# PORTABLE BIOSENSOR: FROM IDEA TO MARKET

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***Abstract**: In the article it is described the family of portable biosensors for express-diagnostics of plant state developed in V.M.Glushkov Institute of Cybernetics from scientific idea to serial production, produced on modern contract manufacture.*

***Keywords**: chlorophyll fluorescence induction; fluorometer; portable biosensor; contract manufacture.*

***ACM Classification Keywords**: J.3 Life and Medical Sciences - Biology and Genetics*

## Introduction

In the modern world scientific-technical progress plays an important role in development of economy and different areas of human activities. It means that supporting of innovations has very important sense. In the general case under innovation we may understand the process of initiation and development of some idea with the following development of new products, services and technologies or their modernization. Exactly in this case the emphasis has to be made on prototype or model development, confirmation of possibility and expediency of innovation application in practice, but not in theory. The following transfer to industrial production manufacture, which is claimed by market and profit making from selling of this production (or license) may be considered as process of commercialization.

In the article it is described the family of portable biosensors for express-diagnostics of plant state developed in V.M. Glushkov Institute of Cybernetics from scientific idea to serial production, produced on modern contract manufacture. It is important to note, that during moving portable biosensor to serial production it is necessary to pay a significant attention not only to design and creation of device hardware, but and to development of optimal and convenient applied methodical and software support. Preparation of quality construction documentation on whole biosensor and its separate parts helps to reduce cost, system design time, and board space on run-up of contract manufacture to serial production. Presence of well prepared software and user documentation causes decreasing costs of supporting of devices moved into market and are in active using of costumers.

There were two aims for preparing serial production of portable biosensors. The first aim was creating technical documentation of smart biosensor device according to requirements of advanced contract manufacture. It was selected electronic contract manufacture of Scientific production firm VD MAIS (Kyiv, Ukraine) [VDMais, 2012] for creating of serial party of the device which consists of Surface mount technology assembly line. According to this technology the bare Printed circuit boards with solder paste, applied in the right places, take the several steps towards becoming fully-fledged boards here.

The second aim was manufacturing serial party of portable biosensor on the mentioned above contract manufacture with modern high-performance equipment.

The work of portable biosensor [Romanov, 2007] is based on measurements of chlorophyll fluorescence induction. One of the most important properties of the molecule of chlorophyll which is the basic pigment of plant cell is ability to fluoresce. For the first time this phenomenon was researched by Kautsky [Kautsky, 1931]. Dependence of chlorophyll fluorescence induction on time passed after start of lightning of plant's leaves is known as an induction curve or a chlorophyll fluorescence induction curve. The form of this curve is rather sensible to changes in the photosynthetic apparatus of plants during adaptation to different environmental conditions. This fact is a basic for extensive usage of Kautsky effect in photosynthesis research. The advantages of the method of chlorophyll fluorescence induction are the following: high self-descriptiveness, expressiveness, noninvasiveness and high sensibility. It gave possibility to develop in the V.M. Glushkov Institute of Cybernetics of NAS of Ukraine the portable biosensor "Floratest", which estimates in several seconds the plant state after drought, frosts, pollution, herbicides etc. without plant damage. Like human cardiogram device builds chlorophyll fluorescence induction curve estimated photosynthesis process, which is the base of plant vital activity.

## Portable biosensor kit

For microprocessor unit it was selected polyamide hand held enclosure with monitor opening Beluga 180. The features of the enclosure are following: ingress protection – IP 65, weight – 0.16 kg, temperature range - from -40 up to +60 C°, color – black. Enclosure Beluga 180 was updated to install printed circuit board of microprocessor unit (see fig. 1), printed circuit board for connector remote sensor, monitor Fordata firm FDCG12864 and control buttons.

