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Introduction to Researches on Protection and Control in Shandong University

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May 19, 2015

How big is Shandong University?

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How big is the protection group?

- 13 academic staff (5 Prof.+6Associated Prof.,+2 Lecturers)
- 70 research students including both Ph.D and M.Sc
- Has investigated more than 50 projects supported by both government and industry during recent 5 years.

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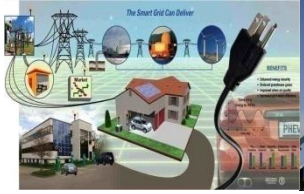


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Part1: Historical Review

Part 1. Historical Review

1963 The earliest protection research group was established .

1965 Invented the first transistor based distance relay in China

1966-1974 a set of transistor based protection device for 220kV transmission line was successfully developed and applied in real systems in both Liaoning and Shandong provinces.

1978 This distinguished achievement was awarded by the National Science Conference in 1978.

Part 1. Historical Review

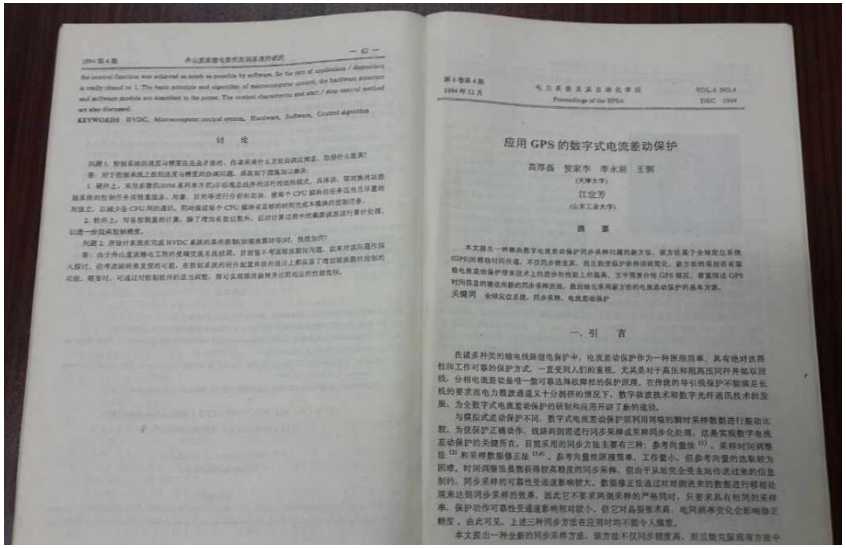
1993 The “signal injection” based faulted line selection technique for neutral non-effectively grounded systems was invented.

1995 National Invention Prize

Part 1. Historical Review

1994 Proposed a GPS synchronized digital current differential protection scheme.

1997 Developed a test prototype of proposed protection scheme



应用 GPS 的数字式电流差动保护

Part 1. Historical Review

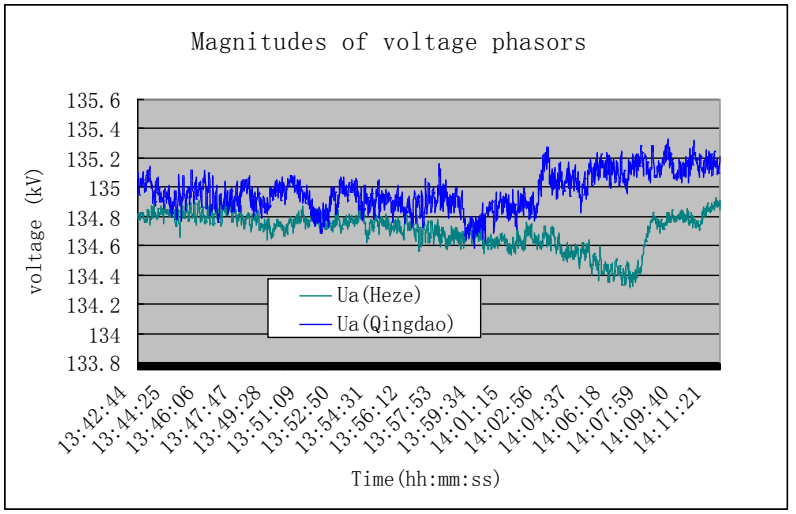
2003 Developed the first phasor measurement unit (PMU) in Shandong province.

