ELECTRONIC TRANSDUCER OF VEHICLE VELOCITY

Jerzy Mirkowski
Marcin Sosnowski,
Wojciech Synoradzki

Częstochowa University of Technology
Institute of Internal Combustion Engines and Control Engineering
Al. Armii Krajowej 21, 42-200 Częstochowa, Poland
tel.: +48 34 3250543, tel./fax: +48 34 3250501, e-mail: sosnowski@imc.pcz.czest.pl

Abstract

The paper presents the design, description and traction research results concerning the prototype transducer of vehicle velocity installed in FIAT CINQUECENTO 1.1i passenger car. Within the confines of paper the original speedometer installed in the vehicle was calibrated in order to obtain the true values of vehicle velocity. The performed measurements of the transducer were compared with the original speedometer readings and the characteristic of the transducer was prepared.

The mechanical part of vehicle velocity transducer, the electronic part of vehicle velocity transducer and traction researches are an object of the paper.

Fuel consumption signal processing, the transducer design, the view of the vehicle velocity transducer, electric diagram of the vehicle velocity transducer, the results of the transducer calibration among other things are presented in the paper. The performed research of the prototype electronic transducer prove that it can be successfully used to design and built more advanced transducer dedicated to liquid fuel consumption measurement given in dm^3/100km unit.

Keywords: *transport, vehicle velocity, electronic transducer*

1. Introduction

Different measuring transducers are used in automotive engineering. The I-type transducer directly converts the measured quantity to another quantity, which is easier to be visualized or post-processed. The example of applying such transducer is the liquid fuel consumption measuring system of a vehicle (Fig. 1). The flowmeter converts the fuel flux on a time-dependent quantity in the system. However, the fuel consumption is commonly given in dm^3/100km unit. That is why the additional processor has to be used to convert the vehicle velocity signal to impulses of proportional frequency or voltage or current analogue signal.

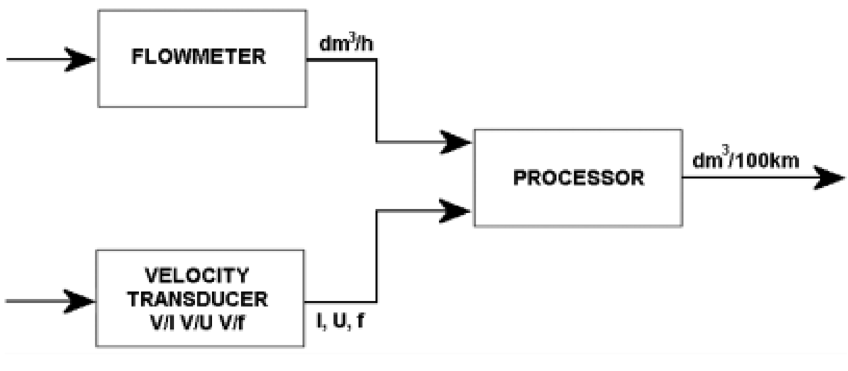

Fig. 1. Fuel consumption signal processing

2. The mechanical part of vehicle velocity transducer

The rotational movement of perpetual screw was used to drive the vehicle speedometer. The vehicle velocity transducer was installed on the output of the perpendicular screw in order to not interfere the work of the original speedometer of the vehicle. The transducer consists of casing, in which the disc with holes rotates. The transoptor is mounted to the casing. There is a gap between the LED diode and the phototransistor of the transoptor. The electronic system of the timer normalizes the pulses in the aspect of the amplitude and the duration.

The transducer casing (Fig. 2, Fig. 3) was made out of bronze in order to prevent it from corrosion and to provide the easy machining. The casing consists of two parts that are joined with the use of four M3x10 screws. The axle with disc is enclosed in the casing. The disc is equipped with 15 holes drilled every 24º. The holes are used as pulse generators, which are to be read by the transoptor. He axle is mounted in two 688Z bearings and set in the proper location by Ø8x1 washers.

