Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems	)	ET Docket No. 98-153
	)	

COMMENTS

of

SIEMENS VDO AUTOMOTIVE AG

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SUMMARY

Siemens VDO Automotive AG ("Siemens VDO") is pleased that the Commission has proposed in its *Further Notice* to amend its rules to permit the operation of Siemens VDO's pulsed frequency hopping ("FH") vehicular radar systems. Siemens VDO submits these comments to respond to the Commission's questions related to the proposed changes, and to request modifications to certain of the Commission's proposals.

- Siemens VDO's pulsed FH systems pose no greater risk of harmful interference than pure pulsed systems. Both the level of each single line power ("SLP") and the distribution of the SLP within the victim receiver bandwidth are identical for pure pulsed and the Siemens VDO devices. Where the level and distribution of the SLP are identical, the interference potential will also be identical.

- Receivers with fast response times will not be at an increased risk from the Siemens VDO devices. The frequency hopping of the Siemens VDO devices over, for example, a 1 GHz bandwidth will produce an additional duty cycle for victim receivers over 50 MHz or less, which will effectively reduce the pulse repetition frequency ("PRF") by a specific amount. Accordingly, the Siemens VDO devices will be peak power limited, not average power limited.

- Spatial integration – where the aggregated power at the victim receiver from multiple transmitters is averaged over a large geographic area – will make it virtually impossible for an EESS sensor to distinguish between a pure pulsed and a Siemens VDO pulsed FH device. Based on their typical operating parameters, police radars and the amateur serves are likewise not susceptible to any greater interference from Siemens VDO devices.

- Siemens VDO supports the Commission's proposal to eliminate the 500 MHz minimum UWB bandwidth requirement, although Siemens VDO proposes that the more stringent "one-tenth of the –10 dB bandwidth" peak measurement requirement be applied only in the restricted band, with the full –10 dB bandwidth being used in the remainder of the 22 – 29 GHz band.

- If the Commission does not eliminate the minimum UWB bandwidth requirement, it should adopt one or both of the bandwidth measurement procedures proposed by Siemens VDO for its pulsed FH devices. The measurement procedure proposed in the *Further Notice* would be difficult, if not impossible, to perform with a standard spectrum analyzer.

- It does not matter whether the peak power measurement of the Siemens VDO pulsed FH devices are taken with the frequency hopping active or stopped.

- The average RMS power measurements must be taken with the hopping active to obtain accurate readings. Tests conducted by NTIA confirm this conclusion.

- Siemens VDO supports the Commission's proposal to apply to general Part 15 devices a peak power limit equivalent to that contained in the UWB rules. However, the use of the one-tenth of the –10 dB bandwidth proposed in draft section 15.35(b)(2) would not result in accurate peak power measurements. Accordingly, the full –10 dB bandwidth should be used.

Siemens VDO asks that the Commission adopt those proposals that will permit the operation of Siemens VDO's vehicular radar systems.

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Siemens VDO Automotive AG ("Siemens VDO")[1] submits these comments in response to the Commission's Further Notice of Proposed Rulemaking ("*Further Notice*") issued in the above-referenced docket.[2] In the *Further Notice*, the Commission sought comment, *inter alia*, on proposed changes that would permit the operation of Siemens VDO's pulsed frequency hopping ("FH") vehicular short range radar ("SRR") system currently under development. [3]/ In these comments, Siemens VDO demonstrates that its pulsed FH system is no more likely to cause harmful interference to terrestrial or space borne receivers than a pure pulsed system.

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1 Siemens VDO is one of the world's leading suppliers of high-tech electronics for automotive applications. The company is active in fields such as cockpit and car communications systems, airbag and ABS electronics, and engine control and fuel injection technology.

2 Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-193, *Memorandum Opinion and Order and Further Notice of Proposed Rulemaking,* FCC 03-33 (rel. March 12, 2003) ("*Further Notice*").

3/ The Commission sought comments on these issues in response to Siemens VDO's Petition for Reconsideration filed in ET Docket 98-153 on June 17, 2002 ("Petition for Reconsideration"). Siemens VDO hereby incorporates by reference that Petition, including the Technical Annex attached thereto, as well as all other filings previously submitted by Siemens VDO in ET Docket 98-153.

Siemens VDO explains its proposals for measuring the UWB bandwidth of pulsed FH systems, as well as for measuring peak and mean power levels. Finally, Siemens VDO offers support for the Commission's proposals to eliminate the UWB definition and apply less stringent power limits to non-UWB wideband devices.

I. PULSED FREQUENCY HOPPING SYSTEMS POSE NO GREATER LIKELIHOOD OF INTERFERENCE

In the *Further Notice*, the Commission expressed concern that the Siemens VDO pulsed FH device could cause a higher level of interference to victim receivers than devices satisfying the current UWB rules. This concern is misplaced. As explained below and in Siemens VDO's Petition for Reconsideration, Siemens VDO's pulsed FH system presents no greater risk of harmful interference than pure pulsed systems. Basic principles of physics and mathematics dictate that, even if the modulation technique used by Siemens VDO to generate a wideband signal is different from that of a pure pulsed system, the interference potential of the Siemens VDO device will be similar to that of pure pulsed systems, provided that certain other operational parameters, such as the single line power ("SLP") spectra are the same. This point is demonstrated in section I.A below, which contains screenshots of a UWB power calculation tool, developed by Siemens VDO, to analyze both pure pulsed and pulsed FH radar devices. The mathematical formulas programmed into this calculation tool describe the relationship between total EIRP peak power, SLP levels and the resulting peak and average power levels in a given bandwidth. Application of such formulas demonstrates that the interference potential of the Siemens VDO device is identical to that of a pure pulsed device operating pursuant to the current UWB rules. 4/

A. Interference Potential of Pure Pulsed and Pulsed FH Devices

The interference potential of an emission into a victim receiver is defined primarily by the victim receiver's bandwidth and by the characteristics of the emission. For pure pulsed systems, the most salient of these characteristics are the total EIRP power, the pulse width and the PRF. Controlled by these parameters, pure pulsed devices generate instantaneously a SLP spectrum that is discrete in the frequency domain. A victim receiver collects all the spectral lines that fall within its bandwidth. (In the *First Report and Order*, the Commission determined that 50 MHz is likely the largest receiver bandwidth that may be encountered. 5/)

This power distribution in discrete spectral lines that is characteristic of pure pulsed system emissions is also characteristic of Siemens VDO pulsed FH system emissions. Both the level of each SLP and the distribution of the SLP within the victim receiver bandwidth are identical. Where the level of each SLP and the distribution of the SLP within the victim receiver bandwidth are identical, the

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4/ The calculation tool also shows the relationship between average and peak power in a given bandwidth with regard to the applied pulse width and the pulse repetition frequency (PRF) used. A copy of the executable software for the calculation tool is being submitted into the record on a CD-ROM, as an attachment to these comments. Siemens VDO will transmit a copy of the software to any party upon request.

5/ Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-153, *First Report and Order,* FCC 02-48 (rel. Apr. 22, 2002) at ¶ 208.

interference potential will be also identical, irrespective of whether these SLPs are generated by a pure pulsed or by a pulsed FH device (see Figures 1 and 2).

