THE ELECTRONIC CONTROL OF VEHICLE STARTER MOTOR

Ing. Petr MELICHAR, Doctoral Degree Programme (1)
Dept. of Power Electrical and Electronic Engineering, FEEC, BUT
E-mail: xmelic03@stud.feec.vutbr.cz

Supervised by: Prof. Vítězslav Hájek

ABSTRACT

This paper deals with electronic control for vehicle starter. It describes the reasons for implementation needs, such as planned "START-STOP" system, and from that resulting enhanced starter motor reliability. There is mentioned flow chart for faultless start of vehicle engine in a view of the starter motor protection. According to designed flow chart is there described one of the possible practical implementation of electronic control system for vehicle starter.

1 INTRODUCTION

For starting of combustion engines of passenger cars, trucks and buses is used electric starter since many years, even that it offers many other possibilities of starting (e.g. pressed air, rope starter). These systems are inconvenient, because it is necessary to assembly other arrangements, which needs electric energy to its running or are their operation no comfortable and physical exacting.

At present, with increased needs on safeness, simplicity attendance, economic efficiency travel and decrease emission is increased attention to component in vehicle. Electric equipment of vehicles got through many significant changes over the last two decennium. Relevant changes as engine control (motor control), active safety and comfort. However engine starter which forms biggest electric load in vehicle, stayed almost unchanged. Many years was used for starting of combustion motors a serial DC motor, especially for its high starting moment.

In context, for implementation of "START-STOP" system (system of automatic turn off and turn on of combustion motor e.g. at stopping vehicles on crossing) is need perfect starting mechanism especially from the reliability and durability point of view. That can be achieved by proper electronic verification of starter activities with elimination of critical states or by usage of new starter system with minimized use of mechanical parts (commutator, pinion).

Increasing requirements on price, weight and reliability of vehicles lead to tendency for unification of two most considerable elements – alternator and starter.

2 STARTING

Combustion engines must by started by a separate system because they cannot self-start like electric motor or steam engines. When starting these engines, considerable resistance resulting from compression, piston friction and bearing friction (static friction) must be overcome. Frictional resistance is highest at low temperatures.

Even under severe conditions, the starter must crank the gasoline engine fast enough so that it can from the combustible air-fuel mixture required for starting, and diesel engines fast enough to reach their self-ignition temperature. To satisfy these requirements, the starter must rotate the flywheel at minimum starting speed. It must also continue to support rotation during initial combustion to maintain until the engine can sustain operation.

The DC series-wound electric motor is suited for use as starting motor, because it generates the high initial torque required to overcome cranking resistance and to accelerate the engine's internal masses. In the majority of cases, starting motor torque is transmitted to the engine via starter pinion and ring gear on the crank-shaft-mounted flywheel.

The energy to start the engine is supplied by the same battery normally used to operate the other electrical system. For this reason, the starter cannot be viewed as an independent component, but, rather, must be discussed as an integral part of the electrical system.

The starter must be designed for the other components of the starting system and the engine with which it is used, because starting requirements vary widely and the effect of temperature is highly significant.

3 REQUIREMENTS FOR NO-PROBLEM STARTING

Starting lock is dependent only upon mechanical turn-buckle in ignition-starter switch namely only in case when is vehicle started during operation of engine. With increasing usage of electronic elements in combustion motors, higher requirements on comfort and safeness, is necessary to control activity of starter electronically.

For error free initiation of internal-combustion engine it is necessary to watch several values. These values can be divided into two groups. To the first group belong values from starter, like engine revolutions, state of battery and outdoor temperature. The values as sensing of winding starter temperature, position of pinion and starter revolutions can be placed in to the second group.

Whole flowchart is displayed on figure 1. This flowchart shows possible variants control algorithm of „electronic verification activities of automobile starter".

In produced cars of present days is electronic control section, which includes many information about state of battery, temperature of motor etc. There is no need further to deal with determination of these values mentioned in a first group. It is necessary to pay attention to state of starter himself, i.e. winding temperature, position of pinion and speed.

