TECHNOLOGICAL STUDY ON INDUSTRIAL HOT BAR SYSTEM

A. HANTIG - Universitatea Politehnica Timisoara, Facultatea de Mecanică
D. PETRESCU (DUBIC) - Universitatea Națională de Științe și Tehnologie Politehnica București, Fac. Inginerie Industriala și Robotică
O. R. CHIVU - Universitatea Națională de Științe și Tehnologie Politehnica București, Fac. Inginerie Industriala și Robotică
A. DUME- Universitatea Politehnica Timisoara, Facultatea de Mecanică
A. FEIER - Universitatea Politehnica Timisoara, Facultatea de Mecanică

Abstract: *This paper presents a technological study on the industrial hot soldering system that is used in the automotive industry. The main objective of the study is to fully analyze the process of making joints by hot element soldering. The study highlights the role of this type of joint in creating reliable, energy-efficient assemblies adapted to the current needs of the automotive industry for quality, productivity and sustainability. In addition, the paper examines the integration of the hot soldering system into the automated production flow. It focuses on the architecture of industrial equipment, the degree of automation and the benefits of the technology compared to other assembly approaches used in the automotive industry. The advantages of repeatability, reduced cycle times, reduced energy consumption and increased operator safety are highlighted.*

Keywords: Hot Bar Reflow Soldering, process calibration, flexible circuit soldering, technological study.

1 INTRODUCTION

Hot bar, also known as pulsed heating, hot reflow soldering or hot soldering, is a selective joining process in which two solder-plated parts are pressed together and heated to a temperature that allows the solder to melt and flow. After that, the parts are cooled to form a permanent electro-mechanical bond.

This paper presents the detailed study of an industrial automatic rotating table soldering system, used in the electronics industry for making joints between printed circuit boards (PCBs) and flexible circuits (flex). An overview of the analyzed system is shown in Fig.1.

The Hot Bar/Pulsed Heat technology used by AMADA systems produces rapid heating and controlled cooling of the joint area through a controlled electric thermode.

Operation principle: Correct positioning of components in the mold, application of pneumatically controlled force, heating of the thermoplastic or active adhesive layer, and pressure cooling to stabilize the joint.

This technology allows for uniform, repeatable and deformation-free joints.

Fiabilitate si Durabilitate - Fiability & Durability No 1/ 2026
Editura "Academica Brâncuşi" , Târgu Jiu, ISSN 1844 – 640X,
DOI: 10.65631/JFD.1(37).2026.29

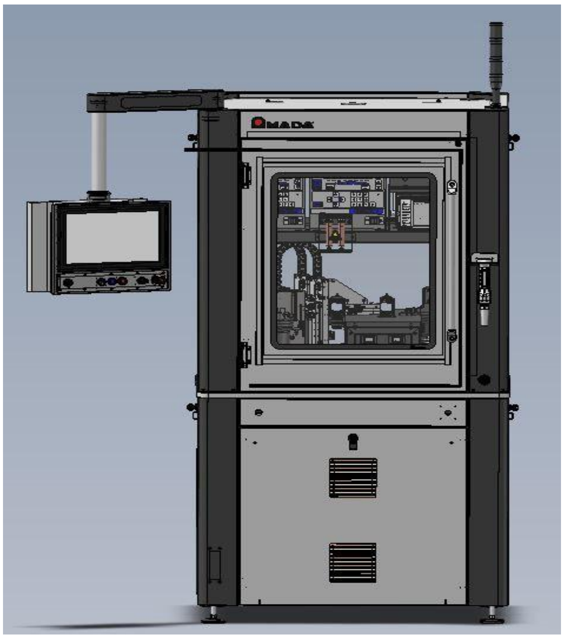

Fig. 1 – Overview of the Jupiter Turntable Solder System.

2. GENERAL DESCRIPTION OF THE SYSTEM

The Jupiter Turntable Solder System is an autonomous industrial equipment, consisting of a rotary indexing table, hot-bar soldering heads, dedicated power supplies and advanced monitoring and control systems, according to the structure shown in Fig. 2.