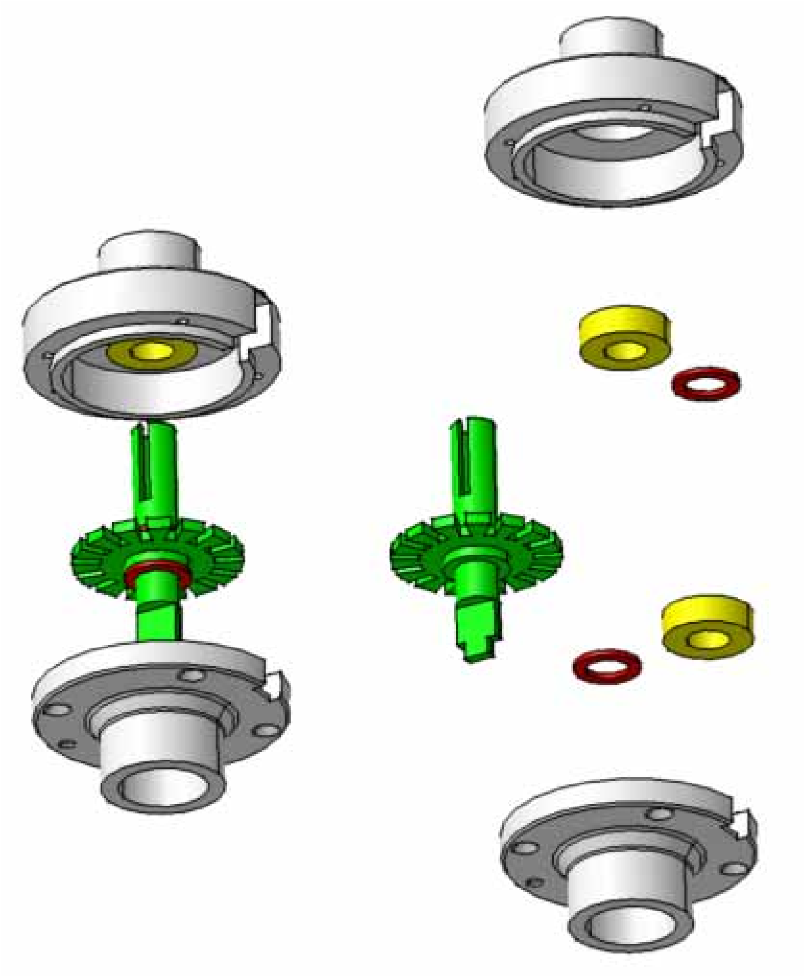

Fig. 2. The transducer design

3. The electronic part of vehicle velocity transducer

The vehicle velocity transducer (Fig. 4), was made using NE555 integrated circuit working as mono-stable generator. The measuring device in the system is TCST1103 transoptor manufactured by Vishy. The rectangular pulses are generated on its output. The frequency of the pulses is dependent on the rotational speed of the disc connected with the shaft by the clutch. The LED diode integrated in the transoptor is powered by the direct voltage of +5V through the resistor of 180Ω. The resistor limits the current to the safe value. The collector of the phototransistor is connected to the positive power bus through the resistor of 10kΩ. The HI signal (+5V) is observed on the transoptor output if the transoptor gap is masked. Otherwise the phototransistor is conducting and ground voltage (LO signal) appears on the collector. It is not possible to directly connect the transoptor output with the NE555 mono-stable multivibrator input as the duration of input pulse is necessary to be shorter than the duration of pulse on the mono-stable generator output. The differentiating circuit was used in order to fulfil the above mentioned condition. The Zener diodes of voltage equal 3.3V connected in push-pull configuration were used in order to prevent the differentiating circuit from damage caused by the pulse interferences induced in the wire. The circuit was designed on the basis of TTL74HC00 integrated circuit and 10kΩ resistors and 470pF capacitor. For such resistors and capacitor the pulse duration dependent on these elements is 1.3ms. The other gates in the structure of TTL74HC00 integrated circuit are connected to the positive power supply bus in order to prevent the possible interferences on the output of the circuit. The output of the differentiating circuit is connected with triggering input of the mono-stable multivibrator. The negative pulse on the multivibrator input initiates the triggering, which generates the HI signal lasting for the time dependent on the used resistors and capacitor. The magneto-electric ammeter is connected to the mono-stable multivibrator output. The ammeter shows the mean value of the current. In this system the mean value of the current is proportional to the rotational speed of the disc. There is a possibility to calibrate the device by changing the value of the potentiometer resistance, which corresponds with the output pulse duration. The resistor is connected in series with the ammeter in order to limit the output current to the safe value. The transducer is designed to be mounted in the vehicle so it will be powered by the vehicle's electric circuit of +12V. As the transducer requires the voltage of +5V, the power supply was designed on the basis of 7805 mono-stable stabilizer.