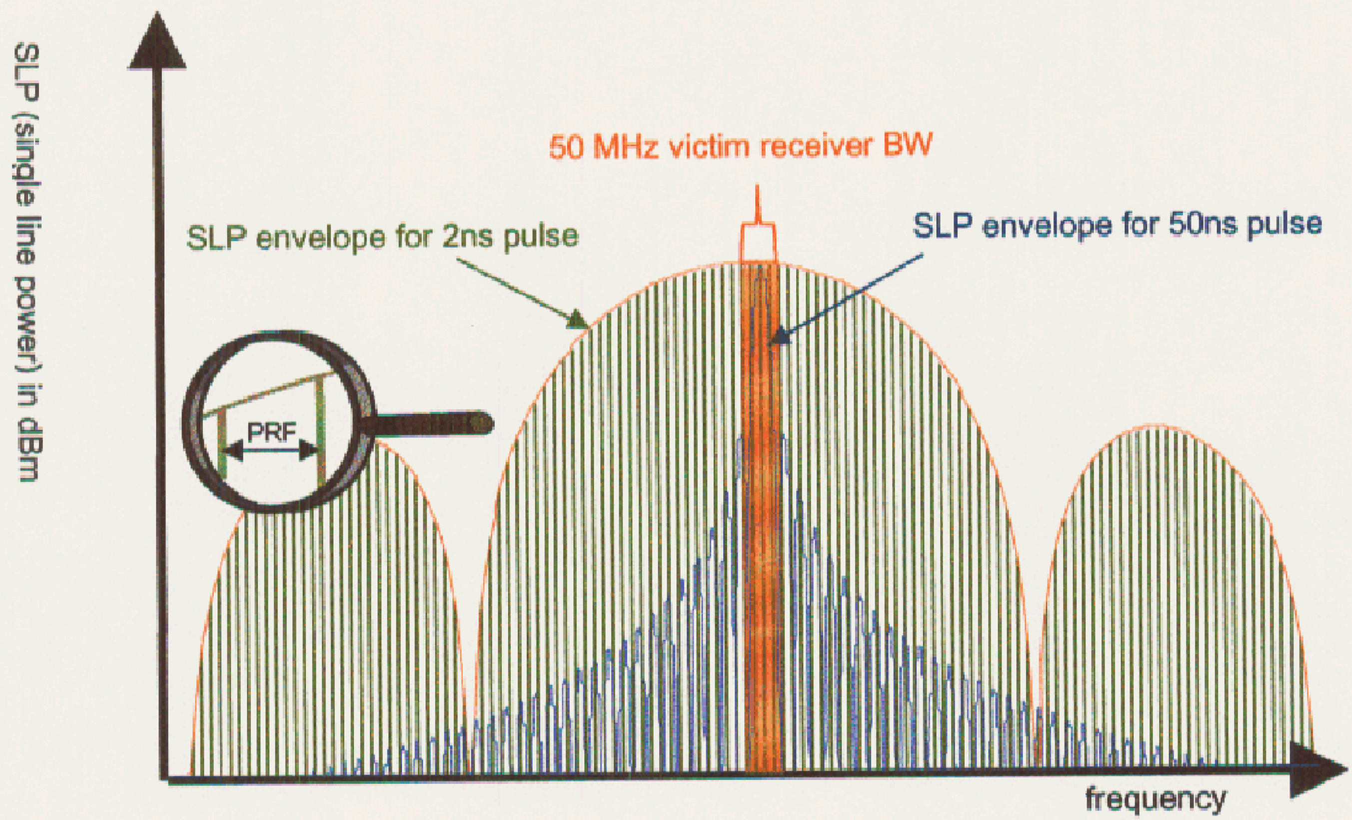

Figure 1: Single Line Power (SLP) of a 2ns and a 50ns pulsed carrier.

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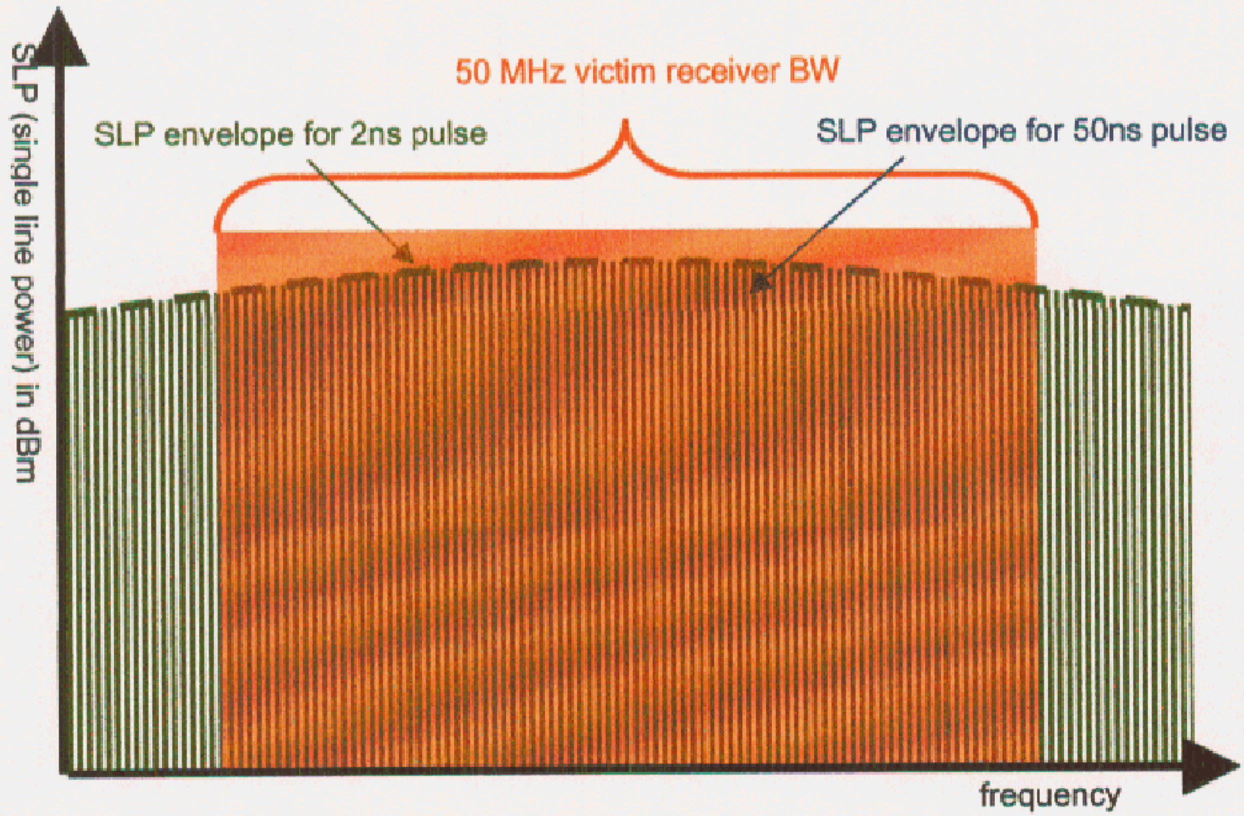

Figure 2: Single Line Power (SLP) of a 2ns and a 50ns pulsed carrier (zoomed in).

