SOLDER JOINT FAILURE IDENTIFICATION SYSTEM

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Abstract: This article deals with defects of the solder joints and their identification. These defects arise in the form of cracks during the thermoelectric cycling. A system capable of identifying these failures and theirs digital process is described below. Moreover, the article defines how to identify errors, the principle of function of the entire system and its parameters. At the end of this article the benefits of this kind of system in practice are described.

Keywords: PC, identification, system, solder, PCB, cycle

1. INTRODUCTION

Due to the thermoelectric stress the tension in the soldered joint arises. The tension may cause a crack of the soldered connections and the subsequent interruption. This interruption is recognized as a failure of the solder joints. These defects may be identified and digitally processed using flip-flops. For this purpose a system identifying the failure of solder joints and with the aid of a serial line is sending these data to the PC was developed. The above-mentioned data are further processed in a PC with appropriate software, which are saved in a database for further processing.

This system is designed either for testing of solder joints in laboratories or in manufacturing processes of enterprises.

2. THERMOELECTRIC STRESS

Thermo-mechanical stress is dominant in soldered assemblies that are implemented through a solder joint rigid connection. In practice it is the assembly of surface kit components or modules. It does not make sense to consider installation of outlet components or connections via wire outlets pins and alike. The temperature changes due to a different thermal expansion coefficient CTE (Coefficient of Thermal Expansion) and occurs in a process of resizing individual parts of the system, in an assembly or during normal operation, resulting in stress and a change of the shape of the solder joint. The theory can be found in [1].

If some parts are rigidly connected (by a solder or a conductive glue), a change in dimension of the relatively inelastic joint causes a change of tension, which cyclically strains joint alternatively by tension and compression. After a while comes fatigue caused by gradually expanding crack leading to an interruption of the connection. In practice, rapid cycling induces the fault. Thermal cycles are applied on the joint. The amplitude of the temperature and thermal dwell are set for the relevant product category by relevant standards [2], [3]. [4].

3. SYSTEM DESCRIPTIONS

The thermo-mechanical stress in the observing material occurs during a thermal cycling, which may lead the formation of cracks. In solder joint and conductive paths it leads to interruption of the electrical signal where this phenomenon occurs to cause defects in electrical equipment and degradation of its functions.

Equipment for identification of failures which has arisen during thermal cycling evaluates solder joint, or a conductive path to the PCB (printed circuit board) and, in the case of cracks it results in a power interruption for at least 100ms, it indicates this failure through a LED with memory that is corresponding to a tested joint. In order to further process and evaluate the data, the board is connected to the computer with software that puts identified errors into the database. Apart from putting the data into the database the software also has a graphic extension that allows depiction of individual test boards with the depiction of the measurement errors. This gives the user an instant overview of the identified errors and their location.

According to the testing, the system is able to set a time period for data collection from the 15s up to tens of hours. There is also a possibility to stop testing and then re-run e.g., when modification of chambers during thermal cycling is needed. The data saved in the database can be exported into MS Excel in required range.

3.1. A PROPOSAL AND PRODUCTION OF SYSTEM

I have designed a system to meet the requirements of having ability to be placed in both automatic and manual mode of measuring. This condition is based on system, which can be used without computer. Apart from functional requirements, the whole project is made for everyone, is easy to be used and enables a simple orientation in manipulation of the system.

