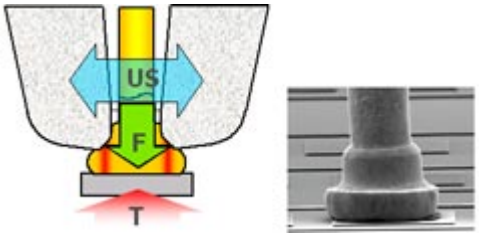
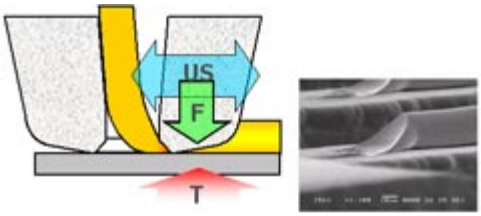
MEI Wire Bonder Brief Operation Guide

1 Basics of the Bonding Process

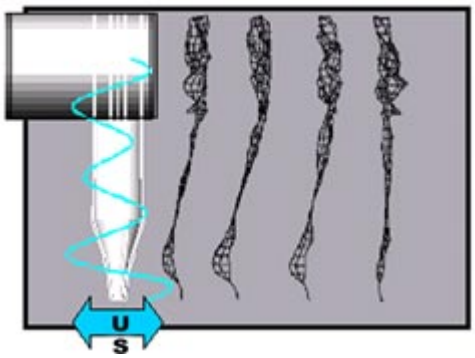
Thermosonic tailless ball and stitch bonding is the most widely used assembly technique in the semiconductors to interconnect the internal circuitry of the die in the external world. This method is commonly called, Wire Bonding. It uses force, power, time, temperature, and ultrasonic energy (sometimes referred to as bonding parameters) to form both the ball and stitch bonds.



Ball bond formation



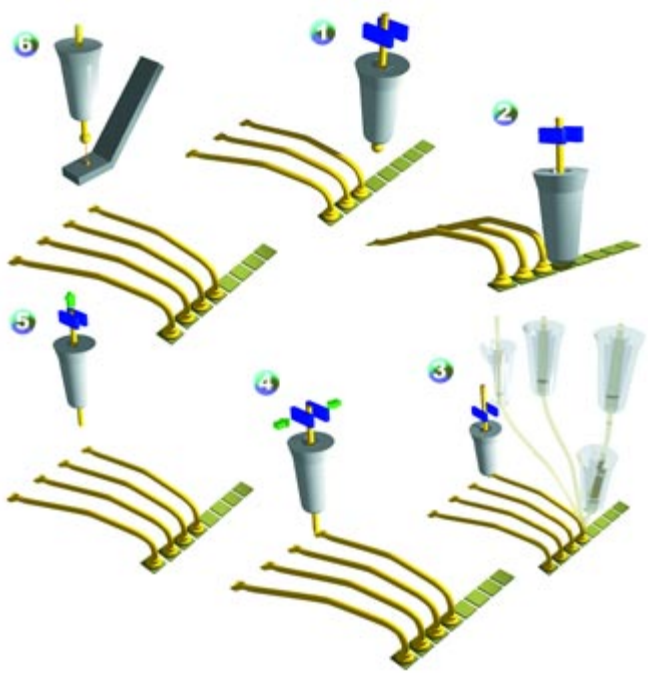
Stitch bond formation



Variation characteristic of the capillary

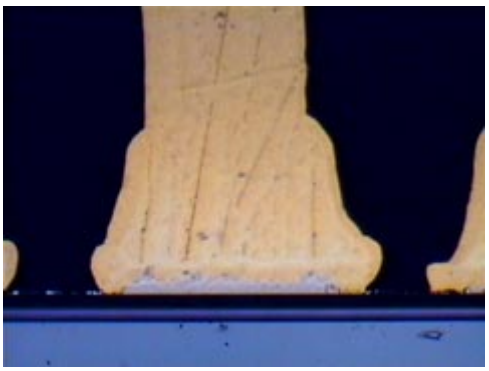
The ultrasonic transducer (typically for new generation of wire bonders, the piezoelectric element is >100KHz), which converts the electrical energy into mechanical energy, transmits this resonant energy at the tip of the bonding capillary. The capillary that is clamped perpendicularly to the axis of the transducer-tapered horn is usually driven in a y-axis direction vibration mode.

