Measurements of Ultra Wideband Radar Cross Sections of an Automobile Using Circular Polarizations

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The authors previously reported the measurements of ultra wideband (UWB) radar cross sections (RCSs) of a passenger automobile at Ka band using linear polarizations (V-V, H-H, and +45°- –45°) (T. Kobayashi *et al*., *Ultra-Wideband, Short-Pulse Electromagnetics 7*, Springer, 2007, 381-390). The RCS (σ) varied in terms of view angles as follows:

σ_{VV} and σ_{HH}	2 to 20 dBm^2
$\sigma_{+45°-\,-45°}$	–4 to 10 dBm^2
$\sigma_{+45°-\,-45°} / \sigma_{VV}$ and $\sigma_{+45°-\,-45°} / \sigma_{HH}$	5 to 20 dB (9 dB on the average).

The measurements were carried out in a radio anechoic chamber with use of a vector network analyzer in making the wideband measurements. Measurements using circular polarizations (L-L and L-R) are described in this present report.

System calibration was made in a twofold way: the wired part comprising the network analyzer, a low noise amplifier, and connecting cables (up to the antennas) was calibrated with a coaxial through adaptor; and the total system including the transmitting and receiving antennas were calibrated by using three standard reflectors—dihedral corner for L-L and trihedral corner and planar for L-R—as targets. Measurement errors typically fell within 2 dB including effects of cross polarization discrimination of transmitting and receiving antennas (around 20 dB).

The UWB RCSs of the automobile were derived by integrating the receiving power from 24 to 29 GHz at every 1° angles. The results varied as follows:

σ_{LR}	2 to 20 dBm^2
σ_{LL}	2 to 15 dbm^2
$\sigma_{LR} / \sigma_{LL}$	–3 to 12 dB (4 dB on the average).

The ratio $\sigma_{LR} / \sigma_{LL}$ was found much smaller than the ones $\sigma_{+45°-\,-45°} / \sigma_{VV}$ and $\sigma_{+45°-\,-45°} / \sigma_{HH}$. This is attributable to the facts that the body of the automobile comprises a number of small scattering objects yielding σ_{LL}, either similar to corner reflectors or asymmetrical to the radar boresight. Fluctuations of the RCSs were smaller in UWB than in continuous wave for the two polarization combinations (similar to the previously reported linear polarizations), as shown in Fig. 1, because the wide bandwidth cancels out RCS plunges that are caused by narrowband interference among reflected waves from various parts of the target.

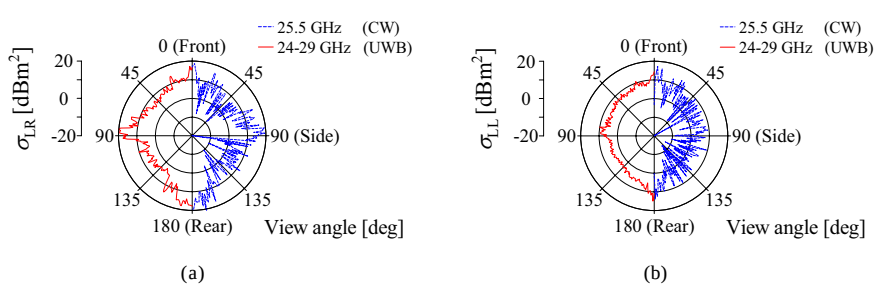

Fig. 1. Radar cross section of a passenger automobile: (a) L-R and (b) L-L polarizations.