ORIGINAL

Before the
Federal Communications Commission
Washington, D.C. 20554

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

Comments of M/A-COM

M/A-COM, a division of AMP, Inc. submits these comments in response to the Notice of Inquiry ("Notice"), FCC 98-208, released September 1, 1998 in the above-captioned proceeding.

Summary of Position

M/A-COM supports a modification to the Federal Communications Commission's Part 15 rules to permit the operation of ultra-wideband (UWB) devices on an unlicensed basis, including permitting intentional emissions within restricted bands.. The definition and rules should distinguish between those UWB devices that operate below 10 GHz and those that operate above, because the wide bandwidths available for UWB devices above 10 GHz achieve the same benefits without needing the large fractional bandwidths that are needed by UWB devices below 10 GHz and those that operate above 10 GHz.

UWB devices used as vehicular radars can, because of the bandwidth employed, achieve a position location to within an accuracy of a few centimeters, while existing vehicular radars can achieve an accuracy of only about a meter. This improved resolution provides substantial public interest benefits in applications such as Blind Spot Object Detection; Parking Aid and Backup Object Detection; Short Range Autonomous Cruise Control -- Stop and Go; and Pre-Crash Alert.

M/A-COM's Interest In This Proceeding

M/A-COM is a world leader in the design and manufacture of RF, microwave and millimeter wave materials, devices, components, subsystems and systems. Our solutions (which include discrete semiconductors, ICs, multi-function assemblies, cables, connectors and antennas) are already hard at work in thousands of government and high volume commercial applications around the world, from cellular phones to wireless LANs, PCS base stations to advanced automotive electronics, and satellite systems to navigation systems. With decades of microwave experience and a heavy commitment to R&D, we are able to provide our partners with the solutions today's market demands. In June 1995, M/A-COM merged with and is now a division of AMP, Inc., Harrisburg, PA.

M/A-COM's interest in this proceeding differs from that of most other participants, because our UWB products are in the millimeter wave range rather than below 10 GHz. Consequently, our views may differ from other comments without necessarily being in conflict.

As described in the Attachment, M/A-COM is developing a 24.125 GHz, high resolution radar sensor for use by automobile manufactures for Object Detection Systems on motor vehicles. The detection system assists drivers in the prevention of accidents dealing with typical driving scenarios such as Blind Spot, Parking Aid, and Backing up, and Stop and Go scenarios. This High Resolution Radar, employing UWB techniques and occupying a bandwidth of 3 GHz or more,, is able to provide safety features that ordinary vehicular radars cannot provide.

Definition of Ultra-wideband device

At frequencies below 10 GHz, the record in this proceeding generally supports the notion that a UWB signal should occupy a bandwidth equal to a large percentage, at least 25%,

of the carrier frequency. For higher frequencies, on the other hand, there is no similar record. At these higher frequencies, the benefits of UWB technology may be achieved with a lower fractional bandwidth than at lower frequencies. The occupied bandwidths of such devices may be very large indeed at these higher frequencies, even though the fractional bandwidths are not as large. Consequently, the same policy issues (primarily, the permissibility of intentional RF emissions in restricted bands) arise when devices at these higher frequencies seek to achieve the same technical and operational benefits as UWB devices at lower frequencies.

In light of these considerations, M/A-COM proposes that the FCC adopt the following definition for an ultra-wideband signal:

> *Ultra wide-band signal.* An ultra wide-band signal is an intentionally radiated signal designed to have a bandwidth to be equal to at least 25% of the fractional bandwidth below 10 GHz carrier frequency, and at least 2.5 GHz above 10 GHz carrier frequency.

The term "fractional bandwidth" should be defined in the Commission's Rules as follows:

> *Fractional bandwidth.* The bandwidth defined by the expression $2(f_H - f_L) / (f_H + f_L)$ in which f_H is defined as the highest frequency limit and f_L is defined as the lowest frequency limit, which mark the frequencies that are 20 dB below the maximum of the power spectral density envelope.

