Design of transformer secondary voltage drop on-line monitoring system based on Internet of things

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Abstract. The "two sessions" of the company in 2019, the company's chairman, Comrade Kou Wei, put forward the strategic goal of "three-type two networks, world-class". making it clear that the 2021 will initially become a world-class Energy Internet company with Global Competitiveness. It has also laid out key tasks in the distribution sector, including the strategy for vigorously fighting poverty through services and rural revitalization, making continuous efforts to improve the business environment for electricity generation, upgrading the construction of power distribution networks, and establishing standards and demonstration zones for power distribution networks. The company proposed the "1135" New Era Power Distribution Management Strategy: customer-centered, to improve power supply reliability as the main line, to strengthen standardized construction, lean operation and maintenance, intelligent management and control, we will endeavor to build a first-class modern distribution network with good structure, equipment, technology, management and service. By improving the distribution network's ability of intelligent perception, data fusion and intelligent decision-making, a "clean, low-carbon, safe and efficient" intelligent distribution network energy system is constructed. The comprehensive error of electric energy measurement in distribution network is composed of voltage transformer error, current transformer error, watt-hour meter error and voltage drop of secondary circuit of voltage transformer. The measurement error caused by the voltage drop of the secondary circuit of the voltage transformer accounts for a large proportion of the total errors of electric energy measurement. Because the voltage drop is too large, causes the little electricity quantity as well as the generation and supply quantity imbalance, the line loss gives the negative number the example all to appear.

Keywords: Pressure Drop Monitoring; Intelligent Transportation and inspection; Intelligent Monitoring; monitoring system; Internet of things; transformer; secondary pressure drop.
1. Introduction
A near voltage SAG or a short-term interruption will cause the load in the distribution network not to work normally or even to stop. However, the sensitive load in the key process areas of many industrial industries will be malfunctioning or stopped. It will bring huge economic losses, environmental pollution, and even human casualties.

The on-line monitoring system of transformer secondary voltage drop based on Internet of things technology, the secondary circuit voltage drop of voltage transformer has a great influence on whether the secondary voltage value obtained by all protection / Automation devices can truly reflect the actual value of system operation. Measuring the voltage drop of the secondary circuit of the total station voltage transformer is the key for the metering device to obtain accurate electric information. The traditional wired testing method is affected by the limitation of the field. The short-circuit fault caused by the overlong voltage test circuit is laid at both ends. The wireless communication device is used to monitor the voltage drop of the secondary circuit of the voltage transformer in real time, which overcomes the traditional cable connection test method. Greatly improve the working efficiency of voltage transformer secondary circuit voltage drop test. With the development of the Internet of things (Iot) technology, it is researched to realize the interconnection of the information of intelligent equipment based on the IOT technology, and to realize the secondary voltage drop data acquisition of the secondary line between the metering service automatic transformer and the watt-hour meter. Instead of the original manual field collection of cumbersome, reduce labor costs, provide work efficiency, will gradually realize the automatic perception of power network operating environment and equipment status, thus realizing intelligent diagnosis and other innovative results, change the traditional management mode and working mode of transportation and inspection in an all-round way.

2. The function of on-line monitoring device for the secondary voltage drop of Internet of things transformer
The CYYJ10000 on-line monitoring device for the secondary voltage drop of Internet of things transformers is a new generation of secondary voltage drop monitoring device, which has the characteristics of small size, easy maintenance and convenient installation. Widely used in automatic production, intelligent buildings, new energy power generation, traffic track and other industries voltage monitoring equipment, meet the GB/T 19862-2016 standards.

Based on the Internet of things (Iot) technology, the instrument transformer secondary pressure drop on-line monitoring device is mainly composed of three parts: The online monitoring device, the online monitoring information operation center and the Monitoring Control Center.

The secondary pressure drop on-line monitoring device transmits monitoring data through the GPRS (later extended to Beidou) mode, the on-line Monitoring Information Center processes the received data, and the monitoring and Control Center receives the monitoring data in real time through the mobile terminal or the PC terminal To do business with.

"on-line Monitoring Information Center" receives the monitoring data returned by the secondary voltage drop on-line monitoring device and sends them to the running server, which decodes and summarizes them and stores them to the back-end Server For Monitoring and Control Center to TCP / Ip Protocol access, according to customer demand server run C / S or b / s two optional access mode.

