MEI1240B Hybrid Ball Bonder

(Marpet Enterprises, Inc.)

Standard Operating Procedure

Faculty Supervisor: Prof. Robert White, Mechanical Engineering (617 627 2210)
Safety Office: Tufts Environmental Health & Safety
(617) 636-3615 (Non-emergency number)

Tufts Emergency Services (fire, medical, police) are at 617 627 6911.

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Warnings:
This tool operates with the workstage at elevated temperatures. Do not contact the workstage during operation or after operation until the tool has cooled completely.

The capillary that feeds the wire to the workpieces is very fragile. Be careful not to bump into it or it will be damaged and must be replaced.

1.0 Material Requirements:

1.1 Equipment: substrate, package, fine precision tweezers (should not leave wire bond table!)
1.2 Personal Protective Equipment: nitrile gloves, safety glasses

2.0 Procedure:

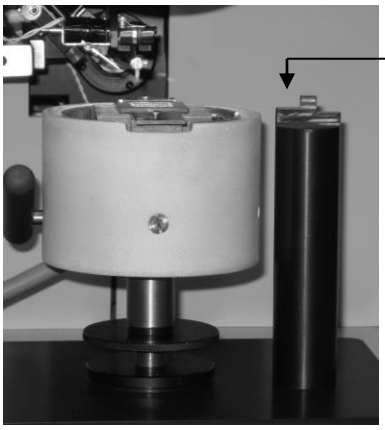
2.1 Setup

2.1.1 Load the package in the workstage. *Be sure that the workstage is cool, as it can be very hot.*

There are two workstages that can be used, a larger with a gray outermost layer and a smaller one with a white outermost layer. The larger workstage is for pin grid array (PGA) or dual inline (DIP) packages with 0.1" pin spacing. The smaller workstage is for flat packages such as leadless ceramic chip carrier (LCC) packages.

2.1.1.1 Smaller stage: Turn the brown knob to horizontal. This raises one of the clamps so that a substrate can be slid into place. Larger stage: Push the button on top down to release the clamp.
2.1.1.2 The clamps can be adjusted to fit the particular package being used by loosening the screws holding them in place and adjusting them to fit secure the package properly.
2.1.1.3 Load the substrate.
2.1.1.4 Turn the brown knob to vertical (small stage), or release the button (large stage), locking the package in plac

2.1.2 Set the workstage height. This is of critical importance for successful bonding!!
2.1.2.1 Make sure that the proper workstage is plugged into the rear of the tool.
2.1.2.2 The height of the **bonding surface** (the surface where you want to make the bond) should be 4.27" (≈4.25" is ok) above the large black baseplate.



This height should be ~4.27" above the large black baseplate … the height you are bonding at.
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The height gauge shown in the picture has been lost. Use a ruler.

2.1.2.2.1 To lower the smaller workstage, loosen the large thumb nut and rotate the workstage clockwise to the desired height, and **then tighten the thumb nut**. It is important to tighten this again to make the stage stable. To raise the workstage, rotate the workstage counterclockwise to the desired height and tighten the thumb nut.

2.1.2.2.2 To lower the larger workstage, turn the top section clockwise while holding the bottom section in place. To raise the workstage, turn the top section counterclockwise while holding the bottom section in place.

2.1.3 Turn on the main power by flipping the switch at the bottom of the tool near the z-arm.

2.1.3.1 Generator should already be turned on. However, if turned off, turn on the generator power by flipping the switch on the rear of the generator.

2.1.4 Double check that you have the workstage height correctly adjusted by checking to see if the bond is happening just below the surface. Move the system so the capillary comes down in an open space near the edge of your workpiece, and push the manual lever all the way down. The ultrasonics should fire (you will see some lights flash on the ultrasonics generator) when the capillary is slightly **below** the bond surface. If the height needs to be adjusted up or down go back to 2.1.2 and do that again.

2.1.5 Ultrasonics generator settings.

2.1.5.1 The generator should be on the "Lo" setting on the back of the machine. Do not change this parameter. Overall, the ultrasonics generator seems to be a bit overpowered for this system.

2.1.5.2 CH1 is the first bond (Ball Bond, typically on the chip or IC) CH2 is the second bond (wedge bond, typically on the package)

2.1.5.3 Here are the recommended settings for Boost, Delay and Ramp:

	CH1	CH2
Boost	15	15
Delay	8	9
Ramp	15	15

2.1.5.3.1 To modify these settings (not recommended) push "Ch1" or "Ch2". Then push "Boost" "Delay" or "Ramp".

2.1.5.3.1.1 TO increase the value, push the button again (that is, push "Boost" or "Delay" or "Ramp" again).

2.1.5.3.1.2 To decrease the value, push “step”.
2.1.5.3.1.3 When the desired value is reached push “SET”.
2.1.5.3.1.4 If no other parameter needs changing on the channel, select “SET” once more. The ultrasonic generator is now capable of generating ultrasonic pulses.

