

SOFTWARE CHECK OF MEASURING INSTRUMENT ACCORDING TO WELMEC AND OIML FILES

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Abstract: Software is used popularly combined with hardware in measuring instruments, which is very important to deal with datum, modify process parameters, and drive the instrument working. Usually metrology characters are checked in type approve of instrument, software check is ignored for no rules or no method to carry out the check. Recent years, WELMEC and OIML formulated some files to instruct software check for instruments, it is useful for metrology institute to establish some detailed plan to carry out software check.

Keywords: Software check, Metrology character

1. INTRODUCTION

With the development of electric circuit, computer and internet technology, measuring instrument shows higher accuracy, reliability and intellectualization [1]. There is little measuring instrument with mechanical principle purely, now more and more instruments are based on transducer, and combined computer and internet technology to add some additional functions, such as monitoring, adjusting, statistics etc. For example, weighing system was realized to work automatically without human watching; weighing data and vehicle information were transferred to the datum center. Electric energy was realized data collected online by electric energy meter, and custom could inquire the quality and pay the fee through internet.

In the designing of measuring instruments, software makes huge contribution, which integrates transducer and hardware a whole, make the measuring instruments playing designed functions, software is the soul in measuring instruments, transducer and hardware is body. Software includes two expressions: embedded resource code and software system based on PC. For embedded system, the software of machine mode is fixed in hardware, which is invisible and difficult to test compliance. There are some risks of artificial or involuntary influences brought by software. So software requirements are necessary to ensure the performances of measuring instruments.

International metrology organization have built some file to standard software, Germany and U.K have done some work to carry out software examination.

Here are reviews of international file to expound software requirements.

2. OIML D31: GENERAL REQUIREMENTS FOR SOFTWARE CONTROLLED MEASURING INSTRUMENTS

OIML D is an international document, which is informative in nature and which is intended to harmonize and improve work in the field of legal metrology. D31 was developed by the OIML Technical Subcommittee TC 5/SC 2 [2].

General requirement of software is follows:

1. Software identification. Software of measuring instrument should have version or another token, which is inextricably linked to software itself, and shall be presented or printed on command or displaying.
2. Correctness of algorithms and functions. Measuring instrument shows value of parameter measured according to transducer signal, software realizes conversion from signal to parameter measured, only algorithms and function are correct, the measuring instrument will be reliable.
3. Software protection. Misuse operation is usual in measuring instrument even if with a perfect instruction manual, so warning or dialog box is necessary facing wrong operation. Some important legally parameter is related metrology performance of measuring instrument, if the parameter is modified, metrology performance would be changed, so modifying legal parameter should be authorized and recorded for maintaining performance of measuring instrument.
4. Support of hardware features. Measuring instrument includes hardware and software, software is soul, which realizes the functions combined with hardware. If the hardware or software part have certain faults, software should support to check, and make response. A good measuring instrument could be used for years, and for a period time it need to be calibrated or adjusted, software should satisfy the check of prescribed time in order to guarantee the durability of measuring instrument.

3. WELMEC FILES

WELMEC is cooperation between the legal metrology authorities of the Member States of the European Union and EFTA. The principal aim of WELMEC is to establish a harmonized and consistent approach to European legal metrology. For software controlling of measuring instrument,

WELMEC have proposed files including WELMEC 7.1 Development of Software Requirements; WELMEC 7.2 software guide; WELMEC 2.3 Development of Software Requirements (no-automatic weighing instruments).

WELMEC gave the requirements of software of type P and type U. A type P instrument is a measuring instrument with an embedded IT system (in general it is a micro processor or microcontroller based system) [3] [4].

1. Documentation. Documentation includes description of legally relevant software, accuracy of measuring algorithms, user interface menus and dialogues, system hardware and operating manual, etc.

2. Software identification. The legally relevant software shall be clearly identified. An identification of the software shall be inextricably linked to the software itself. It shall be presented on command or during operation.

3. Influence via user interface. It is forbidden that legally relevant software and measuring results are influenced by operating interface.

4. Influence via communication interface. Commands inputted via communication interfaces of the instrument shall not inadmissibly influence the legally relevant software and measurement data.

5. Protection against accidental or unintentional changes. Software should have protected ability against unmoral incident, for example, unexpected power or wrong operation.

6. Protection against intentional changes. Sometime intentional operation or change is done to influence metrology character of measuring instrument. So there should be protected ability to avoid or weaken intentional result. It is like “An instrument shall have no characteristics likely to facilitate its fraudulent use” of OIML R76, especially for software, because software change is secret and hard to find it [5].

7. Parameter protection. Measuring instrument always has adjusted function for period verification. Key parameter is adjusted; the metrology character would be normal or bad. Now, for measuring instrument, there are no restricting rules of parameter in software designing. This point is important, necessary restrict will strong the protection ability.

4. SOFTWARE CHECK AND PARAMETER PROTECTION OF ELECTRONIC SCALE

Electronic scale is a kind of non-automatic measuring instrument, and used extensively in market to weighing the food, vegetable and meat. Weighing accuracy is related with trade settlement, and people touch weighing in market usually. If the electronic scale is not accurate, or could be influenced by software, that will be a big problem, this will influence acknowledge of measuring instrument.

