The Modern System for Analyzing and Detecting Lead in Solders

Ladislav Machan and Pavel Steffan

Abstract - **This article describes new approach of modern potentiostat systems for the determination of lead in solders used in electrotechnic industry. It was studied electrochemical detection methods to enable accurate detection of heavy metals. With regard to the requirements of these methods are proposed facility presented. The general aim is principles of quantitative heavy metal detection by the electrochemical methods, optimal method selection and construction of detecting instrument.**

Keywords – **Lead detecting, solders**

I. INTRODUCTION

Lead detection in solders become actual subject in microelectronics. Since 1.7.2006 is valid the prohibition of use chemical substances containing lead. Main theme of work is design and construction of special purpose instrument which allow lead detection in solder irons. The work is divided to theoretical, laboratory and constructional parts. Used electrochemical method is described in the theoretical part. Selected method was tested in laboratory part. Laboratory instrument was designed and constructed on the basis of results from laboratory measurement.

II. DETECTION METHOD

The best result in laboratory measurement had differential-pulse method [1], [2]. Typical curves of this method are described on fig. 1a,1b. Laboratory equipment consists from lead detector, sensor connected via coaxial cable and electrochemistry cell with work lotion (fig. 2). Active part of sensor must be dipped into lotion. Sensor is made by technology of thick layers on corundum substrate [5]. Sensor contains three electrodes: auxiliary (AE), reference (RE) and work electrode (WE). Auxiliary electrode is made from platinum (Pt), reference electrode is made from silver-chloride (Ag/AgCl) and work electrode is made from carbon (C) [3], [4]. Detecting process is illustrated on the fig. 2.

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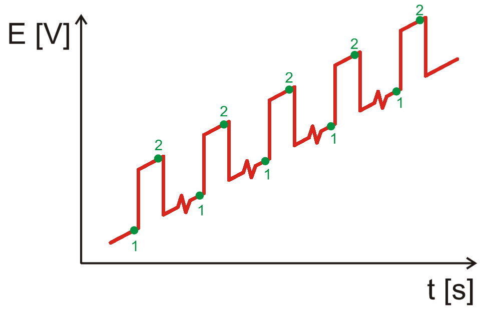
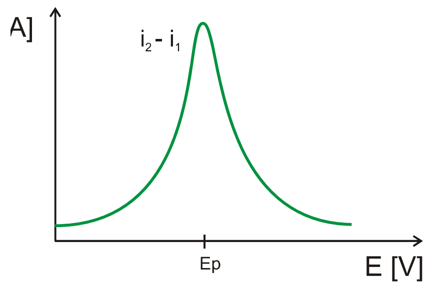


a)



b)

Fig. 1: Differential pulse polarography [1]

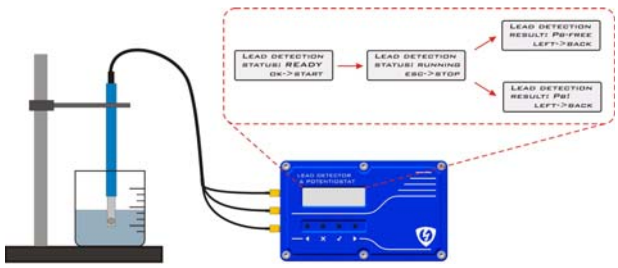


Fig. 2: Laboratory equipment

III. LABORATORY MEASUREMENTS

In the laboratory part was found a work lotion which allows unique lead detection. Sample of solder iron must be dissolved in nitric acid (63% - HNO3). Minimal amount of solder iron was defined on 0,002g. This amount of solder iron must be dissolved in 1.5 ml of nitric acid. Work lotion is prepared as mixture of 30µl sample solution and 2ml acetate buffer (pH 4.6).

A. Measuring results

Results of measurement with constructed instrument (fig. 3-left) were compared with measurement with professional analytical station (fig. 3-right). Both measurements were performed at equal conditions. Lead detection of instrument is based on differences between curves obtained at measurement of lead-free solder iron (green curve) and solder iron containing lead (red curve). Algorithm implemented in software facility detects "lead-peak" in measured curve.

