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

Comments of Rosemount Measurement

1.0 Introduction

Rosemount Measurement is a United States based company that designs, produces, and distributes industrial control products for the process control industries. One of these products is the APEX ™ Radar Level Gauge. This radar gauge is used to measure fluid level in industrial environments as mentioned in paragraph 7 of Docket 98-153. Recent advances in pulsed radar measurement technology (UWB) have made these systems more versatile and cost effective for our customers. We believe that for this technology to recognize its total potential, the FCC Part 15 rules should be changed to 1.) Remove the Pulse Desensitization Correction Factor (PDCF) as a way of determining interference potential, 2.) Provide for full relief of the measured peak power characteristic of these devices based on their duty cycle and not limit the relief to 20dB, 3.) Distinguish between the extreme differences in the types of devices being developed and provide emission limits based on these differences, 4.) Allow operation in the TV and restricted bands, and 5.) Base the interference potential of these devices on measurements that simulate receivers that could receive interference. These issues are summarized below, and responses to pertinent questions raised in this NOI are provided subsequently.

2.0 Summary

1.) When the PDCF is used to determine interference potential of an UWB device, the values obtained do not represent their interference potential. In fact it does the opposite. Applying the PDCF causes a device that has a low potential for interference to look as though it has a high probability to cause interference. This is done by normalizing the most important characteristic, Pulse Width (PW). It can be demonstrated that a shorter pulse width is more difficult to detect and, therefore has a lower probability of causing interference. The way to accurately determine an UWB device's potential for interference using the PDCF would be to subtract the value from the measured peak not add it. The bandwidth of a receiver capable of receiving interference would have to be much greater than the standard 1 or 2MHz bandwidths in order to be affected by emissions from a device with a 10ns or less PW.
There is another problem with the PDCF. The HP 150-2 Application Note specifies that the optimum range for the spectrum analyzer bandwidth setting should be .03/PW<Bandwidth<.1/PW. This cannot be obtained for UWB systems with very short pulses (i.e. < 10ns). Even if it could, the noise floor of the spectrum analyzer would be to high to provide adequate dynamic range.

2.) The current rules for peak power emission limits under Part 15 do not adequately address the potential for interference of fluid measurement pulse systems. The present rules allow a maximum of 20dB relief based on the duty cycle of the system. This maximum relief equates to a duty cycle of 10%. If the duty cycle is much lower, as referred to in paragraph 3 of Docket 98-153, there is no added relief even though the potential for interference is lower due to the shorter “Ton” time of the transmitter. For example: a system with a 5ns pulse width at a 3MHz PRF has a 1.5% duty cycle. This would require 36.5 dB of relief, if there were not a maximum of 20 dB imposed, even though this system is much less likely to cause interference due to the shorter duty cycle.

3.) UWB products have been described as pulse radar systems that either a.) determine distances and imagery or b.) transmit some type of digital information (communication). We believe that the FCC rules should treat these as separate types of devices and provide emission limit considerations based on there intended use and environment. Devices that transmit and receive digital information are typically more susceptible to interference due to the omnidirectional coverage of their antennas and the mobility associated with the equipment. Systems that determine distances or imagery attempt to direct their emissions to a narrow field or target, and are designed for extremely short ranges (i.e. <30 meters). Furthermore, radar systems measuring fluid levels are designed for use in industrial environments where they are bolted to a fluid holding tank with the emissions directed down, and employ a minimum emission beam angle to keep a larger amount of the signal focused on the target. The installation and narrow beamwidth minimizes the possibility of false targets from obstructions near the path of the emission. Finally, such devices require a very small pulse width (less than 10ns) to minimize the distance required from the transmitter to the target.

4.) UWB devices, by definition, use a large piece of spectrum. The rules should not prohibit the operation in restricted or TV bands, except for the “Carrier or Center Frequency” of UWB systems. The sidelobes of fluid level measurement UWB systems are very difficult to detect because the extremely fast pulses they use spread the power over such a large spectrum. Therefore, they have a low probability of causing any interference or even being detected in the TV and restricted bands. If some or all of the restricted or TV bands were retained it would limit the fluid level measurement UWB technology, increase its cost, and lower its performance. This would be due to the required additional filtering and the inability to use the needed spectrum. The final result would be degraded performance from the technology at a higher customer cost.