Fig. 2. – Constructive structure of the system: rotary table, electrical cabinet and process subsystems.

3. WORKING PRINCIPLE OF ROTARY TABLE

The operating principle of the system is based on the use of a rotary indexing table with five workstations, arranged radially. The sequence of technological stages is schematically illustrated in Fig. 3.

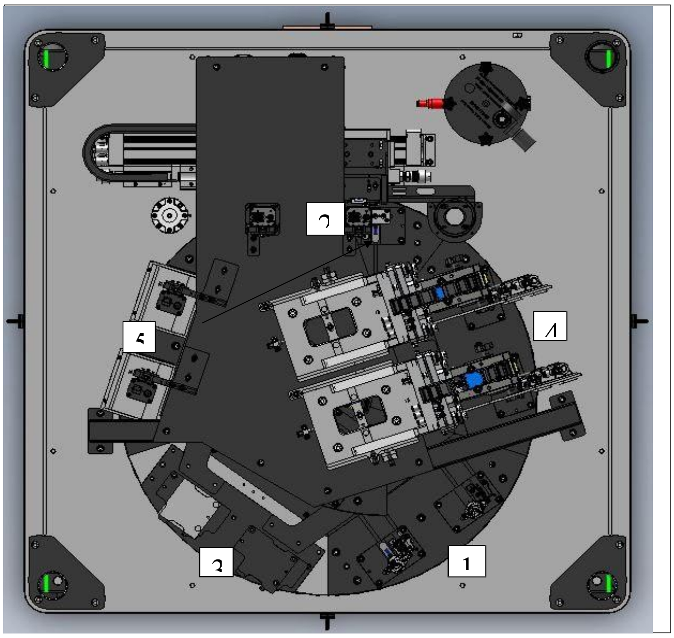

Fig. 3 – Rotary indexing table with five workstations.

4. ANALYSIS OF THE TECHNOLOGICAL PROCESS

The complete technological flow of the PCB–flex soldering process is summarized in Fig. 4, including the stages of loading, flux application, flex positioning, soldering and final control.

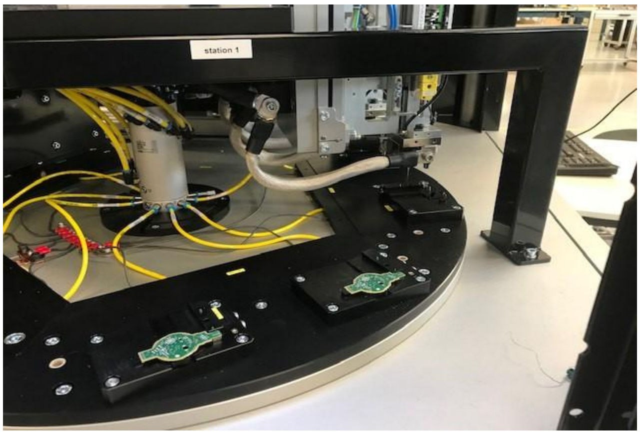

Fig. 4 – Schematic of the technological flow of the PCB–flex soldering process.

4.1. Flow application station

The application of liquid flux and the verification of uniformity by industrial vision system are illustrated in Fig. 5, highlighting the role of optical control in ensuring the quality of the process.

Fig. 5 – Application of the flow and verification of the degree of coverage using industrial vision system.

4.2 Bonding Station

The central stage of the technological process is represented by the soldering station, where the force and temperature controlled by hot-bar ends are applied. The configuration of the station is shown in Fig. 6.