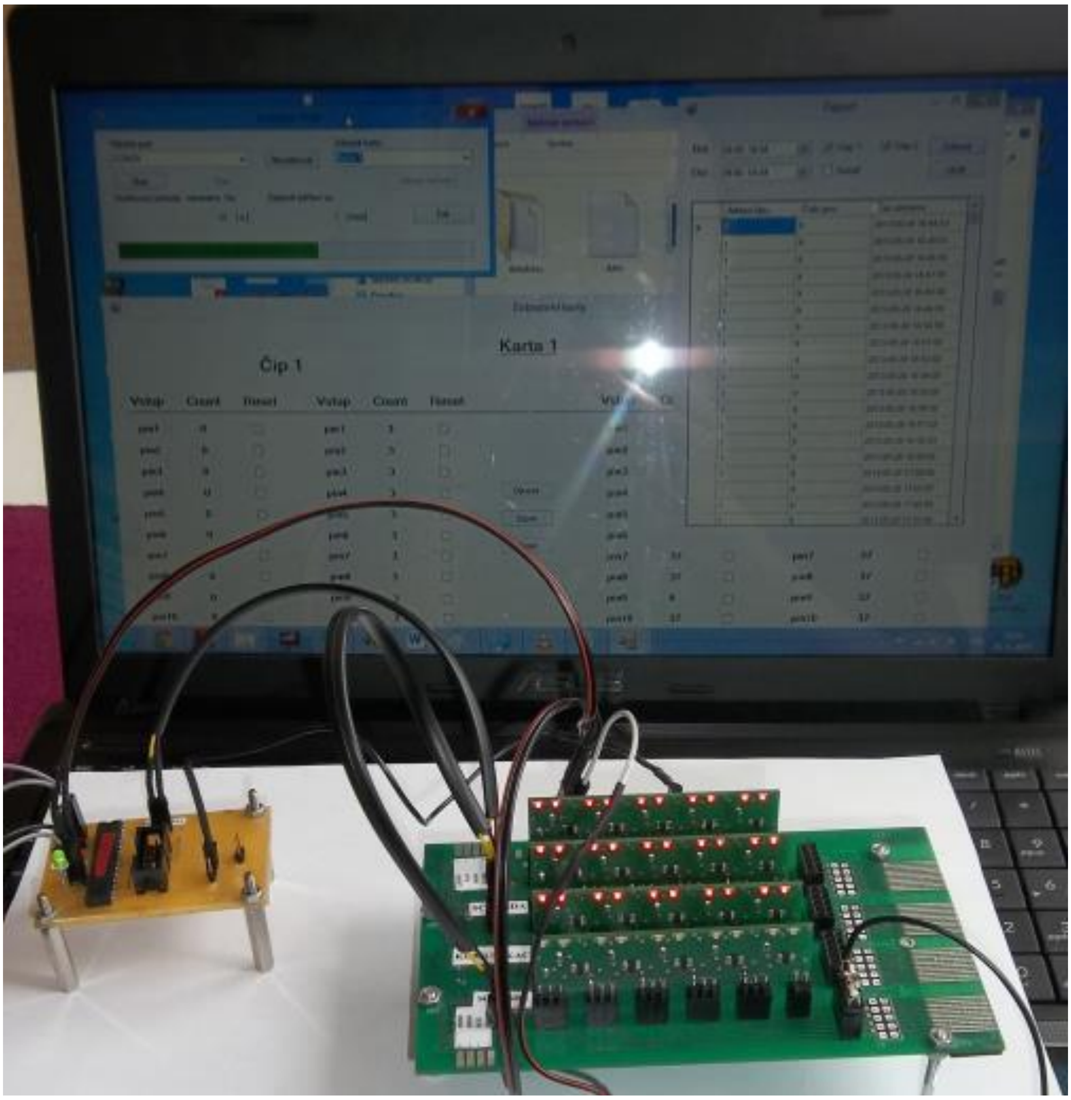

Figure 1: Real system

Further main criterion is that this system is assembled from easily linked up modules that extend or minimalize the system as needed. The system consists of three modules due to this easy connection. First module is board, which tests and monitors failures on solder joints. Mentioned board contains microcontrollers which record interrupts of joint and register information about failure in a form of LED light. Board for measuring can be put into main board that contains microcontrollers ATMEGA 8. These microcontrollers collects information of failure from four inserted boards for testing solder joints. Main board collects all data and waits for a pulse from Communication board that makes connection between computer and named main board. Due to this, communication board controls main board and gives information when to send collected data and when reset main board.

Communication board is subordinated to information from computer so it waits for data from computer. Once received, communication and the main board start cycles of testing solder joints. The entire system is under active measurable mode as shown in Figure 1. There is computer with software, large main board with four boards for measuring failures and yellow Communication board.

3.2. WIRING AND SYSTEM SPECIFICATIONS

In a figure 1 there is seen a connection of the entire system, which is capable of operating in automatic mode only with the main board including necessity for manual operation and reset. The figure only shows the system itself without chambers for thermal cycling, because any device capable of moving in the temperature range of the norm can use this chamber.

