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CENTRALIZED SYSTEM OF DATA ACQUISITION – REGISTER OF PUSH-BUTTON USAGE FOR THE RAILWAY TRAFFIC CONTROL DEVICES

Currently existing registers do not allow recording the time of use of the button, and their mechanical construction is damageable and may cause some abuses. Suggested solution allows registering not only the fact of button applying but also the time of use. The digital construction and hermetic structure prevent from locking the counting along with input signal call. Applied communication standards allow for data export to the surroundings. Developed register encloses a plain construction and small dimensions, and what is more it allows for easy adaptation, and use of construction, programming and transmission standards.

SCENTRALIZOWANY SYSTEM AKWIZYCJI DANYCH – REJESTRATOR UŻYCIA PRZYCISKU DORAŹNEGO W URZĄDZENIACH STEROWANIA RUCHEM KOLEJOWYM

Użycie przycisku doraźnego następuje zawsze w sytuacji wyjątkowej. Wraz ze zwiększaniem prędkości pociągów, a co za tym idzie skracaniem czasów następstw, precyzyjna rejestracja użycia przycisków doraźnych stanowi ważny element analizy skutków i odpowiedzialności w sytuacjach wyjątkowych. Automatyzacja kontroli ruchu i poszerzanie obszarów objętych scentralizowaną kontrolą wymaga dokładnej rejestracji czasowej reakcji pracowników służby inżynierii ruchu. Celem projektu było stworzenie nowego typu rejestratora użycia przycisku doraźnego, pozbawionego wad dotychczas używanych urządzeń analogowych i znacznie rozszerzonego funkcjonalnie m.in. o możliwość akwizycji danych przez zewnętrzne urządzenia centralnego rejestratora. Prezentowane urządzenie jest pierwszym i jednym z podstawowych elementów scentralizowanego systemu rejestracji. Uzasadnieniem podjęcia tego problemu jest konieczność precyzyjniejszej rejestracji użycia przycisków doraźnych, w sytuacji postępującej automatyzacji sterowania ruchem na kolei, przy uwzględnieniu wagi następstw wynikłych z użycia takiego przycisku. Jednocześnie coraz pilniejsza jest potrzeba scentralizowanej rejestracji stanów urządzeń i reakcji personelu obsługi.

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1. INTRODUCTION

Applying the push-button always occurs in a very unusual situation. Due to the speed development the precise registration of the push-button application makes the analysis of the responsibility as well as effects of the unusual situations a very important aspect. Automation of the traffic control along with enlargement of the regions covered by centralized monitoring service cause a precise time registration of the staff reaction.

Creating a new type of register for the push-button application was a main aim of the project. The register ought to be free of the defects typical for the currently used analogue devices, and should have a possibility of the functional development including data acquisition by outer devices of the central register. Described device is one of the fundamental elements of the centralized system of registration.

The necessity of more precise registration for the push-button usage, along with the traffic control automation, and consideration of the consequences for the button application make a good excuse to bring up the problem. There is a need to create the centralized registration system describing the stages of devices and staff reaction.

2. ATTRIBUTES OF THE DEVICE

The device is planned to be an element of the centralized data acquisition system. The attributes that allow increasing the traffic safety as well as market attractiveness are as follow:

- abuse or staff failures resistance;
- precise time registration of use which has influence for raising the work discipline and allows for the particular post factum analysis of the unusual situations;
- permanent collecting the records of the past events;
- low price that is comparable to the mechanical devices although has higher usable value;
- size allowing the mechanism to be set onto the control panels;
- easy maintenance, programming the settings, and data readout;
- realizing the equipment and program standards.

2.1 CENTRALIZED SYSTEM OF DATA ACQUISITION

Described device is planned to be the major element of the centralized system of data acquisition about the condition of devices being under the supervision, and about the staff reaction for occurring events.