2.1.5.4 The following settings are recommended for 1 mil gold wire and stiff substrates (gold pads on silicon or glass, hybrid ceramic/metal packages):

	CH1	CH2
Power	58	58
Time	44	44

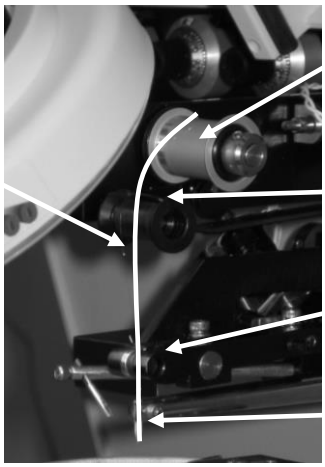
2.1.5.5 For bonding 1 mil gold wire to PC boards (PCBs), **make sure you request ENIG (electroplated nickel immersion gold) coating, or “soft gold”. Lower cost coatings like Tin/Lead solder or immersion tin may not bond.** Recommended settings for ENIG are:

	CH1	CH2
Power	55	55
Time	100	100

2.1.5.6 To modify these values, follow the directions below. In general, higher power and higher time can punch through some oxides and contamination if your pads are not as clean, however, high power and time may result in damage to sensitive parts or fragile materials. Also, if your bonds look very smashed and burned, your power may be too high.

2.1.5.6.1 Push “CH1” or “CH2”, then select “FULL” for power settings, or select “HALF” for time. To increase 1 value, press the “FULL” button again for power (Power settings are on a 0-255 scale of full power (1W on low or 2.5W on high in the back of the ultrasonic generator)) or “HALF” for time (Time settings are 0-255 of full scale time (127.5 ms)). To decrease the value, use the “STEP” button.
2.1.5.6.2 After completing the desired change in power or time, select the “SET” button to set the value.
2.1.5.6.3 If no other parameter needs changing on the channel, select “SET” once more. The ultrasonic generator is now capable of generating ultrasonic pulses.

2.1.6 Thread the bonding wire through the work holder (see picture below). BE CAREFUL NOT TO GET ANY FINGER OIL ON THE WIRE OR CAPILLARY!! This will make it not bond for sure.



2.1.6.1 Load the spool on the spool holder.
2.1.6.2 Feed the wire between the looping drum and the guide wire.
2.1.6.3 Feed the wire through the wire guide and between the clamp pads.
2.1.6.4 Feed the wire down through the capillary.
2.1.6.5 Once the wire is visible at the bottom of the capillary, press E.F.O. Cycle to remove any excess wire and to form a ball at the end of the wire.

2.1.7 Turn on the power to the workstage heat by flipping the switch on the top right front of the tool near the temperature controller.

2.1.8 Wait for the workstage to reach its setpoint temperature. You may adjust the setpoint temperature on the temperature controller. 150 ºC is recommended for 1 mil gold wire bonding if your package and device can survive this temperature.

Important note: The larger K&S workstage has a different thermocouple (J type) than the controller expects (controller expects K type). For this reason, the temperatures displayed on the temperature controller when using the larger K&S workstage are inaccurate! The following table gives the conversion. So, if you are using the larger K&S workstage, and you want 150ºC temperature for your bond, you should set the temperature controller to 191ºC. **This is true for the larger K&S stage only! The smaller MEI stage has the correct thermocouple and the controller reads accurately!**

Actual Temperature at Workstage (ºC)	Measured Temperature on Controller (ºC)
80	97
90	110
100	123
110	137
120	150
130	164
140	177
150	191

The following settings are recommended for 1 mil gold wire and should not be changed unless using a different wire.

E.F.O.	9
DUAL WEIGHT	See below
BOND FORCE	See below
SPEED	5
WORKSTAGE HEAT	150 ºC

2.1.8.1 E.F.O. is the electronic flame off power (which creates the initial ball when the wedge comes over to "flame off" the excess wire. This setting is not critical. If you are not getting enough power to flame off, increase it. If the ball is being burned up decrease it.

2.1.8.2 The DUAL WEIGHT and BOND FORCE are very important parameters. These control the physical force pushing down on the capillary for the first bond and second bond. The first bond will have a lower force (this is the ball bond and typically done on the chip or IC). The second bond will have a higher force (this is the wedge bond and typically done on the package).

2.1.8.3 The BOND FORCE sets the force for the SECOND bond (the larger force).

2.1.8.4 The DUAL WEIGHT is subtracted off of the BOND FORCE to create the force for the FIRST bond (since this force is BOND FORCE – DUAL WEIGHT it is a smaller force than the second bond).

2.1.8.5 To set the DUAL WEIGHT AND BOND FORCE, the small jeweler's scale is used. Take the small workstange and remove the clamps and place the scale on top of the workstage (with the heat off) so that the scale is at the correct working height (4.27").