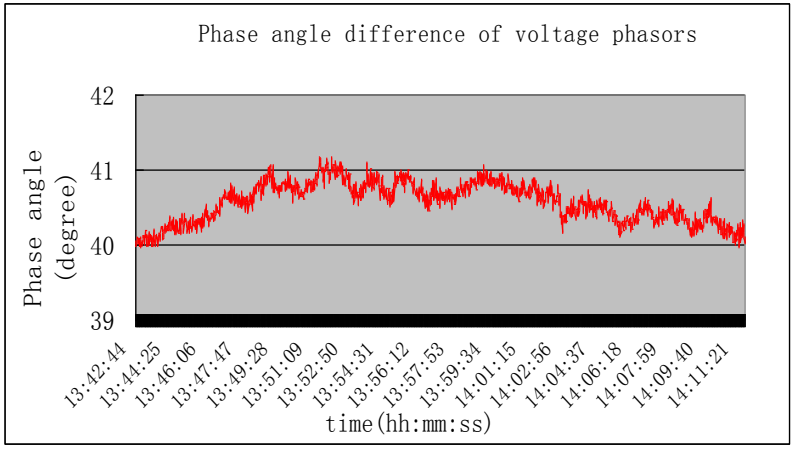
Part 1. Historical Review

2004 Two developed PMUs were Installed at Qingdao power plant and Heze power plant respectively, data was sent to main station at Jinan.

PMU panel at Qingdao

PMU panel at Heze





Real data on Feb.25,2005

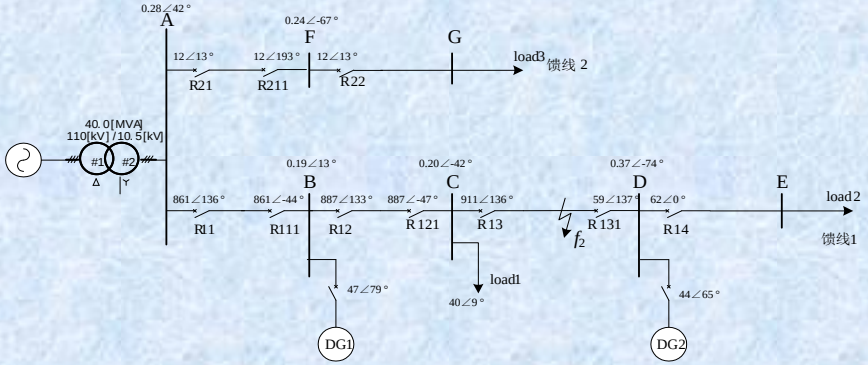
Part2　Current Researches

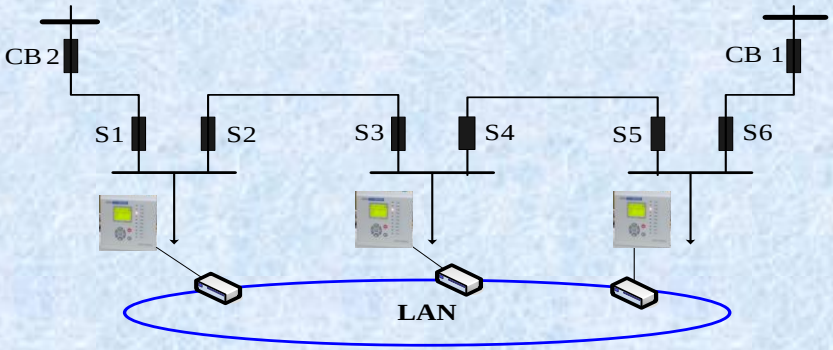
Part 2. Current Researches

- Protection and control technologies for active distribution networks
- Protection and control technologies for smart substations
- New type of protection technologies based on traveling wave
- Online monitoring of fault information and data analysis

