COMPUTER CONTROL OF SPEED OF TRAINS ON SLOVENIAN RAILWAYS

MSc Bojan Cene
Slovenske železnice d. d.

MSc Jože Voršič
Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

In the year 2000 new passenger trains, manufactured by Siemens, and trains with inclination technique – Pendolino - were brought into operation on Slovenian railways. These trains are equipped with a contemporary computer control of speed which is made possible with the use of the safety device, designated as INDUSI I 60 R. The purpose of this device is to prevent accidents or hazards with the aid of self-acting braking, when the engine driver disregards a certain signal mark of the railway signalling system.

The so far existing traction vehicles on Slovenian railways are already equipped with classic speed control devices of the type INDUSI I 60 for point operation only and without computer operation.

The paper is dealing in detail with the system of operation of the new safety device with the emphasis on computer components on the train.

Key words: INDUSI I 60 R, magnet, traction vehicle, microcomputer, DEUTA – WERKE ADS 2.

INTRODUCTION

On Slovenian railways (SŽ) all railway tracks must be equipped with adequate railway track devices, which transmit the required information to devices on the traction vehicle.

Equipment on the railway track consists of passive rail magnets, which are located in accordance with railway track signals. Rail magnets are oscillating circuits, designed for INDUSI frequencies 500 Hz, 100 Hz, and 2000Hz as well as in combination of 1000/2000 Hz [1].

The 2000 Hz magnet is connected to the stop signal and the 1000 Hz magnet to the distance signal. On SŽ, the 500 Hz magnet is installed 150 - 250 m in front of the stop signal. All magnets are fastened to the right outer side of the track (Figure 1) [2].

The magnet is ineffective, when the contact is connected to the signal.

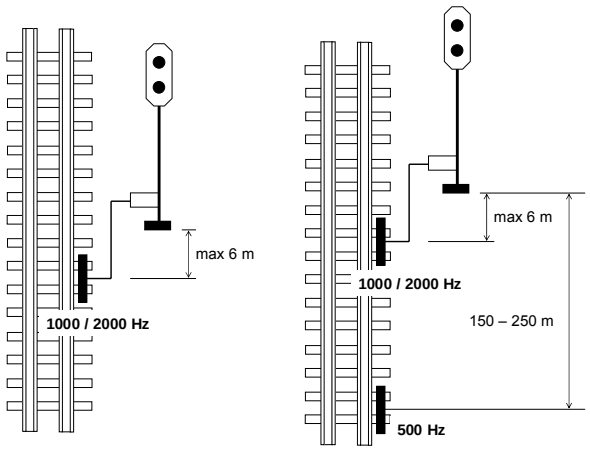

Figure 1: Installation of magnets 500 Hz, 1000 Hz, and 2000 Hz along the railway track

For this purpose an existing contact can be used, a relay can be attached in the control panel, or the signal information can be taken from the signal light circuit.

The traction vehicle is likewise equipped with the locomotive magnet (1000 Hz, 2000 Hz, and 500 Hz), which is shown in Figure 2.

Kontakt: Bojan Cene
Slovenske železnice d. d.
Kutilniška 6, 2000 Maribor, Slovenija
E-mail : bojan.cene@gmail.com,

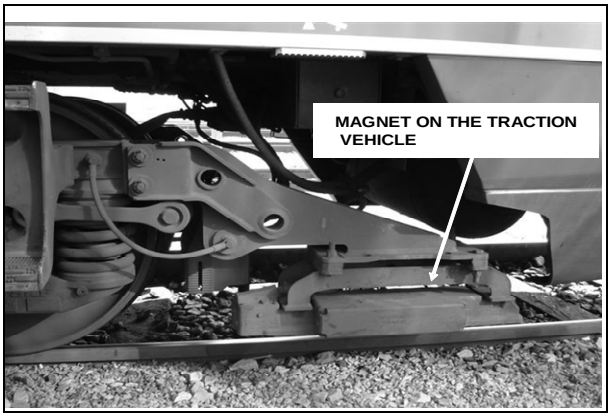

Figure 2: Magnet on the traction vehicle

INDUSI I 60 R EQUIPMENT

With the aid of magnets on the traction vehicle, the INDUSI device is continuously sending all three frequences to the rail. When the vehicle is passing a certain rail magnet, the induction effect is causing a reduction of the resonance current in the INDUSI equipment. Thus the vehicle detects and initiates the adequate safety reaction.

