The Design of Smart Meters for Smart Grid

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Abstract

This paper designs a new type of smart meter that adopts the idea of modularization and STM32F103VET6 single-chip microcomputer is placed as CPU. The software and hardware design method of CPU control module, communication module, and the data acquisition and measurement module. The smart meter not only can realize data acquisition, ladder electricity price, settlement of electricity charges but also can realize the function of meter reading, monitoring and real-time communication.

Keywords

Smart meter, Power quality detection, Automatic data logging, STM32F103VET6.

1. Hardware design of smart meters

The new smart meter adopts the modular design idea, which can be divided into CPU module, voltage and current parameter acquisition and measurement module, storage module, power supply and clock module, communication module, key control, display module and so on[1-3]. The overall structure of the system is shown in Figure 1.

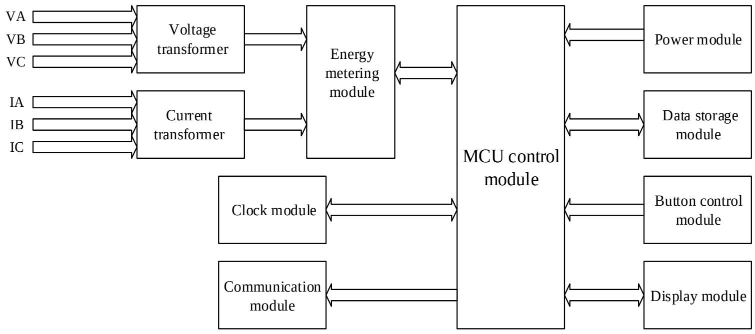

Figure 1. Hardware overall design block diagram

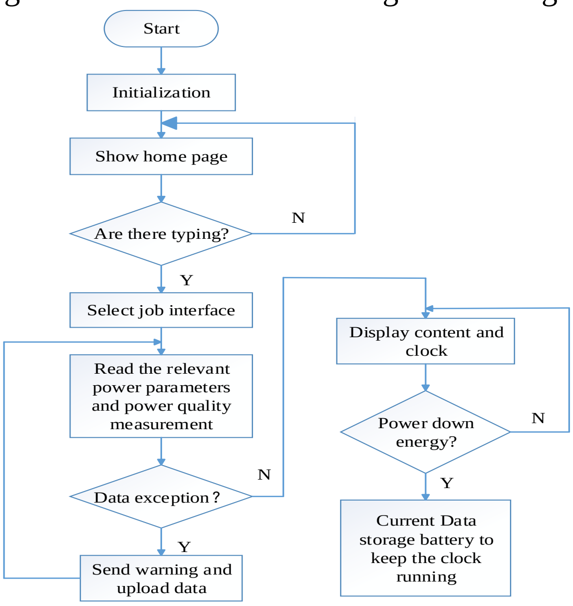

Figure 2. Software system flow chart

2. Software design of intelligent meters

Due to more features in the new smart meters and the high complexity of data process need to achieve, so we put forward to the modular design ideas[4-7]. The overall structure of the software system is shown in Figure 2.

3. Performance Test

According to Q / GDW 362-2009《Single - stage three - phase cost - controlled intelligent energy meter technical specification》, using the standard energy meter method, the ambient temperature of 23 ℃ ±2 ℃.The device in the test environment and smart meter shown in Figure 3.

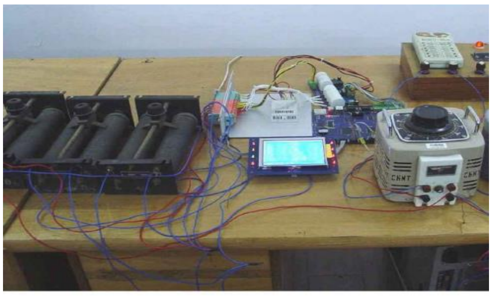

Figure 3. The device of the smart meter hardware and meter reading

Using five and a half desktop digital multi-purpose table measures the power parameters of the meter. At the experimental input voltage: 3 ×220 / 380V, input current: 0A-5A, frequency 50Hz, measured AC voltage error of 0.06%, measurement of AC error of 0.14%, power factor of 1. Selection 900W adjustable load motor in a star connection leads A, B, C phase power can be given Quality data. It is based on respectively active and reactive power, voltage and current RMS, active reactive power, power factor and line frequency measurement[8-9]. This paper only gives the voltage deviation, frequency deviation, power measurement data experimental measurement data, as shown in Table 1 ~ 3.

