cellular (869-894 MHz), PCS (1930-1995 MHz), future AWS, and BRS (2500-2690 MHz) bands. These jammers would need to present sufficient noise to drive C/I levels below acceptable thresholds on all channels not served by the picocell. A second function of jammers would be to mask terrestrial (home) network signals that entered the aircraft cabin and might precipitate the association of handsets initially connected to the airplane picocell with terrestrial networks.

The actual level of wide spectrum noise from a jamming device required to effectively accomplish this, or what contribution this would make to the terrestrial noise floor, is not clear. Path loss calculations for RF signal propagation between the ground and an airplane (and vice versa) depend on a number of complex variables including power of the transmitting antenna, plane altitude and attenuation, regional topography, channel distribution, and regional network density. Rudimentary calculations from our group suggest that the contribution to ground-based systems could be significant and could adversely affect the operation of the existing network(s).

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6 OnAir presentation to the RTCA, April 2005, Wireless Cabin presentation to the RTCA December 2004.

This is especially problematic with respect to CDMA-type networks (both current and 3G/UMTS) that operate by carefully balancing and decoding signals from the background noise floor generated by other users, any increase from external sources will impact performance.[7]

Further, as communication technology and network design continues to improve signal-to-noise ratios and more efficiently utilize bandwidth to accommodate increasing traffic volume, thresholds for network interference that exist today may not accurately reflect levels for future technology. Finally, failure analysis and an appropriate mitigation strategy for the onboard picocell should also be considered in any design.

IV. THE COMMISSION SHOULD NOT ADOPT OUT-OF-BAND AND SPURIOUS EMISSION LIMITS ON HANDSETS THAT EXCEED THOSE IN CURRENT INDUSTRY STANDARDS.

The wireless industry has developed standards that specify current out-of-band and spurious emission limits for mobile phones that adequately protect operations in adjacent bands. Mobile phone manufacturers use these industry standards as requirements in developing all of their products. Most mobile phone handsets on the market today do provide some margin to existing limits in order to operate within their respective networks and to provide for tolerances in the manufacturing process necessary to ensure that every phone meets the standard. Significant modification to existing limits would negatively impact the manufacture and design of handsets by potentially adding increased cost and complexity. There is no basis at this time for assuming that the current industry standards do not provide adequate protection to aeronautical systems and the Commission should not adopt limits in excess of industry standards absent such evidence.

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[7] Outside interference, of even small amounts, can impact the busy hour capacity of many sites, the battery life of cell phones that increase power to compensate for the interference, blocks some phones’ capability to access sites and decreases the quality of resulting connections being carried on the site.

Initial studies indicate that current out-of-band and spurious emission levels from mobile phones are not any more problematic sources of in-band interference for aircraft avionics than other Part 15 intentional and unintentional PED devices. These results are outlined within the recent RTCA SC202 phase 1 report.[8] Furthermore, a recent NASA Langley study commissioned by the FAA to evaluate possible interference from 3G phones with aircraft Navigation and Communications Systems also concluded "[i]n most cases, the wireless phones [that were tested] were seen to have better safety margins [with respect to DO-160 immunity limits][9] than laptops and PDAs due to their lower emissions."[10] Finally, another NASA Langley presentation concluded "FCC rules for UWB and other Part 15 devices below 960 MHz [may exceed current DO -160 immunity limits] that protect aeronautical radio services."[11] These studies/presentations are consistent with operations of WiFi devices which are currently deployed by non-US airlines.[12] Motorola is not aware of interference problems.

Motorola has evaluated some handsets by measuring the level of out-of-band and spurious emissions operating under lower power conditions that would exist under the control of a picocell on an aircraft. Initial results are shown in Appendix A. Motorola observes that there

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8 RTCA DO-294, *Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDs) on Aircraft*, issued October 19, 2004

9 "Environmental Conditions and Test Procedures for Airborne Equipment," DO-160 (A-E).

10 Truong X. Nguyen, Sandra V. Koppen, Laura J. Smith, Reuben A. Williams (NASA Langley Research Center, Hampton, Virginia) and Maria Theresa P. Salud (Lockheed Martin, Hampton, Virginia), report found at: http://techreports.larc.nasa.gov/ltrs/PDF/2005/tp/NASA-2005-tp213537.pdf

11 Jay Ely (NASA Langley Research Center, Hampton, Virginia) presented at the October 2004 meeting of the RTCA SC202

12 WiFi is used to distribute the service inside the plane and is currently available on Korean Air, ANA, JAL, Lufthansa, Singapore Airlines and SAS. *See* http://www.connexionbyboeing.com/.

is a general trend of nearly a 0.77 to 1 dB reduction in out-of-band emissions for each dB the transmit power is reduced. Based on this and the various proposals which limit the transmit power of the mobile devices to the minimum required power level, we believe that the current industry cellular standards will be sufficient to protect aircraft communications against emission from devices.

