Suppression of the Electromagnetic Interference from Satellite Communication On-The-Move System

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Abstract—**Co-site interference is becoming an increasingly significant issue in electronic vehicular systems. Communication system designers are facing challenges due to the ever increasing demand for higher performance systems on one hand, and the need for multi-channels communication in congested electromagnetic environments on the other. Solutions to mitigate the electromagnetic interference in sophisticated system are therefore crucial to enable reliable satellite communications and VHF communications. In this paper, a procedure of interference diagnosing is introduced, and an approach for the mitigation of the interference from Satellite Communication (SatCom) on-the-move system to co-site VHF system is proposed, where a simulation is performed to verify the interference mode and to optimize the suppressing process. In the final test, the result shows that the suppression method of controlling the interference propagation paths is effective.**

Keywords—Interference; SatCom; VHF; suppression

I. Introduction

Modern communications have increased demand on co-operation and efficiency. The desired communication system can be made up of high mobility vehicle and appointed electronic equipment. Since the last two decades, high mobility SatCom on-the-move systems have been widely used. The advance of Satellite Communication (SatCom) on-the-move technologies in modern civil and military communications have transformed the command and control technologies. There has been much effort put into the design of radio systems and system integrations in order to increase the reliability of SatCom systems during the past years. Meanwhile, the Electro-Magnetic Interference (EMI) caused by the co-site electronic devices and their antennas mounted on a space limited vehicle has become a significant problem. Issues associated with co-site interference are multifold. Techniques to mitigate such effects are thus critical for ensuring reliable wireless communications. The usual EMI in SatCom system is the external electromagnetic environment that affects the earth station. A rare but severe EMI problem is introduced in this paper. EMI caused by SatCom is also possible and critical to other wireless system. On the other hand, the usual available method of suppressing EMI from radio system includes shielding/grounding the emission source or victim. For the purpose of improving efficiency of Electro-Magnetic Compatibility (EMC) control for high mobility on-the-move SatCom systems, the suppression to the paths of EMI is introduced in this paper, and also the simulation results for checking the efficacy is reported.

II. Case Study Description

A. Interference Phenomena

Normally, a typical vehicular satellite communication system consists of computers, radios and SatCom. In the case study of this paper, the system has two VHF radio systems, Ku-band SatCom, and other wireless systems. The layout of the antennas is shown in Fig.1.

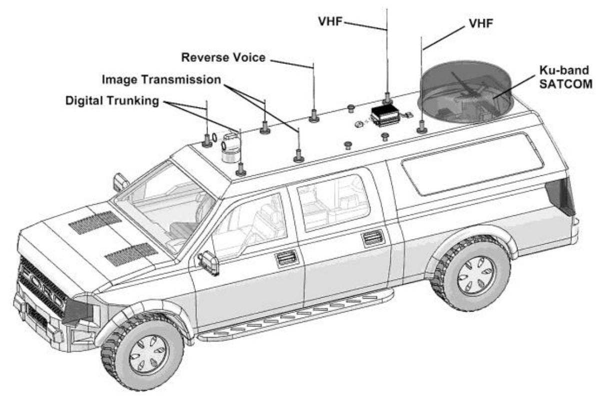

Fig. 1. Typical antenna layout of a vehicular SatCom system.

While the vehicle with on-the-move SatCom is working, the data transmission rate of VHF system is decreased significantly, the voice quality is dropped from loud and clear to unacceptable.

B. Interference Analysis

The electromagnetic filed radiation transmission test of the SatCom system was measured in the Semi-Anechoic Chamber (SAC). The procedures were according to the requirement of RE102 in MIL-STD-461.

During the test, the Antenna Controlling Unit (ACU) with servo system of SatCom is considered as the main cause. When the ACU is powered on, the servo system is initializing or working, meanwhile other subsystems of SatCom are still off, the spectrum from 30 MHz to 88 MHz that VHF antenna receives is increased substantially, as Fig.2 shows.

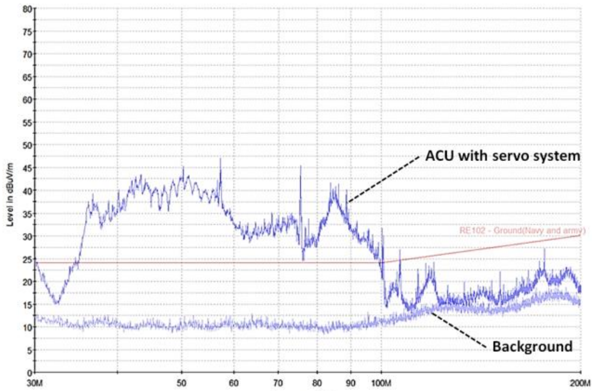

Fig. 2. The background and noise VHF antenna received when the ACU is on.