1.Protection and control for active distribution networks

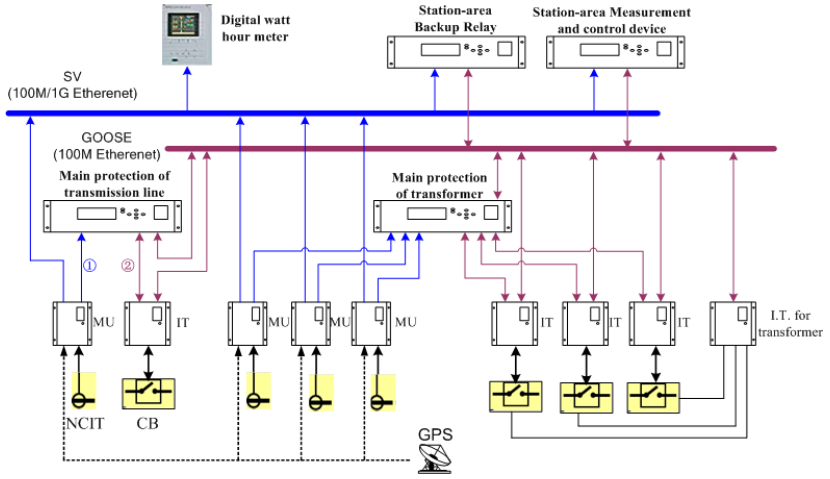
- Proposed and implemented a self-synchronized current differential protection scheme.
- Proposed a fault component based phase angle comparison protection scheme.
- Proposed and tested a fast self-healing scheme based on distributed feeder automation

