

User Responsibility, Training, and Consequences of Misuse

OASIS prototyping facility, Protofab, operates as a shared research and prototyping facility. All users are expected to follow this SOP, facility policies, and applicable safety guidelines to ensure safe operation, equipment longevity, and equitable access for all users.

This SOP is not a substitute for hands-on training or tool qualification. Refer to User's Manual and Guides for details.

Users must complete required Protofab training and receive authorization prior to independent tool use. In the event of misuse, unintentional error, or non-compliance, corrective actions will be educational, proportional, and focused on preventing recurrence, taking into account the user's experience level and the nature of the issue.

Corrective actions may include:

- Clarification or coaching on proper tool use
- Additional training or temporary supervision
- Temporary suspension of independent tool access
- Restriction to supervised use until competency is re-established

Users may be held responsible for repair, cleaning, or downtime costs only in cases of negligence or repeated misuse.

1. Purpose

This Standard Operating Procedure (SOP) defines the safe and proper use of the F&S Automatic wire bonding system within Protofab. This tool is used to create fine-wire electrical interconnections for microelectronic, optoelectronic, and hybrid devices.

2. Scope

This SOP applies to routine wire bonding operations, including setup, alignment, and bonding of approved materials by trained and authorized users. Advanced wafer level process development, non-standard configurations, maintenance, or hardware modifications are outside the scope of this SOP and require prior approval from Protofab staff.

2. Safety & EHS

- PPE such as protective eyewear is mandatory except while using microscope eyepieces. Refer to facility rules for details.



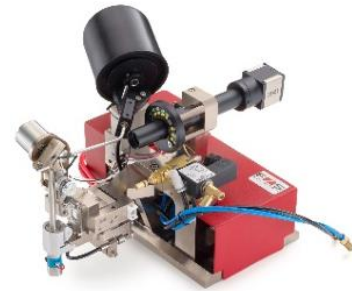
- Hot Surface: The bonding workholder, heater stage, and adjacent components may reach elevated temperatures during operation. Contact with heated surfaces can result in skin burns. Users should assume all heated components remain hot until confirmed otherwise.
- Sharp Objects: Fine bonding wire, capillaries, wedges, broken wire ends, and sample edges may be sharp. Contact with these components can result in cuts or puncture injuries. Tweezers, needles, and other hand tools used during setup also present puncture hazards.
- Shrapnel/Flying Debris: Improper bonding parameters, capillary damage, wire breakage, or sample fracture may generate small fragments or debris. These fragments may become airborne at close range and pose a risk to eyes or skin.
- Electrical and Mechanical Motion: The bonding head, stages, and wire clamp move during operation and may pinch or strike hands or tools. Electrical components are present within the system enclosure.

3. Tool Overview

- XY motor driven table with 100x100mm travel range
- Digital Ultrasonic Generator
- 100x100mm heated workholder
- **Singlewire Bond Mode:** Ideal for prototyping. A wire connection is made between two points, which are approached by the user with the joystick for each wire separately without having to create a bonding program with chips and wires on beforehand.
- **Multiwire Bond Mode:** A complex bonding program with chips and wires is created to set the system ready for production level. The machine then executes image recognition program as often as required so places the bonds precisely in the previously taught positions.
- **Step-Mode:** This mode splits the bond cycle into its individual parts to view them. This mode is often used for first bonding attempts to get an exact overview of the bonding process. Applies to both single/multiwire modes.

