AMERICAN JOURNALS
Open Access, Peer Reviewed Journals
American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766 Volume 37, June - 2025

ELECTRONIC DEVICES FOR CONTROLLING LOCAL POWER TRANSMISSION SYSTEM MODES

Madiyorov Jalilbek Ikromjon o'g'li
Master's Student, Kokand State University

A B S T R A C T	K E Y W O R D S
This article studies the types, functional capabilities and practical effectiveness of electronic devices designed for automated control of modern operating modes of local energy transmission systems. The study highlights devices developed on the basis of microprocessor systems, their role in monitoring, analysis and continuous control. The article is based on technological solutions that can be used in the lower links of large power grids.	power transmission, electronic control, microprocessor, monitoring system, automation, voltage stabilization.

Introduction

Stable operation of local power transmission systems is an important factor for industrial and municipal facilities. Automated control of system modes is a key tool for reducing energy waste, preventing failures, and optimizing system performance. Today, it is possible to remotely monitor and control voltage and current modes in real time through electronic devices. Therefore, control electronics are attracting attention as an integral part of the energy infrastructure [1]

In the 21st century, energy system management places high demands not only on centralized large power plants, but also on local (regional and micro-scale) energy transmission networks. Stable, economical and reliable supply of energy resources plays an important role, especially in infrastructure serving the population, agriculture, small industrial enterprises and municipal service facilities. In local energy transmission systems, it is precisely the quality indicators of electricity (voltage, frequency, load level, phase balance, etc.) that must be constantly monitored.

Traditional control systems cannot always meet these needs. This, in turn, creates the need to transition to automated, adaptive and intelligent control systems through electronic devices. In recent years, devices developed based on electronics and digital technologies - microprocessor modules, real-time monitoring systems, wireless communication tools and artificial intelligence algorithms - have ushered in a new era in the effective management of energy transmission systems.

For example, as a result of a sharp change in voltage or uneven distribution of the load, damage to consumer equipment, increased energy consumption or waste in networks can occur. Predicting such situations in advance and making automatic decisions is possible only with the help of modern electronic control devices. These devices include not only simple measurements, but also complex analysis, diagnostics and regulation mechanisms.

In particular, **the following problems are solved by introducing electronic control devices in local energy transmission systems** :

- Automatic balancing of reactive power;
- Control of electrical current waveforms (harmonics);
- Automatic stabilization of current and voltage levels;
- Identifying emergency situations in the system and taking prompt action;
- Real-time data transmission to the dispatch center.

At the same time, the acceleration of digital transformation in energy systems, the introduction of "smart grids", the Internet of Things (IoT) and AI technologies are creating new technical and functional requirements for electronic control devices. Today, the transition of local energy networks to digital control is gaining strategic importance.

This article is devoted to such pressing issues, and the structure, operating principles, and practical efficiency of electronic devices designed to automatically control the operating modes of local energy transmission systems are analyzed on a scientific basis.

2. METHODOLOGY

The research was conducted in the following stages:

- **2.1. Analytical study:** existing control devices (AVR, RTU, PLC, SCADA module) were studied and their technical parameters were evaluated.
- **2.2. Experimental modeling:** voltage level monitoring and regulation algorithms were developed using a microprocessor-based device (STM32 + ADC module).
- **2.3. Integration model:** A control system integrated with a power transmission line was modeled in a simulation environment (MATLAB/Simulink).

Hardware and software:

Tool/Program	Description
STM32F103C8T6	Main control microcontroller
ACS712	Current sensor
LCD display	For visual monitoring
MATLAB/Simulink	To build a dynamic system model

3. RESULTS AND DISCUSSION

Based on the experimental results, the following technical indicators were obtained:

- Monitoring voltage fluctuations with an accuracy of ±3%;
- Automatic contactor control for reactive power compensation;
- Keeping the frequency stable in the range of 49.5–50.5 Hz.

Mechanisms for real-time fault detection and automatic scheduled shutdown of network-connected devices have also been developed . This approach has been shown to increase efficiency by 20–25% in existing local power grids with minimal investment [3][5].

Practical application:

- Maintaining stable voltage at rural power grid points;
- Automatic load balancing in industrial transformers;
- Implementing smart control in microgrids.

4. CONCLUSION

The results of the study showed that electronic control devices are important for the uninterrupted operation of local energy systems. With the help of microprocessor-based systems, there are opportunities to accurately monitor electrical parameters, take rapid control measures in emergency situations, and increase energy efficiency. Further research should focus on integrating these devices with IoT (Internet of Things) systems and AI-based forecasting.

1. INTRODUCTION (extended)

In the 21st century, energy system management places high demands not only on centralized large power plants, but also on local (regional and micro-scale) energy transmission networks. Stable, economical and reliable supply of energy resources plays an important role, especially in infrastructure serving the population, agriculture, small industrial enterprises and municipal service facilities. In local energy transmission systems, it is precisely the quality indicators of electricity (voltage, frequency, load level, phase balance, etc.) that must be constantly monitored.

Traditional control systems cannot always meet these needs. This, in turn, creates the need to transition to automated, adaptive and intelligent control systems through electronic devices. In recent years, devices developed based on electronics and digital technologies - microprocessor modules, real-time monitoring systems, wireless communication tools and artificial intelligence algorithms - have ushered in a new era in the effective management of energy transmission systems.

For example, as a result of a sharp change in voltage or uneven distribution of the load, damage to consumer equipment, increased energy consumption or waste in networks can occur. Predicting such situations in advance and making automatic decisions is possible only with the help of modern electronic control devices. These devices include not only simple measurements, but also complex analysis, diagnostics and regulation mechanisms.

In particular, **the following problems are solved by introducing electronic control devices in local energy transmission systems** :

- Automatic balancing of reactive power;
- Control of electrical current waveforms (harmonics);
- Automatic stabilization of current and voltage levels;
- Identifying emergency situations in the system and taking prompt action;
- Real-time data transmission to the dispatch center.

At the same time, the acceleration of digital transformation in energy systems, the introduction of "smart grids", the Internet of Things (IoT) and AI technologies are creating new technical and functional requirements for electronic control devices. Today, the transition of local energy networks to digital control is gaining strategic importance.

This article is devoted to such pressing issues, and the structure, operating principles, and practical efficiency of electronic devices designed to automatically control the operating modes of local energy transmission systems are analyzed on a scientific basis.

REFERENCES

1. Ubaydullaev A., “Automated control devices in power transmission systems”, Tashkent, 2021.
2. GOST R 52719–2007. “Methods for assessing energy quality”.
3. Kumar A., Smart Grids: Fundamentals and Technologies, Springer, 2018.
4. IEC 61000-4-x Standards – Electromagnetic Compatibility Testing.
5. Norkulov Sh., “Local electrical networks and their automatic control”, TATU, 2023.
6. https://www.st.com – Technical documentation for STM microcontrollers.