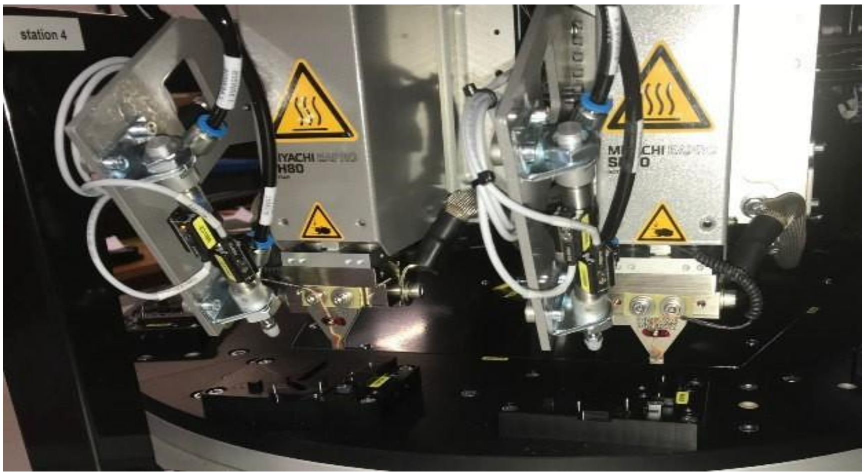

Fig. 6 – Hot-bar soldering station with SH80 ends and downholders.

4.3. Analysis of the SH80 soldering head

The SH80 soldering head is the active element of the bonding process, ensuring the controlled application of force and temperature. Its structure and components are illustrated in Fig. 7.

Fig. 7. – SH80 soldering head: structure and main functional elements.

4.3 Critical analysis and technological limitations

Although the Jupiter Turntable Solder System offers a high level of automation and repeatability, there are technological limitations related to application flexibility, high upfront costs, and the need for frequent calibrations of process parameters. These aspects must be assessed against the requirements of the specific industrial application.

5. SOLDERING PLATES

In the case of this process, all parameters are set according to the already optimized instructions. Parameters have been calibrated and validated. The most important parameters are: temperature, pressing force, distance between components, flatness and flow coverage of the components. In the figures below, some parameters of this process are highlighted.

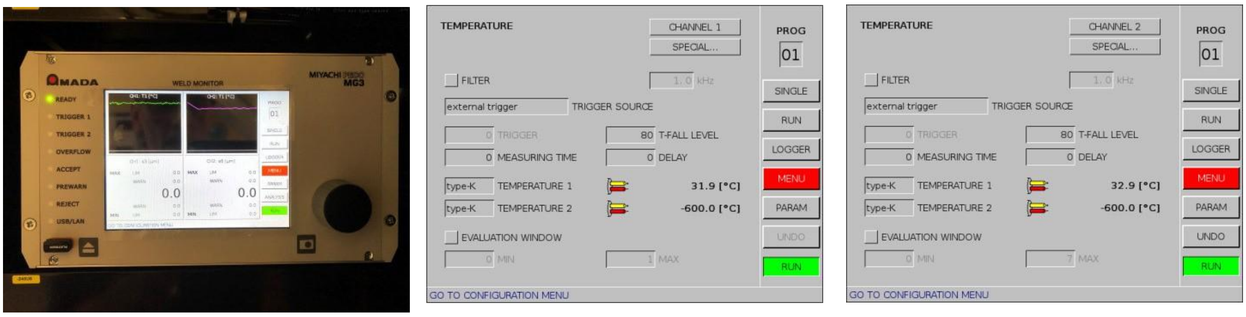

Fig.8. Setting the temperature parameter.

Heating rate:

- Raw Heating Speed: Slow
- Adjusted heating rate: 85%

To determine limits, the data of many products must be recorded and analyzed, including in the case of the temperature parameter.

