Technical Report

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Field strength measurement position is identified with vehicle speed pulse.

When measuring the electric field strength by placing a signal analyzer MSA500 series or ETC / DSRC electric field strength measurement system ME 9200 in a car, the measurement position can be identified using the vehicle speed pulse.
In this paper, the method of converting the vehicle speed pulse to the measurement position will be described.

1. Vehicle speed pulse

The vehicle speed pulse which is a pulse signal proportional to the revolution of the axle of car and is used to calculate the travel distance and speed of the vehicle. This signal can be drawn from the engine control unit or optional connector. As for actual connection, please contact each car dealer.
According to the JIS standard, the number of revolutions of the wire of the speedometer is set to 637 revolutions per 1 km travel. The number of pulses per wire revolution differs depending on the manufacturer of car, but is mostly 4 pulses or 2 pulses. Assuming that the diameter of the tire is 624 mm, the number of pulses is 5 pulses or 2.5 pulses per revolution of the tire.
In our software, the number of pulses per revolution of the tire and the actual diameter of the tire are input in the vehicle speed pulse setting. By adjusting the value of the diameter of tire, it is possible to fit to the numerical value that matches the actual running.

2. Counter for vehicle speed pulse

Signal analyzer MSA 500 can operate the counter with an external trigger input.
The control of this counter and the readout of the count value are performed by using USB command with an external PC.
The following commands are provided.

Command header	Parameters	Explanation
CTR_CLR	0, 1	Clear of counter for external trigger signal (0 : nomal, 1 : clear)
CTR_ENB	0, 1	Enable of counter for external trigger signal (0 : disable, 1 : enable)
CTR_OUT	Nothing	Transmission request of count value for external trigger signal (32bit)

The distance between measurement point A and measurement point B will be obtained as follows.

$$Dab = \pi\,(Pb-Pa)Td\,/\,Pr$$

However

Dab : Distance between measurement point A and measurement point B (m)

Pa : Value of pulse counter at measurement point A

Pb : Value of pulse counter at measurement point B

Tb : Diameter of tire

Pr : Number of pulses per revolution of tire

3. Relationship between traveling speed and frequency of vehicle speed pulse

Assuming that the traveling speed is *Vr (km / h)*, the frequency *Fp* of vehicle speed pulse at that time will be expressed as follows.

$$Fp = Vr / 3.6 \times Pr / (\pi Td)$$

The table below shows the above equation.

Frequency of vehicle speed pulse *Fp[Hz]*

Speed（*km/h*）	20	40	60	80	100
Fp(Pr=2.5)	7.1	14.2	21.3	28.3	35.4
Fp(Pr=5)	14.2	28.3	42.5	56.6	70.8

However, *Td = 0.624 [m]*

4. Measures against noise of connection cable for vehicle speed pulse

Since the vehicle speed pulse is input to the external trigger terminal in MSA 500, the noise countermeasure is carried out in the connection cable. The signals in car are mixed with many pulsed noises, so this countermeasure is indispensable.

When the output impedance of vehicle speed pulse is 5kΩ, the cutoff frequency of a low pass filter for noise suppression will be approximately 1.8 kHz. Since the input impedance of the external trigger input terminal of MSA 500 is 10kΩ, the voltage division ratio is about 1/5.