In the screenshot (Figure 3) below, a comparison is made between a pure pulsed device operating pursuant to the UWB regulations currently in force (*i.e.*, 500 MHz instantaneous bandwidth, peak power below 0 dBm/50 MHz and average power below -41.3 dBm/MHz) and a pulsed FH system. Despite the fact that the instantaneous occupied bandwidths are different (500 MHz vs. 20 MHz), the SLP and the distribution of the SLPs (which is governed by the PRF) are identical. Thus, despite some variation in terms of operational parameters, these two devices cannot be differentiated by any victim receiver with a bandwidth of up to 50 MHz.

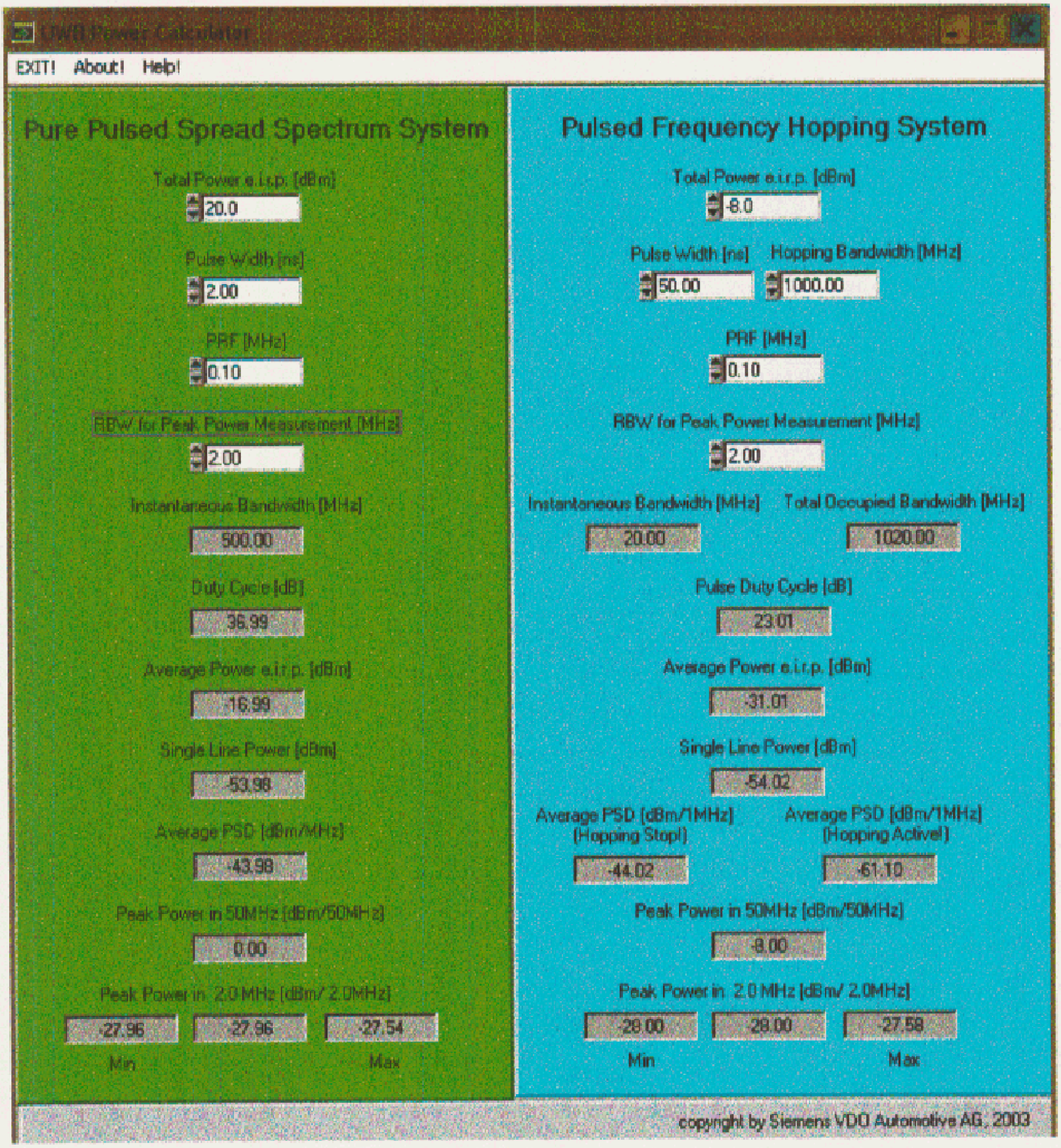

Figure 3: Screen shot of the UWB Power Calculator program.

There are some observations worth noting regarding the screenshot displayed above:

1. The pure pulsed device is also peak limited. This stems from the fact that the Crest Factor (or duty cycle) is rather high. Typically, pure pulsed devices use higher PRF values in the MHz range that make them average power limited.

2. The pulsed FH system has absolutely the same power levels in the SLP, the average PSD (with hopping stopped) and the peak power in a 2 MHz RBW, as a pure pulse device, despite the fact that its instantaneous occupied bandwidth is lower by a factor of 25. The identity of the SLP and its distribution to that of the pure pulsed system is achieved by reducing the total EIRP power of the pulsed FH device to a value that compensates for the reduced spreading effects associated with it.

3. The peak power in 50 MHz is -8 dBm for the pulsed FH device because the instantaneous bandwidth of 20 MHz is less than the 50 MHz victim receiver BW. To compensate for this effect, the total EIRP power has to be reduced by 20 log (50 MHz / instantaneous BW).

4. The average PSD of the instantaneous occupied BW (*i.e.*, the average PSD with hopping stopped) has to be reduced by a factor of 10 log (total occupied BW / instantaneous BW). Actually, the sequential frequency hopping of the instantaneous line spectrum in the time domain results in a "virtual" reduction of the PRF in the victim receiver's BW by an additional duty cycle caused by the frequency hopping. This frequency hopping "duty cycle" is expressed by 10 log (total occupied BW / instantaneous BW).

The *Further Notice* speculates that, for Siemens VDO's system, the emission level being measured "may not be true RMS average emission but could be more similar to a time averaged emission."[8] This speculation is unsupported. As mentioned above in observation 4, the additional frequency hopping "duty cycle" operates as a blanking time period that occurs when the pulsed FH frequency doesn't fall within the victim receiver BW. This can be regarded as a virtual

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8 *Further Notice* at ¶ 159.

reduction of the PRF (or an increase of the Crest factor) and doesn't influence the RMS measurement.

With respect to the RMS measurements, the distribution of individual emissions over the observation (or integration) time is not important.[7] A burst-like emission over time automatically will be limited by the peak power criterion.[8] In figure 4 below, the RMS for different pulse distributions are shown.

