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Diagnostics of locomotive power electrical circuits using the USTA device during rheostatic tests (Based on 2TE10M / UzTE16M)

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Abstract: This article examines the principles of diagnosing locomotive power electrical circuits using the USTA microprocessor-based control system during rheostatic testing. The structure of the system, control algorithms, monitoring of analog and discrete signals, and verification of diesel-generator characteristics are analyzed. The study demonstrates that the application of USTA improves regulation accuracy, enhances protection reliability, and simplifies diagnostic procedures during maintenance.

Keywords: USTA, rheostatic testing, traction generator, diagnostics, diesel locomotive, power circuits, field weakening

1. Introduction

Modern diesel locomotives with electric transmission require precise control and diagnostic systems for power electrical circuits. In locomotives such as the 2TE10M (UzTE16M), these functions are performed by the USTA system (Universal System of Traction Automation).

The main objective of diagnostics during rheostatic testing is to verify:

-proper operation of the traction generator;

-correctness of excitation control;

-ctivation of protective systems;

-functioning of field-weakening contactors;

-compliance of power and current parameters with standard specifications. [1,2].

USTA is intended for:

- regulation of the traction power transmission of diesel locomotives in the traction and electric braking mode, ensuring the parameters and protections stipulated in the technical conditions for their supply and other regulatory documents;

- simplification of the electrically driven locomotive scheme, reduction of the nomenclature of electrical apparatuses, and unification of the electrical schemes of all series of locomotives.

USTA is a microprocessor control system with a device for communication with the object in the form of sensors and measuring converters.

UTA consists of the following main nodes:

- STA regulating unit;

- PN-1 measuring voltage converters for measuring the voltage and current of the main generator, the voltage of the comparison diode block (BDS), the current of the independent winding of the traction generator.

2. Research methodology

The UTA control unit receives power from the locomotive's battery through the closing contacts of the RU16 relay. The power supply voltage is supplied to the external connector XR1 of the control unit to the contacts AO (-Shift) and VO (+75V).

The control unit generates the power supply voltage for the measuring voltage and current converters EP2716, which is connected to the external connector XR1 of the control unit - contacts V6 (+15V), V7 (-15V).

The SUTA control unit generates the power supply voltage for the inductive sensor. The power voltage frequency of the inductive sensor is set by program. The inductive sensor is connected to the external connector XR1 of the control unit to the contacts C8 (iid) and C7 (Oid).

To determine the state of the locomotive's circuit, discrete signals are introduced into the UTA control unit:

sign of connection of the VSH1, VSH2 contactors;

sign of connection of contactors KB, BB;

sign of switching on block - MP1, MP2, MP3, MP4 magnets;

sign of switching on the switches of the motor switches 0M1-0M6. [4].

To verify the operability of the USTA system by the engineer during the acceptance of the locomotive, it is necessary:

- start the diesel locomotive and, upon ignition of the LED indicator on the power board, ensure that the power supply unit has started, and by flashing once a second of the lower LED on the ADC board of the USTA-4 unit or "working" on the processor board of the USTA-5 LED - the control program has been initialized (working);

- turn off OM1-OM6 timers;

- turn off the TUP switch;

- turn on ALSN;

- transfer the CM to the first position and according to the readings of the kilovoltmeter

observe the excitation of the generator. Generator voltage should be

reach the cutting force at the first position of the KM;

-by switching the driver's controller to the second position and subsequent positions, observe the voltage increase. The generator voltage should reach the cut-off voltage at each position of the driver's controller (see tables 1);

Without changing the position of the load rheostat knives, fix the disconnection of the VSH1 contactor, while observing on the remote control indicator:

VSH1 = 1 VSH2 = 1 OP1 = 0 OP2 = 0

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When VSH2, VSH1 are disconnected, the generator voltage increases by 1/8 of the limiting voltage for this position of the driver's controller to prevent VSH ringing and power failure. [4].

