Electromagnetic Compatibility Studies of Selected Components for Present Day Cars

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Abstract— A present car includes more and more electronics. Today each car is stuffed with integrated circuits. Some of them are responsible for correct operation of the engine, others watches over the security, and next ones else control equipment correcting comfort. However, from one hand the electronics in the cars brings the enormous advantage, from the other hand it is the cause of problems. These statements were the base to carry out measurements of emissivity for one of the elements fittings of a modern car. The systems and measurement stands as well as the results of radiated and conducted disturbance emissions have been shown in the article as the function of frequency for motors of car window wipers.

1. STRUCTURE OF THE WINDOW WIPER MOTOR

DC electric motors are very often used execution elements within regulation systems. The primary advantages of these motors are: high torque, good efficiency as well as small dimensions whereas the disadvantages are: sparking (industrial interferences) and wearing and tearing of commutator brushes. For last ten years a series of motors with a special design having very good dynamic characteristics have been introduced into the market. The primary disadvantage from EMC point of view is that sparking on the commutator generates plenty of electromagnetic interferences. A measurement methodology of conducted and radiated disturbances generated by the DC motor is presented later on in the article. The references connected with the topic of this article are [4, 6, 8, 10–17].

2. MEASUREMENT STAND FOR RADIATED AND CONDUCTED DISTURBANCES LEVELS AS WELL AS MEASUREMENT RESULTS

Two electric motors Mitsuba PP-T40 from the car Subaru Forester II and Subaru Forester I used to drive the windscreen wipers are the equipment tested. The measurements of electromagnetic interferences radiated emission levels of the tested motors No. 1 and No. 2 were done within the frequency range from 2 MHz to 1 GHz.

Before making the radiated disturbances measurement, the legalisation of the measurement path between the antenna and measurement data registration equipment has been done [2]. In order to do so, the program application EMC 32 has been used. The EMC 32 application is used to control the measurement process as well as in order to calculate the electric field strength according to the dependence:

$$E = U_{wej} - T + K, \quad (1)$$

where:
E — the electric field strength in the installation site of the measurement antenna [dB(μV/m)],
U_{wej} — signal level at the input of the measurement receiver [dBμV],
T — attenuation of the HF path connecting the measurement antenna with the measurement receiver input [dB],

Figure 1: Motors of windscreen wipers of Subaru Forester II and I.

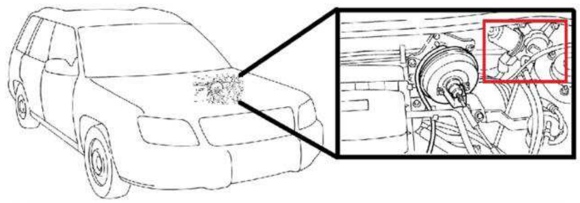


Figure 2: Location of the equipment tested in the Subaru Forester car.

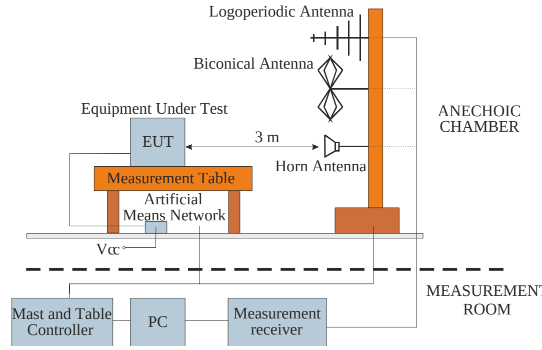


Figure 3: Block diagram of laboratory stand for radiated disturbances measurement.

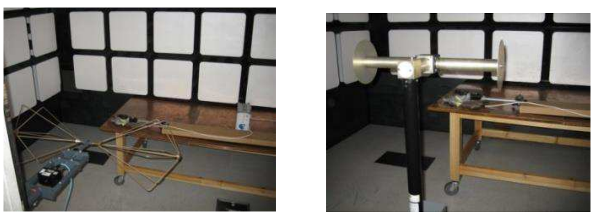


Figure 4: Laboratory stand for radiated disturbances measurement.

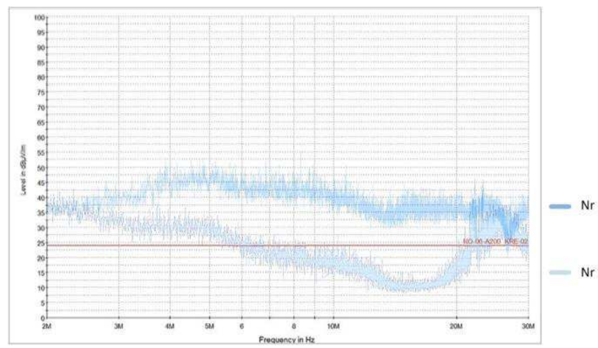


Figure 5: Amplitude diagram of radiated disturbances vs. frequency for windscreen wipers No. 1 and 2.