INDUSI I 60 R is a newly developed equipment, based on a microprocessor. The following aspects have been decisive in the development of INDUSI I 60 R [3]:

- Use of existing track installation,
- Use of general commercial computers,
- Improved speed verification, depending on time and the distance travelled,
- Expanded monitor and management,
- Expanded equipment for diagnosis and processing,
- Integrated electronic recording,
- Flexibility in optimising of management parameters.

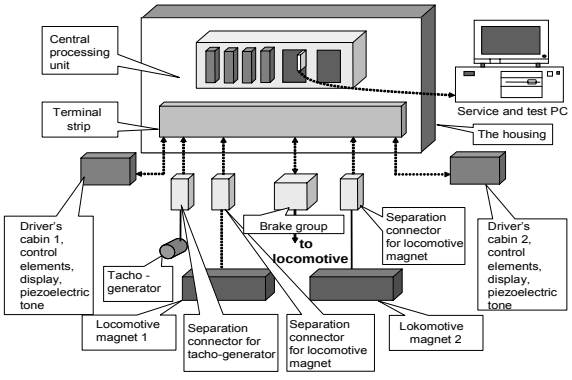

Figure 3: Components of INDUSI I 60 R installed on the locomotive

Figure 3 is showing components of INDUSI I 60 R equipment, installed on the traction vehicle [3].

Components of INDUSI I 60 R are the following:

- The central processing unit,
- The peripheral unit (periphery),
- Control and display components.

The central processing unit consists of the analogue part (frequency generation, impulse receivers, adaptation to the computer interface), the digital part (central microcomputer with the inbuilt data entry and monitor) as well as the data memory on the recording cassette for storage of important data into the buffer RAM battery [3].

In addition to the INDUSI vehicle magnet, the external unit also contains the braking unit as an intermediate medium for pneumatic brakes and the impulse meter (revolution counter) for the determination of actual speed and the distance travelled [3].

Control and display components are the monitor, the switch S160R, and push - buttons, which are also used in ordinary INDUSI devices. It is possible to continue to use these elements in vehicles, in which the AS 160R has been installed at a later stage [3].

By pressing the push-buttons Tw and Tf simultaneously when the train is stationary, the automatic test I 60, controlling the quick-acting brake, the siren, and the indicator light is activated.

The functional operation of the device INDUSI I 60 R is shown in Figure 4 [4].

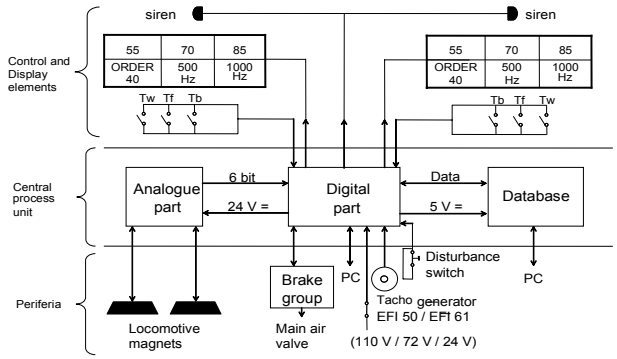

Figure 4: The structure of device INDUSI I 60 R on the locomotive

The frame of the device INDUSI I 60 R consists of the following components (Figure 5) [5]:

- Computer assembly (RCH), which integrates: data initialization, monitor, and service interface,

- Power supply (SVI60) – direct - voltage converter 72 / 24 V DC,
- Two frequency generators (INDFR) – one for each traction vehicle magnet,
- Adaptive assembly analogue / digital part (I80AN),
- Adaptive assembly for impulse meter (WEGAN),
- Output assembly (AS),
- Input assembly for contacts (ARUKO),
- Data storage on recording cassette (DSK),
- Push – buttons SELECT and FETCH (for data entry into the device: train number, date, …),
- Display for the control of data entered by the engine driver,
- Extension for the lap-top computer (PC).