Bonding capillaries are made of high-density Alumina ceramic material, Al2O3, typically 1/16" (.0625" / 1.587mm) in diameter and .437" (11.10mm) in length. The final capillary design depends upon the package/ device application and wire diameter to be used. To determine the correct capillary design in general, bond pad pitch (BPP), bond pad opening (BPO), target mashed ball diameter (MBD) are the essentials.



A fine gold wire made of soft, face-centered-cubic metal (FCC), usually ranging from 18µm to 33µm in diameter (depending upon the device/ package application) is fed down through the capillary. It is usually characterized by its elongation (shear strain), and tensile strength (breaking load). Selection of the appropriate wire type to be used for a given application would be dependent on the specification of these elongation, and tensile strength. In general, the higher elongation (or higher strain), it means that the wire is more ductile. This is a good choice for low-loop, and short wire type of wire bonding application. If the requirement is for higher pull strength readings, a harder wire type having a higher tensile strength has to be considered.

The small incursions of ultrasonic energy at the tip of the capillary are transmitted to the Au ball and down to the Al bond pad to form the ball bond. After which, the capillary lifts up and form the looping profile, and then comes down to form the stitch bond. This cycle is repeated until the next unit is bonded.



Formation of intermetallic compound

If the pad is of a different metal other than Au. An intermetallic compound, Au-Al, is formed when the Au is bonded thermosonically to the Al bond pad metallization. The metallurgical interface of void free Au-Al formation has a significant increase in the shear strength readings of the ball bonds tested- provided that there are no impurities present in the bond interface even if it has been exposed to high temperatures. However, if the impurities are in the interface are welded poorly, the ball shear strength produces a significant degradation in its readings.

2 Instrument Operation

Assuming that the loop and reset heights are in the appropriate positions the basic manual operation of the wire bonder goes as follows.

2.1 Sample Mounting

Mount your sample on the work holder and clamp it, then set the height of the surface to be bonded according to the work height standard. This can be done by loosening the set screw on the side of the work holder and adjusting the hex screw on the underside of the work holder (see Figure 1). Keep in mind the stage can be heated and will be hot when you go to unload your sample.

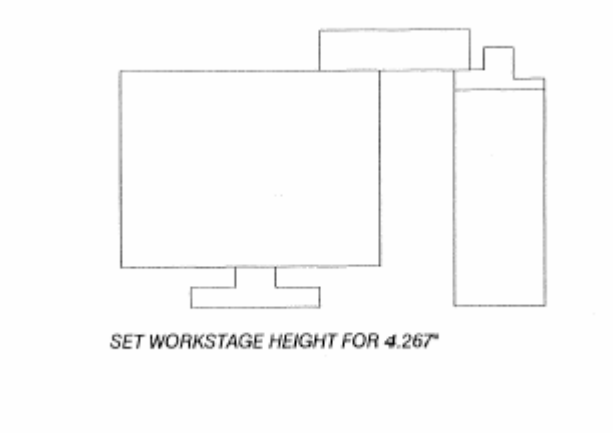


Figure 1 Setting the workstage height

2.2 Setting Bonding Parameters

Turn on the bonder and the heated stage. Check the bonding parameters (power and time on channels 1 and 2, first and second weights) Use recommended starting parameters.