Fig. 1. USTA regulation unit:

Power check with the traction motor disconnected

At the zero position of the controller, turn off one of the OM1-OM6 disconnect switches. Set the controller to position 10 under load. Set the generator current to 3000-4000 A, and observe the following on the console indicator: the measured generator power should be in the 1128-1368 kW range, Nkm = 10 for a high-speed 10D100 diesel engine, and in the 880-1121 kW range, Nkm = 10 for a low-speed 10D100 diesel engine.

Without changing the position of the load rheostat contact blades, set the controller to positions 11-15, observing on the indicator that the generator power for all controller positions above 10 remains within the aforementioned limits. Set the 10th position of the controller under load.

Without changing the position of the load rheostat knives, set the controller to positions 11-15, while observing on the indicator that the generator power at all controller positions above 10 is within the above limits.position for the muscles to generate strength. For a load with a maximum value of less than 1500, the muscle fatigue time is much greater (not indicated on the graph), but still not infinite.

et the operating mode switch to Emergency.The switch on the UPS module must be turned off. Perform standard starting operations and start the diesel engine. After starting the diesel, check the operation of the voltage regulator, observing the battery charging current and the voltage of the onboard network, which is regulated by the voltage regulator, using standard devices.

auxiliary generator. It should be 75±1 V.

When the diesel is running idle, check the rotational speed of the diesel engine's crankshaft according to the position of the engine controller. It must comply with tables 1.

Perform the adjustment of the locomotive's emergency circuit according to the rheostat adjustment instructions.

Check the rotational speed of the diesel generator under load.

of the diesel engine's crankshaft according to the position of the engine controller. It must comply with tables 1.

The duration of the traction generator load should not exceed:

for current - 4320-5000A 20min, 5000-5500A 5min, 5500-6000A 3min, 6000-6300A 1min.

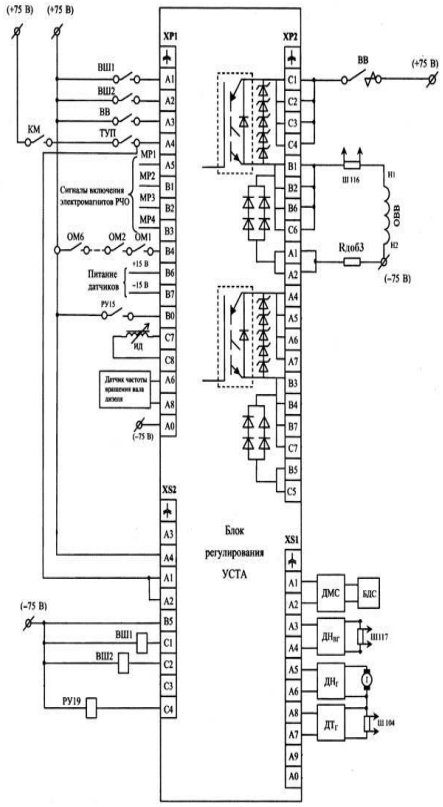

Fig. 2. Diagram of the UzTE16M locomotive's mouth system connection to its electrical circuits

Table 1

pkm	Diesel shaft rotation frequency,rpm	Generator clamp power, kW	enerator current, A	ots	otc, A	enerator power given Pgz, kW.
	2 70+20					
	2 70+20		00-1000			
			000-1400			
			200-1800			
			400-2000			

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			700-2300			
	4 75±20		800-2400	82,5		
		94-654	900-2600	38,6		
		20-806	100-2900			
		25-939	600-3400			
0	6 45±20	80-1121	700-3500			
1		137-1304	100-3900			
2	7 25±20	162-1456	100-4000			
3		318-1638	100-4100			
4	8 10±20	463-1810	000-4200			
5		570-1945	000-4320			

Rheostatic tests on a normal excitation circuit of a traction generator Verification using a portable control panel of the correctness of inputting discrete and analog signals into the UTA control unit.

Set the emergency switch AR to the "Norm" position.

Connect the portable remote with a special

undefined

Perform standard starting operations and start the diesel engine.

Turn on the switch on the power supply module of the control unit.

undefined undefined On the portable remote control, press the "ESC" button. Observe information on the portable remote control indicator:

top row - locomotive type

bottom line - mode: Two; Two; Abh; warmth.