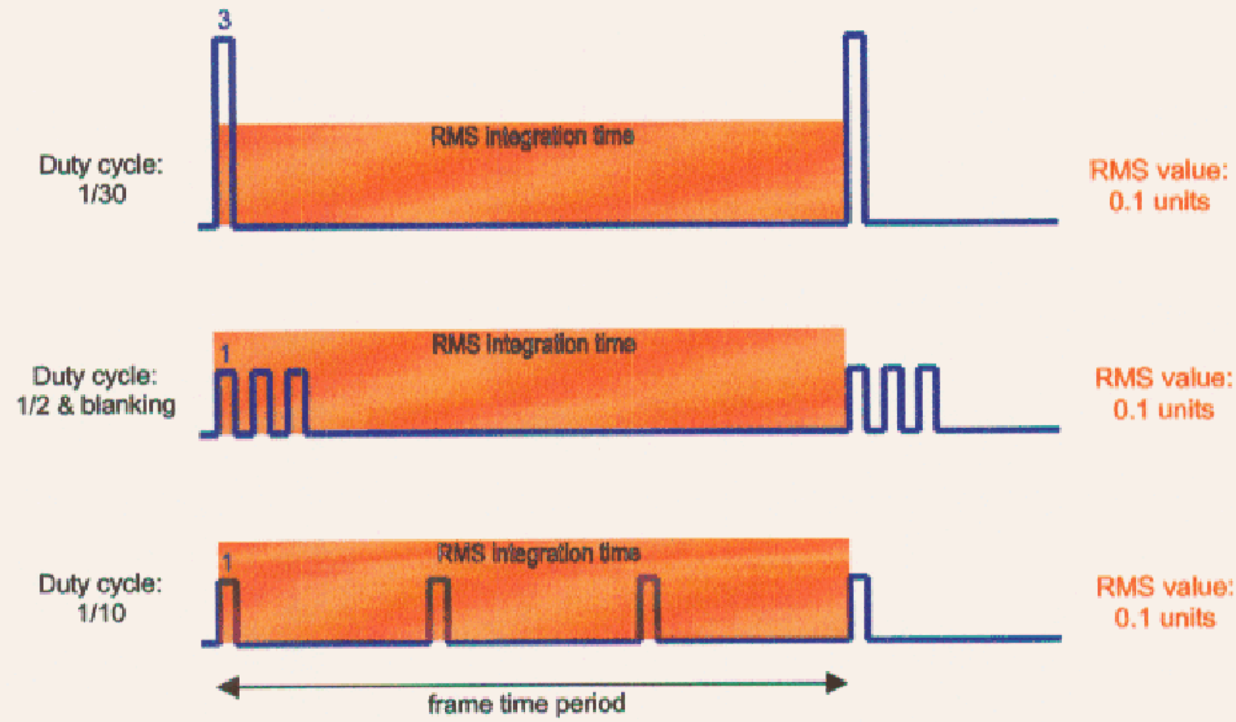

Figure 4: RMS integration time v.s. frame time period (ideal case where RMS integration time = frame time).

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7 The main purpose of a RMS measurement is to compare the energy content of different waveforms in a given time period.

8 In the worst cases, only a single pulse or no pulse at all will occur within the 1 ms RMS averaging time period. Due to the high Crest Factor, this pulse will be limited by the peak power criterion.

When the RMS integration time and the frame time of a complete transmission cycle of a UWB device are not identical, measurement artifacts will occur that make the RMS values more spiky (see figure 5).

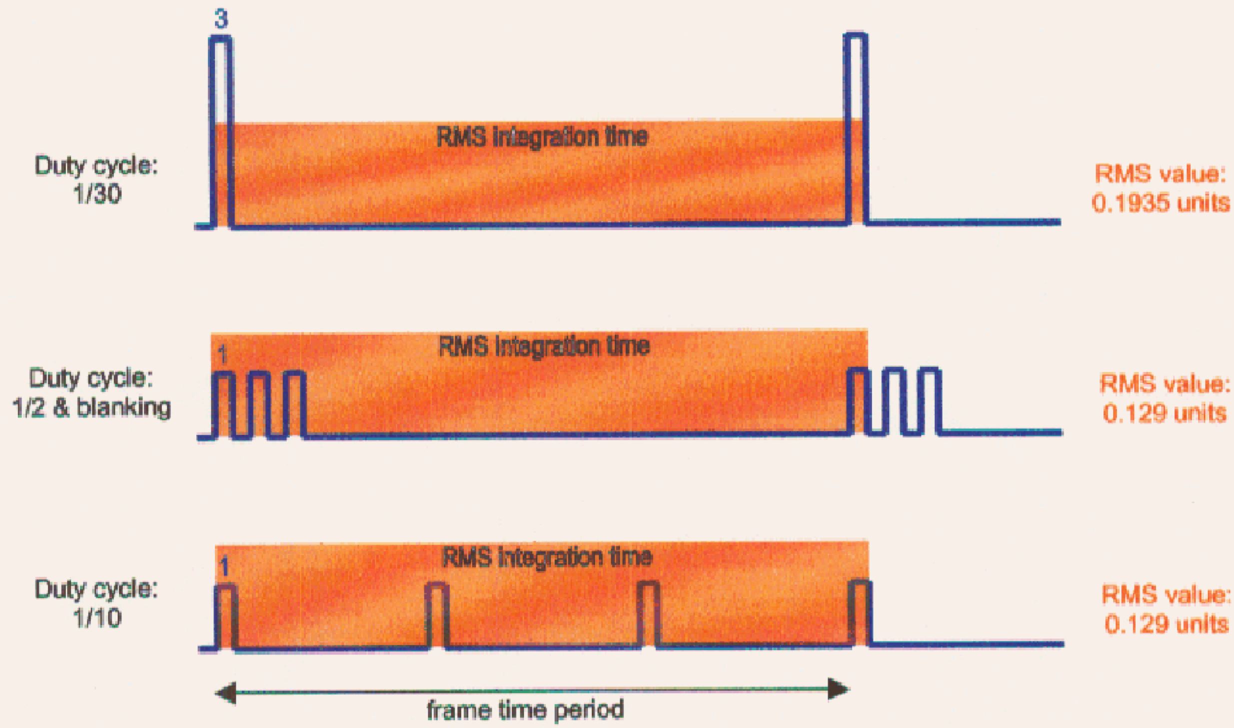

Figure 5: RMS integration time v.s. frame time period (RMS integration time > frame time).

If the RMS integration time is greater than the frame time by at least a decade, the reading error will be negligible. However, the RMS value can end up reaching the peak value of a pulsed emission if the RMS integration time and the pulse width are identical (see figure 6).

