improved methods of applying a constant voltage to an ultrasonic transducer of a wire bonding machine.

SUMMARY OF THE INVENTION

[0009] According to an exemplary embodiment of the present invention, a method of calibrating a voltage for use with an ultrasonic transducer of a wire bonding machine in a constant voltage mode is provided. The method includes: (1) determining an impedance value associated with operation of the ultrasonic transducer of a wire bonding machine; and (2) establishing an adjusted voltage level to replace a reference voltage level for use with the ultrasonic transducer in the constant voltage mode based on the determined impedance value, the adjusted voltage level being a voltage setpoint to be applied to the ultrasonic transducer during operation in the constant voltage mode.

[0010] The methods of the present invention may also be embodied as an apparatus (e.g., as part of the intelligence of a wire bonding machine), or as computer program instructions on a computer readable carrier (e.g., a computer readable carrier used in connection with a wire bonding machine).

[0011] According to another exemplary embodiment of the present invention, a wire bonding system is provided. The wire bonding system includes an ultrasonic transducer and a controller. The controller is configured to (1) determine an impedance value associated with operation of the ultrasonic transducer, and (2) establish an adjusted voltage level to replace a reference voltage level for use with the ultrasonic transducer in a constant voltage mode based on the determined impedance value, the adjusted voltage level being a voltage setpoint to be applied to the ultrasonic transducer during operation in the constant voltage mode.

[0011a] According to another exemplary embodiment, there is provided a computer readable carrier including computer program instructions which cause a computer to implement a method of calibrating a voltage for use with an ultrasonic transducer of a wire bonding machine in a constant voltage mode, the method comprising the steps of: (1) determining an impedance value associated with operation of the ultrasonic transducer of a wire bonding machine; and (2) establishing an adjusted voltage level to replace a reference voltage level for use with the ultrasonic transducer in the constant voltage mode based on the determined impedance value, the adjusted voltage level being a voltage setpoint to be applied to the ultrasonic transducer during operation in the constant voltage mode.

[0011b] According to another exemplary embodiment, there is provided a method of calibrating a voltage for use with an ultrasonic transducer of a wire bonding machine in a constant voltage mode, the method comprising the steps of: (1) determining an impedance value associated with operation of the ultrasonic transducer; and (2) establishing an adjusted voltage level for use with the ultrasonic transducer in the constant voltage mode based on the determined impedance value, wherein step (1) includes (a) producing a sinusoidal output signal using a controller of the wire bonding machine, where the sinusoidal signal is swept across a frequency range including a resonant frequency of the ultrasonic transducer; (b) amplifying the sinusoidal output signal; (c) sending the amplified sinusoidal output signal to the transducer; (d) measuring, using the controller, a feedback signal of amplified sinusoidal output signal sent to the transducer; (e) determining the resonant frequency of the ultrasonic transducer through step (d); and (f) determining the impedance value at the resonant frequency of the ultrasonic transducer.

[0011c] According to another exemplary embodiment, there is provided a wire bonding system comprising: an ultrasonic transducer; and a controller, the controller being configured to (1) determine an impedance value associated with operation of the ultrasonic transducer, and (2) establish an adjusted voltage level for use with the ultrasonic transducer in a constant voltage mode based on the determined impedance value, wherein during the determination of the impedance value associated with operation of the ultrasonic transducer, the controller is configured to (a) produce a sinusoidal output signal swept across a frequency range including a resonant frequency of the ultrasonic transducer; (b) amplify the sinusoidal output signal; (c) send the amplified sinusoidal output signal to the transducer; (d) measure a feedback signal of amplified sinusoidal output signal sent to the transducer; (e) determine the resonant frequency of the ultrasonic transducer; and (f) determine the impedance value at the resonant frequency of the ultrasonic transducer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention is best understood from the following detailed description when read in connection with the accompanying drawing. It is emphasized that, according to common practice, the various features of the drawing are not to scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity. Included in the drawing are the following figures:

Fig. 1 is a perspective view of a transducer of a wire bonding machine and related components in accordance with an exemplary embodiment of the present invention;

Fig. 2 is a block circuit diagram useful in understanding methods of determining an impedance value associated with operation of an ultrasonic transducer in accordance with an exemplary embodiment of the present invention;