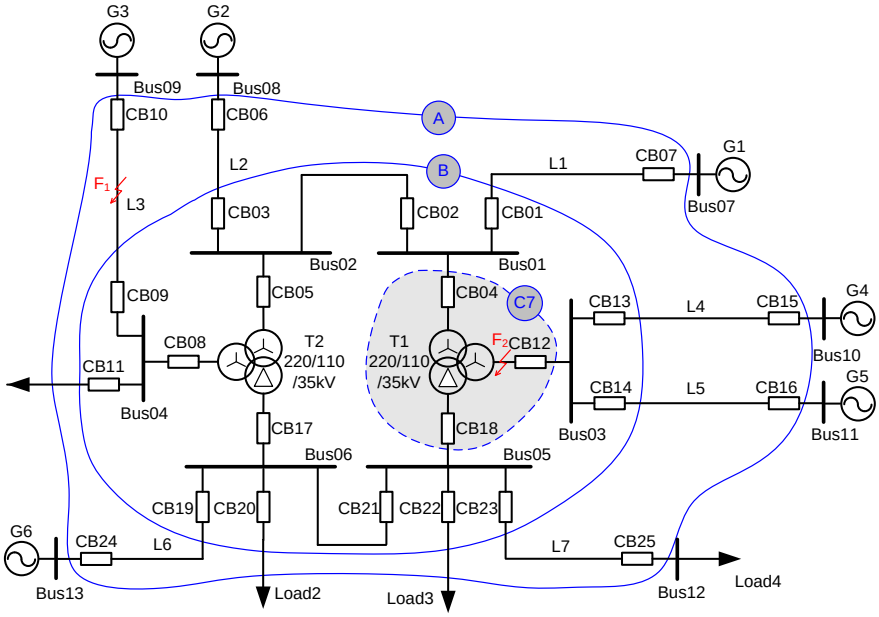




2. Substation-area backup protection for smart substations

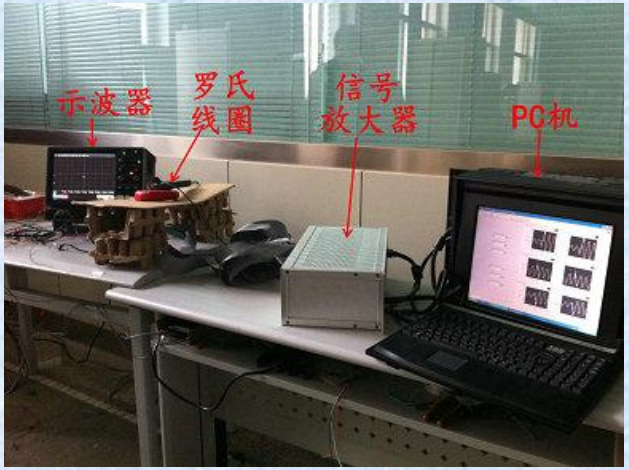
- Proposed a new substation-area backup protection idea based on sharing both SV and GOOSE information.
- Developed a prototype based on proposed principle and IEC61850 standard.

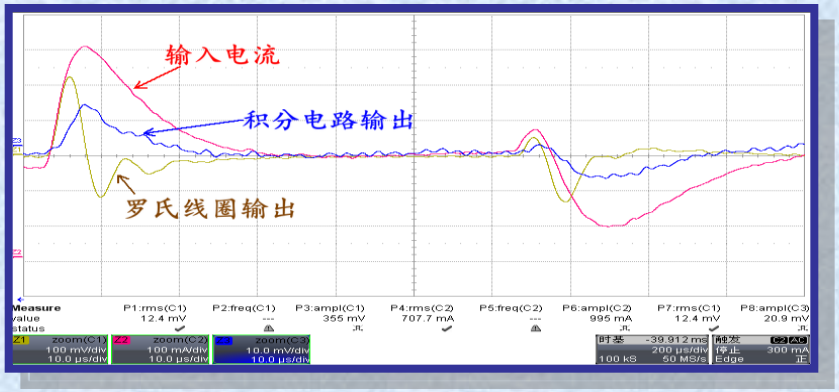




3. Frequency response analysis and test of electronic transducers to traveling waves

- Modeling and simulation of electronic current transducer (ECT--Rogowski coil) and electronic voltage transducer (EVT--capacitor divider)
- Prototypes designing and manufacturing
- Prototypes tests to different high frequency signals including traveling waves and lighting surge
- Test results show that both R-ECT and C-EVT are able to be sensors for fault generated traveling waves