From the spectrum plot, the noise in frequency range 30 MHz to 80 MHz is increased about 25 dB in average. The range between 40 MHz and 60 MHz is the most serious part, the highest increase is about 35 dB.

Fig.3 shows the main electrical connections of SatCom and VHF system. By using the near-field probes and spectrum analyzer, the source of interference can be located. But suppressing the EMI from source is not available for this case, due to the significant but unacceptable mechanical changes. With the help of field probes and real-time analyzer, the in/out cable of servo system can be affirmed as a good interference radiator, which transmits the EMI from servo to VHF antenna through space. So, controlling the propagation path of EMI is the last trial.

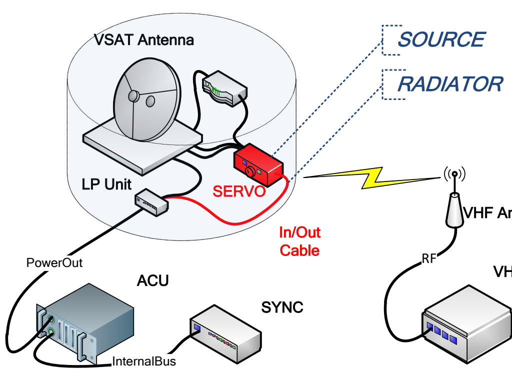

Fig. 3. Diagram of main electrical connections of SatCom and VHF system.

The original layout of the cables inside of SatCom antenna dome is irregular, the in/out cable connects with servo system is arbitrary lifted up to 10 cm in average from the ground plane. Due to the over design of length of cables, the redundant segment of in/out cable forms several loops in the air.

Shielding the cable which acts the role of an effective radiator is the best solution. But in some occasions, the cables cannot be shielded perfectly. In this case, the in/out cable with connectors is unable to be unplugged, and the external shielding layer is unable to be conducted with plugs well.

Thus, to reduce the antenna effect of the cable but without shielding it is worthy to be considered.

C. Computer Simulation and Tests

A series of computer simulation are performed to find the appropriate solution to mitigate the interference. The hybrid Method of Moments (MoM) and Multi-conductor Transmission Line (MTL) for EMI analysis of cable harness is used in this case. For the purpose of comparison of different suppression methods, three types of EMC optimization for the in/out cable in the same environment and configuration are simulated. The voltage coupled by the VHF antenna from ACU and servo system is shown in Fig. 4.

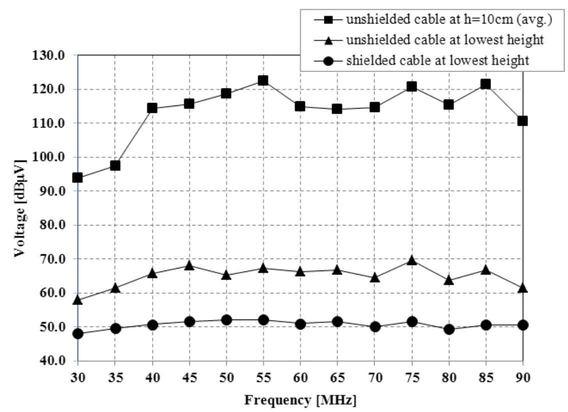

Fig. 4. Simulation result of different EMI suppression methods.

From the simulation result, we know that shielding the cable and fix it near to the ground plane is the best way. But considering the circumstance of SatCom antenna dome and cables inside, the easy-to-implement but effective method is make the in/out cable be laid close to the ground plane as much as possible, and be fixed to the surface every 20 cm, even without shielding it. The field test gets much the same result as computer simulation.

III. Conclusion

The EMI between SatCom and VHF radio system increases significant due to the high density integrations. Using the suppression method of controlling the interference propagation paths is effective. By utilizing the computer simulation of hybrid algorithms and field tests, the efficacy of suppressing process can be testified. The solution with best performance may not be the most suitable one. The proper EMC optimized solution can be decided by analyzing the cable-to-antenna simulation result.

References

[1] Emir A. Ibatoulline. "The antenna on a mobile board and their electromagnetic compatibility," *IEEE Transactions on Electromagnetic Compatibility*, vol. 45, pp.119-124, Feb. 2003.

[2] E. Yalcin, C. Girard. "Modeling interference phenomena between cosite radio communication equipments to evaluate systems performance degradation," *IEEE*, pp.249-254, Oct. 2009.

[3] MA Xie, SHEN Dong-yuan. "Analysis and Control of Electromagnetic Environment Effects of Vehicular Communication System," *Communications Technology*, vol. 47, No.7, 2013, pp.146-150. (In Chinese).