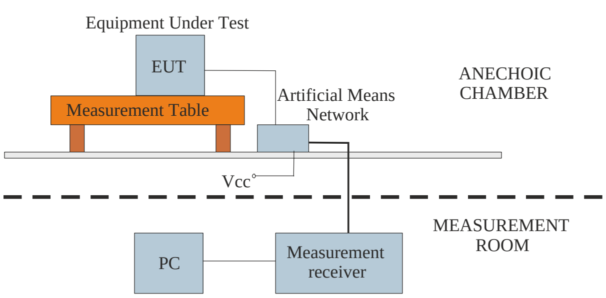


Figure 6: Block diagram of laboratory stand for conducted disturbances measurement.

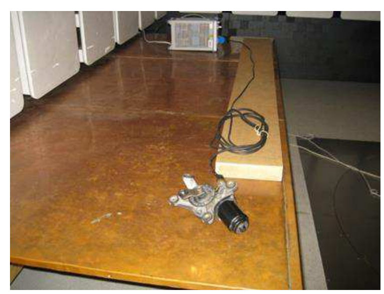


Figure 7: Laboratory stand for conducted disturbances measurement.

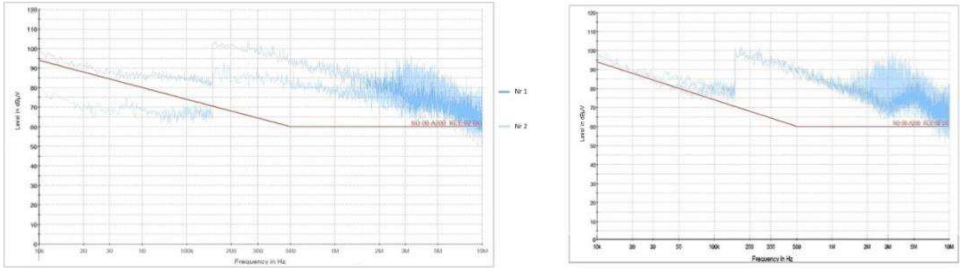
K — correction coefficient of the measurement antenna used, which takes the effective surface of the antenna into account [dB/m].

The appearance of the motors tested as well as their location inside the vehicle is shown in the Figs. 1 and 2 respectively.

The electrical motor of the windscreen wipers is placed in the higher right corner under the bonnet of the Subaru Forester car.

Measurements of the radiated disturbances and conducted levels generated by the tested windscreen wipers motors have been done inside the anechoic chamber. The block diagram of the measuring stand for radiated disturbances as well as its external view is presented in the Figs. 3 and 4. During the measurement the antennas have ti be used [3, 5, 7]. The measurement results of radiated emission of the windscreen wipers motors No. 1 and No. 2 within the frequency range of 2 MHz–30 MHz is presented in the Fig. 5.

The block diagram as well as external view of the measurement stand for conducted disturbances within the power supplying circuit are presented in the Figs. 6 and 7 respectively. The measurement results of the conducted emissions for the motors of the windscreen wipers No. 1 and No. 2 for the



+ line Neutral line

Figure 8: Amplitude diagram of conducted disturbances vs. frequency.

phase as well as neutral conductors within the frequency range of 10 kHz–10 MHz are presented in the Fig. 8.

3. CONCLUSIONS

A lot of various subassemblies and components are installed in cars. They are stressed to electromagnetic interferences, and also they can generate interferences themselves. Standards of the International Electrical Engineering Committee describe selected processes taking place inside the cars. Manufacturers of the motorisation branch have their own methods for testing electromagnetic emissions as well as own requirements related to the electromagnetic compatibility of radiated and conducted interferences. The requirements related to defence equipment, including vehicles, are given in the standard MIL-STD-461F.

After measurements of radiated and conducted emissions of disturbances for two motors of windscreen wipers used in the Subaru Forester I and II cars done in the anechoic chamber the above amplitude vs. frequency diagrams have been achieved. It can be inferred from these diagrams that the motor No. 2 produced in earlier years (1997–2002) emits higher disturbances than the motor No. 1 from the Subaru Forester II (2002–2008). It can be stated that together with passing years the progress of technology makes that equipment manufactured emit less of electromagnetic disturbances. Both motors do not satisfy requirements related to the disturbances levels forced by the defence standard. In destination, in order to reduce disturbances in the moment of installation of the motors within the cars the suitable technical measures should be used. One of the ways of limiting interferences generated is to use protecting diodes that are to be installed in order to eliminate voltage pins. The diodes should be mounted near the interfering equipment in the way eliminating electromagnetic interferences in the place of their generation. A next way to level interferences that are mainly generated within the DC brush motors is to use capacitors and impedance coils. In order to reduce the radiated emissions from electronic equipment the dedicated materials have to be used [1, 8, 9] for their enclosures.

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