2.1.8.6 Cycle the E.F.O. button so that the A-SEARCH is the next cycle.

2.1.8.7 Bring down the manual bond arm and push the capillary against the jewelers scale. Adjust DUAL WEIGHT and BOND FORCE (see above for how these work together) to get the desired bond force for the first bond. Approximately 50g is recommended for bonding to a typical gold pad on a silicon or glass integrated circuit. This force can be reduced for bonding to more fragile materials, but the bond may not be as strong or may have trouble breaking through an oxide or surface contaminant. You may also want to adjust the CH1 power and time settings on the ultrasonic generator for fragile substrates (see previous section).

2.1.8.8 Raise the arm (system should go to "B Search"). Bring the arm back down and push on the scale. You are now measuring the force fort he second bond. Adjust the BOND FORCE and DUAL WEIGHT to set the second bond force. Approximately 90g is recommended for bonding to a hybrid metal/ceramic package or PC board.

2.1.8.9 Raise the arm back up.

2.1.8.10 Remove the scale and replace the clamps and resume bonding as normal.

2.2 Bonding

<u>Note:</u> As of August 2021, the semi-automated functions (A-search, B-search, Loop and Reset) have been disabled as they are not needed for low-volume work and just cause confusion and mechanical problems.

2.2.1 Use the micropositioner to position the capillary above the first bond site.

2.2.2 Bring the manual arm down until the capillary hits the bond site. You should hit the pad a little bit before the arm bottoms out. If not, adjust the workstage height as needed (see section above).

2.2.3 Press the manual arm all the way down and the ultrasonics should fire, making the first bond.

2.2.4 Bring the arm up as desired to make the bond loop.

2.2.5 Move to the second bond site.

2.2.6 Bring the manual arm down until the capillary hits the bond site. As before, you should hit the pad a little bit before the arm bottoms out. If not, adjust the workstage height as needed (see section above).

2.2.7 Press the manual arm all the way down and the ultrasonics should fire, making the second bond.

2.2.8 Move the manual arm up. The clamps should grab the wire and break off the bond wire tail automatically.

2.2.8.1 Note: There is a set screw at the back of the wire clamp arm on the right hand side that sets the clamping force for the wire clamp solenoid. If this is misadjusted the wire clamp and tail breakoff will not occur correctly. It is set up for 1 mil gold wire and **should not be adjusted.**

2.2.9 EFO should fire automatically and flame off the wire to get the ball ready for the next bond.

2.2.10 If anything does not work, break off the bond, push the EFO button to do a manual flame off, and try again.

2.3 Troubleshooting

2.3.1 If bonds are not sticking, check the following:

2.3.1.1 Is the workstage height adjusted correctly? See above.

2.3.1.2 Is your bond surface clean, free of contaminants and surface oxides, and solidly mounted? If not, use chemical or plasma cleans, and find a better material surface for fabricating your bond pads that is stiff and has good adhesion.

2.3.1.3 Is the capillary clean and free of debris? The bond wire should easily pass through the capillary and make a nice ball. If this is not happening, pull the wire through (with tweezers) and try some fresh wire. AVOID ANY FINGERPRINTS ON THE WIRE OR CAPILLARY! Finger Oil is poison!

2.3.1.4 Check the bond force and dual weight using the jewelers scale (see above). Increasing the force (remember dual weight substracts from the force during the first bond!! See above) may help break through oxides or surface contaminants but can damage fragile or poorly adhered bond pads.

2.3.1.5 Check the power and time settings on the ultrasonics generator (see above). Increasing power and time may help break through oxides or surface contaminants but can damage fragile or poorly adhered bond pads.

2.3.2 If the bond site is burning or tearing away, check the following:

2.3.2.1 Is your bond pad too fragile, poorly adhered, or built on a soft substrate? If so think about ways to change your device design so you have a strong, stiff, well-adhered bond pad. Gold bond pads are recommended.

2.3.2.2 Try reducing the bond force, reducing the ultrasonics power, or reducing the ultrasonics time (see above)

2.4 Shutdown

2.4.1 Turn off the workstage heat.

2.4.2 Turn off the main tool power.

2.4.3 Once the workstage has cooled, the substrate can be removed.

If at any time you feel a situation is dangerous, do not hesitate to call the Tufts safety office at **(617) 636-3615** (non emergency number) the faculty supervisor or lab manager (617 627 2210, r.white@tufts.edu, Robert White, james.vlahakis@tufts.edu, Jim Vlahakis).

Tufts emergency services can be reached at 617 627 6911

Report all accidents (injuries, major spills, fires) to Tufts Emergency Services at 617 627 6911, the Tufts safety office at (617) 636-3615 (non emergency number) and Prof. White at 617 627 2210, r.white@tufts.edu.