Table 1. Voltage Deviation Measurement Data

	Measured voltage (U/V)	Standard voltage (U/V)	Relative error	Voltage deviation (U_Δ)
A	220.03	220.2	0.08%	0.18%
B	219.36	219.6	0.01%	0.72%
C	219.80	220。0	0.09%	0.36%

Table 2. Frequency deviation measurement data

Phase number	Nominal frequency (f_N/Hz)	Measured frequency (f/Hz)	Frequency deviation (f_Δ)
A	50Hz	50.04	0.08%
B	50Hz	50.03	0.06%
C	50Hz	50.01	0.02%

Table 3. Power measurement data

Phase number	Active power (P/W)	Active power relative error	Apparent power (S/VA)
A	300.1	0.38%	300.1
B	300.4	0.29%	300.4
C	300.9	0.23%	300.9

The data from the above indicators are within the allowable requirements to meet the overall design of the basic requirements.

4. Conclusion

This paper designs a new smart meter for smart grid. The data of the power quality data and the remote meter reading are tested. The results show that the data indexes of power quality are within the allowable requirements, and achieve a new smart meter power quality testing capabilities. It meets the design specifications.

Acknowledgments

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References

[1] B.W.McDaniel and Keith Rispler. Horizontal Wells with Multistage Fracs Prove to be Best Economic Completion for Many Low-Permeability Reservoirs. *SPE Eastern Regional Meeting, 23-25 September 2009, Charleston, West Virginia, USA.* SPE125903.

[2] B.W.McDaniel and Loyd East etc. Overview of Stimulation Technology for Horizontal Completions without Cemented Casing in the Lateral. *SPE Asia Pacific Oil and Gas Conference and Exhibition; Melbourne, Australia (Oct. 8-10, 2002);* SPE77825. 2002.

[3] P.D.Ellis Kniffin, G.M. etc. Application of Hydraulic Fractures in Open hole Horizontal Wells. *SPE/CIM International Conference on Horizontal Well Technology, 6-8 November, Calgary, Alberta, Canada,* SPE65464. 2000.

[4] Liang Chong, Zhang Baorui, He Anle at el, Research and application of acid fracturing technique for low permeable reservoirs in AMG[J]. *Oil Drilling & Production Technology*. Vol.36, no.2, pp.92-95. 2014.

[5] Liu Jian, LianZhanghua, Lin Tiejun, Production forecasting formulas of horizontal wells under multiform completions [J], *Special Oil & Gas Reservoir*, Vol.13, no.1, pp.61-63.2006.

[6] Xiao Hui, Guo Jianchun, Zeng Jun at el, Technical study on staged acid fracturing of horizontal wells in fractured-cavernous carbonate reservoir [J]. *Fault-Block Oil & Gas Field*. Vol.18, no.1, pp.118-122.2011.

[7] He Chunming, Hu Feng,Liu Zhe, Research on Acid Fracturing Technology of Horizontal Section of the Deep Marine Carbonate Reservoir[J]. *Well Testing,* Vol.22, no.5, pp.5-9.2013.

[8] Roussel N P, Sharma M M. Optimizing fracture spacing and sequencing in horizontal-well fract uring[J]. *SPE Production & Operations*, Vol.26, no.2, pp. 173-184. 2011.

[9] 9.D.Buller, S. Hughes, J. Market, E. Petre, D. Spain, and T. Odumosu, “Petrophysical evaluation for enhancing hydraulic stimulation in horizontal shale gas wells,” *in Proceedings of the SPE Annual Technical Conference and Exhibition*, pp. 431–451, September 2010.