The Commission should not adopt any new rule that would require hardware or software modifications to new and/or legacy mobile phone handsets, either comprehensively or as a prerequisite to operation on an airplane system.

V. AIRBORNE USAGE OF CELLULAR HANDSETS IS HIGHLY UNLIKELY TO PRODUCE RF EXPOSURES TO PASSENGERS EXCEEDING THE COMMISSION'S GUIDELINES FOR HUMAN RF EXPOSURE

While not raised in the NPRM, this rulemaking may raise questions about RF exposure levels resulting from the simultaneous, proximate use of cellular handsets within the aircraft cabin. It may be hypothesized, for example, that high RF exposure levels could occur due to reflection and accumulation of RF energy produced by handsets within the metallic cavity of the airplane fuselage. The facts in aggregate, however, demonstrate that even using "worst case" assumptions, RF exposure limits are unlikely to be exceeded because: (1) the Commission's equipment authorization procedures for portable devices preclude the possibility of excessive exposure of device users and "bystanders"; (2) RF attenuation and absorption phenomena from materials inside the aircraft significantly reduce the likelihood of reflection and accumulation of RF energy and; (3) onboard control of cellular phones by a picocell network will result in handset power levels substantially below maximum.

The Commission's equipment authorization procedures ensure that cellular handsets, whether used on the ground or in an airplane, comply with RF exposure limits defined in terms of specific absorption rate (SAR). For handsets and other RF transmitters placed against the ear, the peak spatial-average SAR is the governing exposure parameter. The peak SAR is determined by protocols and test procedures specified in Institute of Electrical and Electronics Engineers (IEEE) Standard 1528-2003.[13] During these tests, the handset is set to transmit at its maximum power level, even though in practice the transmit power is often greatly reduced via typical dynamic adaptive power control and delayed transmission protocols. The handset is also evaluated in two representative "intended use" positions, even though in actual use it may not be pressed tightly to the head or tilted at 15°. The results obtained by following the protocols specified in this IEEE 1528 recommended practice "represent a conservative estimate of the [peak spatial average] SAR induced in the head of a significant majority of persons."[14] The adequacy of SAR measurement data is reviewed and approved either by FCC-trained telecommunications certification bodies (TCBs) or the FCC Laboratory Equipment Authorization Branch before the handset is marketed by the manufacturer. In sum, FCC's existing exposure guidelines and equipment authorization regime for RF compliance of portable devices adequately assure that users of cellular handsets do not exceed prescribed exposure limits.

It can be similarly concluded that passengers *adjacent* to persons using handsets will also not be exposed to RF levels above the FCC guidelines. SAR is highly dependent on distance, i.e. it is inversely proportional to the square of the distance to the exposed person at distances greater than 3-4 cm.[15] Under this "bystander" scenario, the passenger not using a cellular phone would

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13 Institute of Electrical and Electronics Engineers, *IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques*, 2003.

14 *Id.* at Abstract.

15 N. Kuster and Q. Balzano, Energy Absorption Mechanism by Biological Bodies in the Near Field of Dipole Antennas above 300 MHz, *IEEE Trans on Vehicular Technology*, 41, 17-23 (1992).

be exposed to RF levels orders of magnitude lower than the peak SAR limit, depending on distance. Even at close proximity (30 cm or approximately one foot), neighboring cellular phones operating at maximum power would each contribute about one hundredth (0.016 W/kg) of the peak SAR compliance limit. In an airplane cabin, large numbers of passengers may be seated in close proximity for long periods of time, so a scenario exists where a passenger may not only be exposed to RF energy from his/her own handset, but also to RF transmissions from several other passengers' handsets. However, for these RF sources to be additive with respect to local peak SAR limits, the major portion of the incident energy from each would have to be locally absorbed in the same 1 gram of tissue, which is not realistic. The actual RF exposure in such a situation where cellular phones sources were positioned throughout the airplane cabin, however, would not localize RF energy to the head or any other single body part of the passenger but would diffuse it over various parts of the body. In this case, whole-body averaged SAR is the governing exposure parameter. If two passengers were making calls and absorbing all the energy from their cellular phones operating at 1.0 W maximum power, the whole-body averaged SAR per person (assuming 60 kg. body weight) would be 0.0167 W/kg. Even if two hundred passengers used cellular phones simultaneously inside the plane, the whole-body averaged SAR values per person would not change perceptibly.