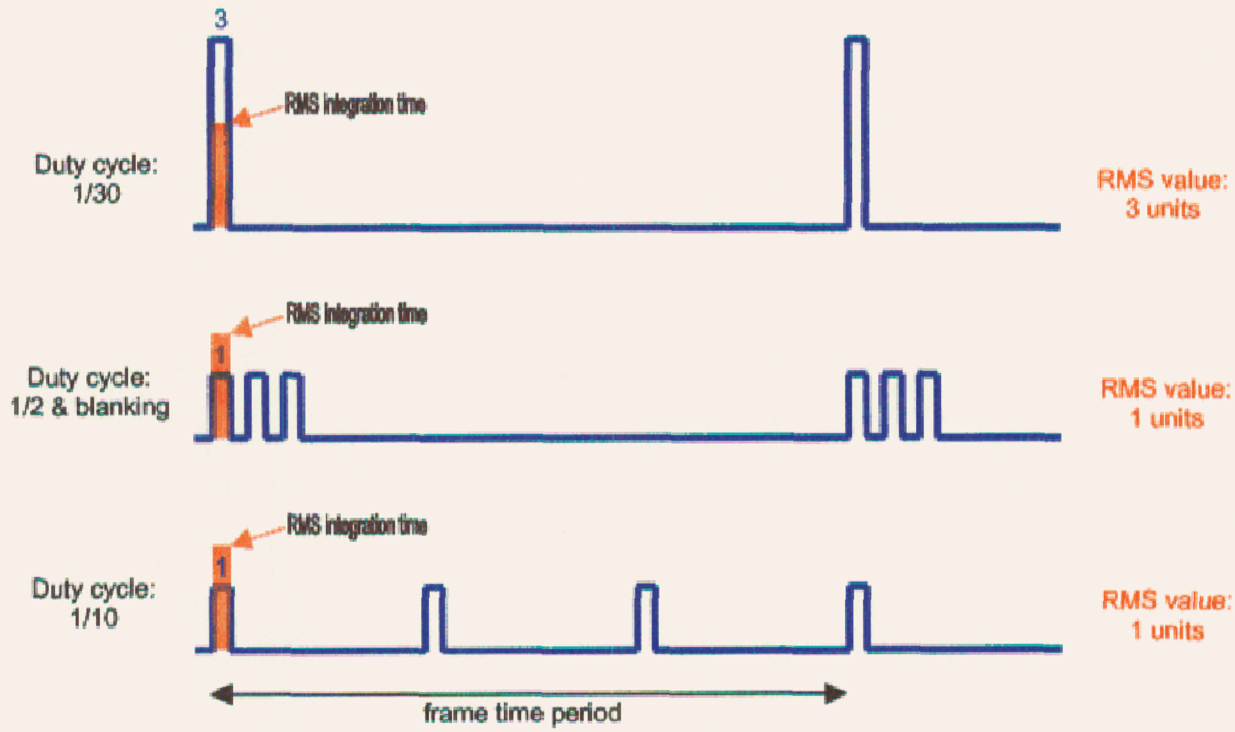

Figure 6: RMS integration time v.s. frame time period (RMS integration time = pulse width).

With only a 1 ms RMS integration time, the resulting power reading will be inaccurately high, because the frame time is greater then the RMS integration time (see figure 7). For this reason, Siemens VDO has proposed a 10 ms integration time, although Siemens VDO can accept the use of a 1 ms integration time in the restricted band from 23.6 to 24 GHz.[9]

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9 The 10 ms integration period is suggested because the Siemens VDO devices' frame times are in the order of 2 to 5 ms, which is the appropriate update time for vehicular applications based on system reaction time, vehicle dynamics and control strategies.

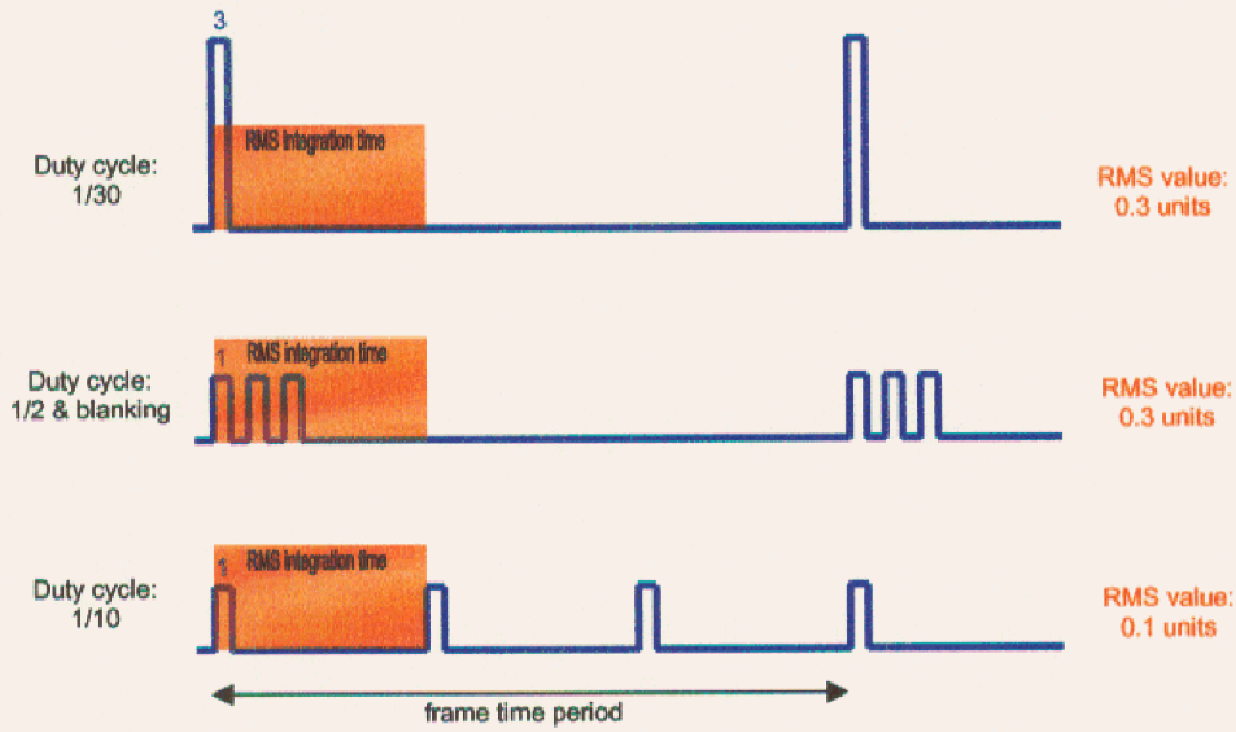

Figure 7: RMS integration time v.s. frame time period (RMS integration time < frame time).

B. Receivers with Fast Transient Response Times Are Not at Increased Risk from the Siemens VDO Devices

The Commission's suggestion that a victim receiver with a fast transient response time may be more susceptible to interference from Siemens VDO's devices than from pure pulsed systems is not accurate. 10/ The frequency hopping of Siemens VDO's devices over, for example, a 1 GHz bandwidth produces an additional duty cycle for victim receivers that operate over 50 MHz or less. This additional "frequency hopping" duty cycle effectively reduces the PRF by a specific amount. Thus, the Siemens VDO devices will be (very) low PRF devices. For such devices, the relevant limiting power criteria will not be the RMS criterion of -41.3

10/ *See Further Notice* at ¶ 159.

dBm/MHz, but will instead be the Commission's 0 dBm/50 MHz peak power limit. As discussed in section I.A. above, the interference potential of the Siemens VDO pulsed FH devices is identical to that of pure pulsed systems operating in accordance with the current UWB rules if the SLP (single line power) level and the distribution of the SLPs in the victim receivers are identical (see figure 2). Siemens VDO therefore respectfully disagrees with the suggestion that its pulsed FH devices will emit higher instantaneous power into some victim receivers than pure pulsed devices. 11/

C. Siemens VDO Devices Will Not Cause Harmful Interference to Space Borne or Terrestrial Services

The Siemens VDO devices will have no greater likelihood than pure pulsed devices to cause interference to any victim receiver, whether terrestrial or space borne. First, contrary to the suggestion contained in the *Further Notice*,[12] Siemens VDO's assertion that its pulsed FH devices will not cause harmful interference to EESS is not based wholly on the fact that most EESS sensors have long integration times. A second, more important factor where multiple interferers are present (the appropriate scenario for evaluating the impact of the Siemens VDO devices on EESS), is the spatial integration that takes place over several sensors. With spatial integration, the aggregated power at the victim receiver is not only averaged over

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11/ In some cases, pure pulsed devices may effectively face instantaneous power limits that are below the 0 dBm/50 MHz peak power limit, as they are unable to take advantage of the maximum allowed peak EIRP due to the need to comply with the average (RMS) power limits. By contrast, the Siemens VDO pulsed FH system will always be limited by the peak power criterion, but this will have no influence on the interference potential as long as the permitted UWB limits are respected.