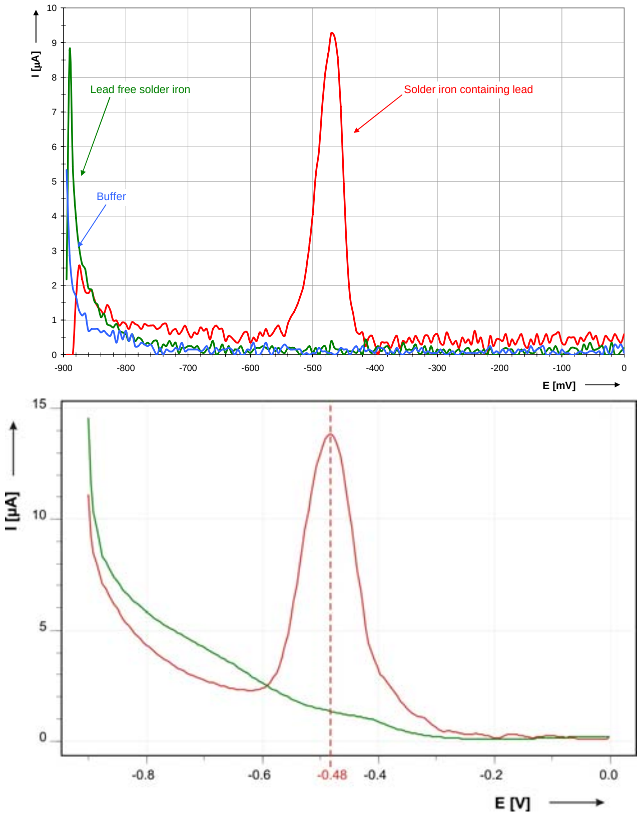


Fig. 3: Measured curves (differential pulse polarography)

IV. Constructional Part

Block diagram of instrument is divided into: digital block, analog block and power supply (fig. 4). Digital block provide interaction with operator, controlling of analog block according to adjusted parameters and measured data collection. Analog block scales signal levels and make them suitable for processing with A/D and D/A converter. Converters are controlled by digital block. Power supply regulates voltage from supply block of Li-Ion accumulators.

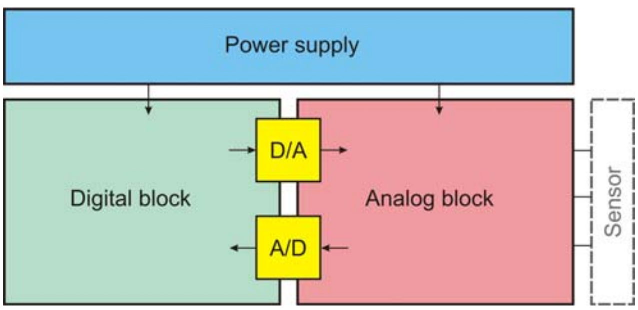


Fig. 4: Block diagram of instrument

A. Digital Block

Block diagram of digital part (fig. 5) is divided into three main logical parts: input part, data processing and output part. Input part consist keyboard which makes it possible to control instrument and A/D converter. Data obtained from A/D converter are processed by microcontroller in data processing part. Output part includes LCD, relays and D/A converter. The status of instrument is displayed on LCD. A range of measuring is adjusted through relays. Digital block include external memory and USB communication module.

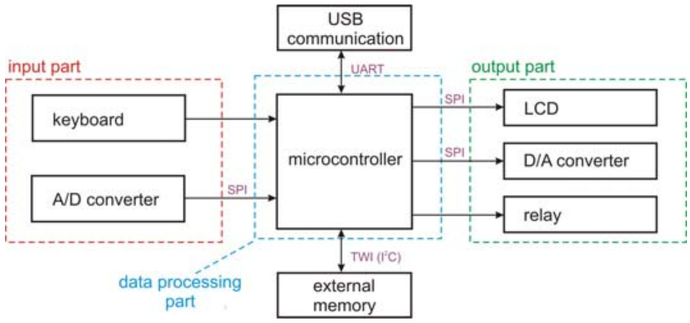


Fig. 5: Digital block

B. Analog Block

Output signal generated by D/A converter is shaped via Butterworth's filter (fig. 7). Output amplifier transform voltage level of signal to required values and provide current boosting for auxiliary electrode (AE). Signal obtained from reference electrode (RE) via follower is connected to auxiliary amplifier circuit. A negative feedback is realized by this way. This feedback allows making output voltage (from reference electrode) independent on passing current. Signal from reference electrode is converted to required levels for A/D converter processing. Current flow from work electrode (WE) is transformed to voltage levels via I/U converter. Output signal is converted to required levels for A/D converter processing. Analog block include reference power supply. Reference supply allows keeping constant measuring conditions.