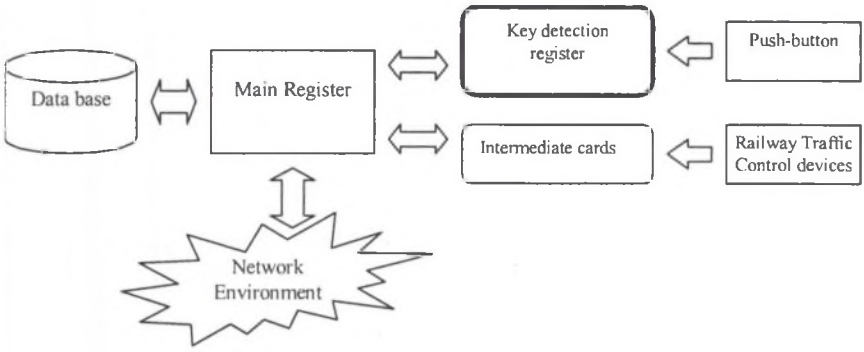

Fig.1. Scheme of centralized system of data acquisition

2.2 ABUSE OR STAFF FAILURES RESISTANCE

Mechanical registers might be under the influence of the staff overuses. Suggested implement fulfills the condition of overuses resistance in many ways:

- protection from mechanical interventions;
- complete registration of the button use including precise time of applying the button.

What is more, the programming threshold of application had been implemented. It lowers the device sensitiveness for the multiple button application in a short time. The time when the button is pressed, as well as time of the device insensitiveness after using the button are controlled.

2.3 PRECISE TIME REGISTRATION

Time registration of the button application is a new option for the device that is being created. Applied real-time clock allows for the time readout with accuracy of one millisecond, and the data range includes also day, month and year. The time registration will let for precise studies of the staff behavior correlating with other recorded events.

2.4 PERMANENT COLLECTING THE RECORDS OF THE PAST EVENTS

Using the EEPROM type of memory will allow for permanent registration of the previous button applications. That may let for the analysis of the staff behavior in usual situations.

2.5 LOW PRICE

The economical and standard electronic elements have been applied to the device. In stead of using the small sized LCD displayer the LED displayer have been put into operation. That move made the price low down about €50 what is important for the market success.

2.6 SMALL SIZE

Creating the appliance for the railway usage there was a need to keep dimensions limits due to the size of standard control panel. The cube inner dimensions are 38x38 mm. That made to use small sized displayers and assembling SMD technology devices (excluding those that classical technology allows simple maintenance of the appliance).

2.7 ERGONOMIC USAGE

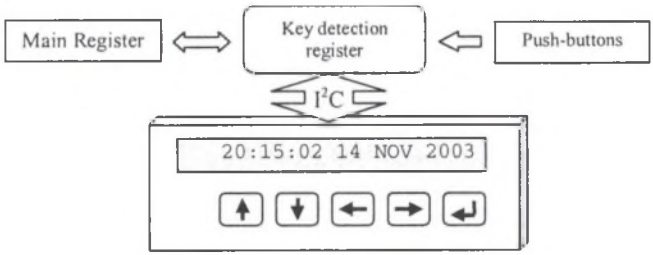

Fig.2. Cooperation between register and control setting device

The register uses the I^2C bus for inner communication with the memory chip and real-time unit. The bus provides communication with outer devices that are used for direct regulation of the real-time clock operation, and data readout form the EEPROM memory.

This solution makes the authorized staff to control chosen register in a very clear and easy way.

2.8 REALIZING THE EQUIPMENT AND PROGRAM STANDARDS

The I^2C transmission standards as well as equipment and program standards for 8051 are realized by the appliance. The device uses the EEPROM memory clarifications and tiny versions of one-unit microcomputers by ATMEL, and the most popular real-time unit by PHILIPS.

2.8.1 THE I²C STANDARD

The serial transmission is characterized by a low amount of the transmission lines. Reduction of the connecting lines lowers the surface of the modules, simplifies printed circuits, and lowers the amount of leads. I²C is the most popular serial synchronic interface. This standard has been developed by Phillips for the audiovisual equipment. Currently the surface might be applied also to the PC computers as a method of data transmission in the electronic cards.

The I²C bus contains of Serial Data Line (SDA) and Serial Clock Line (SCL). The form of signals of the both lines is characterized by a two-state digital course. The data line is two-way what allows reading and writing data. The clock line is one-way which means that in case of communication between two units only one of them may generate the SCL course [1].