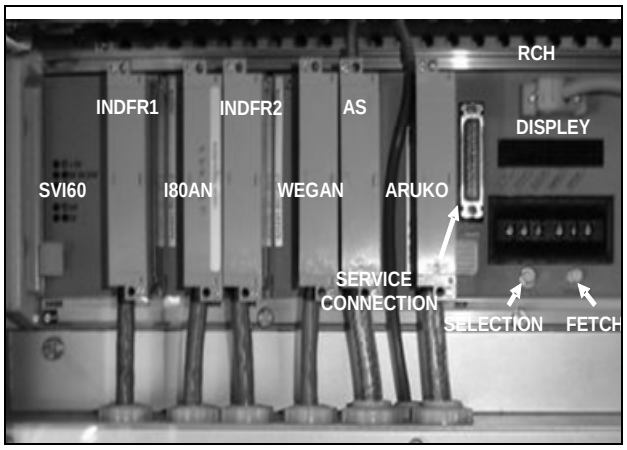

Figure 5: Frame for the device INDUSI on the traction vehicle

SOFTWARE

Software for INDUSI I 60 R, written in the high – level program language (PASCAL 86 and DiBase), contains the software package for the INDUSI I 60 R computer, and the program for the data storage on the cassette, controlled by the computer. The software package of the INDUSI I 60 R computer consists of parts for data input and the display, software INDUSI I 60 R, the program for handling of failures and for data exchange with data storage on the cassette and the testing device respectively.

As software is used DEUTA – WERKE Software, Version 1.63 and service software for parameter transformation (wheel diameter, date, time) in the device [6].

OPERATION

Data input to INDUSI I 60 R

Six rotary switches on the computer (Figure 5) enable the engine driver to enter actual train data (Braking modus, braking percentage train number, personal number of the engine driver and administration number). Each entered data (parameter) is displayed on the LC display for the engine driver. Using the testing device, the maintenance personnel can with the aid of the service interface enter data, which are valid over a longer period of time or permanently (e.g. wheel diameter, number of the train, date and time). Entered data can be controlled with the testing device or on the six-digit display of the INDUSI I 60 R computer.

Operating program of INDUSI I 60 R

The operating program of INDUSI I 60 R is monitoring the speed of the vehicle. In comparison with the so far existing equipment INDUSI I 60, this monitoring is essentially improved, since the so far existing point system is replaced by monitoring, which simultaneously depends on time and distance travelled, and makes continuous speed verification over individual track sections possible. The management modus and the monitors are the same as on so far existing INDUSI devices.

Sequence of operation of INDUSI I 60 R

When the control desk in the electric locomotive driver's cabin is switched on, one of the three blue signal lamps (85, 70, 55) is turned on by the software, with regard to the data entered. At the same time, the control of the maximal predicted speed is activated.

Based on the influence of INDUSI the predicted speed is determined, for which the following influences (1000 Hz, 2000 Hz, or 50 Hz) are valid [3]:

- THE INFLUENCE OF 1000 Hz

To prevent the self-acting braking as a consequence of the influence of 1000 Hz, the electric locomotive driver must activate the confirmation push – button within four seconds. Simultaneously with the actuation of the push – button the yellow signal lamp "1000 Hz" is lit. After 2.5 s follows the time – dependent reduction of the actual / controlled speed in accordance with the selected mode of braking and the percentage of braking to the engaged verified speed of 85, 70 or 55 km/h after 23, 29

or 38 s. The minimal length of the total supervised distance is 700 m.