Example Parameters: Ball Bonding 50nm sputtered Au on Channel 1: Power: 6 Time: 4 Dual Weight: 7.
Bonding Au emulsion layer on PCB board on Channel 2: Power: 6.7 Time: 7 Bond Force: 8.5 Heated stage: 80 C

2.2.1 Bonding Weights:

*Manual Recommends 35 to 50 grams for Dual Weight for 1 mil wire. With the instrument calibrated: the 0-14 range on the "Dual Weight" dial goes from 10 to 110 grams this is the bond force for **Channel 1 (first bond).** The "Bond Force" dial 0-14 ranges from 60 to 150 grams when calibrated this is for **Channel 2 (second bond)**. (see end of this guide for calibration routine) (Calibrated and dials reset 1_22_08)*

2.2.2 Bonding Heights:

If the work height standard was used a value of for Loop Height and for Reset Height should work. ***It is important that the Reset Height is high enough so the EFO wand clears sample when firing***. See towards the end of this guide for adjusting the values.

2.3 Manual Operation using the Z-arm control

The Z arm lets the operator have direct control of the up and down motion of the machine during the bonding process (see figure 2 for bonding process). The Z-arm gives the operator multi-level bonding capabilities for more complex applications without changing any settings on the machine. The Z-arm is located on the lower right side of the machine. ***Do not cycle the EFO with the Z-arm depressed***

2.3.1 The Bonding Cycle

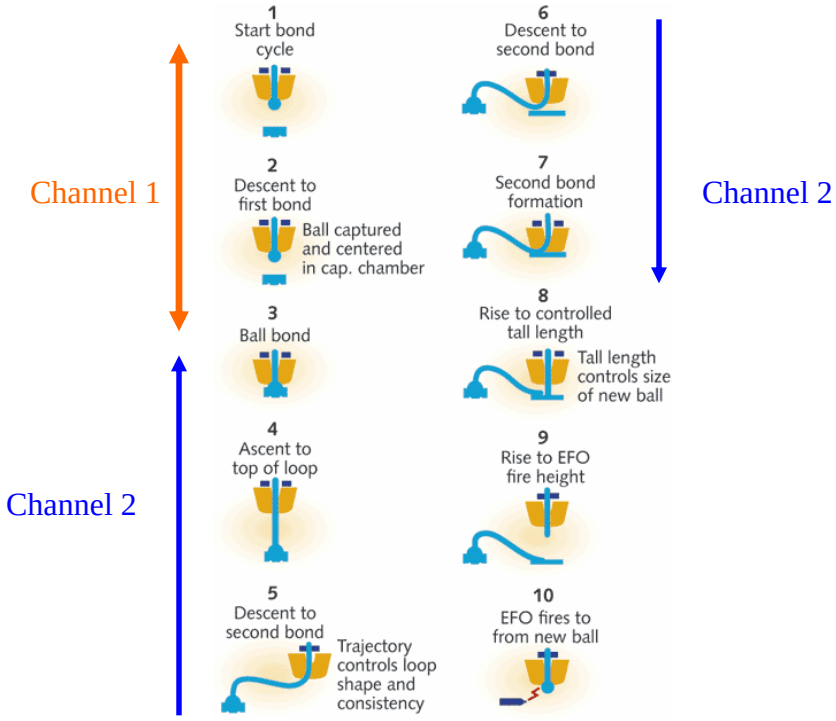


Figure 2 Bonding Cycle

2.3.2 First Bond (Ball Bond, Channel 1)

After properly loading the sample on the work holder and setting the height, place the work holder on the stage and look through the microscope to position the part to make the first bond using the micro positioner. Lower the Z-arm until the bonding

tool contacts the part. Continue down with the Z-arm to cycle the machine. Once the ultrasonics have fired, raise the Z-arm.

2.3.3 Second Bond (Stitch Bond, Channel 2)

Move the part to make the second bond, using the micropositioner. Lower the Z-arm again, which will trigger the ultrasonics at the end of its stroke.