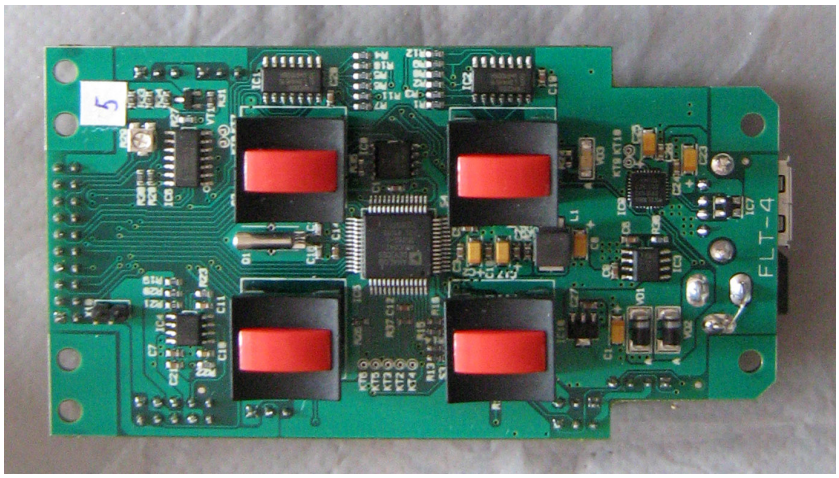
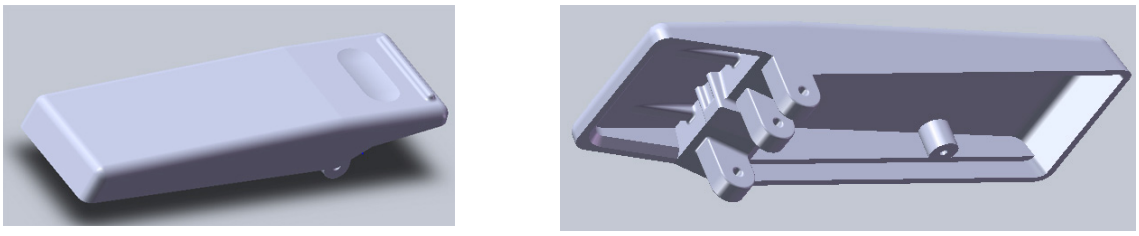



Fig. 1. Printed circuit board of microprocessor unit

It was used Laser prototype technology for designing and manufacturing remote sensor enclosure. This technology can offer the competitive edge in getting products to the market faster from early design and concept models through to skilfully finished engineering models and low volume production runs. 3D-model of remote sensor enclosure is shown on fig. 2. Manufactured remote sensor enclosure is shown on fig. 3.



a b

Fig. 2. 3D-model of remote sensor enclosure: a – top, b – bottom

Fig. 3. Manufactured remote sensor enclosure

Smart biosensor "Flaratest" kit is shown in fig. 4. It consists of microprocessor unit, remote optical sensor with cable, data cable, power supply unit and four rechargeable batteries.

Also as part of biosensor kit it was prepared and replicated CD with software and user documentation for supporting work biosensor users. The appearance of CD is shown on fig. 5.

## Contract manufacture

It was used electronic contract manufacture of VD MAIS firm (Kyiv, Ukraine) [VDMais, 2012] for creating serial party of the portable biosensor.

So the main features of technical documentation were matching functional diagrams of device units with interoperability of Surface mount technology assembly line. There were selected Surface mount technology electronic components such as resistors, capacitors, inductances, diodes, transistors, and integrated circuits for device units and on this base it was designed technical documentation of the Printed circuit boards of microprocessor unit and remote optical sensor.

According to Surface mount technology assembly the bare Printed circuit boards with solder paste, applied in the right places, take several steps towards becoming fully-fledged boards here. The Surface mount technology machines pick and place the tiny resistors, solid-state capacitors and other Integrated Circuit chips onto the Printed circuit boards at ultra high speeds. If you look for example at the motherboard in computer, some of these small components are no more than 1 mm square. Each board passes through two sets of Surface mount

technology high-speed machines, the 'small pick and place' and 'large pick and place' devices. Each machine in the set adds a few components, from tiny resistors up to Integrated circuit chips. Using belt fed from tape-like cartridges of components the Surface Mount Technology gear places components like a machine gun, taking as little as an eighth of a second to place a component with exact precision on the Printed circuit boards.

During the manufacturing of printed circuit boards of all units of the device it was fine-tuned assembly technological processes and technical documentation too. For the perfecting of documentation and manufacture technology it was creating more than one hundred printed circuit boards of all types.

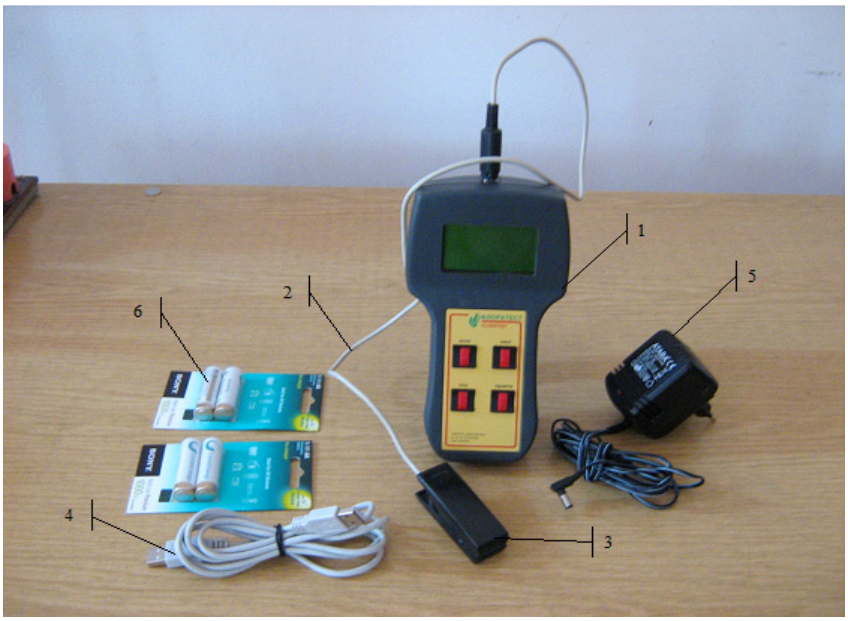



Fig. 4. Biosensor "Floratest" kit:

1 – microprocessor unit, 2 – cable of remote optical sensor, 3 – remote optical sensor, 4 – data cable,

5 – power supply unit, 6 – four rechargeable batteries


Fig. 5. The appearance of CD with software and user documentation

Structure of contract manufacture technological line and its composition are shown on fig. 6.

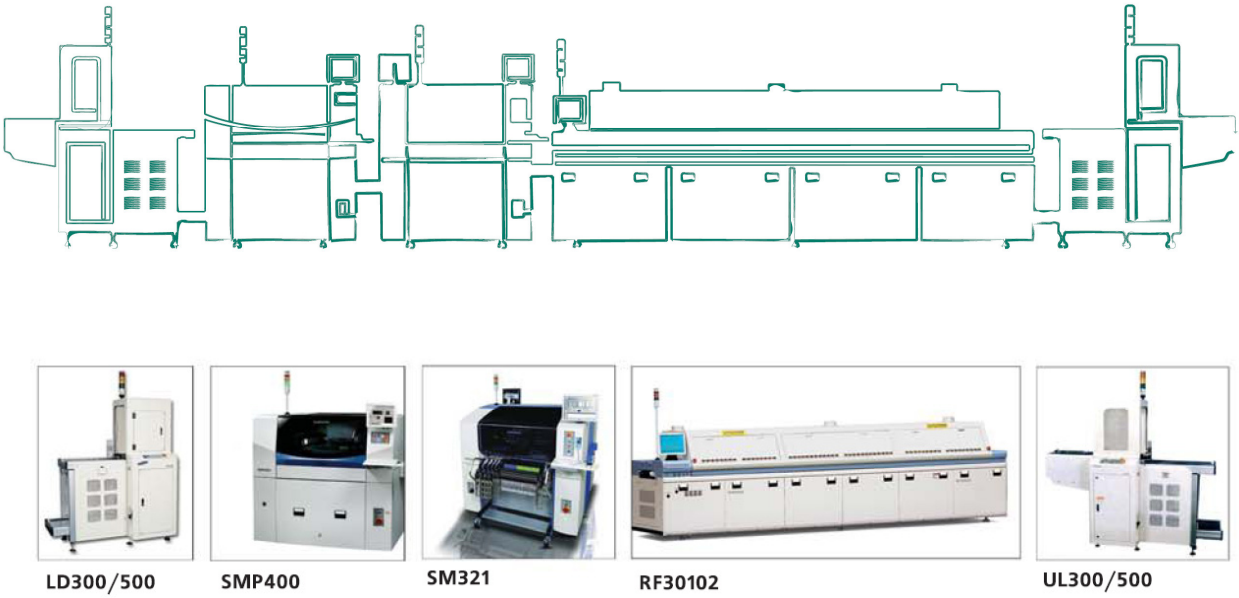



Fig. 6. Structure and composition of contract manufacture technological line:
1 – automatic loader of boards, 2 – stencil printer, 3 – automatic placer,
4 – conventional-conveyor oven, 5 – automatic unloader of boards

## Conclusion

It is clear, that neither state nor research organizations have possibility to full finance development and implementation of new innovation products. In this case the unifying element between innovation and commercialization may be business structures and private financial funds interested in such researches. As example of such approach is Science and Technology Center in Ukraine, financed the preparation of portable biosensor to serial production and manufacturing the first serial party of this biosensor. Integration of scientific capacity of research organization and financial capacity of business structure gave possibility to prepare and serial produce modern competitive portable cost-effective biosensor for express-diagnostics of plant state.

## Bibliography

[Kautsky, 1931] Kautsky H., Hirsch A. Neue Versuche zur Kohlenstoffassimilation // Natur wissenenschaften. – 1931. – 19. – S. 964.

[Romanov, 2007] Romanov V., Fedak V., Galelyuka I., Sarakhan Ye., Skrypnyk O. Portable Fluorometer for Express-Diagnostics of Photosynthesis: Principles of Operation and Results of Experimental Researches // Proceeding of the 4th IEEE Workshop on "Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications", IDAACS'2007. – Dortmund, Germany. – 2007, September 6–8. – P. 570–573.

[VDMais, 2012] http://www.vdmais.kiev.ua.

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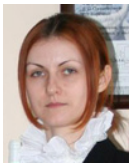

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