PRECISION THICKNESS METER PHASED ARRAY

Guva A.A., Nikonova G.V., Shchelkanov A.I.
Omsk State Technical University, Omsk,
e-mail: ngvlad@mail.ru

Proposed construction of ultrasonic thickness using technology ultrasonic phased array for the automated control of the details.

Thickness measurement – precision research method that eliminates the traditional error. One of acoustic methods of nondestructive testing, occupies a leading position, is the ultrasonic thickness. This methodology is based on the electromagnetic-acoustic method of sending and receiving ultrasonic vibrations, which allows a high level of accuracy to determine the thickness of the object to be measured, not causing him thus no damage [1].

Ambiguity of reference for the control of parts of complex shape with a small radius of curvature of the surface and equidistant – drawback of this method the operator can not know the position of the surface relative to the contact. It must vary the angular position of the sensor to at one point of time the incident ultrasonic wave is directed along the normal to the surface of the part. The position of the sensor depends on the angle of the emitting ultrasonic vibration input in the product and the length of the path that they run to the front of the sensor. This is especially significant for the measurement of small thickness.

The solution of the problem is the use of ultrasonic phased array technology in the design of precision thickness gauge.

The main feature of the ultrasonic phased array technology – computer-controlled amplitude and phase of the excitation pulses in multi-individual piezoelectric transducer [2]. Excitation of the piezoelectric elements can be implemented in such a way to be able to control the parameters of the ultrasonic beam, such as angle, focal length, focal spot size by a computer program.

Thickness consists of microprocessor control and computing (MCC), the reference oscillator (Goch), generator trigger pulses (GTP) time intervals measuring (TIM), digital-to- analog converter (DAC), a comparator, a temporary selector, keyboard, LCD display and a piezoelectric transducer phased array (PTPA) [3].

In the radiation MCC commands the simultaneous launch GTP and TIM. Pulse with GTP arrives at PTPA and radiated into the product. In receiving the reflected ehoimpuls adopted PTPA amplified, subjected to amplitude and time selection and enters the TIM signal the end of the pulse counting Goch. The resulting code at the output goes to the TIM MCC, which, after appropriate calculation gives the value of the thickness on the indicator. In receive mode, the amplifier comes from PTPA pulse sequence: pulse reflected from the front face of the product; pulses longitudinal and transverse waves reflected from the bottom surface of the article; reflections impulses in prisms PTPA. Owing to the small phase shift some impulses PTPA perceived as one.

The amplitude of the received pulses depends on the thickness of the product, and the differences of the coefficients of attenuation of ultrasonic waves in a product, the surface roughness of the product quality and acoustic contact. To reduce the influence of these factors, it is used in the selection of the amplitude at a variable voltage threshold, which is carried out using a DAC and comparator. DAC controlled MCC determines the threshold voltage. The comparator selects the pulses that exceed the threshold voltage level.

Temporary selection pulses output from the comparator is performed by using a time delay circuit and the selector, controlled MCC. Time selector selects the longitudinal momentum of the wave reflected from the bottom surface. The measurement time interval is made TIM, which counts the number of pulses per Goch time between pulses reflected from the front face, and the momentum of the longitudinal wave reflected from the bottom surface. Impulse wave reflected from the front face of the product is for TIM start pulse counting pulses Goch. Impulse longitudinal wave reflected from the bottom surface of the article is the terminal count pulse.

The measured time interval MCC enters for processing the measurement results and the formation of image information. When the processing of measurement results taken into consideration delay in the prism is regarded as a known value. The value of the speed of propagation of longitudinal acoustic waves in the material of the measured product is installed in thickness meter using the keyboard or measured on a sample of known thickness. Recorded in the memory of the gauge dataset can be transferred to a PC for analysis, processing and use of the documentation. To transfer the recorded data to a computer in a procedure thickness meter transmission measurements from the instrument memory to the PC.

The measurement process is independent of subjective assessment of the operator increases the measurement accuracy. Such a construction of the gauge using a phased array technology allows for control of parts in automated production and excludes subjective operator error when installing the sensor on the details.