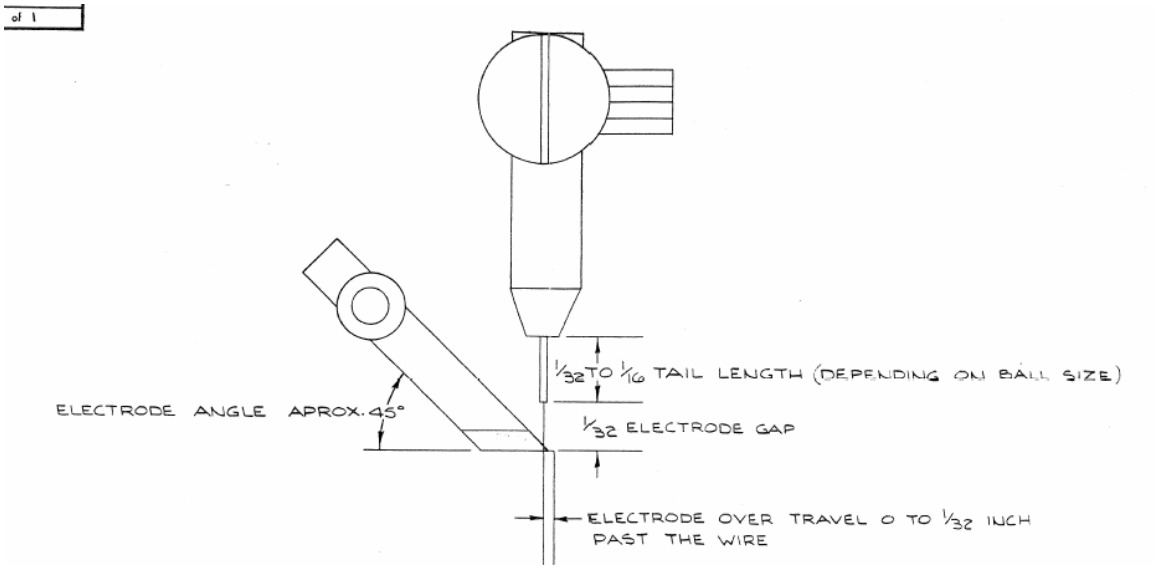
The Z-arm triggers the logic on the machine by using photocells located in the bottom of the machine.

The operator should not use much force to move the Z-arm. Bond head speed is controlled by the damper, and is independent of the speed the Z-arm is moved. This provides a uniform force for bonding.

2.4 Issues That Effect Bonding Performance

2.4.1 Free air ball (FAB).

The EFO knob should be adjusted to achieve consistent ball size. A properly adjusted EFO should form the ball up into the capillary. Too much voltage (too high a setting) will cause off center bonds (golf clubs); too little voltage (too low a setting) will cause the ball to be mis-seated in the capillary when the first bond is made.



2.4.2 Adjustments to Change Free Air Ball Size

BONDING ADJUSTMENTS

Once the machine has been checked out and you are familiar with the bonding procedure, there are several adjustments to optimize speed and quality of the bonds.

TAIL ADJUST

The tail adjust screw sets the ball size. It is usually desirable to keep the ball size between 2X and 4X the wire diameter.

To adjust: Turning the tail screw clockwise (unscrewing) will increase the ball size and counterclockwise will decrease the ball size.

NOTE: This is a sensitive adjustment. 1/8 turn of the tail screw should be a noticeable change in ball size.