Bond Heads and Modules

- Ball-Wedge and Bumping Bonding
 - Gold wire 12,5-50 μm
 - Placement accuracy: +/- 5 μm
 - Repeatability: +/- 3 μm
 - Loop height accuracy: +/- 5 μm



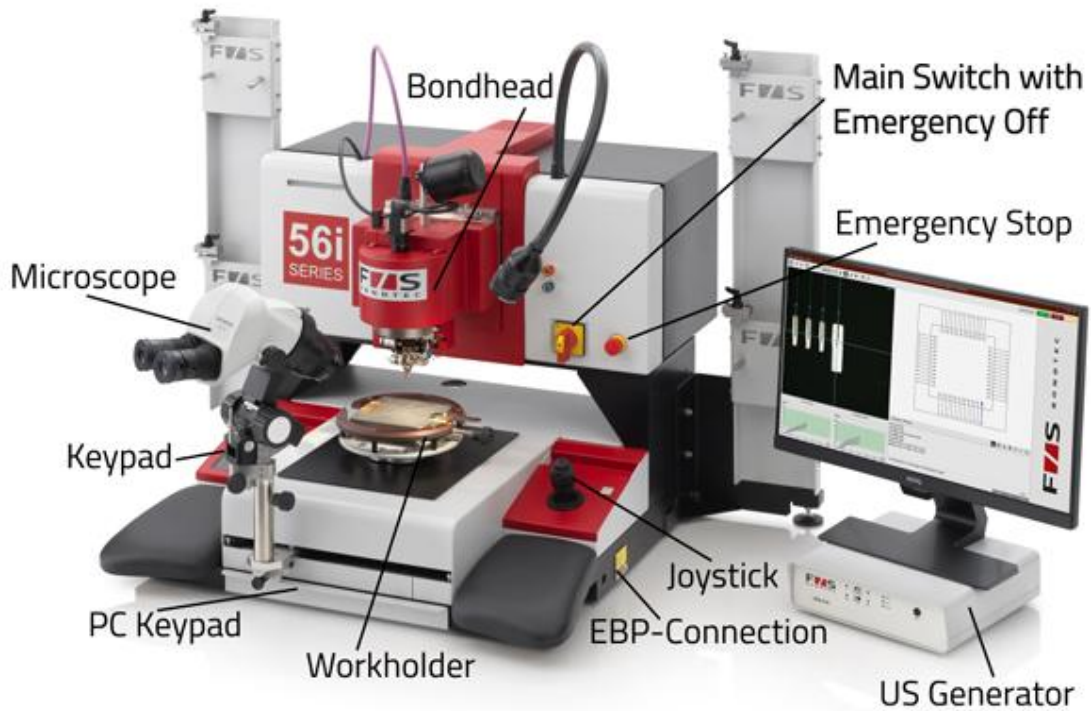
- Wedge-Wedge, Deep Access, Bonding
 - Aluminum and gold wire 12,5-75 μm
 - Ribbons from 30x12,5 μm to 250x25 μm
 - Placement accuracy: +/- 5 μm
 - Repeatability: +/- 3 μm
 - Loop height accuracy: +/- 5 μm



- Die Shear and Wire Pull Force Tester
 - Wire Pull up to 100gf
 - Ball/Die Shear up to 500gf
 - Die Shear up to 5000gf



Tool Overview



5. Pre-use checks (before every run)

- Verify utilities (power/CDA/vacuum) in range
- Visual inspection: E.g., Cleanliness of workholder.
- **Verify that the correct bond head or module is installed. Contact Protofab staff if not.**
- Verify Tooling (Wedge, capillaries & Pull/Shear)
- Verify calibration status (if applicable)