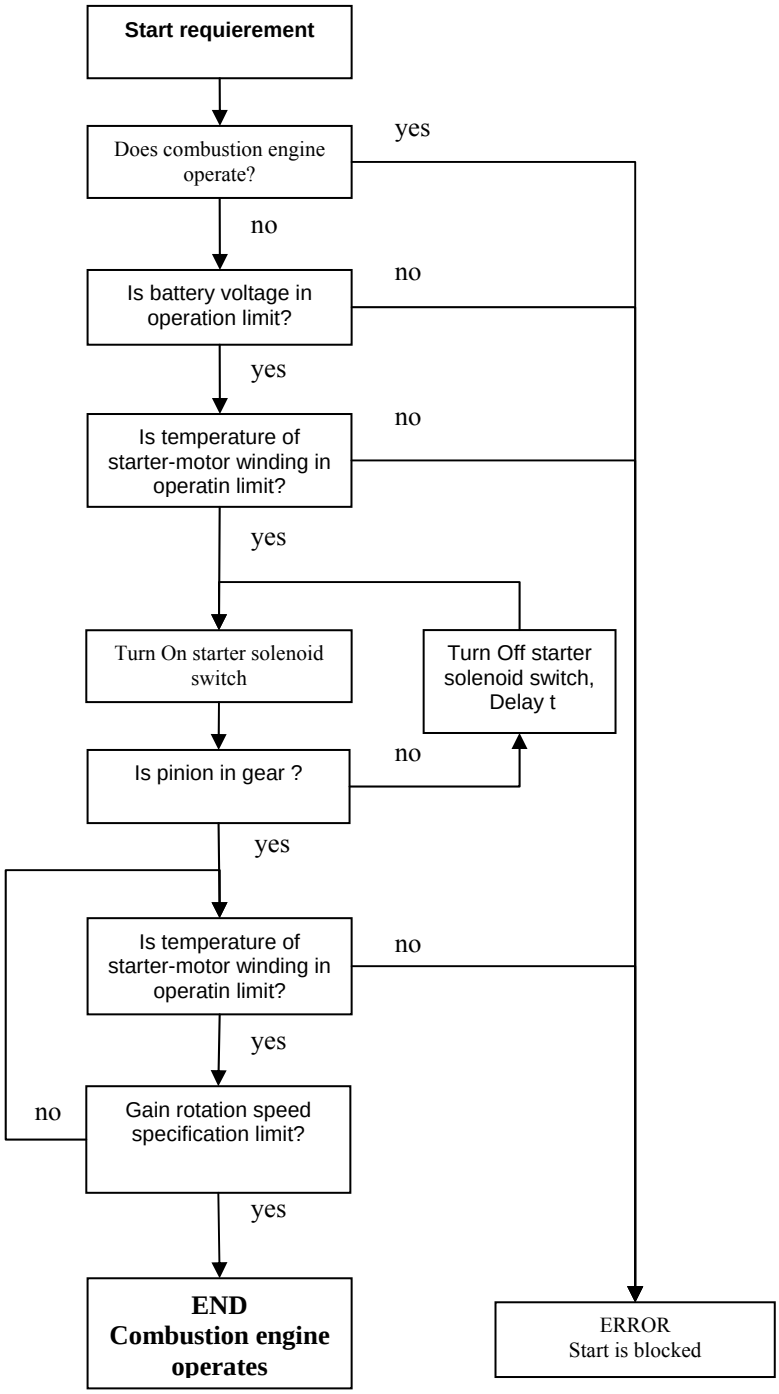

Fig. 1: *Flow chart diagram for protection of combustion engine start*

One of the possible protections of starter motor is controllers for controlling a starter motor electronically. They generally include a control unit which receives as input a flag concerning the open or closed state of a starter switch – which switch is generally actuated by the vehicle key – and which controls the application of power to coil(s) of a power contactor which, when closed, serves to power the electric starter motor. The power contactor includes, in particular, a moving core which, at the end of its stroke, closes the power supply circuit for the electric starter motor and whose displacement causes the starter pinion to be entrained

towards the ring gear. The control unit also serves to control other functions such as automatically stopping the starter or indeed providing protection against surge currents or against operator error such as trying to start an engine that is already running. The control unit is either integrated within the starter itself, or else it is housed externally thereto in special box. In another variant it may be constituted by an already – existing electronic system, such as the injection and ignition processor.