As a general principle, ultra-wideband devices should be restricted to power levels and field strengths that are consistent with other devices regulated under Part 15 of the Commission's Rules on an unlicensed basis.

Conclusion

In light of the these considerations, the Commission should permit the operation of UWB devices on an unlicensed basis under Part 15 of its rules, and should recognize in the definition of such devices that, above 10 GHz, the fractional bandwidth need not be as large as below 10 GHz in order to achieve the benefits of UWB technology..

Respectfully submitted,

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ATTACHMENT

Object Detection and Threat Assessment Systems in Automotive Applications Using Ultra-Wideband Radar

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ABSTRACT

There are numerous devices and approaches that improve motor vehicle occupant safety. It is possible to categorize these approaches in one or two ways. The first approach encompasses reactive devices, devices which increase the probability of an occupants survival once involved in a vehicle accident (i.e., restraining devices, airbag). The second approach encompasses more proactive devices that provide early warning information for a driver to become cognizant of a potential threat to his/her vehicle, while allowing them to react appropriately to prevent an accident. The later approach could be viewed as a threat assessment or early warning system for vehicles. This paper discusses the potential of ultra-wideband radar to improve automotive safety by means of improved object detection in automotive applications.

INTRODUCTION

Through the technology transfer of radar and signal processing techniques, advancement in proactive driver aid systems are attainable today for automotive application. Technology that provides drivers with concise and time-critical information allow drivers to perceive hazardous situations and take appropriate actions early, thereby avoiding an accident. The results are lives saved and a reduction in economic losses.

The two fundamental requirements for a driver aid system, or object detection and warning system, are: 1) Earliest possible detection of an object which allows the driver to react appropriately, and 2) Extreme accuracy, or, knowing the objects precise physical location relative to the vehicle.

Ultra-wideband radar devices provide these two benefits in the form of high range resolution, and close range accuracy [3]. In both pulsed and frequency modulated ultra-wideband radar units, the range resolution of the radar is directly proportional to the transmission bandwidth [7]. The result is that ultra-wideband devices supply the necessary performance levels to provide the industry with low cost, highly accurate object detection device for motor vehicle applications.

Around the globe, the increasing demand by society for greater personal mobility is growing rapidly [2]. As we approach the next century, the numbers of vehicles on already over-crowded roads are increasing at a rate greater than ever experienced in automotive history. This continual congestion leads to frustration and anger on the part of the vehicle operators, often distracting their attention and impairing their judgement. The result is careless maneuvering which generally results in an accident.

BACKGROUND

Each year over 40,000 people die in motor vehicle crashes in the United States [4]. The NHTSA estimates the societal economic loss in the United States alone is $150 billion dollars annually [5]. Driver error is identified as the primary cause in approximately 90 percent of all the police reported crashes that involve passenger vehicles, commercial trucks, and buses [5]. If vehicle safety is to be improved significantly during the next decade, the number of vehicle accidents must be reduced.

Teamed with European automobile manufacturers and automotive suppliers, M/A-COM Corporation, a Division of AMP, is researching and developing automotive object detection systems based upon ultra-wideband radar technology. In essence,

these are automotive radar systems that provide drivers with summarized, real-time information regarding the dynamic environment surrounding the vehicle.

Examples of motor vehicle applications that AMP / M/A-COM is currently developing include:

- Blind Spot Object Detection
- Parking Aid and Backup Object Detection
- Short Range Autonomous Cruise Control -- Stop and Go
- Pre-Crash Alert

It is M/A-COM's goal to accelerate product introduction by working with vehicle manufacturers and tier-1 suppliers throughout the United States, Europe, and Asia with a narrow pulse, 24.125 GHz object detection radar system. When used properly, the system assists drivers in reducing vehicle accidents. The system is *not* designed to remove the driver from the equation, but interact with the driver by providing him/her alert information in advance of a potential situation. Armed with the alert information s/he may take the appropriate intervening steps to prevent an accident. The results are lives and dollars saved.

