DIAGNOSTICS SYSTEM OF CURRENT GENERATING AGGREGATE OF DIESEL LOCOMOTIVES

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Abstract

The significance of existence train communication network for diagnostic purpose is described in this paper. It provides background for modern stand for power transmission system in diesel locomotives implemented at the beginning of 2006. Diagram of diagnostic stand for diesel-locomotive is presented. The main diagnostic tests are listed. Tests are divided in two groups: no-load tests and under-load of current aggregate. The last part of paper characterizes software specially created for described object and divided in three parts: software for control of test running, database software and auxiliary software.

Keywords: *diagnostics, current generating aggregate, diesel locomotives*

1. Introduction

Railway manufacturers who are in possession of modern railway vehicles largely avail themselves of on-board diagnostics, due to the actual technical state recognition.

In majority vehicles are provided with the network TCN(Train Communication Network) which consists of two control buses: train bus – WTB (Wire Train Bus) and vehicle one – MVB (Multifunction Vehicle Bus), connected through Gateway (GW) of structure as on fig.1.

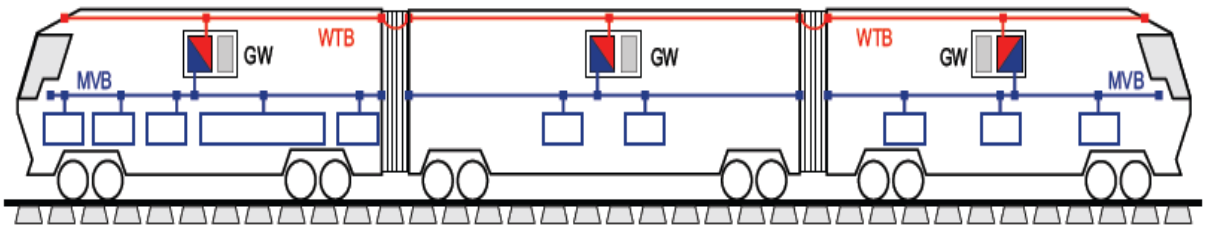

Fig. 1. Basic device of networks communication in UIC Trains.

Presence of these two buses is normalized accordingly to the charter of UIC – the organization of the majority of carries by train in Europe and also in US, China and Japan.

The vehicle network MVB has connectivity up to 255 separate controllers and 4095 individual measurements points. Thus continuous watching performance of all main vehicle units is possible. Presence of diagnostic-oriented controllers allows to record probable action errors or worsening work parameters.

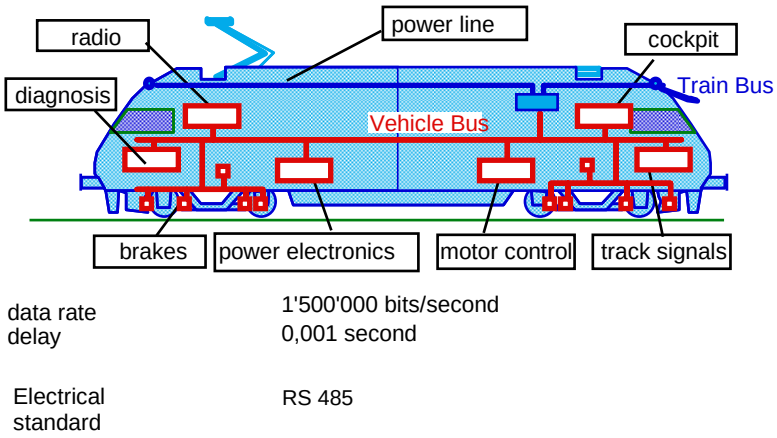

Fig. 2 MVB - Standard communication interface for all kind of on-board equipment in locomotive

Unfortunately, the situation in Poland is quite different for complete lack of rolling-stock electronization.

The whole diagnostics has to be founded on periodical surveying effected on Railway Rolling Stock Works. Stand testing has to ensure the determination of technical condition for main vehicle units. In case of diesel locomotives the base block configuration of the vehicle is shown in fig. 3.