12 *Further Notice* at ¶ 157.

time, but also over a spatial surface (*i.e.,* over a geographic area like the EESS antenna footprint on the earth surface). This spatial integration results in a further smoothing of the individual pulses, and makes the identification of a single device practically impossible.[18] Thus, the pulsed FH devices contemplated by Siemens VDO will not pose any higher risk of interference to EESS sensors than pure pulsed devices, as long as the Commission's peak and average UWB power limits are respected.

In addition to EESS, the Commission requested information regarding potential interference to police radar and amateur/amateur-satellite services. The Short Range Automotive Radar Frequency Allocation Group ("SARA") recently commissioned an independent third-party interference study with regard to SRR compatibility with police radar. The study, which specifically considered the Siemens VDO pulsed FH modulation type, concluded that, assuming "real road conditions," it is "quite unlikely that UWB-SRR equipped cars will interfere with"

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[18] The occasionally-cited scenario – whereby the PRF and "pulse on" time of all interferers are synchronized – may be useful for academic discussions, but cannot practically occur in real life. The time synchronization of different devices at different locations is already quite a laborsome task. Due to propagation time reasons, each device needs another spatial time trigger to compensate for the runtime effect to the selected point where the "synchronized" interference should occur. If the interference point or one of the interferer locations is moved, the "synchronized" interference automatically becomes desynchronized. Given that EESS satellites are always moving in orbit and all the cars in the satellite's footprint are assumed to move around randomly, "synchronized" interference is impossible and, as a consequence, the individual character of the pulse train of a single SRR devices cannot be resolved, regardless of the applied modulation scheme.

police radars. 14/ The study found that the police radars exhibited high immunity to interference. The interference threshold of the police radars could only be breached when the frequencies of the two devices were less than 1 MHz apart, and the SRR was positioned very close to and within the main beam of the police radar device, which is unlikely to occur under actual road conditions. 15/

It is also unlikely that any harmful interference will occur to the amateur services. There will be a strong decoupling of the antennas of amateur stations and the Siemens VDO pulsed FH devices due to the highly directional nature of each. Amateur stations most typically work with directional antennas typically having more than 40 dBi gain, which results in a symmetrical beamwidth of less than 2 degrees. Many unlicensed devices, including those with omnidirectional radiation patterns and with higher power than the Siemens VDO device, are already operating in the amateur band with no ill effects. 16/ Moreover, the mounting position close to the ground (approx. 50 cm) of the Siemens VDO device will lead to a high attenuation of its transmitted signals. Similarly, amateur-satellites should not be affected for some of these same reasons that terrestrial amateur and EESS operations will not be affected (*e.g.,* other unlicensed operations already in the band; spatial integration, etc.). Moreover, according to the Radio Amateur Satellite

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14/ *See* Interference Study (SRR – RSM) of Cetecom ICT Services, Inc. (May 22, 2003) at 2, attached as Attachment B.

15/ *Id.*

16/ *See* §§ 15.245 and 15.249 (providing significantly higher power limits for devices operating in the 24.075 – 24.175 GHz and 24.0 – 24.25 GHz bands, respectively).

Corporation ("AMSAT"), currently the only amateur satellite operation at 24 GHz is limited to a downlink on one satellite. 17/

II. THE COMMISSION SHOULD ELIMINATE THE MINIMUM UWB BANDWIDTH REQUIREMENT OR ADOPT SIEMENS VDO'S PROPOSAL FOR MEASURING THE BANDWIDTH OF ITS PULSED FREQUENCY HOPPING SYSTEMS

A. Elimination of the Minimum Bandwidth Requirement

Siemens VDO supports the Commission's proposal to eliminate the definition of an ultra-wideband transmitter contained in 47 C.F.R. §15.503(d). As the Commission correctly recognizes, the requirement that UWB devices occupy at least 500 MHz of bandwidth "at any point in time" creates a perverse incentive, as it unintentionally encourages manufacturers to design transmitters that instantaneously occupy more bandwidth than is necessary (including the restricted bands) in order to take advantage of the UWB rules including the higher peak power limits. 18/

In general, Siemens VDO also supports the Commission's proposal to apply the same alternative peak emission limit as it proposed in paragraph 164 of the *Further Notice* for non-UWB, wideband Part 15 systems. However, Siemens VDO proposes that the more stringent one-tenth of the -10 dB bandwidth peak

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17/ *See* AMSAT, "Amateur Satellite Frequency Guide" (April 2003) (showing the AO-40 as the only satellite – out of some twenty operational amateur satellites from various countries – with any K band capacity).

18/ Moreover, Siemens VDO also recommends that, in order to further reduce the incentive to transmit in the restricted bands, the Commission should adopt emission limits and/or measurement procedures outside the restricted bands that are the same as or less stringent than the limit in the restricted bands. This will encourage device designers to avoid the restricted bands whenever possible.

measurement requirement be applied only to the restricted band. For the rest of the 22 – 29 GHz UWB vehicular radar band, the full -10 dB bandwidth should be allowed for the peak measurement, with the caveat that the total EIRP power must be reduced by 20 log (50 MHz / instantaneous occupied BW). Actually, the one-tenth bandwidth criterion would eliminate all systems with less than 10 MHz instantaneously occupied bandwidth, as shown in figure 8.

