UC SANTA BARBARA
OASIS *Protofab*

F&S 5600Ci Pull Shear Tester SOP#: OAS-PF-0910-00

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 die shear and wire pull strength test system within Protofab. This tool is used to evaluate quality of wire bond or die attach process for microelectronic, optoelectronic, and hybrid devices.

2. Scope

This SOP applies to routine wire pull and die shear operations, materials and methods approved 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

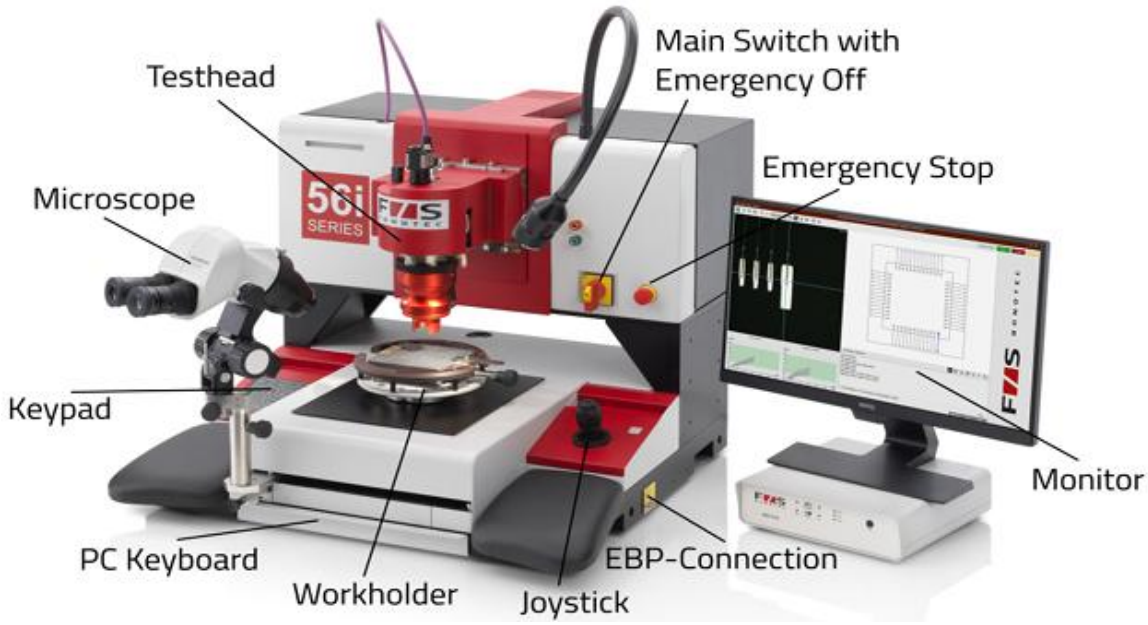
- PPE such as protective eyewear is mandatory during operating of this equipment except looking into the microscope (via eyepiece).

- Sharp Objects: Pull hooks and tools, 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: Destructive test and improper movement settings 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 tester head and stage move during operation and may pinch or strike hands or tools. Electrical components are present within the system enclosure.

3. Tool Overview

- **PH100i:** Wire Pull up to 100gf with accuracy of 0.25gf and test speed up to 10mm/s.
- **SH500i:** Ball/Die Shear up to 500gf with accuracy of 1.25gf and test speed up to 10mm/s.
- **SH5000i:** Ball/Die Shear up to 5000gf with accuracy of 12.5gf and test speed up to 10mm/s.
- XY motor driven workholder with 100x100mm travel range
- Z axis with 60mm range and 360° rotation.

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 module is installed. Contact Protofab staff if not.**
- Verify attached tooling (Wire hook or shear chisel).
- 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 Bondtester" Application: .You may need to enter a username and password.