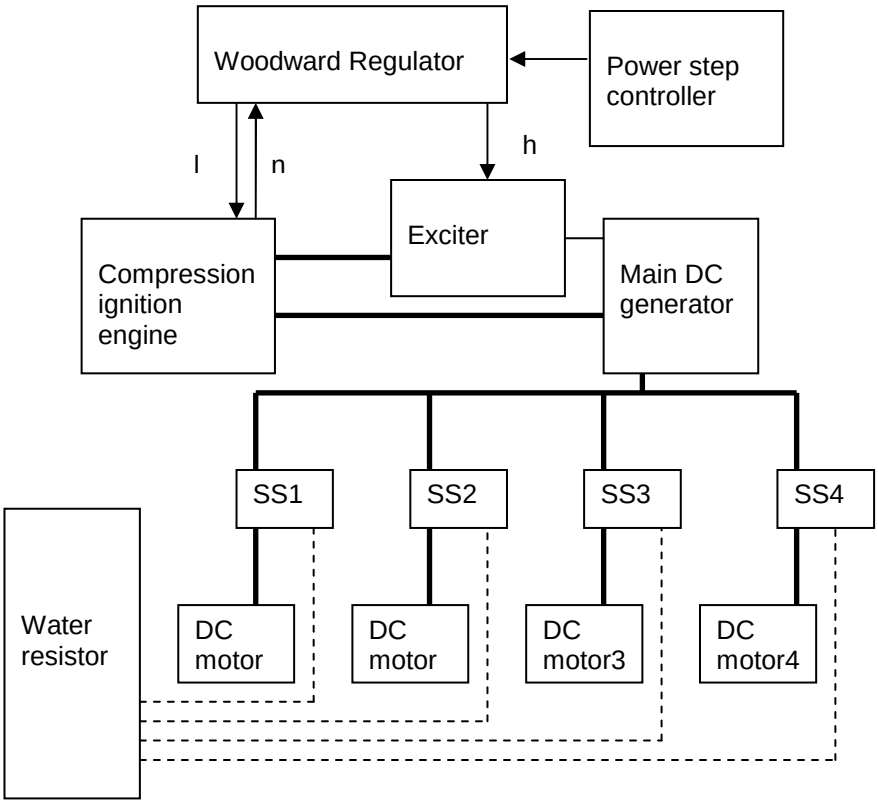

Fig 3. Block diagram of diesel-locomotive, SS1..4 - Motor contactors

2. Stand for power transmission system test

The idea of diagnostic stand testing of diesel locomotives consists in disconnecting electrical driving motors and switching on the water resistor with power selected accordingly. Changes of a resistance of the water resistor allow to vary a quantity of load for current-generating aggregate which is the basic element of power transmission system being examined.

2.1. Stand construction

In this paper one presents the stand being PKP CARGO property located on ground of Railway Rolling Stock Works in Warsaw. The stand is designed for diagnostic testing and adjustment of diesel locomotives.

With the object to make diagnostic investigations, driving motor contactors are disconnected. Instead, load leads are connected through high voltage cubicle and joined to the water resistor. Beside this a locomotive is equipped with additional sensors which allow to measure a number of nonelectric quantities.

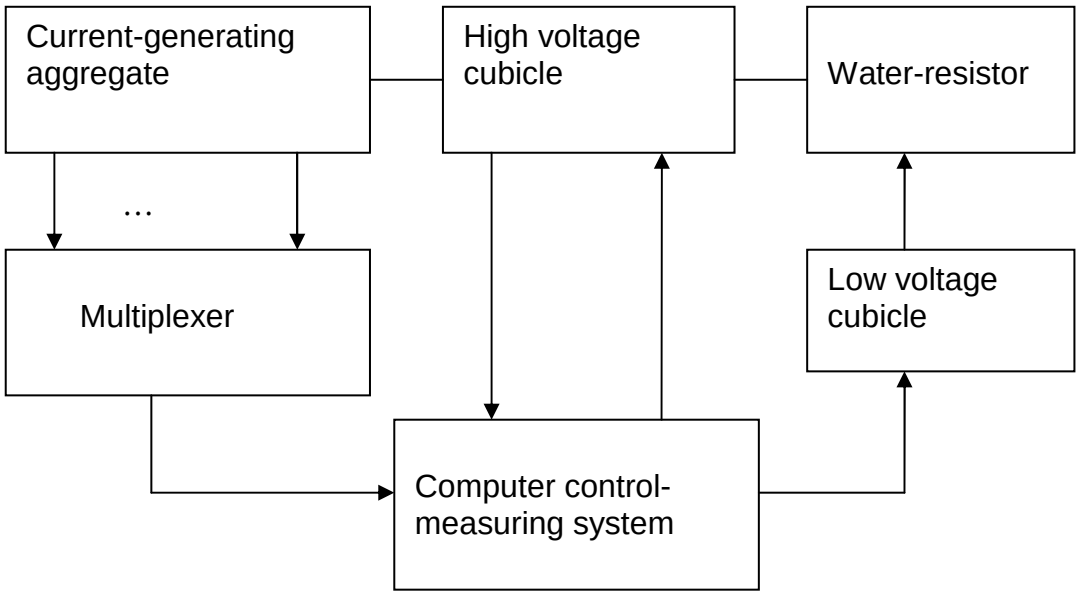

Fig.4. Diagram of diagnostic stand for diesel-locomotive

The sensors are multiplexed by a portable auxiliary cubicle and then directly joined to the measuring system. The sensors indicate, among other things, values of temperature of : ex-haust gas in cylinder, water, oil, fuel; rotational speed of : diesel engine shaft, turbo-compressor, fan; position of fuel charge controller, fuel charge quantity. For proper state evaluation, command of a number of electric quantities is required.