Below the "Regime" word in the bottom line, the "_" marker is displayed.

Using the " - "; or "< - " buttons, place the "_" marker under the word Avx

(analog inputs).

Press the "ENTER" button and observe the portable indicator

Information from the remote control:

Top line - Analog inputs str.=0000

Lower row UG=0000 JG=0000

where: str.= page number 0,1,2,3,4;

Ug - generator voltage, V;

JG - generator current, A.

Changing the page number is performed by the " - " or "< - " buttons, so that when the " - " button is pressed, the page number increases, while:

- on the page. = 0001 on the lower line of the indicator, observe the information: Ubx=0000 Pz=0000 Uid = 0000

where: Ubx - boxing voltage, V;

Id - position of the inductive sensor measured, units;

Pz - given power, kW;

- on page - 0002 on the bottom line of the indicator, observe the information:

Uz = 0000, DP = 0000,

where: Uz - given voltage, V;

DP - power differential, kW;

- on page - 0003 on the lower line of the indicator, observe the information:

FL = 0.0000, S = 0.0020.

where: FL - 0.1 weakening flag;

S1 = 0020 - 6000 units of control pulse duration of the SHIM1 power switch;

- on the page. - 0004 on the lower line of the indicator to observe the information: MT = 0001

where: if MT = 0001, then the fixed power mode; if MT = 0257, then the TNVD rod regulator mode.

Press the "ESC" button on the portable remote indicator

observe information:

upper row - diesel locomotive type lower row - mode: Two; Two; Abh; warmth. Using the " - " or "< - " buttons, place the "_" marker under the word DVx - discrete inputs.

Next, press the "ENTER" button on the portable remote control and on

observe information in the indicator:

upper line - discrete inputs line = 0000 lower line VSH1 = 1 VSH2 = 1 KB - 0 TUP = 0 where: if VSH1 = 1, then the VSH1 contactor is switched off;

if VSH1 = 0, then the VSH1 contactor is engaged;

if VSH2 = 1, then the VSH2 contactor is switched off;

if VSH2 = 0, then the VSH2 contactor is switched on;

if KB = 0, then the KB, BB contactors are switched off;

if KB = 1, then the KB, BB contactors are switched on;

if TUP = 0, then the junction control switch is switched off;

if TUP = 1, then the transition control switch is turned on.

Next, on page = 0001 on the bottom line of the indicator, observe the information:

KM1=0 KM2=0 KM3=0 KM4=0

where: if KM1 = 0, then the MP1 electromagnet is switched off;

if KM1 = 1, then the MR1 electromagnet is switched on;

if KM2 = 0, then the MP2 electromagnet is switched off;

if KM2 = 1, then the MP2 electromagnet is switched on;

if KMZ = 0, then the MRZ electromagnet is switched off;

if KMZ = 1, then the MRZ electromagnet is switched on:

if KM4 = 0, then the MP4 electromagnet is switched off;

if KM4 = 1, then the MP4 electromagnet is switched on;

On page = 0002 on the lower line of the indicator, observe the information: OM = 0000

where: if OM = 1, then one or all switches of the OM1-OM6 motor switches are switched off. If OM=0, then all switches of the OM1-OM6 motors are switched on.

On the portable remote control, press the "ESC" button and observe the information on the indicator:

top row - locomotive type

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bottom line - mode: Two; Two; Abh; warmth.

Using the " - " or "< - " buttons, place the "_" marker under the word "Two output keys."

Top line - discrete outputs str.=0000

Bottom line - FW1 = 0 FW2 = 0 Ai = 0

where: FW1 = 0, the first stage of traction motor field weakening is off;

FW1 = 1, the first stage of traction motor field weakening is on;

FW2 = 0, the second stage of traction motor field weakening is off;

FW2 = 1, the second stage of traction motor field weakening is on;

Ai = 0, then Ur < 850 V and Jr < 7200 A, protection is deactivated (contactors KB, BB are on);

Ai = 1, then protection is activated (contactors KB, BB are off, i.e., load shedding has occurred);

$$P=Pgz+(Uind-Uind-J)*(ng-l), \quad (1)$$

Where Pgz is the given power value, code units;

Uind - current value of the inductive sensor position, code units;

Uind-f-fixed value of the inductive sensor, code units;

Ng - position of the driver controller.

