Development of Vehicle-borne Substation State Intelligent Calibration System

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Abstract. Aiming at the existing problems such as heavy workload and low efficiency of intelligent substation state monitoring device calibration, combined with the current information technology and intelligent technology, his paper presents a vehicle-borne intelligent verification system. The system adopts vehicle as the platform and transport data through GPRS/3G and MIWAVE wireless network. From the point of function optimization, information interaction and intelligent monitoring, the system realizes the integrated, information and intelligent transformation of kinds of standard signal source device and monitoring equipment for calibration. The use of the system can effectively complete calibration and improve the quality of work. The system has completed the calibration of many 500kV, 220kV substations monitoring devices successfully. Facts show that it can provide a powerful guarantee to grid equipment reliable operation.

Introduction

With the development of technology, the on-line monitoring techniques and equipments are applied to monitor the various power equipments of transformer substation[1-8]. Because of the accuracy and reliability of the monitoring device determine the credibility of the monitoring and play an important role in analysis of whether electrical equipment work properly, monitoring devices need to be verified. At present, calibrator has many versions, each device has different requirements on checking of personnel expertise and required time, so the efficient calibration work is impossible.

In tackling these questions, this paper presents the vehicle-borne intelligent calibration system which is suitable for the calibration of substation intelligent monitoring device. The system uses vehicle-borne integrated design and optimized the spatial arrangement of vehicle. It establishes a wireless LAN environment which covers the entire station and a stable, reliable wireless encryption standard network link between the vehicle platform, a variety of standard signal source and the monitoring device. It can realize the data verification of all kinds of on-line monitoring device through developing various of standard signal source and monitoring devices[1-2].

Vehicle-borne Intelligent Calibration System Overall Design

The vehicle-borne intelligent calibration system is made up of hardware and software. The software is composed of check background, vehicle control background and hand-held PAD control terminal. The hardware is composed of vehicle host, wireless translate module(host + terminal), mobile video, standard signal source and standard monitoring device.

System software is mainly responsible for data exchange: the check background is in charge of establishing the communication link of data center and vehicle control background. It reads the real-time data of the checked device from check background, sends these data to the vehicle control background and receives the calibration data and result. Through the long distance direction of video, automatic generating the calibration report and storing it. Vehicle control background is responsible for controlling the output data of standard signal source, setting calibration model, receiving control information, contrasting data, automatic generating the calibration report and

storing it. PAD control software is used to control the output of standard sensor. It is a supplement on automatic calibration. The overall system architecture as is shown in figure 1.

System hardware is on the basis of vehicle. It integrates standard signal source simulator, standard monitoring device, mobile video, SF6 gasholder etc. and it is furnished for 220V protection module, AC 220V convert DC 12V rectifier module, battery charge module, UPS power with 500W rated output and 2 64Ah storage battery which type is A412/65G. It guarantees vehicle devices work normally in 8 hours without external power[3]. In addition, the vehicle has air conditioning which can provide a comfortable work environment for calibration staff. The system software block diagram as is shown in figure 2.

Fig 1: Vehicle-borne intelligent calibration system architecture

Fig 2: System software block diagram

Through an unified calibration platform, the vehicle-borne intelligent calibration system can realize disposable calibration about the on-line monitoring devices which need examine. There are two methods: 1) simulate the operation data by refitting the checked device sensor through loading standard signal source during the power-off maintenance and contrast the real-time monitoring data to the data of standard signal source in the whole range. 2) When the substation without power cut and the checked device work normally, install the standard monitoring device in the same situation. Then, contrast the real-time monitoring data from the checked device and signal monitoring device.

Data Transmission Model

Data transmission of vehicle-borne intelligent calibration system adopts GPRS/3G communication style and MIWAVE broadband wireless network.

In order to convenient the data change with data center, the vehicle-borne intelligent calibration system adopts GPRS/3G communication style. It receives the real-time data of the checked device which are sent down by the data center of provincial company and uploads the check conclusion of the monitoring device. According to the IP address and interface, GPRS module will establish connection with check background when it is combined with electric. The check background will display the link state. If the link is effective it will show successfully, otherwise, it will show the link break. GPRS module sends heartbeat packet per minute to avoid the link being broken by mobile base station because of have no data for a long time. After sending the data, if the check background does not return the data packet for data receive successfully, the data will be sent again until it return the data packet for data receive successfully. When the communication connection disconnects, the background will save the data automatically until the connection is restored and the remaining data are uploaded[4].

The intermediate portion between vehicle-borne background and standard signal source adopts wireless LAN communication mode. Through the MiWAVE broadband wireless network flexible deployment, it can realize real-time information intercommunication among inspection robots, security operator on duty, inspection analysis system and leadership during inspection tour. This mode is beneficial for operation center to master the safety condition of substation and make

reaction in time.