4 TEMPERATURE PROTECTION OF STARTER MOTOR

Because it is impossible to use standard contact sensor in winding (because motors with permanent magnets are still more often used), is necessary for temperature sensing motor winding select other alternative solving.

The below mentioned principle uses the time of opened and closed state of starter switch for temperature determination.

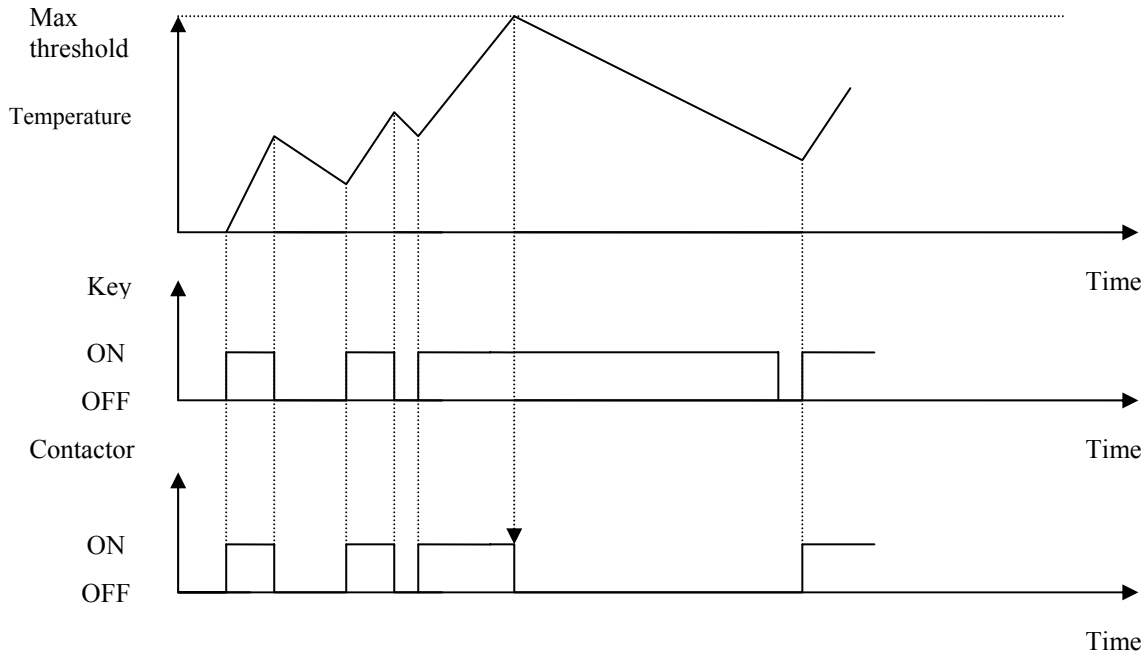

Fig. 2: *Diagram for temperature determining*

Each time when is starter activated, the starter motor heats up quickly, how shows figure 2, and its temperature rises significantly by a few degrees as a function of its operating characteristics and as a function of the length of time it is activated. The lengths of pauses between successive attempts of starting are in the order of several seconds and they enable the starter motor to cool down. However, its rate of cooling is much slower than the rate of heating, in general the starter motor does not return to its initial temperature when it is reactivated.

This gives rise to a cumulative heating effect which, if too many attempts are made or if they last for too long, will lead to the starter motor being destroyed.

The principle of protection is in repeated ON and OFF switching of contactor how shows fig.2. Electronic realization offers very simple solution with a counter. At ON position of contact counter counts up with higher speed than counts down at position OFF of contact. If value in counter overruns its limit, it will disconnect the power to solenoid switch. Another switch on of the power is possible after underflow of counter to defined limit, so to warrant the minimum time needed to initiation of combustion motor. Rate of rise of counter is determined empirically for given starter motor type.

5 CONCLUSION

Project summarize information about problems of combustion engine starting and piece of knowledge from progress in development of electronic drive starting system of combustion motor. Designed flowchart of electronic drive starter system includes necessary steps to reliable start, reduction of mechanical parts wear and damage of starting system of combustion engine in maximum possible measure. There is shown possible way of realization of starter motor heat protection without necessity hit to the starter construction.

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