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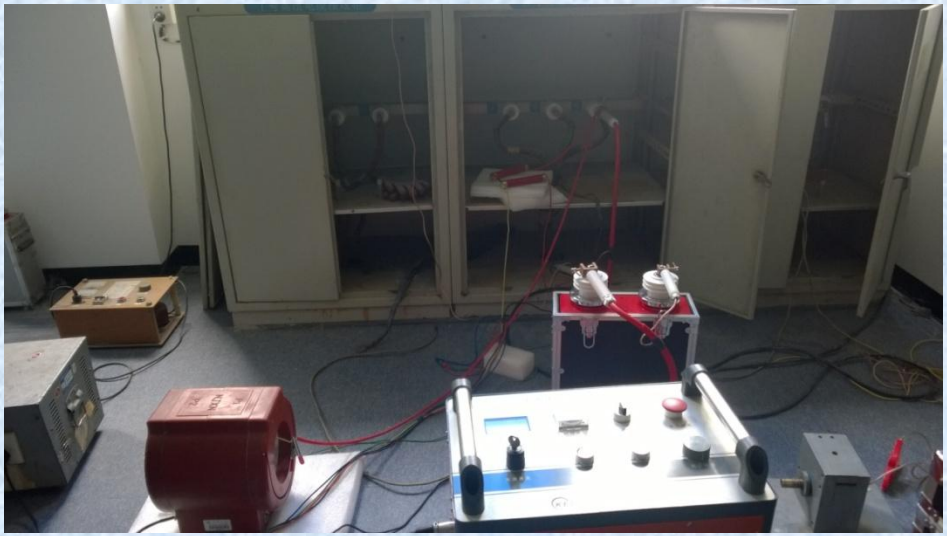
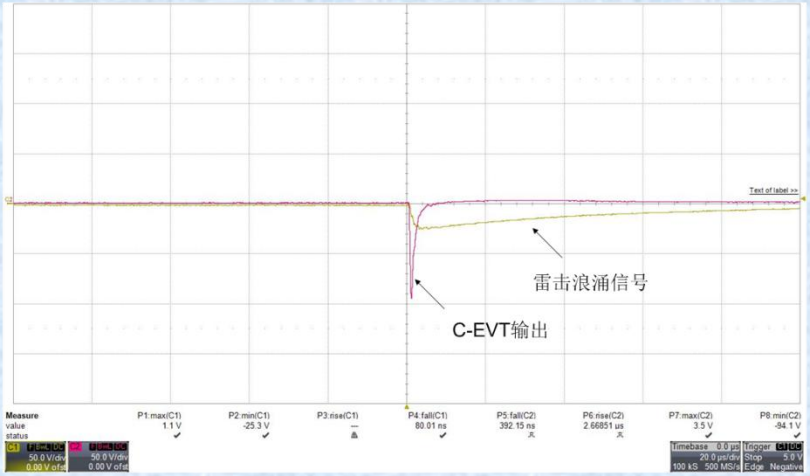
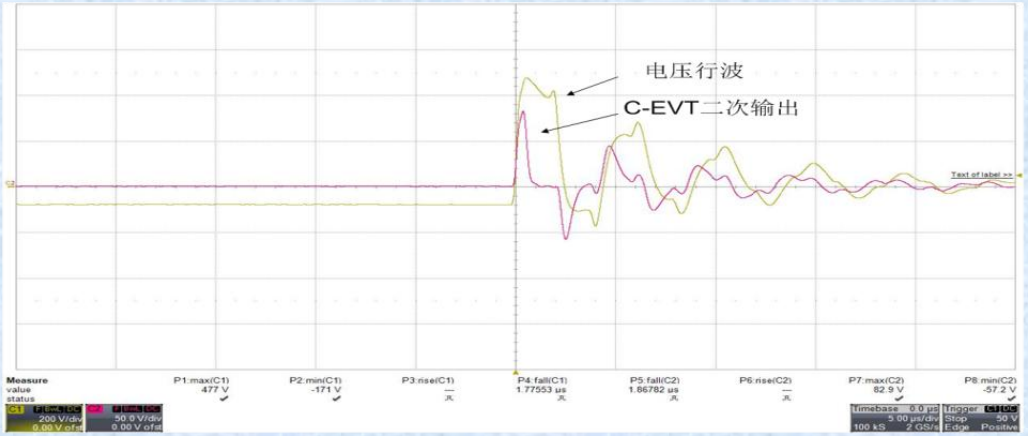
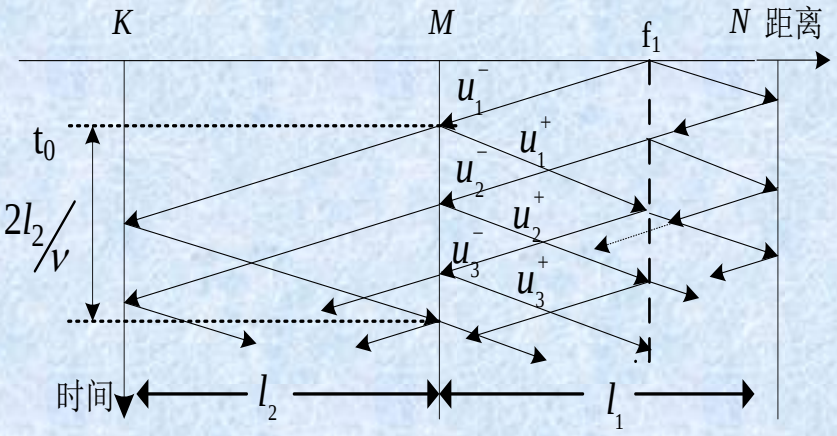