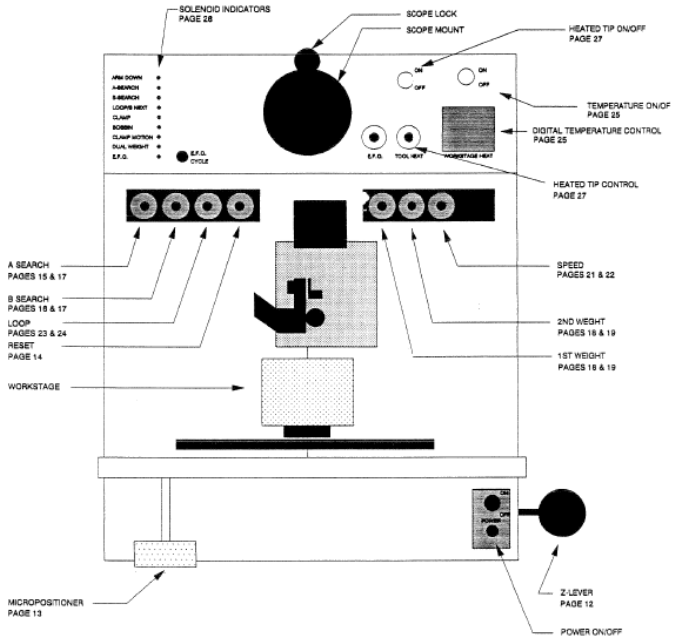


Figure 3 Wire bonder components

2.4.3 First Height Adjustment

Reset Control Dial

The reset dial is located on the upper left side of the MEI 1204 series bonders. The purpose of this control is to adjust the height of the bonding tool at reset. This is the position the bond arm after finishing the second bond. This height should be set high enough to easily load and unload parts from the workholder and clear all obstructions and allow the flameoff wand to come across without touching the work.

How to use the reset control dial

1. Turning the reset control dial clockwise will increase the number on the dial. This will also increase the reset height. When the machine is in reset position, only the dual weight and Bobbin LEDs should be lit.

2. Place a workstage that has been adjusted to the proper height by using the tool height gauge under the bonding tool.

3. Increase the reset control dial so that the bonding tool and EFO wand, when extended, clear everything on the workstage.

4. If the reset height cannot be moved high enough to clear all obstructions, follow calibration reset procedure.

Note: The reset control is preset at the factory and should not need any further calibration or adjustment. The following calibration procedure should be necessary only if the height cannot be adjusted properly.

5. The reset control is calibrated for the use of 0.375" (9,53 mm) capillaries for the 1204B.

2.4.4 Second Height Adjustment

Loop Control Dial

The loop control dial is located on the upper left side of the MEI-1204 series machines. This knob controls how far up the bonding tool travels between first and second bonds. This distance determines the loop height of the bond.

Use of the loop control

1. Check that the workstage is at the correct height using the tool height gauge. Adjust this height as necessary, so that the surface to be bonded to is at the proper height.

2. With a part to be bonded on the workstage, make an "A" bond using either the pushbutton or Z-arm.

3. At this point, the loop LED should be lit. Adjust the loop height by turning the loop control dial. Turning it clockwise (increasing the number) increases the loop height. Looking through the microscope, adjust the loop height as required by the application.

4. The loop height should only be adjusted while the loop LED is lit. If the loop height does not change while the LED is lit, perform the calibration procedure below.

The loop height is calibrated at the factory, and should normally not need adjustment. For 1204B series Ball Bonders, the loop height is calibrated for use with a 0.375" (9,53 mm) capillary. If a different sized tool is to be used, consult the factory.

