

# The measurement of injector voltage



ZPSiSS, 2011

## 1. Basic phenomenon of voltage

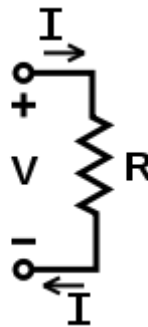
### 1.1. Basics' laws

**Voltage, otherwise known as electrical potential difference or electric tension (denoted  $\Delta V$  and measured in volts, or Joules per Coulomb) is the difference in electric potential between two points -- or the difference in electric potential energy per unit charge between two points.**

Ohm's law. The current through a conductor between two points is directly proportional to the potential difference across the two points, and inversely proportional to the resistance between them.

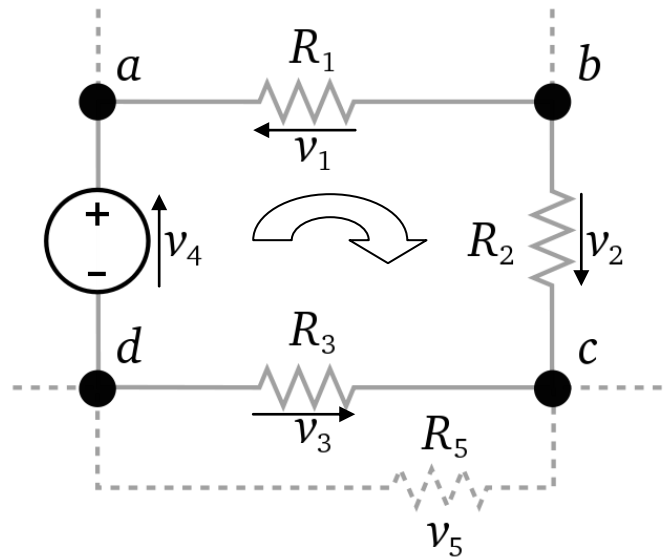
$$I = U/R$$

$$[I] = V/\Omega = A$$



Second Kirchhoff's law (loop rule). The directed sum of the electrical potential differences (voltage) around any closed circuit is zero.

$$\sum U_k = 0$$



In this case (figure):  $v_4 - v_1 + v_2 - v_3 = 0$

### 1.2. Common Rail

Common rail direct fuel injection is a modern variant of direct fuel injection system for petrol and diesel engines. On diesel engines, it features a high-pressure (over 1,000 bar/15,000 psi) fuel rail feeding individual solenoid valves, as opposed to low-pressure fuel pump feeding unit injectors (Pumpe/Düse or pump nozzles). Third-generation common rail diesels now feature piezoelectric injectors for increased precision, with fuel pressures up to 1,800 bar/26,000 psi.

### 1.3. Experiment description

On the figure (fig. 1) showed supply wires for injectors. Voltage is measured with probe (fig. 2) and oscilloscope (fig. 3). Experiment relays on measure currents for all (four) injectors.



Fig. 1. Fiat 1,3 tdi common rail engine and voltage supply wires for injectors



Fig. 2. (voltage) probe



Fig. 3. Oscilloscope

### 1.4. Elaboration of results

1.4.1. Find a relation (function) between crankshaft speed (for one injector), voltage frequency.

| No. | Crankshaft speed | f [Hz] |
|-----|------------------|--------|
| 1.  | 500              |        |
| 2.  | 800              |        |
| 3.  | 1200             |        |
| 4.  | 1500             |        |
| 5.  | 1800             |        |
| 6.  | 2000             |        |
| 7.  | 2200             |        |

1.4.2. Find injection time (for all injectors) and draw chart ( $\omega=f(t)$ ).

| No. | Crankshaft speed | $t_I$ [ms] | $t_{II}$ [ms] | $t_{III}$ [ms] | $t_{IV}$ [ms] |
|-----|------------------|------------|---------------|----------------|---------------|
| 1.  | 500              |            |               |                |               |
| 2.  | 800              |            |               |                |               |
| 3.  | 1200             |            |               |                |               |
| 4.  | 1500             |            |               |                |               |
| 5.  | 1800             |            |               |                |               |
| 6.  | 2000             |            |               |                |               |
| 7.  | 2200             |            |               |                |               |