The RF emissions from cellular phones are not confined by the metallic fuselage of the aircraft and RF levels do not "accumulate." Some of the energy will leak out of the windows. Some of the remaining RF energy may be reflected, but such reflections would be damped very quickly. Nearly all the radio waves are ultimately absorbed and dissipated by materials of construction and passengers inside the aircraft. Human exposures from cellular phones inside enclosed spaces, *e.g.* train carriages, elevators and cars, have been the subject of a number of radio engineering studies and commentaries.[16] Proper engineering studies suggest that simultaneous use of many mobile phones in enclosed areas is highly unlikely to exceed international RF exposure guidelines.

Finally, cellular phones operating within an aircraft would presumably be under the control of an on-board picocell. Although the picocell itself would transmit RF energy in the low milliwatt range, the antenna is currently envisioned to be in a luggage compartment or closet, creating significant separation distance (greater than 30 cm or one foot) from passengers. More relevantly, the picocell would control the cellular phones by directing them to transmit at sub-maximum power levels, further reducing passenger RF exposure levels.

All these factors suggest that even under worst-case conditions, non-compliance with the Commission's RF exposure guidelines is highly improbable, even if multiple handsets are used simultaneously.

VI. CONCLUSION

Prior to lifting its ban on airborne usage of 800 MHz cellular handsets, the FCC must ensure that such airborne operations will not cause harmful interference to terrestrial-based systems. As outlined above, however, none of the proposed solutions for allowing airborne operations have demonstrated the provision of adequate protection. Accordingly, the FCC should retain its ban on airborne operation of 800 MHz cellular handsets until such time that it is proven that operation will not cause harmful interference. If, however, the Commission ultimately determines to develop a framework that allows for cellular airborne operation, it should adopt the same framework for PCS and other commercial mobile services. Motorola

[16] A. Toropainen, Human Exposure by Mobile Phones in Enclosed Areas, *Bioelectromagnetics* 24, 63-65 (2003); A. Kramer, J.Frolich and N. Kuster, Towards Danger of Mobile Phones in Planes, Trains, Cars and Elevators, *Journal of the Physical Society of Japan,* 71, No. 12**,** 3100-3100 (2002).

looks forward to working with the Commission to resolve the technical interference issues raised in these comments in a way that will ultimately lead to the development of a framework that will allow for the airborne operation of all wireless services.

Respectfully submitted,

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Appendix A: Effects of reducing transmit power on out-of-band emissions

Shown below in Figures 1-3 are measurements of the out-of-band emission levels from two sample GSM mobile devices. The transmitter was set to a center frequency of 1909.8 MHz and the out-of-band emissions were measured at 1930 MHz. Shown in Figure 1 is a sample measurement of a device at 24 dBm, it should be noted that the relationship between transmit power and out-of-band emission is presented at only one specific frequency. The results summarized in Figures 2 and 3 are indicative of the relationship between the out-of-band emission level as a function of the transmit power, it should be noted that at full power, the peak emission level is compliant with the emissions levels specified in the GSM standards. For further details on absolute emissions levels see Motorola reply comments in Docket 04-356.[17]

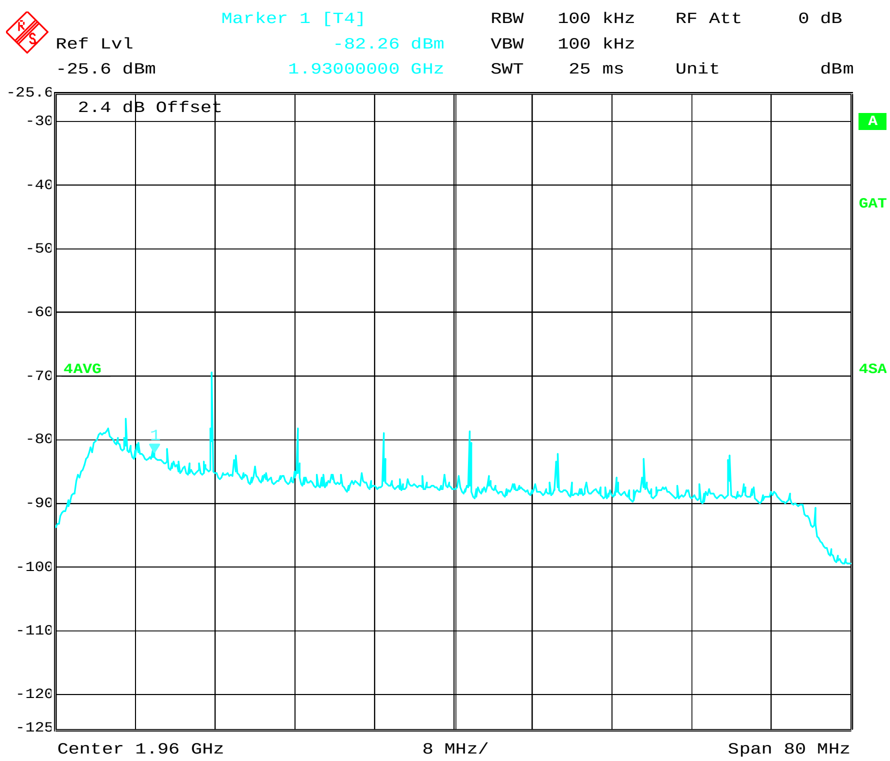

Figure 1: Sample #1 measurement at Tx power of 24 dBm.