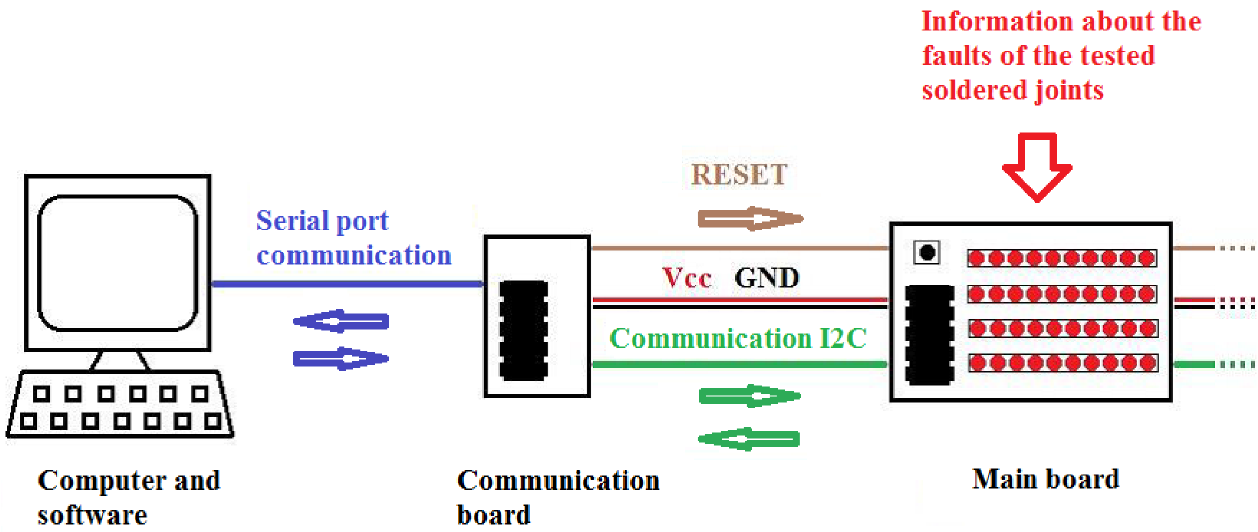

Figure 2: Block diagram of system

Due to the microcontroller ATMEGA8 placed on a system a device is easy to extend and modify it. A measured board is able to identify approximately 40 solder joints or conductive paths. The entire device can be extended to 50 measuring boards, which gives the ability to serve up to 2,000 tested places.

3.3. SYSTEM TESTING

I have chosen testing to point at reliability and precision of system, as well as at time stability. It is a device for long-lasting intervals stage. Besides, I have put the system to the test in three ways.

First option was functionality. I have accomplished this with random solder joints-aided and testing-aided in case of all failures will be correctly identified and evaluated by software. No mistake had appeared while testing so system recorded all artificial interrupted solder joints. All things considered, this system could be declared as reliable.

Second test was accomplished by connection of system for long interval in active mode. Long time interval means ten days; in those ten days the system was turned on and was testing failure of solder joints, which were going through temperature cycles. During this period the system didn't detect any hack or strike. After mentioning above, this system is able to test solder joints for long period without any mistakes or interrupts.

Last test of system was made for software and its difficulty for computer. During this test I have observed an output of processor and RAM capacity in dependence on various parameters and system options. For instance, opening some measurable cards in all, recording value into database, etc.. The system has minimal demands on computer; this process of test is shown in Figure 3.

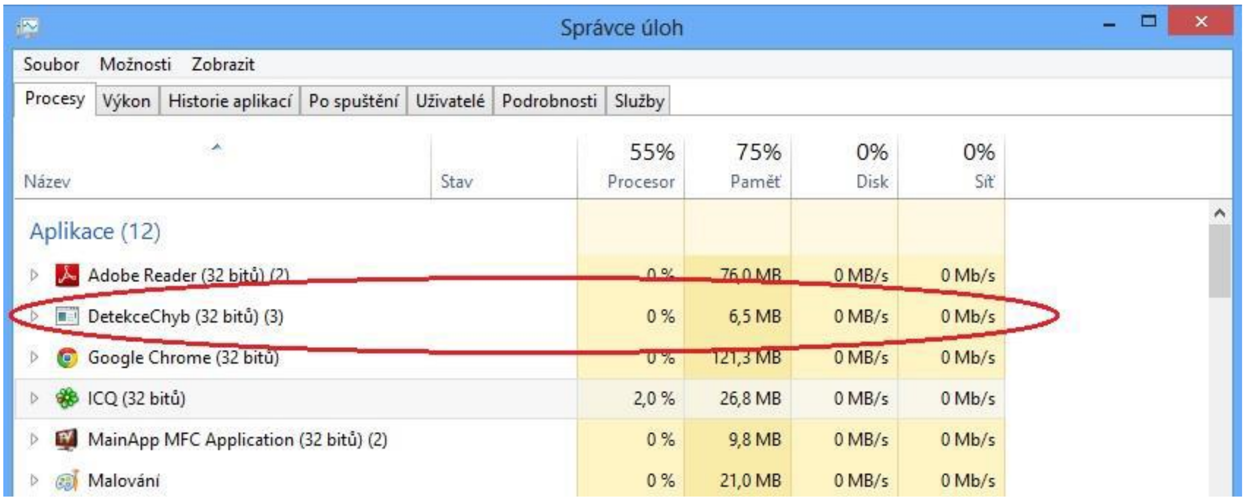

Figure 3: Software test

4. CONCLUSION

Almost every electronic device that will be placed on market is struggling with testing solder joints and ensuring theirs high reliability. Therefore to create a functional system that identifies failures of solder joints is autonomous and collects data without any additional service is highly desirable and needed.

Described system enables to work in two different modes. First mode, a mode for the testing solder joints with the presence of the attendant was not used due to the time duration. The second mode, way more essential and gravely described above, enables to test solder joints through PC while data are recorded into an electronic form and are able to be processed afterwards. This mode reduces an amount of errors that are made while subtracting by attendant and eliminates a presence of attendants itself.

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