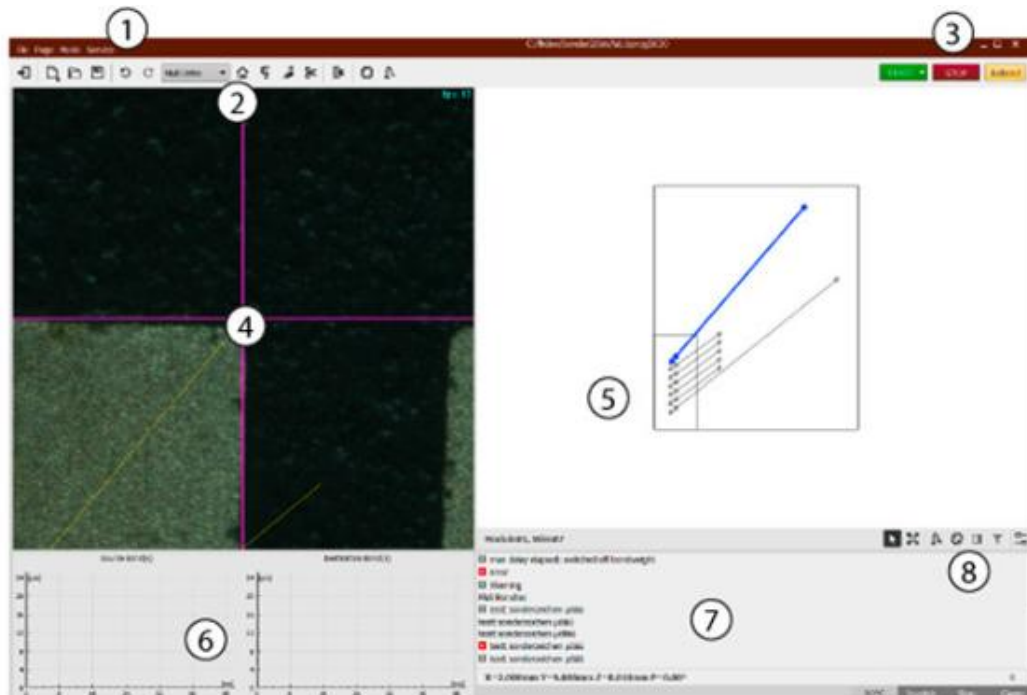
6. Standard operating procedure

6.1 Startup

- 6.1.1. Turn on the system by the main switch.
- 6.1.2. Wait for the operating system (Windows TM) to boot up.
- 6.1.3. Start the “F&S BONDTEC Bonder” Application.
- 6.1.4. Confirm the question “Do you want to move Home?”
- 6.1.5. Wait for the axes (Z, P, X, Y) to reference (move).
- 6.1.6. The bonder user interface will appear.

6.2 Normal operation

6.2.1. The GUI and Sections:



6.2.1.1 Main Menu:

- File: Load/Save files and application closing.
- Page: Program Specific and Global Parameters.
- Mode: Contains functions for setting up and calibrating the machine.
- Service: Support Data and Files

6.2.1.2. Toolbar:

- Controls (buttons) for quick access to the core functions.
- Machine mode selection menu.

6.2.1.3. Process quick access: Enables the execution and control of the machine's bonding process during operation.

6.2.1.4. Camera View: Live video from bonding area with additional graphical information.

6.2.1.5. Bond Map: Graphical display of the current multiwire program.


6.2.1.6. Bond Plots: Graphical display and plot of wire profile.

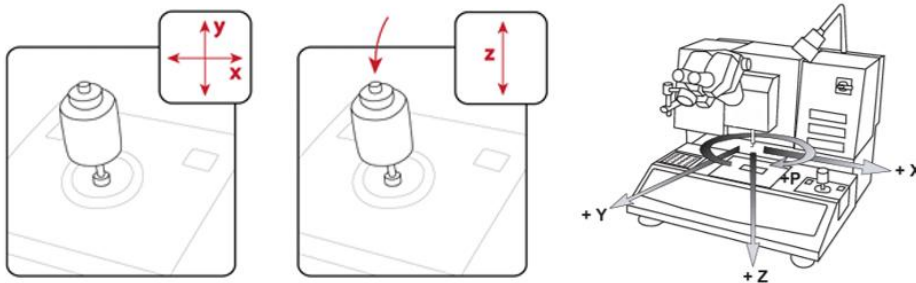
6.2.1.7. Status Console: Process related information and notes.

6.2.1.8. Program Toolbar: Controls (buttons) to interact with bond map display.

6.2.2. Simple Actions

6.2.2.1. Manually moving the axes by joystick (which can be deactivated).

 or <Home> will move all the axes to the origin.