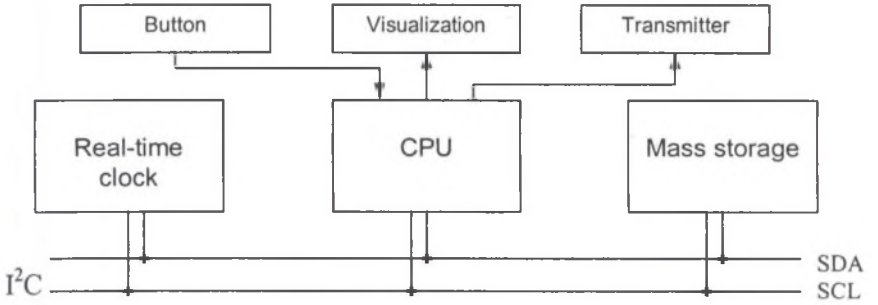

Fig.3. Scheme of device with characteristic architecture for the I²C bus

Applying the I²C transmission for the internal communication between register functional elements allows for flexible development of the device such as wireless and non-wireless transmission modules, additional mass storage module or unit for better visualization of the register state.

2.8.2 THE 8051 MICRO CONTROLLER

Applying the 8051 microcontroller allows for the source code modification according to the huge identification of this platform and various specifications used for creating the object code.

Selecting particular model of the microcontroller is determinate by energy-consumption and maximum dimensions of the register. The first parameter seems not to be such important, although applying low energy-consuming microcontrollers allow reducing the device sensitivity for disturbances form the supply system. For the CL micro-controller the supply voltage range oscillates from 1.8 up to 6.0 V.

The second parameter is brought by the need of placing the unit into a standard size cube of the control panel. This aspect might be skipped by applying devices that use the SMD

technology of setting. However applying micro-controllers with regular terminals as well as mainframes will allow for easy software care.

2.8.3 THE CLOCK

The PFC 8583 unit by Philips has been implemented as a clock. It makes the integrated real-time clock with the significant precision and low energy consumption. The first parameter depends on accuracy of the quartz-crystal resonator is made with. That makes the clock regulation as a must. The energy consumption for the regular mode is a little above 2μA with the level of voltage around 2.5V and resonator frequency of 32.768 kHz. That allows running the clock from the little cell continuously for several months in case of cutting down the outer energy.

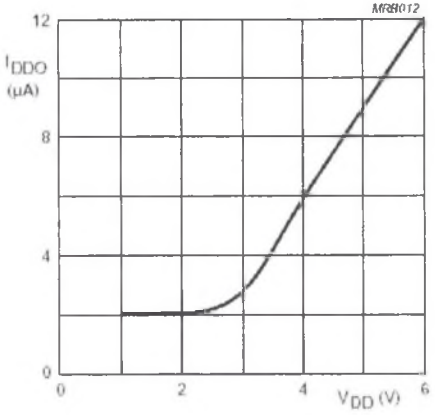

Fig.4. Current-voltage characteristic for the PFC 8583 clock by Philips

2.8.4 MEMORY CHIP

According to the necessity of memorizing the device unique address on the I^2C bus the serial memory chip 24c08 is applied to. That allows writing and reading up to 1024 bytes of data located in 4 memory banks of 256 bytes each. That permits to register up to 128 events of push-button usage. The format of data is as following: *year – month – day – hour – minute – second – counter position.*

The *year* value is recorded beginning from the number of 2000 and the counter position allows receiving 2 bytes of data. 128 records are a sufficient number of data needed for keeping events in the memory and further post factum analysis.

The durability of those kinds of chips allows for a million cycles of writing and reading, and to keep data for a hundred years.

2.8.5 INPUT/OUTPUT

A closing button makes the input signal and due to the standards it is a separate element of the control panel. The switch output that is an element of the register makes the output unit.

2.8.6 DISPLAYER

Due to the costs reduction the set of 4 seven-segment LED displayers have been applied. There is a possibility to implement the LCD displayer managed by the I^2C bus although such a decision seems unreasonable.

3. CONCLUSIONS

The register is an important element for the traffic safety development. Precise time registration of the push-buttons applications will let for strict analysis of the staff behavior in unusual situations. Applied time intervals will allow eliminating accidental or multiple use of the button in the emergency situation.

The readout unit of the register memory that has been designed additionally will eliminate a computer usage for data readout what allows for information readout free from equipment and programming platform.

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Reviewer: Prof. Zbigniew Ginalski