The network schematic diagram as is shown in figure3. The base station communication vehicle drives to intelligent substation field region and stops at the relative commanding point. At the same time, make the base station antenna at the reservation height through lifter. After starting the machine, there will be an area which can cover 3-5km taking for command vehicle as center. It will realize intelligent substation plant area covering and compose the multi-service MiWAVE broadband wireless network. With the maintenance personnel moving, the maintenance single mobile station can move freely and realize real-time communication with base station communication vehicle.

The wireless network can realize the following functions. (1) The data interaction of power grid maintenance analysis system. (2) Bidirectional multi-channel D1 video surveillance (support remote/mobile). (3) VoIP voice communication. (4) Audio-video teleconference. (5) GPS location.

Standard Signal Source and Monitoring Device

The vehicle-borne intelligent calibration system is equipped with circuit breaker standard signal source, arrester\capacitive equipment\iron core leakage current standard signal source, neutral point current standard signal source and SF6 gas density standard signal source. In order to ensure output results can reach the target value, the output state adopts digital closed-loop.

(1) In vehicle-borne background or hand-held PAD, allocate circuit breaker model under different running states and send them to circuit breaker standard signal source through WIFI. The signal source transforms these parameters to equivalent circuit breaker signals and output them. Then, confirm and feedback these output signals through measurement.

(2) In this paper, arrester\capacitive equipment\iron core leakage current standard signal source adopt three-phase ac dc indicating instrument. Work flow as is shown in figure 5. In vehicle-borne background, allocate different current data of different devices under different running states. Including voltage signal, leakage current amplitude, leakage current phase (iron core leakage current phase is 0), stack harmonic number, phase, amplitude, send to arrester\capacitive equipment\iron core leakage current standard signal source[5]. The standard signal source sends out corresponding current, voltage signals and confirm correctness through feedback.

(3) In vehicle-borne background transformer neutral point current standard signal source check module, allocate neutral point current data under different running states, including voltage signal, current containing dc component, send to transformer neutral point current standard signal source. Transformer neutral point current standard signal source transforms these data to equivalent neutral point current signal and send out them. Confirm the correctness of these data through feedback.

(4) In vehicle-borne background SF6 gas density check module, allocate different pressure values and send them to SF6 gas density standard signal source through WIFI. SF6 gas density standard signal source can collect variable stroke cylinder internal pressure through inner set pressure sensor and ratio to setting value to control motor rotation speed and steering.

Based on the need of contrast calibration, the vehicle-borne intelligent calibration system is equipped with corresponding standard monitoring device, including standard circuit breaker on-line monitoring device, standard arrester\capacitive equipment\iron core leakage current on-line monitoring device, standard SF6 gas density micro-water on-line monitoring device.

Field calibration model

The vehicle-borne intelligent calibration system is suitable for performance verify of field state monitoring device during the intelligent transformer operation and maintenance. In the same time, the calibration data can be transferred through WIFI. It can realize contrast the calibration data to monitoring background and form the detection result. The work model is embodied as follows.

(1) Transfer work place.

The vehicle-borne intelligent calibration system can remove the workload of demolishing the state monitoring device and send them to the laboratory to calibrate. It satisfied the need of field

calibration of unable-dismantled device and realize the movable calibration.

(2)Reduce detecting personnel.

The vehicle-borne intelligent calibration system can realize automatic recording of checked parameters and data wireless transmission. Cancel the background observed personnel and reduce the workload of field detecting personnel.

(3)Improve work efficiency.

According to the advanced setting detection value, these standard signal sources of vehicle-borne intelligent calibration system can output the standard signal one by one without manual intervention. It can also conduct error calculation between detection value and background monitoring result and improve the work efficiency greatly[6].

Field Application

The vehicle-borne intelligent calibration system has applied to jiangsu 500kV changshu south substation. It developed field calibration to arrester leakage current monitoring device, transformer neutral point dc current monitoring device, SF6 gas etc. 7 kinds of state monitoring devices. Contrast to the previous single station device field detection model, work personnel reduce by half, work time reduce by 1/3, generate detection result automatically.

Conclusion

The vehicle-borne intelligent calibration system adopts integrated design, optimized vehicle space allocation. Establish reliable wireless cryptographic network link through covered whole stations wireless LAN environment. Develop kinds of standard signal sources and monitoring devices to realize data calibration of common on-line monitoring devices.

Contrast to the previous methods of on-line monitoring device calibration, the vehicle-borne intelligent calibration system has the following advantages.

(1)The vehicle-borne intelligent calibration system can decrease the number of field professional technical personnel, saved a lot of personnel and time.

(2)The vehicle-borne intelligent calibration system integrated many kinds of calibration terminals. It can realize disposable calibration to all of on-line monitoring devices in substation.

(3)The vehicle-borne intelligent calibration system adopts high precision standard signal source to calibrate on-line monitoring device. The calibration result is authoritative.

(4)The vehicle-borne intelligent calibration system can construct archives to record the operation state, calibration time and calibration result in detail and it is convenient to realize the unified management of on-line monitoring devices.

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