4. New type of protection principles based on traveling wave

- High speed directional line unit protection based on positive and negative direction traveling wave energy comparison
- High speed directional busbar protection based on positive and negative direction traveling wave energy comparison

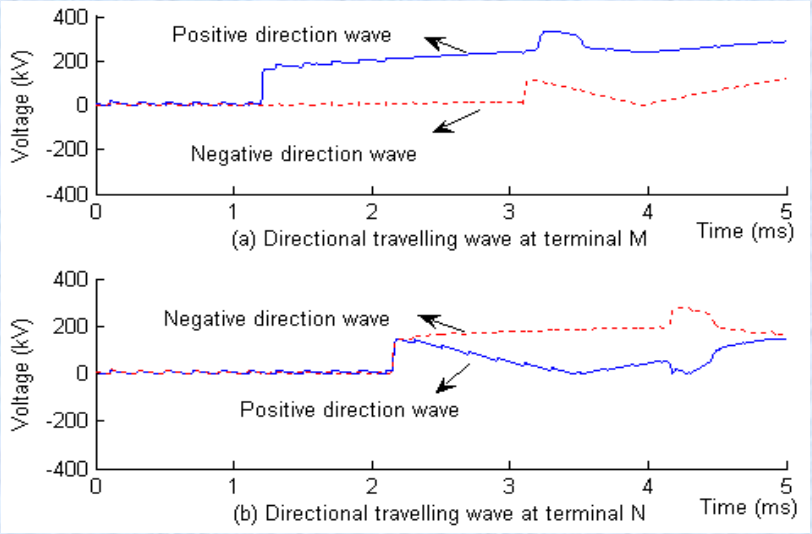


Published papers

[1] Guibin Zou, Houlei Gao, A travelling wave -based amplitude integral busbar protection technique, IEEE Trans. on Power Delivery, 2012,27(2),

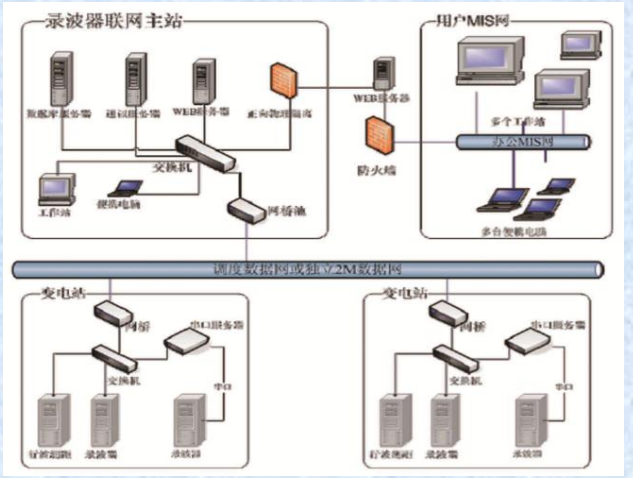
[2] Guibin Zou, Houlei Gao Fast pilot protection method based on waveform integral of traveling wave，International Journal of Electrical Power & Energy Systems，2013-09-01, VOL.50 , 1-8,

[3] Guibin Zou, Houlei Gao. Extra High Speed Hybrid Protection Scheme for High Voltage Transmission Line. International Journal of Electrical Power & Energy Systems, 2014, 63:83-90.



5. On line monitoring of fault information and data analysis

- Five generation fault recorders have been developed and applied in power systems since 1989.
- Fault recorder networking system has been developed and installed in 72 dispatch centers.
- Some fault diagnosis and warning methods have been proposed based on multi-source information



Part3 Facilities

1.Power system dynamic simulation laboratory

2. Substation automation platform

3. Digital substation test platform

The IED panels

The installed ECTs and EVTs

4. RTDS Platform

Thanks for your attention!