5.) The current measurement procedures required by the Part 15 rules were designed to measure the interference potential of a device by selecting measurement bandwidths that represent receivers that could receive interference. Furthermore, the rules are aimed at determining the interference potential of narrow band CW or long pulsed signals. For these types of systems, the rules provide fair, accurate measurement procedures and emission limits. They do not, however, do this for fast pulsed UWB systems.
We agree that the best way to determine an UWB device’s potential to cause interference is to measure its emissions with a spectrum analyzer that has been configured to simulate receivers that could receive interference. We do not agree that this measurement should be adjusted with the PDCF or any other factor because this has the affect of increasing the sensitivity of the receiver to create a fictitious super receiver. As explained in point 1, the PDCF is a good example of how and why receivers are not going to see very fast pulses. The measured emission value obtained from a correctly configured spectrum analyzer would accurately represent the UWB device’s potential to

cause interference as compared to a CW signal, then further considerations for emission limits should be given to the UWB device based on its pulse width and duty cycle.

3.0) Response to Questions

In the Notice of Inquiry, the Commission poses several questions. Below are Rosemount Measurement's response to these questions. They are related to the issues discussed alone.

Question 1
What types of UWB devices can we expect to be developed?

Answer 1
Rosemount Measurement has developed and is developing Radar Level Tank Gauging used to measure the fluid level of products in tanks in industrial environments. These systems may or may not employ a carrier, and would typically have a pulse width of < 10ns and a maximum range of <30 meters.

Question 2
What are the frequency ranges and bandwidths expected to be used by UWB devices?

Answer 2
For fluid level radars, the center frequency could be anywhere from 0-40 GHz and bandwidths about that center frequency that could be up to 5 GHz. As this technology continues to be developed, shorter pulse widths will probably become more feasible which would increase the overall performance of these devices, and may also increase their bandwidth.

Question 3
What are the expected total power levels and spectral power densities, peak and average, of UWB devices?

Answer 3
For fluid level radars, peak powers could be as high as -30dBm @ 3 meters, with associated power averages at –43dBm @ 3 meters. The peak and average power densities of 5.75V/m and 1.3V/m @ 3 meters respectively represent the high directionality employed by fluid level radars. These values were arrived at by assuming a 10ns pulse width, 5MHz PRF and a transmitted power of 15dBm with a 25dBi gain antenna. This example represents a worse case scenario. The majority of systems developed would have lower values.

Question 4
What are the expected or desired operating distances?

Answer 4
For fluid level measuring systems, up to 30 meters

Question 5
Are there certain types of UWB devices or applications that should be regulated on a licensed basis under some other rule part? If so, which rule parts?

Answer 5
Fluid level radars that are designed to be low power, short range, and intended for industrial

use, should not be licensed under any other part of the FCC rules. They should be unlicensed and regulated under appropriately modified Part 15 rules.

Question 6
If provisions are made for UWB technology under Part 15, how should we define UWB technology?

Answer 6
There are several types of fluid level radar gauges that could be classified as UWB devices. Some of these systems are: Frequency swept systems that employ a fast sweep over a large spectrum, Pulsed systems with a carrier frequency, Pulsed systems without a carrier frequency, etc. All of these systems have the characteristics of UWB systems, but each has benefits that make them more suitable for particular applications. Each of these types of pulse modulation techniques should be classified as UWB because of their spectrum usage. We believe the best way to define UWB technology is: Any modulation technique that has a spectrum usage of greater than 1.5GHz.

Question 7
Should the rules generally continue to prohibit operation of UWB systems within the restricted bands and the TV broadcast bands?

Answer 7
See summary point number 4.

Question 8
If certain restricted bands were retained, what impact would this have on the viability of UWB technology?

Answer 8
See summary point number 4.

Question 9
Are the existing general emission limits sufficient to protect other users of the spectrum, especially radio operations in the restricted bands, from harmful interference?

Answer 9
Yes. We believe that limits based on spectral power density do not take into consideration the directionality of fluid level measurement systems. By producing a product with a narrow transmitted beam width, the spectral density at 3 meters will be considerably higher than a system that tries to employ an isotropic emission even though their transmitter powers may be the same. Highly directional emissions have direct advantages that reduce the possibility for interference. I.e. Fluid level measurement systems typically have beam angles < 20 degrees. This alone reduces the possibility for interference by 94% because only 6% of the area contains direct emissions from the device. It is almost impossible for a receiver to be in the emission path of a fluid level gauge who's RF is primarily emitted into a tank. Another advantage is that more of the reflected energy from the target returns to the device. Putting this information together with the fact that fluid level measurement devices are used in industrial applications and their emissions are pointed down toward the earth provides for an extremely low probability to cause interference.

Question 10
Should different limits be applied to UWB systems?

Answer 10
See summary points 1, 2 and 3

Question 11
Should we specify a different standard for UWB devices based on spectral power density? Should these standards be designed to ensure that the emissions appear to be broadband noise?