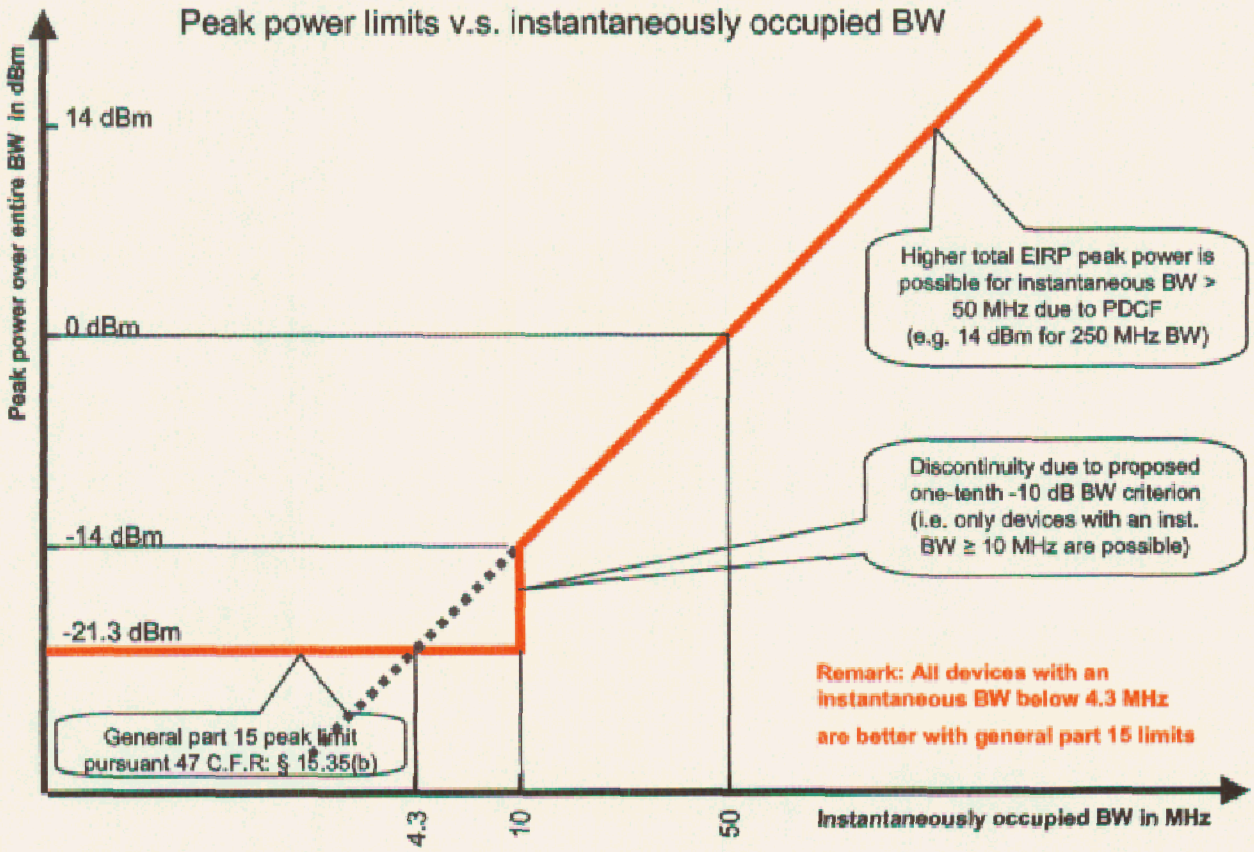

Figure 8: Total EIRP peak power limit vs. instantaneously occupied BW.

B. UWB Bandwidth Measurement Procedures

In the event the Commission chooses not to eliminate the minimum bandwidth requirement applicable to UWB devices, the Commission should adopt one or both of the measurement methods proposed by Siemens VDO in its Petition for Reconsideration for confirming UWB bandwidth for its pulsed FH systems. The Commission should not adopt the proposal, contained in the *Further Notice*, to measure the -10 dB bandwidth of a single hopping channel and multiply it by the number of non-overlapping hops that occur within a 10 ms time period. 19/ Siemens VDO fears that such a measurement procedure would be difficult, if not impossible, to perform with a standard spectrum analyzer. See some spectrum analyzer measurements in the Technical Annex for further details.

Based on Heissenberg's uncertainty theory, it is impossible to measure an instantaneous occupied bandwidth at any point in time (*i.e.*, limes of measurement time against zero). Measurement of an instantaneous pure pulsed CW carrier emission results in a line power spectrum that is discrete in the frequency domain and separated by the PRF. This can be measured with a commercially available spectrum analyzer that employs a sweep time consistent with the spectrum analyzer's specifications (ADC sample rate, DSP processing, etc.). Thus, with the frequency hopping stopped it is possible to measure such a power line spectrum in a pulsed FH system (see figure 9).

19/ *Further Notice* at ¶ 161.

Pulse-modulated (1.6 ns PW, 50MHz PRF) carrier in 50,20 and 10 MHz RBW

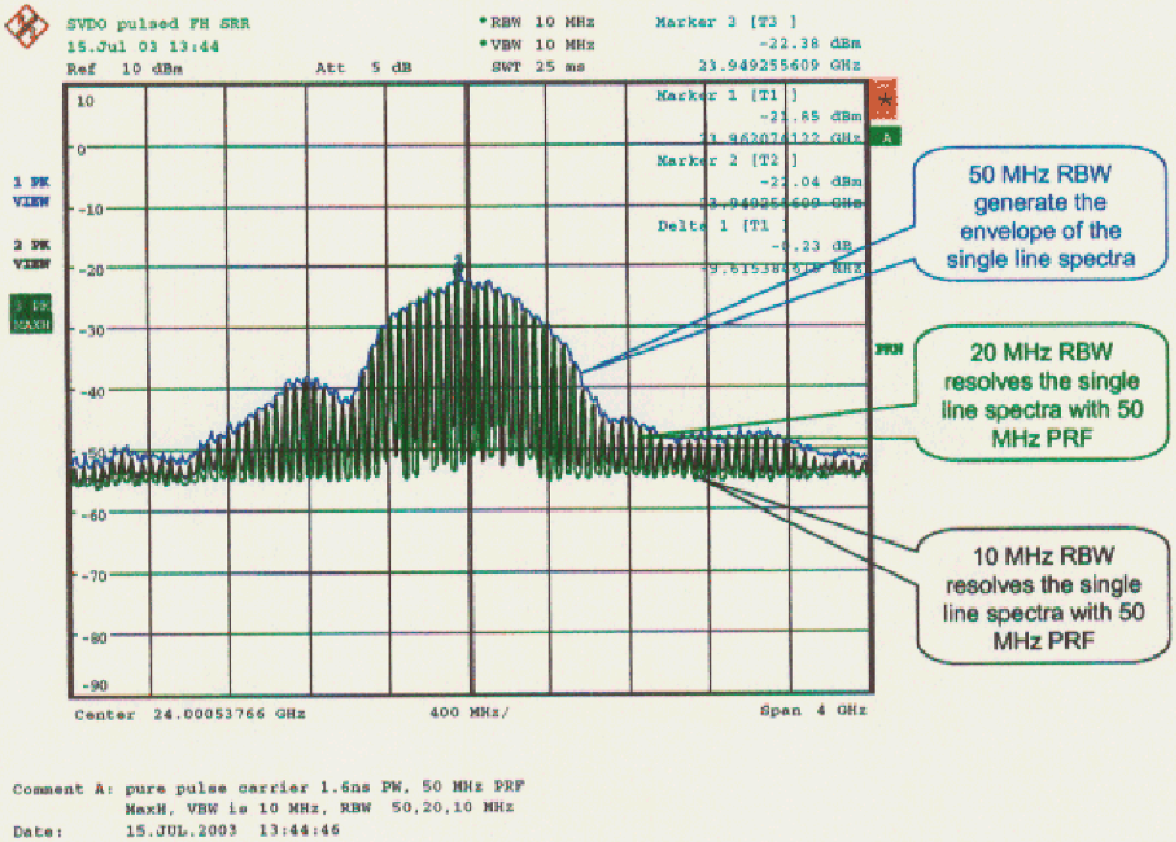

Figure 9: Discret SLP of a pulse carrier with frequency hopping stopped.

Finding a measurement method to determine the non-overlapping hops within a 10 ms time period, however, is more complicated. First of all, due to the "theoretically" infinite line spectrum, all the hops will overlap to some extent. Allowing an overlapping in the side lobes of the sinc-envelope (*i.e.*, after the first spectral zero-crossing) would result in a ripple of the RMS measurement (*see* figure 10).