Shown in Figures 2 and 3 are the levels measured at 1930 MHz as a function of the transmit power of the sample devices. The relationship of the noise level to transmit power of the device indicates has a slope of 0.77 to 1.0, thus the out-of-band emissions are reduced by 0.77 dB for every dB that the device reduces the transmit power, in some architectures the level may be reduced even further.

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17 Reply Comments of Motorola, Inc., WT Docket No. 04-356, WT Docket No. 02-353, 4-5, A8-A12 (filed Feb. 8, 2005).

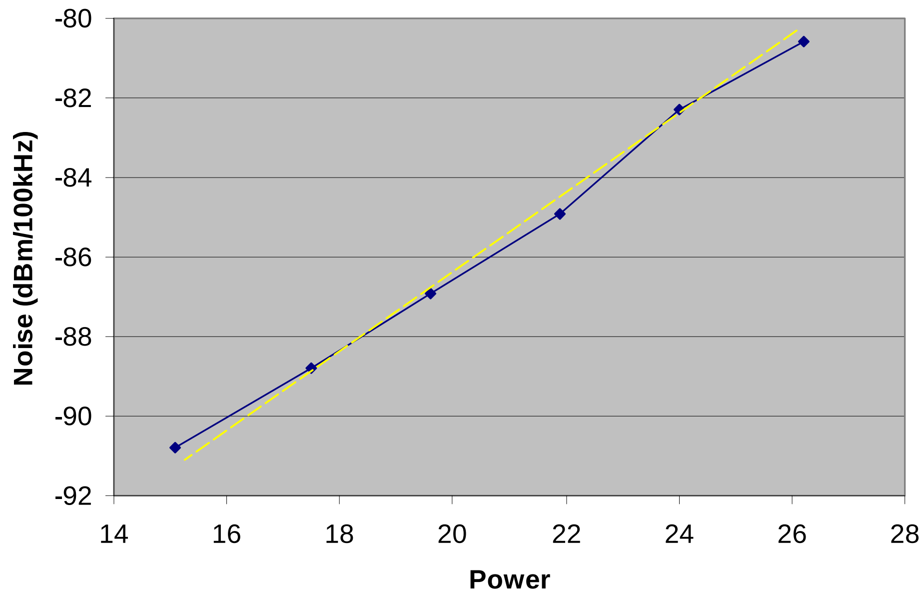

Figure 1: Sample #1, GSM mobile device noise power vs. transmit power (Yellow line indicates slope of 1).

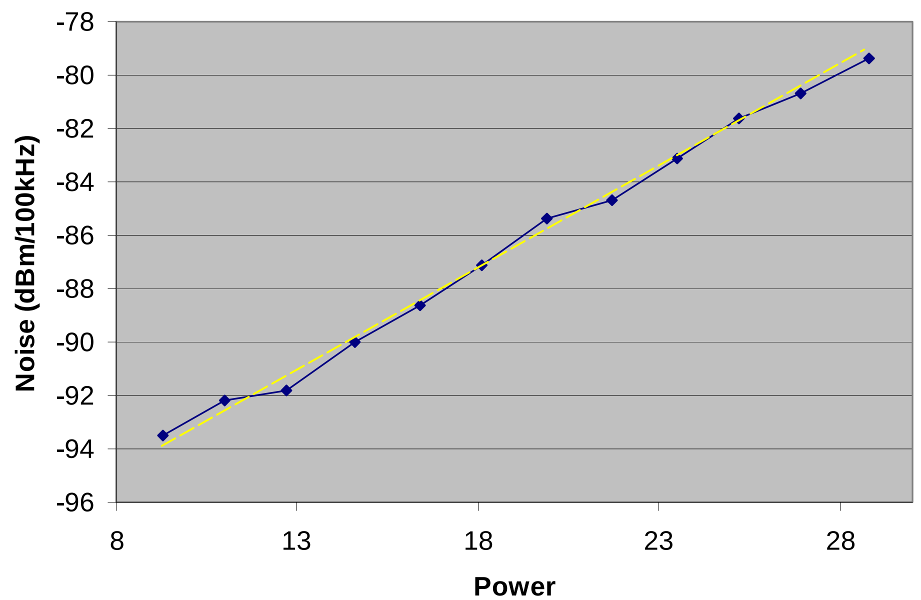

Figure 2: Sample #2, GSM mobile device noise power vs. transmit power (Yellow line indicates slope of 0.77).