Umdmin"170efl, Uindmax"440 units, Kr-0.09896 kW/unit.

Set the controller to position 15 under load with all auxiliary consumers switched on.

By changing the position of the load rheostat blades, set the generator currents to 2000 A, 2500 A, 3000 A, 3500 A, 4000 A, 4500 A, 5000 A, 5500 A, and 6000 A. Using a portable instrument, record the specified and measured power of the traction generator, while monitoring the position of the inductive sensor, which should remain approximately constant (300-330 units) in

the traction generator current range of 2600 A to 6000 A. Without changing the load rheostat resistance corresponding to the generator current of 4000-4320 A (position 15), set the controller to position six and check that the generator power corresponds to the table. If there is a discrepancy, adjust the position of the inductive sensor and repeat the power check at position fifteen.

3. Conclusion

Diagnostics of locomotive power electrical circuits using the USTA system during rheostatic testing ensures:

-real-time monitoring of traction generator parameters;

-ccurate verification of diesel-generator characteristics;

-reliable control of field-weakening stages;

-effective overload protection;

-improved safety and operational reliability.

The implementation of the USTA microprocessor-based system significantly enhances regulation precision, reduces testing time, and simplifies fault detection in locomotive power circuits.

References

[1] Fayziev B.T., Abdullaev N.S., Djanikulov A.T., Isakov Z.Z., Vysotsky S.E. UzTE16M diesel locomotive. The device and the principle of operation. Tashkent -2016. – pp. 85-86.

[2] Strekopytov V.V. and others. Electric transmission of locomotives. Moscow: Route, 2003. pp. 178-179.

[3] Grishchenko A.V. Microprocessor systems for automatic regulation of electric transmission of diesel locomotives: textbook. handbook for university students of railway transport / A.V. Grishchenko, V. V. Grachev, S. I. Kim, Yu. I. Klimenko./ – M. : Route, 2004. – 172.

[4] Microprocessor control systems for regulation and diagnostics of TEP70BS and 2TE25K diesel locomotives [Text] : textbook / N. A. Grudin. Kursk: Slavyanka Publ., 2013. 172 p

[5] Volchek T.V. Analysis of methods and technical means of field attenuation systems for traction electric motors of DC and AC electric locomotives / O.V. Melnichenko, S.G. Shramko, A.O. Linkov // Bulletin of Irkutsk State Technical University / Irkutsk National Research Technical University. – №3(23). – 2019. – Pp. 531-542.

[6] Vilkevich B. I. Electrical circuits of diesel locomotives of types TE10M and 2TE10U. Moscow: Transport: 1993. 145 p.

[7] Maznev A.C., Evstafev A.M., Kalinin M.V. and others / Modern speed control system for electric rolling stock // Proceedings of the St. Petersburg University of Railway Communications. St. Petersburg, 2006 — Issue 1(6).-pp. 89-94

[8] Khamidov, O. R., Kamalov, I. S., & Kasimov, O. T. (2023, March). Diagnosis of traction electric motors of modern rolling staff using artificial intelligence. In AIP Conference Proceedings (Vol. 2612, No. 1, p. 060018). AIP Publishing LLC.

[9] A. T. Djanikulov and U. I. Abdulatipov. Torsional oscillations of armature shaft of generator of main diesel locomotive in diesel start-up mode. In E3S Web of Conferences (Vol. 401, p. 01072).

[10] Jamilov, S., Safarov, U., Julenev, N., & Qosimov, K. (2024, June). Analysis of Experimental Studies of Transient Processes during the Start-up of the Protection of the Diesel Generator Set. In ICTEA: International Conference on Thermal Engineering (Vol. 1, No. 1).

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