These quantities are first of all the following ones: main generator current and voltage, excitation current of main generator, exciter voltage, voltage of Woodward regulator.

Main parameters of data processing system are presented in tab.1

Tab. 1. Main parameters of computer measuring system

Computer measuring system			
	Number of analog channels		80
	AD converter resolution		16 bits
	Maximal frequency		250 kS
	Insulation voltage		5 kV
Measuring converters			
	Number of voltage channels		4
		Producer of converter	Knick Varitrans
		Model of converter	P27000
	Number of current channels		12
		Producer of converter	LEM
		Model of converter	PR 20, 200, 2000
	Number of pressure channels		32
		Producer of converter	ZEPWN
		Model of converter	CL1, CL5
	Number of temperature channels		19
		Producer of converter	ZEPWN
		Model of converter	CL61, CL62
	Number of displacement channels		2
		Producer of converter	ZEPWN
		Model of converter	CL70
	Number of rotational speed channels		3
		Producer of converter	OPTOM
		Model of converter	S50-PA-5C01-PP (PNP)

2.2. Diagnostic tests

The basic task of diagnostic station software is to regulate the diagnostic test run. However because of practical considerations the station acts also as a regulation stand. In the case of unsuitable work detection of system, as for as it is possible, setting correction of regulating elements is done.
Locomotive tests are divided into following groups:

- No-load tests
  a) control of main generator excitation
  b) control of stepping excitation
  c) control of disconnected-motor voltage

- Under-load tests:
  a) outer characteristic control
  b) shunter characteristic work control
  c) regulation of shunting control
  d) overload relay control
  e) earth fault relay control
  f) transient state characteristic
  g) cooling system control regulation
  h) diesel engine starting test
  i) compression pressure measurement
  j) fuel injection measurement
  k) peak firing pressure measurement
  l) measurement of exhaust gas emission
  m) motive-power battery evaluation

Before carrying out proper tests of power transmission system it is necessary to check the excitation of main generator; no-load test units provide this purpose.

Among the under-load tests the most important are (a) and (f). If improper characteristics or suspicious as to wrong diesel engine work are found then tests (j) and (k) are concluded. The residual tests are conducted in purpose to see auxiliary locomotive systems work properly.

2.3. Database software

Test execution should be proceeded by the vehicle and test files. In this purpose station diary is kept. The diary contains general data about the vehicle, and service staff. During basic data input it is possible to reload vehicle data with results of "hand-made" measurements scheduled for periodical surveying. Exemplary of such data are: results of insulation resistance measurement of main circuit and generator R_{15} and $R_{60,}$ also standard required R_{15}/R_{60} coefficient. Moreover, with the purpose of recording, one loads data of water and oil analyses.

2.4. Auxiliary Software

Measuring computer system takes out data from sensor units in voltage form and processes them with analog-to-digital converters. In the object to demanded accuracy assurance it is possible to calibrate respective measuring channels by change of voltage gain and also characteristic shift in zero. For this purpose, unit of program aid of calibration was built up in system. For servicing and screen display it is possible to make configuration of particular channels, in the meaning of availability, during measuring processes.

Protocol listing of particular tests is necessary element of investigation. Formatting procedure is determined in pattern sheets modified by system administrator.

Because of importance of measuring data operating, process has to be protected against unauthorized access with the aid of individual passwords for each system operator and administrator.

3. Summary

The presented system was implemented at the beginning of 2006. It is modern treatment and allows to improve operating quality of diesel locomotives. Precise control of power transmission systems permits to obtain significant economical effects in fuel consumption.

References

[1] *Train Communication Network IEC 61375* International Electrotechnical Committee, Geneva http ://www.iec.tcn.org

[2] Kirchmann Hubert, *The ICC/IEE Train Communication Network*, ABB Corporate Research and P.A. Zauber Daimler Chrysler Rail Systems, http://lamspeople.epfl.ch/kirchmann/Pubs/m2kirr.lo.pdf.

[3] Plint Michael, Martyr Anthony, *Engine Testing Theory and practice*, Butterworth Heineman, Oxford Boston Johannesburg 1999.

[4] *Dokumentacja Techniczno Ruchowa. Urządzenie do diagnostyki agregatu prądotwórczego lokomotyw*. Zakład Elektroniki Pomiarowej Wielkości Nieelektrycznych, Marki, Unpublished Issue, 2006.