Through TCP / Ip Protocol, "Monitoring Andcontrolcenter" obtains real-time secondary voltage drop monitoring data from "on-line Monitoringgg Information Center." Fo RoDECISION-MAKINGNg Users can access the information using their computers, mobile phones, pads and other devices over an internal wireless wireless network.
Figure 1. The function of on-line monitoring device for the secondary voltage drop of Internet of things transformer

Figure 2. The function of on-line monitoring device for the secondary voltage drop of Internet of things transformer

3. Appearance of on-line monitoring device for secondary voltage drop of Internet of things transformer

He on-line monitoring device CYYJ10000 for the secondary voltage drop of the Internet of things (IoT) is small in size, easy to maintain and easy to install. It can be used in distribution automation, measurement business, automatic production, intelligent building, new energy power generation, traffic track and other industries.
4. Characteristics of on-line monitoring device for secondary voltage drop of Internet of things transformers

On-line monitoring system of transformer secondary voltage drop based on Internet of things technology:

- High-precision sensing technology: High Sensitivity, high accuracy, fast response, good interchangeability of the new sensor;
- Low power consumption, passivity: with high reliability of intelligent sensing technology, to low power consumption and passive development;
- INTELLIGENTIZE and digitalization: The digitalization sensor with the function of acquisition, communication and control;
- High-speed processing technology: Integrated high-speed processing chip to support intelligent decision-making technology;
Two-way interaction, multi-service Fusion: two-way communication, to achieve two-way user interaction, multi-sensor or multi-source information integrated processing.

5. Design of on-line monitoring system for secondary voltage drop of Internet of things transformer

The invention relates to an on-line monitoring method for the secondary voltage drop of a transformer based on Internet of things technology, which comprises an on-line monitoring device for the secondary voltage drop of a transformer, an on-line Monitoring Information Center for the secondary voltage drop and a monitoring and Control Center. The transformer secondary pressure drop on-line monitoring device connects the secondary pressure drop on-line Monitoring Information Center through GPRS Network / Bluetooth / Beidou, and the secondary pressure drop on-line Monitoring Information Center connects the Monitoring Control Center through a network;

The secondary voltage drop on-line monitoring information center receives the monitoring data sent back by the secondary voltage drop on-line monitoring device of the transformer and sends the monitoring data to the running server, which decodes and summarizes the data and stores it to the backend Server. For Monitoring and Control Center to TCP / Ip Protocol access, according to customer demand server run C / S or b / s two optional access mode;

The monitoring and Control Center obtains real-time secondary voltage drop monitoring data from the secondary voltage drop on-line monitoring information center through TCP / Ip Protocol for decision-making. Users can access the information from their computers, mobile phones, and Pad devices via an internal wireless wireless network. An on-line monitoring device for the secondary voltage drop of a transformer includes: Real-time data measurement module, Harmonic data measurement module, power data measurement module, flicker data measurement module, voltage SAG measurement module, voltage rise measurement module, short-time interrupt module, history data measurement module.

The on-line monitoring system of transformer secondary voltage drop based on Internet of things technology includes:

- Data acquisition: Collecting the real-time waveform data of three-phase Voltage and current;
- Data calculation: The real-time waveform data of voltage and current are calculated to obtain the power data, including the effective value, harmonics, power;
- EVENT JUDGMENT: real-time monitoring of the voltage and whether it is abnormal, voltage rise, voltage drop, short-term interruption, and save the corresponding waveform file;
- Data statistics: every minute statistics voltage, current effective value, and save into the corresponding statistical file;
- Parameter configuration module: Configuration function for measuring parameter of equipment;
- Mobile APP COMMUNICATION: The data, events and operation parameters of the device are viewed through the mobile APP; Monitor back-end Communication: The transient event data and statistics from the device are uploaded to the back-end remotely.

The mobile phone APP communication includes harmonic management module, voltage drop monitoring module, flicker management module, Fault diagnosis module and device account module.

The monitoring background communication includes real-time data measurement module, Harmonic data measurement module, power data measurement module, flicker data measurement module, Voltage Sag measurement module, voltage transient rise measurement module, short-time interrupt module, history data measurement module.

The secondary pressure drop on-line monitoring device transmits monitoring data through the GPRS (later extended to Beidou) mode, the on-line Monitoring Information Center processes the received data, and the monitoring and Control Center receives the monitoring data in real time through the mobile terminal or the PC terminal To do business with.
6. Summary and outlook
Distribution Internet of things (IoT) is a new type of power network formed by the deep integration of traditional industrial technology and IoT Technology. Integrating advanced technologies such as intelligent sensing, ubiquitous communication, big data analysis and artificial intelligence into all aspects of distribution network production and operation, through comprehensive interconnection, interworking and interoperability among distribution network equipment, to realize the overall perception, data fusion and intelligent application of the distribution network, to meet the distribution network lean management and customer diversification needs, support the rapid development of the Energy Internet. From the application form, the application of power distribution Internet of things has the characteristics of plug-and-play terminal, extensive interconnection of equipment, comprehensive state perception, application mode upgrade, rapid business iteration, deep fusion of resources and so on.