2.4.5 Changing the Capillary

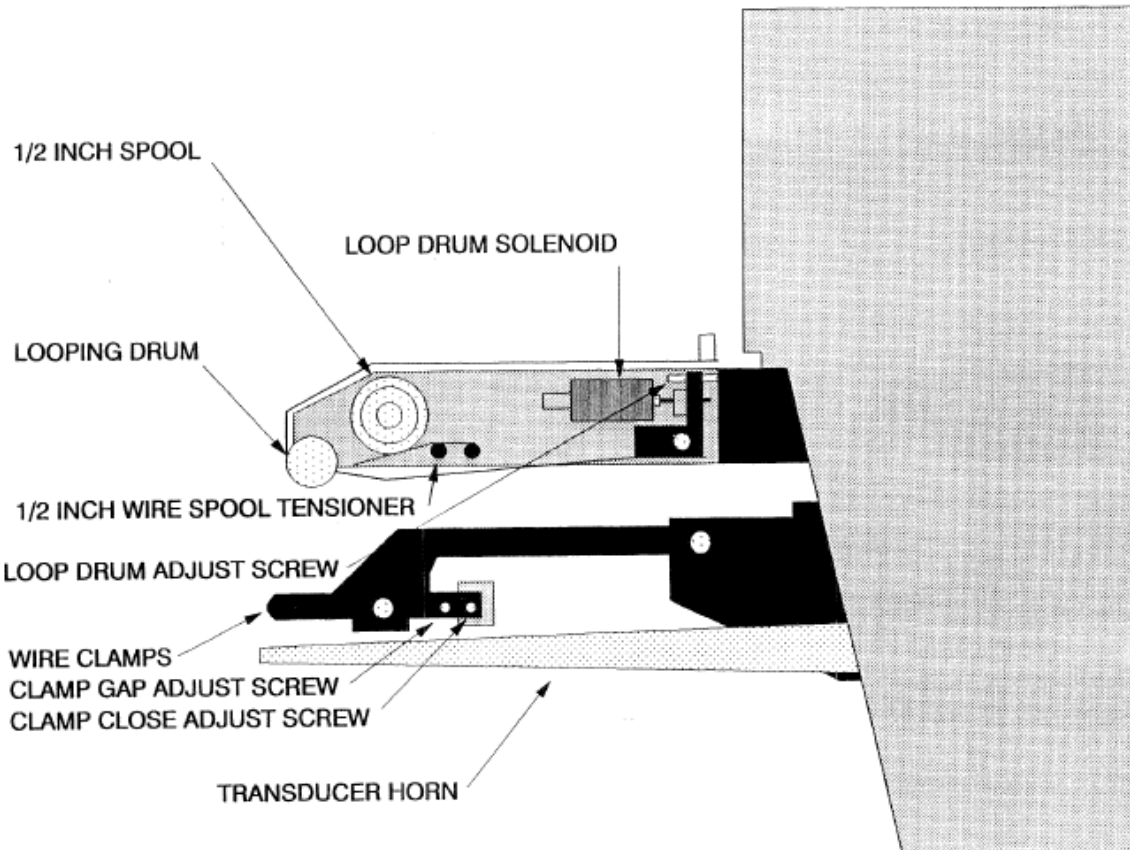


Figure 4 MEI Transducer Side View

If the capillary appears damaged and or the shape of the top of the ball bond appears inconsistent the capillary may need to be changed. In transducer, place appropriate capillary for wire size to be bonded. Note: Top of capillary should be flush with the top of transducer. Secure capillary by tightening cap screw using tool height gauge to set height.

The wire feeds off the bottom of the spool and threads between the looping drum and guide wire then straight through the wire guide (about the clamps) between the clamp pads and through the capillary.(Fig 4)

NOTE: After threading the machine, pull the wire through the capillary and check that the wire feeds smoothly through the guides and off the spool.

2.4.6 Parameters needed for semi-automatic bonding (using the silver 'cycle' button on the micropositioner.)

"A" Bond Search Height Control Dial

The "A" search height dial is located on the upper left side of the MEI 1204 series bonders. This control is only in effect while using the semi-automatic (pushbutton) bonding feature. When the silver pushbutton is depressed, the bond head will descend from reset height to "A bond" search height so that the operator can accurately target the position for the "A" bond.

How to use the "A" Bond Search Height Control Dial

1. Adjust the workstage to the correct height using the tool height gauge.

2. Press and hold the silver button on the positioner puck assembly. This will bring the bonding tool down to the work stage.

3. Turning the "A" search dial clockwise will increase the number on the dial, and will move the search height higher.

4. Adjust this dial until the bonding tool is at the highest "A" bond location or your most common "A" bond level.

5. Release the silver button and the 1204 will make the "A" bond.

Note: The "A" Bond search height control is preset at the factory and should not need any further calibration or adjustment. The following calibration procedure should be necessary only if the height cannot be adjusted properly.

6. The "A" bond search height control is calibrated for use with a standard 0.375" (9,53 mm) capillary for the 1204B. If a different sized tool is to be used, contact the factory.

Note: The machine will not cycle with the search height adjusted to zero.

"B" Bond Search Height Control Dial

The "B" search height dial is located on the upper left side of the MEI 1204 series bonders. This control is only in effect while using the semi-automatic (pushbutton) bonding feature. When the silver pushbutton is depressed, the bond head will descend from loop height to "B bond" search height so that the operator can accurately target the position for the "B" bond.