We anticipate expeditious acceptance of ultra-wideband 24 GHz radar in Germany by the regulatory agency Regulierungsbehorde fur Telecommunikation und Post (Regulatory Authority for Telecommunications and Post (Reg TP)), which will place Germany ahead of the United States in automotive safety. Foreign-based car manufacturers would then be in the forefront of such product introduction. They will be able to offer more advanced automotive technology to their constituents, foster more enthusiasm from industry for collaboration investments, and provide safer vehicles in terms of driver assisted applications over our domestic counterparts. This fact should be anticipated in the setting of policy on the use of ultra-wideband radar, as it may well affect domestic employment and the health of a major domestic industry [5].

DISCUSSION

Throughout their history, automobile manufacturers with help from other industries, have provided new and improved driver assistance systems for vehicle operators. Among these noted enhancements are servo-assisted steering systems to improve vehicle handling while maneuvering or while parking [2]. Likewise, antilock brake systems reduce stopping distance while allowing the driver to maintain vehicle control [2]. Just as these previous examples show enhancements to existing automotive products, ultra-wideband provides the potential to create new and innovative products.

Example applications for ultra-wideband technology in automotive use include:

Blind Spot Detector

The purpose of Blind Spot detection is to alert the driver of objects that may not appear in the external rear-looking wing mirrors as the driver plans, or initiates a lane change. Vehicles configured with the M/A-COM object detection system will be able to monitor the lateral space adjoining the left and right side of the vehicle. In conjunction with looking at the lane adjoining the vehicle, the blind spot detection zone also extends longitudinally aft of the vehicle to detect the presence of approaching object.

The use of a Blind Spot Detector system will assist drivers in the decision as to when a safe lane change may be executed.

Currently, vehicular radar systems are not in use for Blind Spot and Lane Change object detection.

Parking Aid and Backup Alert

The purpose of Parking Aid and Backup alert is to notify the driver of range to object with range resolution measured down to centimeters. This is applicable to both parallel and direct drive-in parking scenarios. Sensors mounted in the front and rear bumper measures and report the range between the sensor vehicle and

adjoining objects. Detectable objects include other automobiles, trees, posts, motorcycles, bicycles, animals, adult and children human beings.

Numerous fatalities involving children and/or household pets are reported annually due to the driver's inability to detect a child, or pet playing behind a vehicle in the family driveway. The vehicle is placed in motion by a family-member or friend, and for those involved the consequence lasts a lifetime.

The use of a Parking Aid and Backup alert system will assist the driver in decisions on vehicle clearance by providing relative range to an object. It notifies driver, especially those of high-rear profile vehicles (i.e., sport utility, mini-vans, panel trucks, etc.) of the presence of objects behind the vehicle prior to, and during a parking or backup maneuver.

Some auto manufacturers use ultra sound technology for Parking Assistance. The ultra sound system relies upon a vibrating diaphragm within each sensor to transmit, then receive reflected signal. The reflected signal is received by multiple sensors and relayed to a follow-on processor. The follow-on processor uses triangulation methods to determine the distance to an object.

Physically mounted on the exterior of a bumper, an ultra sound sensor is exposed to the elements (i.e., snow, ice, mud, dust, etc...). These elements interfere with the diaphragm ability to freely vibrate, which adversely affects performance. The effective range of an unencumbered ultra sound system is 30 cm – 150 cm [6].

Short Range Autonomous Cruise Control – Stop and Go

The use of the Stop and Go application will assist drivers by alerting them to the relative range of the vehicle directly in front of them. The fundamental capabilities of ultra-wideband radar (e.g., range information and accuracy) are utilized in low-to-moderate speed congested traffic situations (i.e., rush hour, stop and go traffic).

Stop and Go is a traffic scenario where drivers often become complacent and easily distracted by other activities in and around their vehicle. This leads to the potential for rear-end collisions caused by a distracted or inattentive (day dreaming) driver. The results are further traffic delays, and heightened emotions by those involved in, and now detained by the accident.