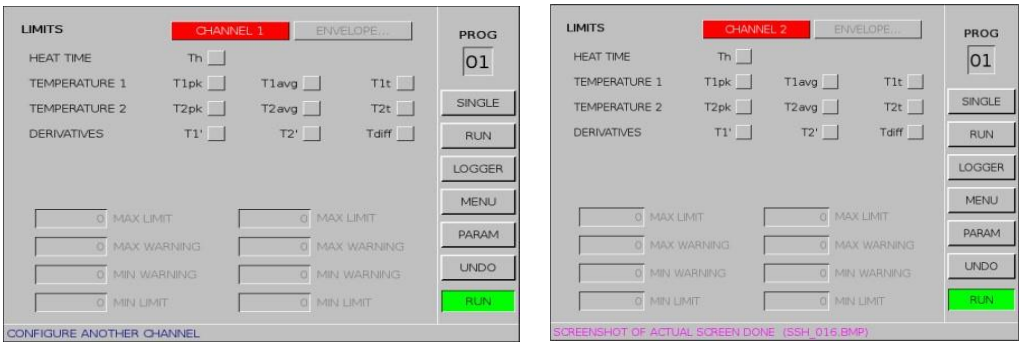

Fig.9. Setting the limits in case of the temperature parameter

In the case of another very important parameter, namely force, measurement and calibration is very important to obtain the correct values. An example of parameter calibration in the images in fig. 10.

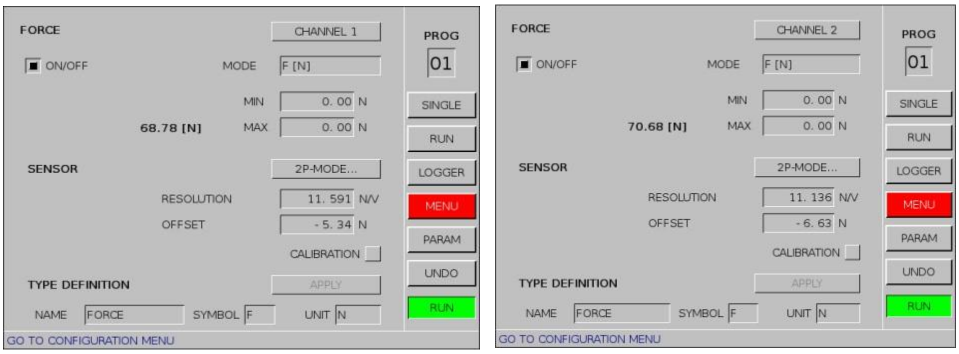

Fig.10. Calibration of the force parameter

Another important parameter is the position of the thermocouple and planarity on the soldering head. Each soldering head has an adjustment possibility for X (green arrow), Y (red arrow) and phi (blue arrow) (fig.11). Each thermocouple can be set plane in X (red arrow) and Y (green arrow) (fig.11).

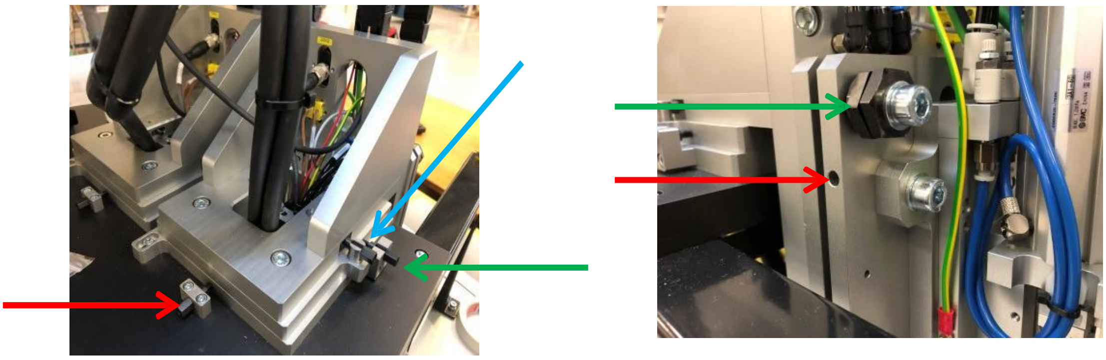

Fig.11. Flatness calibration

Changing the position of X, Y, phi has no effect on the planarity of the thermocouple, but changing the planarity will have a direct effect on the position of the thermocouple.