Fig.1 is the principle of electronic scale; it is a open-loop system, load cell is the input element, weighing to be displayed is the output value. Between load cell signal and weighing, there is a linear relation approximately, a key parameter is formed; and wrote in the microprocessor in electronic scale.

Hypothetically, the key parameter is x_0 in the first verification; the maximum permissible error is only 1.5e

between 2000e and 3000e for III electronic scale, showing in Table 1. C2 load cell is commanded to meet III electronic scale at least, if the regulation range is extend to $\pm 5\%$ in full span, the load cell would have better adaptability [6]. Conversely, x_n ($n=1, 2, 3 \dots n$ means calibration times) should satisfy

$$(1-5\%) x_0 \leq x_n \leq (1+5\%) x_0 \quad (1)$$

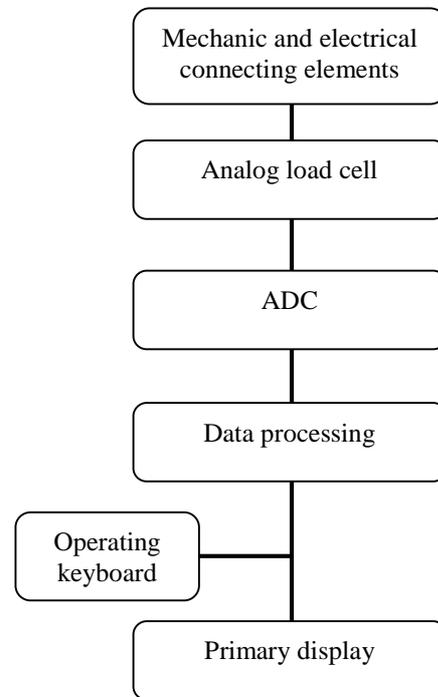


Fig.1 Principle of electronic scale

Table 1 MPE of III electronic scale

	Load	MPE
III	$0 \leq m \leq 500e$	$\pm 0.5e$
	$500 < m \leq 2000e$	$\pm 1.0e$
	$2000 < m \leq 10000e$	$\pm 1.5e$

For software designing, a reasonable restraint of x_n should be considered to void the intentional changes; and it would be a check term in documentation or code test.

Early, type approve is focused on metrology characters and legally management, less considered directly on software and algorithms, there is some problem occurred. So, some designing is necessary to assure the metrology safety and reliability, such as a restraint of x_n and calibration times. In the software check, documents of software designing, reasonable restraint, protection designing and legally parameter record should be provided to assure the functions correct. Source code test is a complicated and hard work; for there are no mature, universal tools to execute code test; and the programming level is different, confirmatory results is hard.

5. SOURCE CODE TEST AND MANAGEMENT

Source code test should have clear and definite aim, and have a executable process with relevant tools. A special tool

is developed to test source code of measuring instrument, which has following parts:

1. Test analysis of source code;
2. Uniqueness test of software functions;
3. Uniqueness test of software variable;
4. Black box designing and test;
5. Compare of source code with code of type approve;
6. Relevant form and report created.

For software test of measuring instrument, some viewpoints must be emphasized to make a clear distinction.

1. The aim of source code test of measuring instrument is to improve safety and reliability of measuring instrument; it is different from software developed by special company to improve use character, and lessen the service cost.

2. Source code test could find part problem or wrong program, but there is no possibility to find the all problem, especially software leak, back door and cheat code.

3. Source code test should be study further, a feasible and operational method is needed, test tools should be developed to meet source code test.

4. It is wrong viewpoint to test all measuring instrument, only part need to test source code; test method and test tools should be estimated.

5. Source code test is a technology method to perfect the management of measuring instrument, management and technology are two tools to assure measuring instrument manufacturing, marketing, using and maintaining. Measuring instrument is particular goods, integrity and fair is the base of business; management method is better method to supervise the intentional change to measuring instrument.



Fig.2 Loading source code

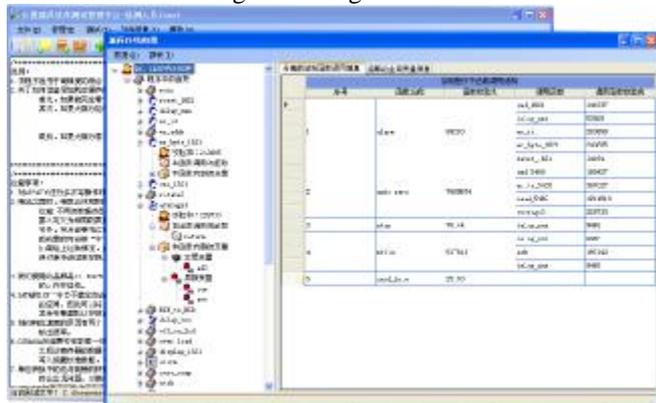


Fig.3 Structure analysis of source code



Fig.4 Testing report of variable



Fig.5 Compare codes



Fig.6 Testing example designing of black box

6. REFERENCES

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