6.2.2.2. Wire Clamp: Or <Wireclamp> opens or closes the wire holding clamp holding.


6.2.2.3. Wire Feed/Flame Off:

- On 5610i Head: Will raise the transducer and create a ball on wire by EFO.

- On 5632i Head: Will trigger a wire feed.


6.2.2.4. Device Clamp or  : Activates/Deactivates the tool holder vacuum clamp.

6.2.2.5. Feed-in wire and bond: The <Feed In Position> is initiated with  which enables the functions to facilitate the threading of wires.

During the <Bond Off> function or , the wire can be bent at a predetermined position to create a tail.


6.2.2.6. Flame off (5610i only): Creates a ball at the end of the wire. Parameters can be found on Page>Global Program Settings> Process. Refer to section 6.2 of the User's Manual for more details.

6.2.3. Frequent Operations

- ← Previous Object (previous selection)
- Next Object (select next)
- + Add Object (insert)
- Remove Object (delete)
-  Advanced Settings (Additional Settings)

Ctrl+Shift and cursors for XY movements in micro steps.

6.2.4. Creating a Bond Program

6.2.4.1. Navigate to File > New (or ) to open the <Create Program> dialog. This wizard guides the user through the essential basic settings across three pages before the bond program is created. **Note that creating a new program clears any previously loaded programs from the system's working memory.**

Bonding parameters are typically inherited from the Single Wire dialog of the most recently loaded program. Alternatively, selecting 'Create from Default Value' allows you to load recommended baseline values for various wire diameters from the database.

The global lighting and camera parameters configured here enable the operator to properly align and navigate the workpiece using the live monitor feed.

6.2.4.2. Workheight: Is the height in which XY table can move without collision.

- Workheight 1 is applies to the entire workholder.
- Workheight 2 is within a single component.

6.2.4.3. Joystick Limit is the lowest Z-position which can be moved manually with the joystick. This limit is used for example when focusing the camera and can usually be left at the same height as Workheight 2.

6.2.4.4. Max Z Position: Defines the lowest position that can be approached automatically with the Z axis.

6.3 Shutdown

1. Move the tool holder and the head to a safe location (Load/Unload)
2. Exit the application and close it.
3. Shut down the system using the main switch.

7. Process recipes

- Default recipe(s): WIP.
- To create a custom single wire program, follow the instructions on Section 7 of the User's manual.
- To create custom multi wire program, follow the instructions on Section 9 of the User's manual.
- If no bond was created or the shape of the bond or loop does not meet the specifications, the process settings must be changed or adjusted after the first bond attempt. Refer to Section 8 of the User's Manual for process optimization.

8. Metrology / acceptance criteria

Wire Bond Pull Strength

- Test Method: Telcordia GR-468 references MIL-STD-883, Method 2011 (Destructive Bond Pull) or Method 2023 (Nondestructive Bond Pull).
- Acceptance Criteria: A failure is defined as any bond separation occurring at an applied stress less than the minimum force specified in the MIL-STD-883 Table I:
 - 1.0 mil Gold (Au) Wire: ~3.0 grams-force (gf) minimum.
 - 1.25 mil Gold (Au) Wire: ~4.0 grams-force (gf) minimum.
 - Nondestructive Pull: Typically set at 80% of the pre-seal minimum bond strength.

Ball Shear Testing

- Test Method: GR-468-CORE follows JEDEC JESD22-B116 (Wire Bond Shear Test Method).

- Purpose: This test specifically assesses the integrity of the gold ball-to-bonding pad interface, which wire pull tests may not fully characterize.
- Metrology: Force is applied laterally (parallel to the substrate) to the ball bond until failure.
- **Criteria:** Results are typically correlated with the **ball diameter** to determine if the shear strength meets the required grams-force per unit area. Standard is $>0.0062 \text{ gf}/\mu\text{m}^2$.
- Example minimum force: 2.2mil (56 μm) dia is 15.5gf and 3.5mil (89 μm) dia is 43.4gf.

11. Change log

- Date / author / summary