V. Mechanical Construction of Chassis

Chassis of instrument is made from aluminum alloy. Chassis provide mechanical protection and electromagnetic shielding. Chassis was designed with support of mechanical 3D CAD software (fig. 7) and produced on CNC machine.

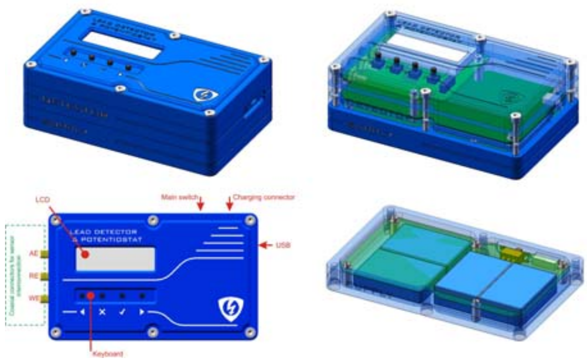


Fig. 6: Mechanical construction of chassis

VI. Conclusions

It were studied and proved methods of electrochemical detection focused on heavy metals. The work lotion was found and solders iron composing was analyzed during laboratory work. It was designed and made unique measuring instrument for lead detection on the basis of laboratory work results. Instrument allows single valued detection of lead presence in soldering irons. Instrument was designed and made with support of CAD and CAM software. Individual analog blocks were simulated in PSpice.

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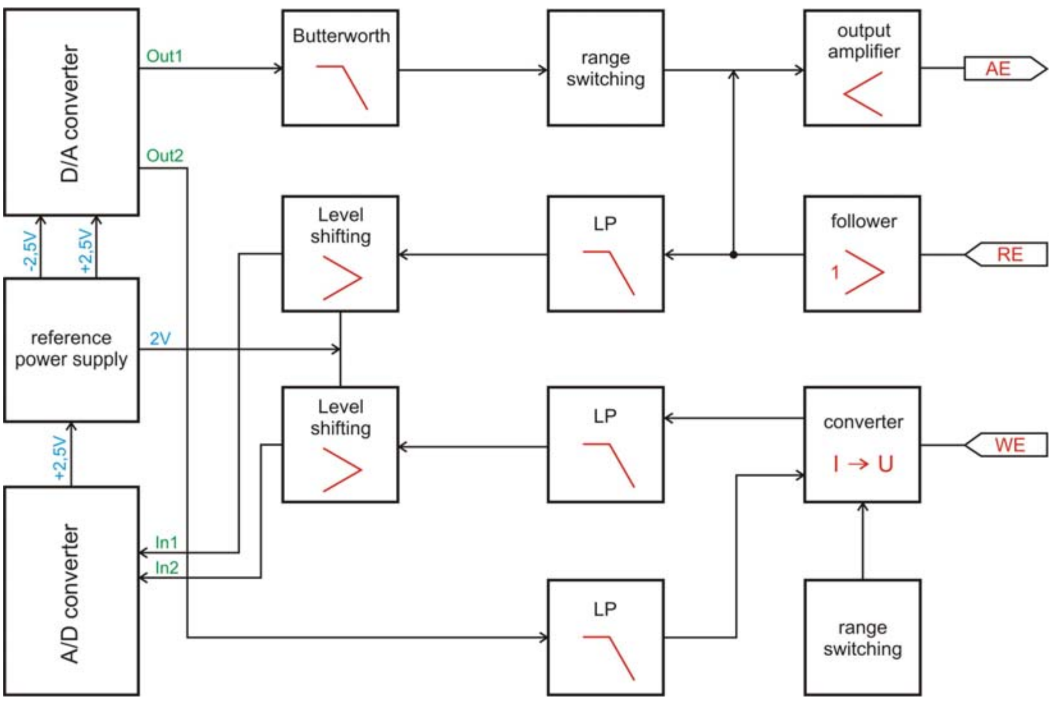

Fig. 7: Analog Block