With the development of national "Belt and Road" and "Global Energy Interconnection", a strong smart grid with high intelligence, Information and integration is urgently needed. The company has responded positively to the relevant requirements of the construction of the intelligent transportation and inspection system of state-owned network companies, relying on technological innovation to realize management innovation, and integrating new technologies such as the Internet of things, mobile interconnection, 5G, Beidou positioning, etc. The development of an on-line monitoring device and platform for the secondary voltage drop of the Internet of things based on Beidou and 5G has realized the transformation from the traditional manpower-intensive inspection mode to the three-dimensional, informational and intelligent mode, and has become a new idea for innovating the operation and maintenance of substations.

After the application of this project, the on-site secondary pressure drop data can be transmitted to the user's terminal in real time through the Internet of things technology, and the on-site secondary pressure drop data can be monitored anytime and anywhere It used to take six days to test a substation, which could be completed in 10 minutes and increase labor productivity by more than 20 TIMES It can be widely used in automatic production, intelligent building, new energy power generation, traffic track and other industries of voltage monitoring equipment, with strong promotion and economic value.

References
[1] Zheng Yao et al. (Technical Manual of Electric Energy Measurement [Z] (China Electric Power Publishing House, 2002.))
[2] Huang Wei et al. (Electric Energy Measurement Technology [M] (China Electric Power Publishing House, 2004.))
[3] Wang Hongxin and He Jingliang (Electric Power System Electromagnetic Compatibility [M] (Wuhan University Press, 2004)
[4] Baiyang, Zhangjian, Yu Yuzhi (On-line CT Admittance Test and Its Application [J] (Electrical Measurement and Instrument, 2004 (9): 52-55)
[5] Qiao Jianjian. Application of Electricity Information Acquisition System in Quadrant Line Loss Statistical Analysis [J]. Electronic World, 2014 (09): 50-51.
[6] Qi Yanshou, He Ling, Wang Zhimin. Analysis of zero voltage drop optical fiber power management system [J]. Qinghai Electric Power, 2014:59-62.
[7] GB/T 7714 Cui Mingxuan. Brief discussion on the causes of electric power metering errors and improvement strategies [J]. Modern State-owned Enterprise Research, 2017 (8).
[8] MLA Cui Mingxuan. "Brief discussion on the causes and improvement strategies of power metering errors." Modern State-owned Enterprise Research 8 (2017).
[9] APA Cui Mingxuan. (2017). Brief discussion on the causes and improvement strategies of power metering errors. Research on modern state-owned enterprises (8).
[10] GB/T 7714 Dong Ruihai, Gaojun. The influence of PT secondary voltage drop on the error of power meter [J]. Coal Technology, 2009 (7): 46-48.
[11] MLA Dong Ruihai, and Gaojun. "The influence of PT secondary voltage drop on the error of power meter." Coal Technology 7 (2009): 46-48.
[12] APA Dong Ruihai, & Gao Jun. (2009). The influence of Pt secondary voltage drop on the errors of watt-hour meters. Coal technology (7), 46-48.

[13] GB/T 7714 Zhang Bin, Li Shengtao. Brief analysis on eliminating voltage drop of secondary circuit of voltage transformer in high voltage electric energy measurement and its benefits [J]. China Electronic Commerce, 2012 (2): 208-208.

[14] MLA Zhang Bin, and Li Shengtao. "Brief analysis on elimination and benefit of voltage transformer secondary circuit voltage drop in high voltage energy metering." China Electronic Commerce 2 (2012): 208-208.

[15] APA Zhang Bin, & Li Shengtao. (2012). Analysis of eliminating voltage drop in secondary circuit of voltage transformer in high voltage electric energy metering and its benefits. China Electronic Commerce (2), 208-208.

[16] GB/T 7714 Wu Jiaying. Reason analysis and solution study of measurement error in Jiangmen area [D].

[17] MLA Wu Jiaying. Reason analysis and Solution Research of measurement error in Jiangmen area. Diss.

[18] APA Wu Jiaying. (0). Reason analysis and Solution Research of measurement error in Jiangmen area. (Doctoral dissertation)