6. PROCESS AUTOMATION BENCHMARKING – ET VS. GP

Role and purpose

6.1. ET (Electrotechnik)

- It details *how* the installation is technically made: AC/DC power supplies, protections, I/O scheme, PLC & Safety, networks, HMI/IPC, wiring, clamps, bills of materials.
- It is the basic document for execution, commissioning, troubleshooting.

6.2 GP (General plan / Gesamtplan)

- It presents *what* the installation is at the overall level: functional architecture, division by stations/zones, correlation of subassemblies (robot, fluxer, stores, transport).
- It is the basic document for overall understanding, conceptual validation, communication between disciplines.

Level of Detail

- ET: very granular (terminal level, I/O channel, addressing, IPs, part code).
- GP: macroscopic (technological flow, interactions between modules, limits of responsibility).

Main users

- ET: electricians, automation engineers, service/maintenance.
- GP: project manager, systems engineer, safety officer, client/audit.

Functional safety

- ET: concrete implementation (PROFIsafe, FDI/FDQ, NotHalt circuits, doors, STO).
- GP: safety logic at the level of zones and scenarios (who stops what and why).

Network & Communications

- ET: physical/logical topology, cabling, switches-, fixed IPs.
- GP: functional dependencies (robot ↔, PLC, ↔ vision ↔ fluxer).

Complementarity

- GP without ET = difficult concept to implement.
- 2. List of risks and critical remarks
- A. Safety and compliance
- High leakage current at PE (≥10 mA)
- Risk: unintentional trips, PE heating, EMC problems.
- Remark: required *a second correctly* sized EP; periodic continuity checks.

7. CONCLUSIONS

AMADA offers a mature and high-performance solution for industrial applications with high demands on precision and productivity. Hot Bar/Pulsed Heat technology provides stable and controllable joints, making it ideal for modern automated production lines.

The technological analysis of the industrial automated hot soldering system developed by AMADA shows that this solution represents an advanced level of technological maturity in the field of modern assembly processes.

In an automated architecture, the integration of Hot Bar technology enables the realization of high-quality joints, which are characterized by high repeatability, dimensional stability and precise control of process parameters. These joints are essential in industries that have strict requirements for quality and reliability.

Traceability and process monitoring are two more important aspects.

The continuous recording of technological parameters, such as temperature, force and process times, allows the creation of powerful quality control systems and facilitates the analysis of causes in the event of a defect.

In this context, the AMADA system aligns with the current requirements of production digitalization and Industry 4.0 concepts, providing good premises for integration into quality management and predictive maintenance systems.

8. REFERENCES

[1]. https://www.amadaweldtech.eu/products/hot-bar/hot-bar-systems

[2]. https://www.directindustry.com/prod/amada-weld-tech-inc/product-23347-672257.html

[3]. https://www.amadaweldtech.eu/knowlegde-base/hot-bar-reflow-soldering

[4].https://www.amadaweldtech.eu/sites/default/files/documents/whitepapers/AMYE%20Hot%20Bar%20Reflow%20Soldering%20Technology%2003-2016.pdf

[5]. Amada – User Manual – Jupiter Turntable Solder System

[6]. Amada – User Manual – 61P0072 & 73 – Settings, adjustments & calibrations

[7]. **D. Wagner, K. Pitschmann, F. Sebastian, B. Schmidt, M. Detert, and U. Schumann,** *"Hot bar joining method for medical applications,"* in Proc. 21st Eur. Microelectron. Packag. Conf. (EMPC) Exhibit., Warsaw, Poland, Sep. 2017, pp. 1–4

[8]. **J. Zhou, L. Zhuang, Z. He, and D. Herscovici,** *"Practical design, simulation, and prototype of a hot bar blade for printed circuit board soldering,"* J. Manuf. Syst., vol. 20, no. 3, pp. 177–187, Jan. 2001.

[9]. **Demetrius Petrescu (Dubic), Oana Roxana Chivu, Anamaria Ioana Feier, Marilena Gheorge,** *An automated process for bonding a PCB circuit to a flexible polyamide circuit,* Sudura nr. 4, 2024