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The work is submitted to the International Scientific Conference "Modern science technologies", Spain (Tenerife), November 21–28, 2014, came to the editorial office on 16.11.2014.

THE ACTUAL SCIENTIFIC AND EDUCATIONAL PROGRAM OF SMALL SPACECRAFTS ENGINEERING

Kovalev I.V.

Siberian State Aerospace University named after academician F. Reshetnev, Krasnoyarsk, e-mail: kovalev.fsu@mail.ru

The Siberian State Aerospace University and its strategic partners are described. Two satellites series are considered.

At the present time the Siberian State Aerospace University named after academician M.F. Reshetnev (the SibSAU) in cooperation with the strategic partners – the Joint-stock Company "Information Satellite Systems" named after academician M.F. Reshetnev" (JSC "ISS") and the Scientific Center of Krasnoyarsk under Siberian branch of Russian Academy of Sciences – implements the program of creation of the scientific and educational, technological microsatellites series [1-3].

The SibSAU is one of the leading Russian Universities in the aerospace technologies domain. The University develops on principles of the research university and implements the integrated system of preparation of specialists and scientific brainpower for the enterprises of space domain. The specialists preparation programs combine educational process, research activities and students work practice in the leading Russian space enterprises [4]. SibSAU implements the innovation educational programs [5–11] and performs scientific researches in close cooperation with the strategic partners – the base enterprise JSC "ISS" and the scientific institution – Scientific Center of Krasnoyarsk under Siberian branch of Russian Academy of Sciences, which have cooperatively created the subdepartments, scientific and educational laboratories and research centers [12, 13].

The JSC "ISS" is one of the leading enterprises of Russian space industry which possesses the technologies of complete space complexes creation cycle starting by the design to the spacecrafts control in all types of orbit – from low circular to geostationary. During its activities the enterprise has taken part in implementation of more than 30 Russian and international space programs in the domains of communication, retransmission, television, navigation, geodesy and scientific researches. The enterprise has designed, manufactured and launched about 1200 spacecrafts of 50 different types which distinguish by the high reliability and are intended for operation in low circular, circular, high-elliptical and geostationary orbits.

The objectives and tasks of the program for creation of the scientific and educational, technological microsatellites series being implemented [14, 15]:

- development of the integrated system of the engineering education (distance learning system, laboratory sessions performing using the ground stations of microsatellites control etc.);
- implementation of the design-oriented educational technology during formation of the space domain specialists professional capacities (students' participation in designing and manufacturing of satellites, service systems and scientific devices);
- scientific experiments in space (development of the Earth natural resources space monitoring methods, multifunctional nanomaterials, high-temperature superconductors and other intelligent materials use in space);
- technological development and obtaining of the flight qualification for the advanced service systems, devices and elements of the satellites (of the attitude determination and control subsystem, electric power subsystem, thermal control subsystem and other subsystems with the increased lifetime).

In 2007 the SibSAU in cooperation with the JSC "ISS" and the Scientific Center of Krasnoyarsk under Siberian branch of Russian Academy of Sciences have concluded the strategic partnership agreement on creation of students' small satellites series according to which the program of technological, scientific and educational satellites regular creation and following launch was adopted (smka.sibsau.ru). Due to this program the technological work-out in space and flight qualification obtaining will be provided for the new elements of satellites and space systems developed on the basis of the University. The SibSAU is the single Russian higher school which will perform the manufacturing of elements and the assembly of microsatellites, the mounting of technological and scientific instruments as well as the part of small satellites tests directly on the basis of the joint scientific and educational center "Space systems and technologies" and the industrial resource center "Spacecrafts and space systems" which has the clean room and production facilities for these purposes.

The "Yubileyniy" satellites series

In 2008 the first satellite of the "Yubileyniy" satellites series has been developed and put into operation (Fig. 1). Structurally the "Yubileyniy" satellite consists of the unpressurized instrumentation module formed by the hexagonal frame on which the solar array panels are mounted and by three transversal panels – upper, middle and lower. On-board equipment is accommodated in the instrumentation module as well as on the outer surface of the upper panel. On the upper panel which is directed towards the Earth during the satellite operation the attitude