- THE INFLUENCE OF 2000 Hz

When the electric locomotive driver is driving past the signal “STOP” (2000 Hz activated) then in principle the self – acting braking is activated. After the train comes to a halt, he can release the self – acting braking by pushing the relieve push – button Tf. When the engine driver wilfully wants to drive through the signal “Stop”, he has to activate the push – button “By order” Tb. In this case, the white signal lamp “Command 40” lights and the maximal speed of the train is verified at the speed of 40 km/h.

- THE INFLUENCE OF 500 Hz

At the influence of 500 Hz the red signal lamp “500 Hz” lights. The Maximum allowed speed at this point is with regard to the braking mode and the braking percentage 65, 50 or 40 km/h. The total length of the supervised distance travelled is 200 m.

Treatment in case of failure.

The computer INDUSI I 60 R itself will in most cases identify failures in the external and in the central unit. The engine driver is warned of each failure by the intermittent yellow control lamp and a short sound signal. The number of the failure is transferred to the data storage on the recording cassette.

Numbered failures facilitate the search of faults during repair work.

Data exchange with the data storage on the recording cassette

There exists a continuous data exchange between the computer INDUSI I 60 R and the computer of the data storage on the recording cassette (DSK), which is directed by the computer INDUSI I 60 R. At the same time DSK is storing all data of significance for function and management operations as well as eventual faults, which have been reported. The DSK computer is generating the date and time and relaying them to the computer I 60 R.

The capacity of the data storage is at present 512 kByte (Expansion possible up to 1 MByte). This is sufficient to record 15 000 to 30 000 km of railway line, depending on the course of the line and the number of events during the drive, like consequences of operations of the engine driver.

DIAGNOSIS WITH THE USE OF THE VERIFICATION DEVICE

The verification device is enabled to read the numbers of failures from the data storage on the recording cassette automatically or it verifies all functions of the INDUSI I 60 R with the aid of the keyboard and performs the simulation and testing of interfaces. Using the verification device, based on a personal computer, maintenance workers can also enter specific data into the computer INDUSI I 60 R.

Testing of device INDUSI I 60 R

The figure 6 is showing the components of the device INDUSI I 60 R in the test laboratory in Ljubljana.

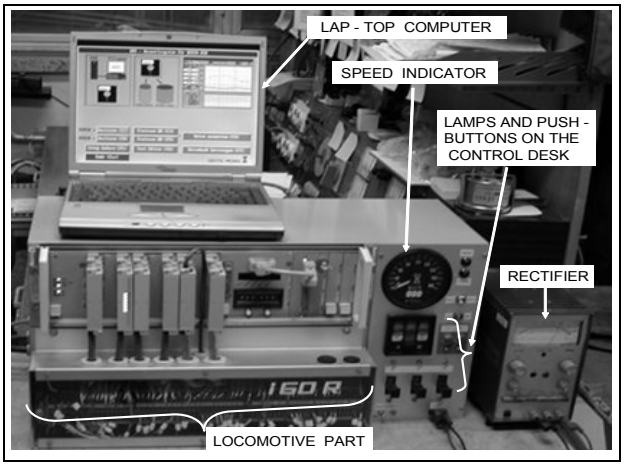

Figure 6: Test equipment for INDUSI I 60 R

Within the frame of workshops for maintenance of traction vehicles in Ljubljana, Slovenian Railways are maintaining a special test laboratory with the following equipment:

- Complete device INDUSI I 60 R, which is identical to the device, used on the traction vehicle,
- Analogue speed display from the drivers cabin of the traction vehicle,
- Control push – buttons and signal lamps of the device INDUSI I 60 R from the drivers cabin,
- Rectifier for the power supply of the device INDUSI I 60 R,
- Lap-top computer for program processing and recording of test data.

