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New Generation of In-Mirror Integrated Antennas

Barcelona (Spain), 29th March 2010.- ***Vehicle manufacturers tend to integrate all modern communication services into their vehicles. This requires a certain number of antennas to support these services. On the other hand they put the requirement that the antennas should not influence the design and aesthetics of the vehicle, they should be as compact as possible and in the best case not visible at all, at the same time that the solution offers modularity across different car platforms. FICOSA developed such a solution, integrating the antennas into the side mirrors of a car. Paper stresses the in-mirror integration possibilities but also shows other new ideas how to make the well functioning antennas invisible within the vehicle.***

I. INTRODUCTION

The number of available communication services is constantly growing. As the users appreciate the usage of these services, not only the manufacturers of portable devices but also the vehicle producers want to have these services integrated in the cars. The proper functioning of traditional radio or more common in the USA Satellite Digital Audio Radio System (SDARS), as well as Global Positioning System (GPS), Digital Video Broadcasting Terrestrial (DVB-T), Global System for Mobile communications (GSM), Digital Audio Broadcasting (DAB) and Universal Mobile Telecommunications System (UMTS) relies on good antenna reception. Every of these services require the implementation of a separate antenna or more multi-band antennas. The wish of the vehicle manufacturers is to construct the antennas as small in size as possible, preferably to hide the antennas and make them in this way invisible. That wish will also help to find modular antenna solutions that can be implemented across different car platforms, without having to implement customized solutions for each platform. So far, a popular classical approach for the antenna system was to have roof top wire antennas and more modern shark-fin antennas (Fig. 1).

These are in most cases mounted on the roof of the vehicle and therewith influence the aesthetics. Moreover, each of these antennas has to be customized for each car platform, as it will not be the same solution for a cabriolet, station wagon, sedan, 5-door or 3-door car, for instance.

For this reason the mirror manufacturer FICOSA came with the new idea to integrate small antennas for all services in the external side-view mirrors and therewith begin a new era for automotive antennas.

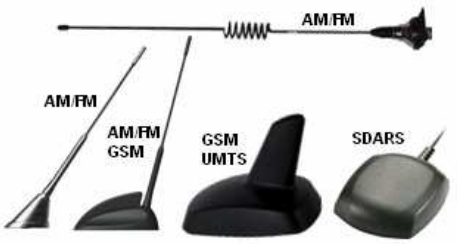

Fig. 1 Collection of conventional automotive antennas

II. INTEGRATING THE ANTENNAS IN THE VEHICLE EXTERNAL REAR-VIEW MIRRORS

FICOSA proposes to integrate the antennas both into the left and right mirror dependent on the service. An example of antenna allocation is visible in Fig. 2. In the right mirror there are antennas for radio, DAB, TV and SDARS and in the left mirror for radio, TV, telephony (quadband or pentaband solution) and GPS. Radio antennas can even cover the Japanese frequency requirements (Table I).

The strategy for antenna assignment to the right and left mirror is very important. GPS could be integrated either in the LH (Left Hand) mirror or the RH (Right Hand) mirror. If the LH mirror is chosen, then in order to avoid crosstalk, isolation with telephony antenna should be taken into account. Due to the fact that Band-III is used in both TV and DAB services (Table I), these antennas have to be separated. It is not possible to use the same antenna for both but it is favourable to use the same flexible PCB or foil.

Due to different polarizations, SDARS and GPS antennas could be even implemented in the same package. Another solution is different packages for GPS and SDARS and special separation in LH and RH mirrors. Design of SDARS antenna inside the mirror has to be carefully dealt as the ground-plate limits the performance of the antenna.

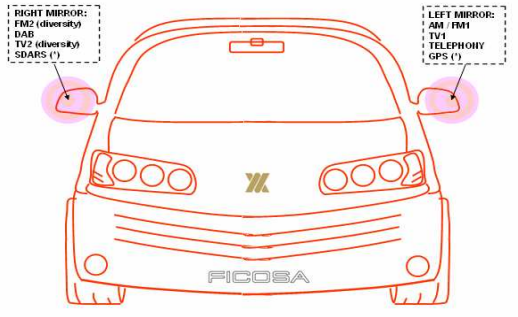

Fig. 2 Integration of communication services with their assignment to the left and right mirror in a vehicle.

For FM antennas the distance between both mirrors is about half wavelength of the centre FM frequency and therefore it is favourable to employ two identical antennas in LH and RH mirror. In this manner the received signal quality will take advantage of antenna diversity.

TABLE I

SERVICES AND FREQUENCY ASSIGNMENT

Service		Frequency	Wavelength
AM radio	Amplitude Modulation radio	0.15 MHz- 2 MHz	150m - 2000m
FM radio	Frequency Modulation radio	88 MHz – 108 MHz	2.77m - 3.4m
FM radio Japan	Frequency Modulation radio	76 MHz – 90 MHz	3.3 m - 3.94m
DAB in Europe	Digital Audio Broadcasting	174.160 MHz – 229.840 MHz	1.3 m - 1.72 m
SDARS	Satellite Digital Audio Radio System (Sirius and XM)	2320 MHz – 2345 MHz	0.128 m – 0.129 m
GPS	Global Positioning System	1575.42 MHz	0.19 m
Telephony	AMPS & GSM & UMTS	825 MHz – 960 MHz, 1710 MHz – 2200 MHz	0.3125 m -0.364 m 0.136 m – 0.1754 m
TV	Bands III, IV and V	174 MHz – 230 MHz, 470 MHz – 606 MHz, 606 MHz – 862 MHz	1.304 m - 1.72 m 0.495 m – 0.638 m 0.348 m – 0.495 m

The schematic of how the antenna is built in the mirror is presented in Fig. 3. The antenna system is composed by a flexible PCB or any other type of foil, an RF amplifier (only needed for some services), a ground connection (depending on the service) and a coaxial cable. Final solution is highly dependent on the inner mirror structure. This influences antenna fixing in the inner bracket, the type of connection between antenna PCB or foil and amplifier as well as adequate ground connection. Further, when several services are integrated in the same mirror, proper location for the different antenna parts has to be carefully dealt in order not interfere with other mirror components, such as the glass actuator, power fold actuator, glass defrost system, blinkers, etc.

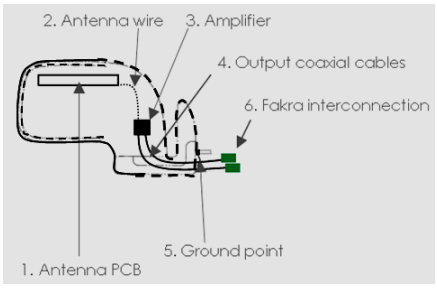

Fig. 3 Block diagram of the mirror with built-in antenna

III. ADVANTAGES OF THE MIRROR ANTENNA SOLUTION FROM FICOSA

Taking into account present existing solutions such as mast roof antennas or on-glass antennas (backlight, windshield, sidelight), FICOSA in-mirror antennas show the following advantages:

- No visual impact on the vehicle design.
- Modular and integrated solution.
- Cost effective solution. Car manufacturer drastically reduces the assembly time at the manufacturing plant by having antenna and mirror in one package.
- Only one antenna for all car models (independent from the car body, roof shape for example for sedan and cabriole).
- Weight reduction of the vehicle mainly due to coaxial cable length reduction.
- CO_2 reduction.
- Only one supplier for both antennas and rear-view mirrors.

The most important feature is the antenna functionality. It has been shown and proved in the market that FICOSA integrated antennas in rear-view mirrors are comparable or have even better signal reception than traditional monopole or shark antennas.

IV. ABOUT THE AUTHORS

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