How to use the "B" Bond Search Height Control Dial

1. Adjust the workstage to the correct height using the tool height gauge.

2. Cycle the machine so that it is between "A" and "B" bonds. Loop solenoid LED should be lit. Press and hold the silver button on the positioner puck assembly. This will bring the bonding tool down to the work stage.

3. Turning the "B" search dial clockwise will increase the number on the dial, and will move the search height higher.

4. Adjust this dial until the bonding tool is at either the highest "B" bond location or your most common "B" bond level.

5. Release the silver button and the 1204 will make the "B" bond.

Note: The "B" Bond search height control is preset at the factory and should not need any further calibration or adjustment. The following calibration procedure should be necessary only if the height cannot be adjusted properly.

6. The "B" bond search height control is calibrated for use with a standard 0.375" (9,53 mm) capillary for the 1204B. If a different sized tool is to be used, contact the factory.

Note: The machine will not cycle with the search height adjusted to zero.

Calibration of "A" and "B" Bond Search Height Controls

1. Calibrate the "A" search height before the "B" search height. Place the tool height gauge under the bonding tool that is in the transducer. (Use the tool height gauge to install the tool).

2. Turn the machine on and push and hold the silver button on the positioner puck. This will allow the bonding tool to move down to the "A" search height. Then adjust the "A" search dial while looking through the microscope so the bonding tool touches the correct level on the tool height gauge for the bonding tool you are using.

3. When this process is complete, remove dial using the appropriate Allen wrench (do not move dial). Then, with the dial off the machine, adjust dial so that it reads 0.

4. Place the dial back on machine making sure not to turn the dial. Tighten the Allen screws. At this point, the "A" search dial is calibrated.

5. To calibrate the "B" search control, cycle the machine so that the hold back, loop, clamp, and solenoid LEDs are on.

6. Keeping the tool height gauge under the bonding tool, push and hold the silver button on the positioner puck.

7. Look through the microscope, adjust the "B" search dial so that the bonding tool touches the appropriate level of the tool height gauge.

8. When this process is complete, remove the dial using the appropriate Allen wrench. Then, with the dial off the machine, adjust it so that it reads 0.

9. Place the dial back on the machine, making sure not to turn the dial. Tighten the Allen screws. The "B" search control is now calibrated.

Calibration of First and Second Weight Dials

1. Remove the rear cover from the MEI-1204.

2. Turn the machine off. Turn the second weight dial counterclockwise until it stops turning (it may or may not stop at 0).

3. Adjust the lower round weight to it's correct position at the end of the weight rod. Place the tool height gauge under the transducer.

4. Using the Z-arm, lower the bond arm until the transducer rests on the tool height gauge. Using a 0-150 gram gauge, lift the bond head at the tip of the transducer and note the reading on the gauge. Adjust the round weight until the gram gauge reads 60 grams.

5. Lock the position of the round weight on the shaft using the nuts on the weight rod. Remove the second weight dial making sure not to turn the dial.

6. With the dial off the machine, adjust it so that it reads 0. Put the dial back on the machine, making sure the number does not change. The second weight dial is now calibrated. The weight range for the second bond should now be approximately 60-150 grams. Zero on the dial will be the lightest weight (approximately 60 grams).

7. Once the second weight calibration is complete, the first weight can be calibrated. Turn the machine on, and cycle it to the reset position (Dual weight solenoid and Bobbin LEDs are on).

8. Turn the first weight dial counterclockwise until it stops turning (This may or may not be at zero).

9. Remove the first weight dial, making sure not to turn the dial.

10. With the dial off the machine, adjust it so that it reads 0. Put the dial back on the machine, making sure the number does not change. The first weight dial is now calibrated. The range of weight for the first bond will be approximately 10-110 grams, with 0 on the dial being the lightest weight.

3 MEI Bond Parameter Sheet

				Ball Bond		(1st weight) Dual Weight	Stich Bond		(2nd weight) Bond Force	Comments
Name	Date?	Mat?	Thick?	Power	Time		Power	Time		

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