Fig. 3. The view of the vehicle velocity transducer

4. Traction research

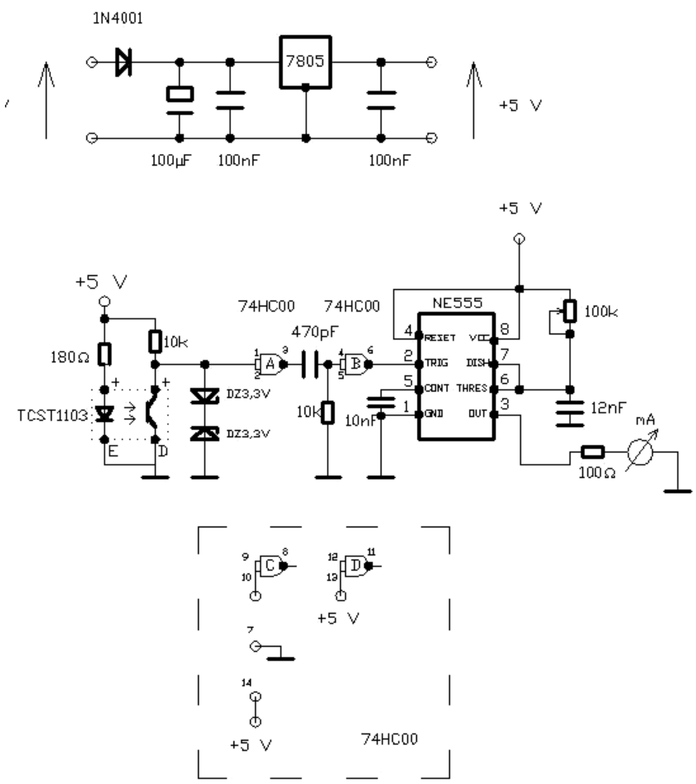

Fig. 4. Electric diagram of the vehicle velocity transducer

The vehicle velocity transducer (Fig. 5, Fig. 6) is installed in Fiat Cinquecento1.1i passenger car and it was calibrated in service conditions. The vehicle velocity reading from the original speedometer was used as a basic size. The output quantity was the mean current value generated in the electronic transducer. The exemplary results of the transducer calibration is shown in Fig. 7.

Fig. 5. The vehicle velocity transducer prepared to be mounted in the vehicle

Fig. 6. The view of the transducer mechanical part mounted in the vehicle

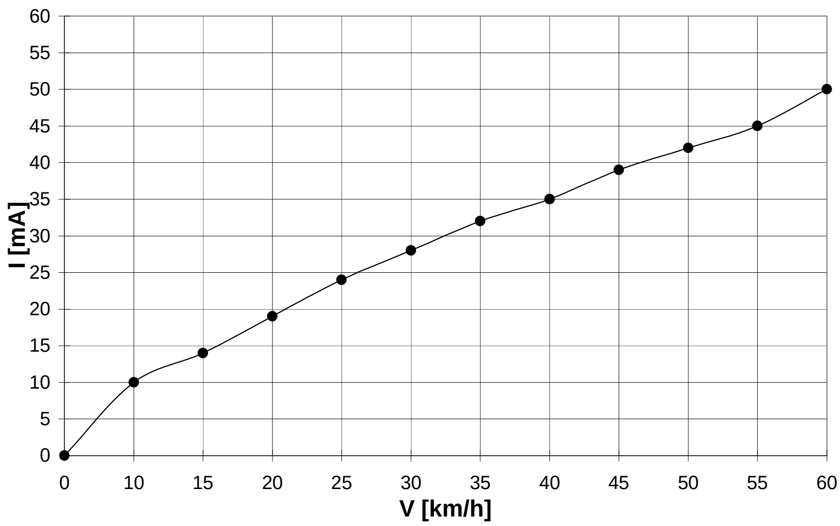

Fig. 7. The results of the transducer calibration

5. Conclusions

The characteristic of the vehicle velocity electronic transducer is almost linear, what can be seen on the basis of traction research of the transducer. The differences of original speedometer and the prototype transducer readings do not exceed 10% in the researched range of velocities. The differences are resulting from the inaccuracy of the ammeter that was used and also from the selection of used electronic elements and the inaccuracy of the mechanical part workmanship. The difference of 10% is a satisfying result and is not greater than the deviation of the original speedometer. It means that the prototype electronic transducer works as good as the standard speedometer as the vehicle.

The performed research of the prototype electronic transducer prove that it can be successfully used to design and built more advanced transducer dedicated to liquid fuel consumption measurement given in $dm^3/100km$ unit.

References

[1] Brennan, K., Brown, A., *Theory of Modern Electronic Semiconductor Devices*, WileyIntersci, 2002.
[2] Rommer, E., *Miernictwo przemysłowe,* PWN Warszawa 1970.
[3] Konopiński,M., *Elektronika w technice motoryzacyjnej*, WKŁ Warszawa 1987.
[4] Pomykalski, Z., *Elektrotechnika samochodów*, WKŁ Warszawa 1978.
[5] Dziubiński, M., Walusiak, S., *Elektrotechnika i elektronika samochodowa*, WUPL Lublin 1999.
[6] Gasvik, K., *Optical Metrology*, WileyIntersci, 2002.