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AUTOMATISATION ET INSTRUMENTATION

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ANALYSIS OF THE FEK DELVOTEC 6400 WEDGE BONDING SYSTEM

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Modern production of microelectronics and hybrid electronic modules is characterized by high requirements for the accuracy of interconnection formation, stability of technological parameters, and reliability of electrical contacts. Among the key factors influencing the quality of the wedge bonding process are the positioning accuracy of the bonding tool and the stability of ultrasonic impact during the formation of the bonded contact. The use of the FEK Delvotec 6400 system makes it possible to implement high-precision control of the tool trajectory, monitoring of ultrasonic energy parameters, and automation of the wire bonding technological process. In this regard, an important task is the analysis of the positioning system and ultrasonic impact in the wedge bonding process in order to improve the quality of interconnections and the efficiency of electronic module manufacturing.

The main elements of the technological system for thin aluminum wire wedge bonding based on the FEK Delvotec 6400 machine, which is used in the production of microelectronics and hybrid electronic modules, are presented. The central element of the system is the bonding tool, which ensures the formation of

a bonded contact between the aluminum wire and the bonding pads of the semiconductor die and substrate. A CCD camera and the PRU system are used for coordinate control and precise positioning, determining the locations of the bonding points before the beginning of the technological cycle. The process stability is ensured by the touch-down sensor, the ultrasonic impact system, and the wire clamping mechanism, which make it possible to form reliable interconnections. The movement of the electronic module between the bonding points is performed using an X-Y table that ensures positioning accuracy within the working area of the system. The general structure of the wedge bonding system is shown in Figure 1.

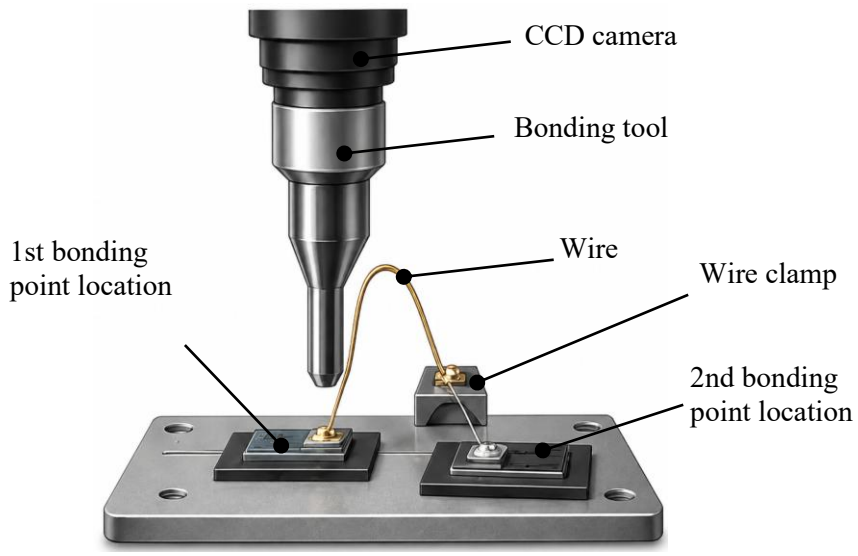

Fig. 1. **General structure of the FEK Delvotec 6400 wedge bonding system.**

The main technical characteristics of the FEK Delvotec 6400 wedge bonding system are presented in Table 1.

Table 1

Main technical characteristics of the FEK Delvotec 6400 wedge bonding system

Parameter	Characteristics
Technology type	Ultrasonic wedge wire bonding
Wire type	Thin aluminum wire
Wire diameter range	17–75 μm (depending on configuration)
Bonding tool type	Wedge Tool

Continuation of table 1

Parameter	Characteristics
Contact formation method	Ultrasonic impact + mechanical pressure
Positioning system	Precision X-Y table
Positioning accuracy	Up to ±1–2 μm
Visual inspection system	CCD camera with PRU (Pattern Recognition Unit)
Contact control	Touch-down sensor
Bonding pad material	Al, Au, Cu-compatible surfaces
Product types	Integrated circuits, power modules, hybrid electronic modules
Integration capability	Digital Twin / Industry 4.0 systems

Conclusion. The conducted analysis of the FEK Delvotec 6400 wedge bonding system demonstrated that the use of a high-precision positioning system, CCD camera, and ultrasonic impact ensures stable interconnection formation in the production of microelectronics and hybrid electronic modules. It was established that the quality of wire bonding largely depends on the positioning accuracy of the bonding tool, the stability of ultrasonic energy parameters, and contact control within the working area of the system. The presented structure of the wedge bonding system makes it possible to integrate the technological process into the Digital Twin concept and implement real-time monitoring of process parameters. The obtained results confirm the prospects of using the FEK Delvotec 6400 for the development of intelligent automated manufacturing systems for modern electronic modules.

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