Answer 11
No. See summary points 1, 2, and 3

Question 12
What is the potential for harmful interference due to the cumulative impact of emissions if there is a large proliferation of UWB devices? Could the cumulative impact result in an unacceptably high increase in the background noise level? Should the Commission limit proliferation by restricting the types of products or should the rules permit manufacturers to design products for any application as long as the equipment meets the standards?

Answer 12
For fluid level measuring devices, there would not be a cumulative impact for two reasons. 1.) The physical size of the tanks where the devices are deployed requires adequate spacing and 2.) the highly directional emission pointed at the earth would not provide for a cumulative effect.

Question 13
Should a limit on the total peak level apply to UWB devices?

Answer 13
No. Only a measured peak limit with relief for pulse width and duty cycle as described in summary point 5.

Question 14
Can emissions below or above a certain frequency range be further filtered to reduce the potential for interference to other users of the radio spectrum without affecting the performance of the UWB systems?

Answer 14
See summary note 4.

Question 15
Are the existing limits on the amount of energy permitted to be conducted back onto the AC power lines appropriate for UWB devices?

Answer 15
We know of no reason why an UWB fluid level gauge would require a higher limit than other devices.

Question 16
What operational restrictions, if any, should be required to protect existing users?

Answer 16
The current requirements to correct any interference are adequate.

Question 17
Is the use of UWB modulation techniques necessary for certain types of communication systems; if so, for what purposes?

Answer 17
It is not necessary for fluid level measurements, but it would greatly reduce the cost and complexity of such devices.

Question 18
Is a pulse desensitization correction factor appropriate for measuring emissions from a UWB device? Should any modifications be made to this measurement procedure for UWB devices?

Answer 18
The Pulse desensitization Correction Factor (PDCF) mentioned in the ANSI C63.4-1992 Section 13.1.4.2 Final Radiated Emissions Measurements, Note for pulsed systems, references the Hewlett Packard Application Note 150-2 which has been declared obsolete by HP for several years with no replacement. As described in summary point 1 and 5 the PDCF is not appropriate for determining the interference potential of an UWB device and should be removed from the test requirement.

Question 19
Would another measurement procedure that does not apply a pulse desensitization correction factor be more appropriate for determining the interference potential of an UWB device?

Answer 19
See summary point 5

Question 20
The frequency range over which measurements are required to be made depends on the frequency of the fundamental emission. Is the frequency of the fundamental emission readily discernible for UWB devices? Are the current frequency measurement ranges specified in the rules appropriate for UWB devices or should these ranges be modified?

Answer 20
For UWB systems with a carrier this should not be a problem because the basic theoretical characteristics are known. For example: a 5ns pulse of a 6GHz carrier at a pulse repetition frequency of 1MHz would provide for a center frequency of 6GHz with a main lobe of 2*(1/5ns)=400MHz and first side lobes 200MHz wide with a line spectrum of 1MHz spacing. Therefore, we would look for harmonics of the signal at 12, 18GHz etc. This is, of course, theoretical but gives a very good starting point to measure the emissions and determine their true characteristics.

Systems without a carrier are more difficult because we don't have as clear of a starting point. 3 main things will determine the center frequency of these devices. 1) Pulse width, 2) waveguide or other filtering, and 3) antenna characteristics. Because of the difficulty to accurately predict the center frequency and signal characteristics a wider search should be employed.

Question 21
Are the measurement detector functions and bandwidths appropriate for UWB devices? Should these standards be modified and, if so, how?

Answer 21
We believe that they are appropriate for UWB devices if the measurement equipment is attempting to simulate a receiver capable of receiving interference. See summary point 5.

Question 22
Should the prohibition against Class B, damped wave emissions apply to UWB systems or is the prohibition irrelevant, especially in light of the relatively low power levels employed by UWB devices?

Answer 22
It is irrelevant because of the power levels are so low, and because a significant amount of the spectrum transmitted will be used negating the idea that it is wasted.

4.0 Recommendations

We recommend the following changes to the Part 15 rules to accommodate UWB devices.

1. **Define UWB devices as emission systems that have a spectrum usage of greater than 1.5GHz.**

2. **Create categories of UWB devices based on their use attributes (mobility, installation environment, range etc.) and provide emission limit relief based on these categories.**

3. **Provide relief of the measured peak power limits based on the pulse width and duty cycle of the system without a maximum. (as the duty cycle or pulse width goes down the peak can go up).**

4. **Allow operation in the restricted bands as long as the "Center" frequency is not aligned there.**

5. **Take into consideration the directionality antenna system when applying emission limits.**

6. **Remove the PDCF as a way of determining the interference potential of an UWB device, and do not replace it with procedures that create fictitious super receivers (See summary point 5).**

Sincerely,

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