The above mentioned laboratory performs tests of the device INDUSI I 60 R in the following cases:

- Prior to the installation of the device INDUSI I 60 R on the traction vehicle,

- In case of intervention in the electronic part of the device INDUSI I 60 R,
- In case of modernization of software in the device,
- When disturbances of operation arise during the journey,
- At training of workshop personnel and personnel handling the device INDUSI I 60 R.

Processing of data from the data storage on the recording cassette

With the aid of the special program package DEUTA – WERKE ADS 2 for data processing, which could be installed in a common computer, it is possible to select data recorded on the recording cassette [6]. The selected data can be presented to various scales, be expressed in the form of tables, be stored on other data carriers or be deleted. Furthermore it is possible to search for certain events with a specific aim [6]:

- The time of a specific event during the journey of the train,
- Travelling speed of the train,
- The position of the train on the track at a given time,
- Stops of the train on the railway line and in railway stations,
- Signal signs of signals along the railway line
- Disturbances in operation of the device INDUSI I 60 R.

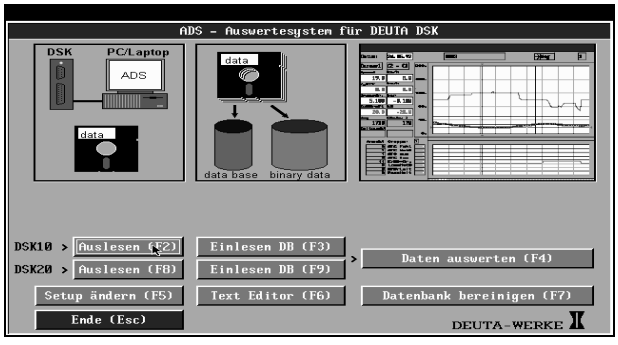

Figure 7: Home menu of the program ADS 2

Figure 7 is showing the home menu of the program ADS 2, from where different possibilities of data processing of a journey can be selected: selection of input data, data transformation, …

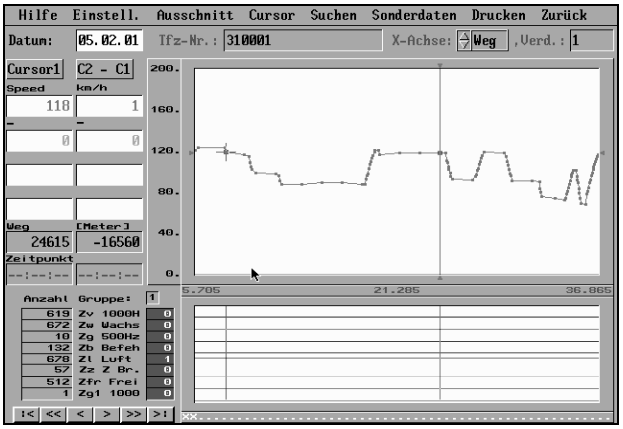

Figure 8: Graphic presentation of results of a journey

All recorded data of the journey can be analysed in the graphic form as shown in Figure 8. With graphic treatment it is possible to change the width of the area (the upright line in the upper field) and thus exactly define the selected data (time, distance,…). The value of the selected data is shown in the lower field of Figure [8].

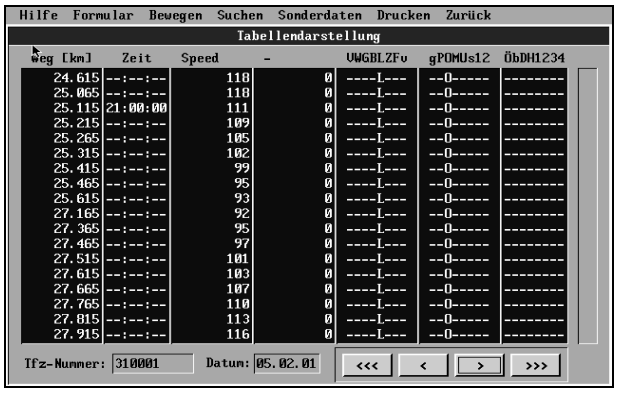

Figure 9: Numerical analysis of data in the program ADS 2

Using the program ADS 2, data of the journey can also be analysed graphically, as shown in Figure 9.