Daimler-Benz/Chrysler offers an automated cruise control system as optional equipment in the 1999 Mercedes S-Class, but without the high resolution that UWB radars can offer.

Pre Crash Alert

In some instances, apriori knowledge will not avert an accident. However, the advanced knowledge of an impending impact collected by the M/A-COM developed radar system may be used by other vehicle systems. An example is the pre-tensioning of the restraining devices. This positions the occupants in a proper upright orientation, away from the steering wheel, dashboard, and windshield. In addition, airbags may be pre-armed, allowing for lower power deployment.

Because of its extended bandwidth, ultra-wideband radar provides excellent resolution measured in centimeters resulting in the ability to distinguish distance between closely spaced objects accurately. Because of this, UWB radar has the ability to detect and characterize the presence of objects such as vehicles, wood and metallic posts, bicycles, and human beings unambiguously.

The value of ultra-wideband radar technology is represented herein by only a few applications. A radar system that envelopes the vehicle, constantly identifying new objects, continuously tracking previously identified objects, and discarding objects which pass the vehicle and no longer pose an approaching threat. This multitude of information is summarized for the drivers and presented to him/her as merely the presence of a threat that requires his immediate attention. To achieve this level of system performance, the best sensor technology, with good sensor

quality and high reliability must be used to produce highly accurate vehicle systems.

The M/A-COM High Resolution Radar operates at a 24.125 GHz, and is capable of unambiguous range detection beginning at 10 cm, with resolution down to 10 cm [3].

M/A-COM has received a very promising preliminary review by testing laboratories for the German regulatory agency, (Regulatory Authority for Telecommunications and Post (Reg TP)). Final approval of the sensor for use by European automobile manufacturers and Tier-1 suppliers in Europe is expected in early 1999.

OEM interest within the United States regarding their use of the M/A-COM radar is strong. U.S. automakers are aware of the on-going work and strong interest by their European competitors and the eminent benefit to European motor vehicle safety.

Each application sited here, (e.g., Blind Spot, Parking Aid, Stop and Go, and Pre-Crash) requires very fine resolution to estimate accurately the closest distance between the vehicle equipped with radar and the object to be detected. The 76 – 77 GHz automotive-band provides only 1GHz of bandwidth. The best theoretical range resolution achievable is limited to 15 cm. Given practical equipment limitations, the attainable range resolution is more likely to be 1 meter in this band. While this resolution is sufficient for highway cruise control it is too crude to allow the radar to distinguish between the edge of the bumper and grill.

SUMMARY and CONCLUSION

This paper offers an overview of the benefits of M/A-COM's High Resolution Radar, an ultra-wideband technology. It is a tool that potentially could assist drivers in reducing accidents that are classed by the NHTSA as driver error. The application of *Blind Spot, Parking Aid, Stop and Go, and Pre-Crash* are merely

examples of the public interest benefits from the development and implementation of high-speed, extremely accurate ultra-wideband radar devices on vehicles in the United States and throughout the world as quickly as possible.

It remains the responsibility of the industry to determine which driver assist devices provide the greatest value at an affordable price for the customer. It is the Government's responsibility to ensure that driver assist tools, such as ultra-wideband radar are approved and made available to the public as soon as possible.

The Governmental Role

Government regulatory agencies of all countries need to provide the means for industry to introduce new technology swiftly to improve automotive safely. This is attainable through promotion and acceptance of International Standards for ultra-wideband devices [1].

The matters of international competitiveness for many United States firms are at issue and should be considered. Vehicle manufacturers and their suppliers are global entities, and can ill afford the costs of repeated redesign and re-investment to meet differing regional and national requirements [1].

One final comment. The societal and economic improvements achieved by the availability of this radar device, on every price level of vehicle, not only in Europe, but also throughout the United States and Asia, are available to all, but only if the technology is permitted by applicable regulatory policies. It is respectfully recommended that the Federal Communication Commission should permit the operation of ultra-wideband (UWB) devices on an unlicensed basis under Part 15 of its rules.

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