Pulse-modulated carrier (50 ns PW, 1 MHz PRF): 8 discrete FH frequencies

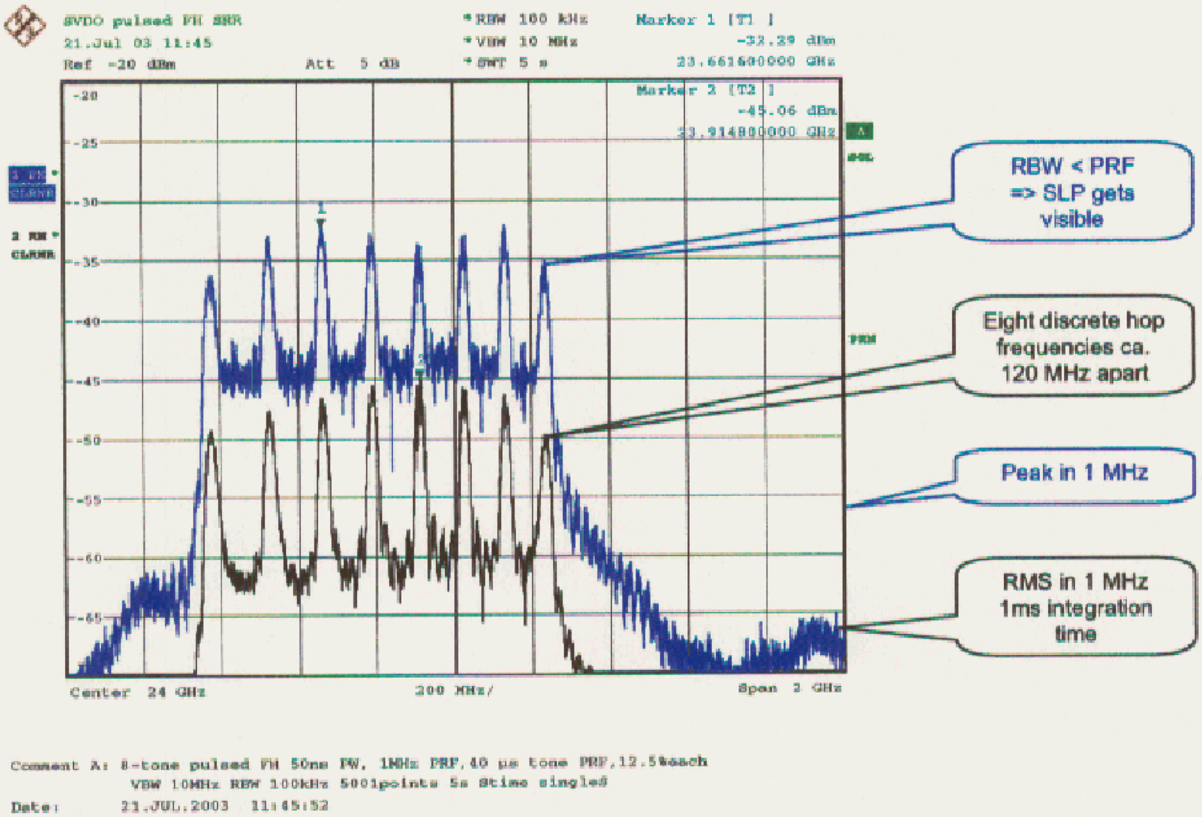

Figure 10: Ripple in the RMS (and peak) measurement for non-overlapping hopping frequencies in the main lobe of the instantaneous SLP spectra.

To produce a smooth RMS spectrum, overlapping should occur also within the main lobe of the sinc-envelope. The most difficult aspect of the measurement involves differentiating between two individual, instantaneous hop line spectra within a given sweep time period. As the spectrum analyzer's sweep time and the SRR's PRF are running asynchronously, only fractional spectra can be measured. Within a 10 ms frame time, pulsed FH devices will fill up the occupied bandwidth very smoothly and evenly, as many individual line spectra will be shifted over the bandwidth in a predefined pattern. However, because the spectrum analyzer asynchronously scans over the occupied bandwidth, it will capture only a fraction of the emitted pulses. In its Petition for Reconsideration, [20]/ Siemens VDO proposed, therefore, the following two methods to confirm satisfaction of the UWB instantaneous bandwidth requirement of 500 MHz in a 10 ms observation interval: [21]/

Method A:

- Spectrum analyzer is set to zero span mode
- RBW is set to 3 MHz, VBW ≥ 3 MHz
- Detector mode is maximum peak
- Sweep time of 10 ms
- Center frequency is set to several "test points" within the indicated occupied bandwidth

Notes:

For all selected frequency test points at least two burst signals should be within the required time period of 10 ms.

If the entire bandwidth of 500 MHz has to be verified (with a 1 MHz RBW), in total 500 frequency test points would have to be tested, which is very time consuming if measurement automation is not available.

Method B:

- The span of the spectrum analyzer is set to accommodate the occupied bandwidth of the DUT (device under test)

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[20]/ *See* Petition for Reconsideration, Appendix A at 16.

[21]/ Siemens VDO notes that the occupied UWB bandwidth is defined by the -10 dB points where, starting from the maximum power level, the spectrum first falls below these limits. A line spectrum or an excessively spiky "instantaneous line" spectrum that overlaps only in the side lobes – which are already 13 dB down – has to be avoided. Even for a pure pulsed device with a very high PRF, the UWB bandwidth criterion has to be refined, because, due to the line spectra characteristics of such a device, the –10 dB bandwidth is already reached at the two side edges of the very small spectral line. For example: 5 MHz PRF measured with a 1 MHz RBW in a spectrum analyzer results in a resolvable line spectrum. *See* Technical Annex from slide 1 to 9).

- RBW is set to 3 MHz, VBW ≥ 3 MHz
- Detector mode is maximum peak
- The number of points of the spectrum analyzer is selected so that each point represents at maximum the RBW (example: Span = 1.8 GHz => minimum 600 points necessary)
- The sweep time is set to 10 ms multiplied by the number of points
- A single sweep is conducted

Notes:

The occupied spectrum should be flat without any holes in between, as for each frequency pixel (or bucket) within the 10 ms observation time at least one peak value should be detected, independent of the kind of modulation pattern applied. If the device doesn't fill up the minimum required bandwidth of 500 MHz within 10 ms, some holes will appear in the spectrum because no peak value occurred.

The shape of the RBW filter and the effective observation time per pixel (bucket) is spectrum analyzer-dependent. Thus, a correction factor for the sweep time might be necessary.

Methods A and B can serve as a means to prove that the 500 MHz bandwidth is filled up smoothly and evenly *in any 10 ms time period.*22/ The primary emphasis is on the smoothness of the power distribution and the frequency points where the −10 dB points are reached for the *first* time. 23/

22/ A third method C, although more theoretical in nature, would involve the simultaneous use of multiple spectrum analyzers in zero span mode. To cover a 1 GHz bandwidth with the required 1 MHz RBW for RMS power measurements, 1000 analyzers would be required, with each one scanning a frequency set 1 MHz apart from the others. But even here the sweep time has to be set higher than the inverse of the PRF to capture at least one of the emitted pulses. For a pure pulsed device with a 5 MHz PRF, the spectrum analyzer's sweep time must be greater than 200 ns to capture at least one pulse emission. 800 of the 1000 spectrum analyzers would not capture any of the spectral lines because they are "tuned" in between the single line power frequencies.

23/ Siemens VDO notes that if the pure presence of a line power spectrum or some single SLP were enough to comply with the Commission's rules, Siemens VDO's pulsed FH radar would easily satisfy the 500 MHz minimum UWB bandwidth requirement simply by emitting continuously on two frequencies (*i.e.*,