Moreover, automatic (e.g., robotic) soldering is currently strictly an open-loop time based event, where a robot moves to the specific joint, the solder tip is automatically placed on the joint, solder is automatically applied, and a prescribed time later (determined by a specific software for the robot), the solder tip is automatically removed from the joint. This process is repeated until the robot's program is complete. This open-loop time based event can be significantly improved by using the various embodiments of connection validation (CV) technology disclosed herein, with a real-time feedback of the solder quality.

SUMMARY

In some embodiments, the present invention is an intelligent soldering cartridge that includes: a housing; a solder tip; a heater for heating the solder tip; a storage device for storing information about characteristics of the cartridge; a processor for retrieving the information about characteristics of the cartridge, monitoring ~~the~~ an amount of power ~~level~~ delivered to the solder tip to detect liquidus occurrence at a solder joint, determining a thickness of an intermetallic compound (IMC) of the solder joint using some of the retrieved information, determining whether the thickness of the IMC is within a predetermined range, and generating an indication signal indicating that a reliable solder joint connection is formed when the thickness of the IMC is within the predetermined range; and an interface for transmitting the indication signal.

In some embodiments, the present invention is an intelligent soldering cartridge that includes: a housing; a solder tip; a heater for heating the solder tip; a storage device for storing information about characteristics of the cartridge; a processor for retrieving the information about characteristics of the cartridge, detecting liquidus occurrence at a solder joint, receiving a 3D current image of the solder joint, determining volume of the dispensed solder after occurrence of the liquidus from the 3D current image, comparing the volume of the dispensed solder to an amount of solder needed to fill in a barrel of a hole for a through hole component, or to fill in a surface of a barrel of a hole for a surface mount component to determine how much of the dispensed solder is dissipated onto the barrel or on the surface area of the barrel, repeating the comparing of the volume of the dispensed solder until the dispensed solder has

filled the barrel or the surface area of the barrel, and generating an indication signal indicating that a reliable solder joint connection is formed when the dispensed solder has filled the barrel or the surface area of the barrel within the predetermined tolerance; and an interface for transmitting the indication signal.

The interface may be a wireless and/or wired interface. In some embodiments, the cartridge includes a temperature sensor for measuring a temperature of the solder tip, where the temperature sensor periodically measures the temperature of the solder tip and feeds the information to the processor, and wherein the processor adjusts the temperature of the solder tip when said temperature changes from a predetermined value.

The intelligent soldering cartridge in embodiments of the present invention may be used in a handheld soldering iron or an automatic soldering station for soldering work pieces.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A depicts an exemplary handheld soldering iron, according to some embodiments of the present invention.

FIG. 1B is an exemplary block diagram of a processor and associated components, according to some embodiments of the present invention.

FIG. 1C depicts an exemplary handheld soldering iron where the processor and associated circuitry are in a power supply, according to some embodiments of the present invention.

FIG. 1D shows an exemplary handheld soldering iron where the processor and associated circuitry are in a handpiece, according to some embodiments of the present invention.

FIG. 1E illustrates an exemplary handheld soldering iron where the processor and associated circuitry are in a cartridge, according to some embodiments of the present invention.

FIG. 1F shows an exemplary handheld soldering iron where the processor and associated circuitry are in a work stand, according to some embodiments of the present invention.