When running the numerical analysis, it is possible to read in the menu of the program ADS 2 a certain cipher for every specified time, speed, and distance (in Figure 9: I, O,…). With the aid of this cipher, it is possible to analyse a specified event.

Based on values of results in numerical form, if necessary the standard deviation can be calculated by the following formula [6]:

$$s = \sqrt{(\sum x_i)^2 / n - (\sum x_i / n)^2} \qquad (1)$$

where:

- s = standard deviation,

- x_1 = points of the string (km, distances, speeds,…),
- n = total number of points

CONCLUSION

The safety device INDUSI I 60 R has a good reputation in Europe over several years. It is in use on different European traction vehicles. On Slovenian railways the safety device INDUSI I 60 R is installed on the suburban passenger train manufactured by Siemens (Figure 10), and on the train with inclination technique – Pendolino (Figure 11). Its essential advantage is the continuous computer speed control (even on railway lines, where there are no track magnets installed), and the simple computer analysis of data in the laboratory and in the field in case of extraordinary events.

Figure 10: The suburban passenger train manufactured by Siemens

Figure 11: Passenger train with inclination technique – Pendolino

Nevertheless, this control is still far away from the control centre, which means that it is operating only on the railway line. In projects has already appeared the third generation of computer speed control of trains, where data are transmitted through the track magnets and devices on the train directly to the control centre, from where it is even possible to stop the train in case of emergency.

BIBLIOGRAPHY

/1/ NAVODILO 426 JŽ, Zavod za časopisno – založniško in propagandno dejavnost JŽ, Beograd, 1975.

/2/ NAVODILO 427 JŽ, Zavod za časopisno – založniško in propagandno dejavnost JŽ, Beograd, 1975.

/3/ OPIS DELOVANJA ASN I 60 R NA EMG 312, Slovenske železnice, Ljubljana, 2000.

/4/ "Bahn Praxis", *Zeitschrift zur Förderung der Betriebssicherheit und der Arbeitssicherheit bei der DB AG*; Eisenbahn - Unfallkasse (Hrsg.); Ausgabe 11/2002.

/5/ Peter Naumann, Jörn Pachl; *"Leit- und Sicherungstechnik im Bahnbetrieb, Fachlexikon"; Schriftenreihe für Verkehr und Bahntechnik herausgegeben vom VDEI*; Tetzlaff Verlag; 2002

/6/ *Priročnik programskega paketa za analizo za db*, Deuta Werke, München, 2000.

KOMPJUTERSKA KONTROLA BRZINE VOZOVA NA SLOVENAČKOJ ŽELEZNICI

U 2000-itoj godini novi Siemens-ovi putnički vozovi i vozovi sa tehnikom naginjanja – Pendolino – pušteni su u rad na slovenačkoj železnici. Ovi vozovi raspolažu savremenom kompjuterskom kontrolom brzine što je omogućeno upotrebom sigurnosnog uređaja, sa oznakom INDUSI I 60 R. Svrha ovog uređaja je da spreči nesreće ili havarije pomoću samoaktivirajućeg kočenja, u slučaju kad mašinovođa zanemari određeni signal železničkog sistema signalizacije.

Već postojeća vučna vozila u slovenačkoj železnici su opremljena klasičnim uređajima za kontrolu brzine tipa INDUSI I 60 samo za pojedine operacije i bez upotrebe kompjutera.

U radu se detaljno opisuje sistem funkcionisanja novog sigurnosnog uređaja sa akcentom na kompjuterski kontrolisane komponente u vozu.

Ključne reči: INDUSI I 60 R, magnet, vučna vozila, mikrokompjuter, DEUTA – WERKE ADS 2.