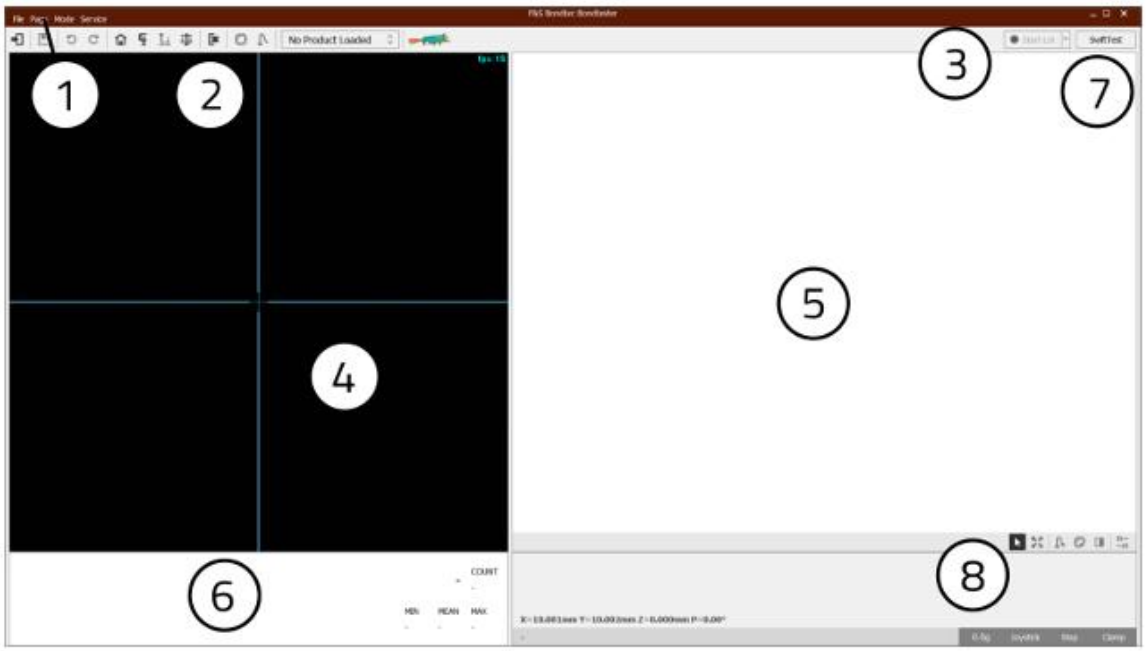
6.1.4. Confirm the question "Do you want to move Home?". Make sure the work area is not obstructed.

6.1.5. Wait for the axes (Z, P, X, Y) to reference (move).

6.1.6. The tester 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.
- Test method selection.
- Tool height offset.

6.2.1.3. New Test Session: With options regarding the program (recipe) or previously taken data manipulation.

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

6.2.1.5. Test Map: Graphical display of the current test program.

6.2.1.6. Bond Plots: Graphical display of the force curve and statistics.

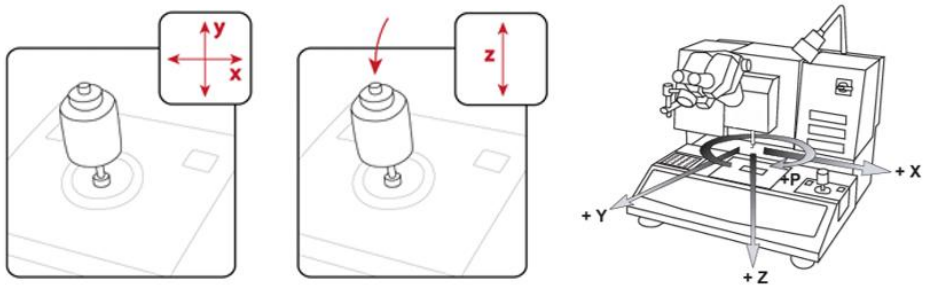
6.2.1.7. Quick Test: A single test can be performed without creating or adding the results into the database.

6.2.1.8. Program Toolbar: Controls (buttons) to interact with test map parameters.

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 Feed/Flame Off:

Moves the tool to its lowest limit in both manual or quick test modes.

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

6.2.2.4. Tare Force Sensor or : Sets the force value to zero when the tool is idel.

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 Test Program

6.2.4.1. Follow File>New>Automatic(/Manual)>New Automatic Test (/New Manual Test) to create a step-by-step guide for a test program. In manual mode, “Test Definition”,

"Height" and "Test Parameter" tabs will be available. In automatic mode, "Test Definition", "Light & Camera" and "Height "will be available.

6.2.4.2. Change Cartridge: Provides step by step instructions to change the cartridge.

1. Movements of stages to a safe position.
2. Remove the cartridge and press next.
3. Mount the desired cartridge.
4. A short wait for the system to recognize the new cartridge and initialize.
5. When completed, the "New Test" will have the updated cartridge information.

6.2.4.3. Workheight: Height of XY table (work holder) which can move without collision. Workheight1 refers to height across work holder and Workheight2 refers to a single component.

6.2.4.4. Joystick Limit: Defines the lowest position that can be approached manually. It is usually set same as Workheight2.

6.2.4.5 Max Z Position: Defines the lowest position that can be reached automatically.

6.2.4. Additional Process Parameters

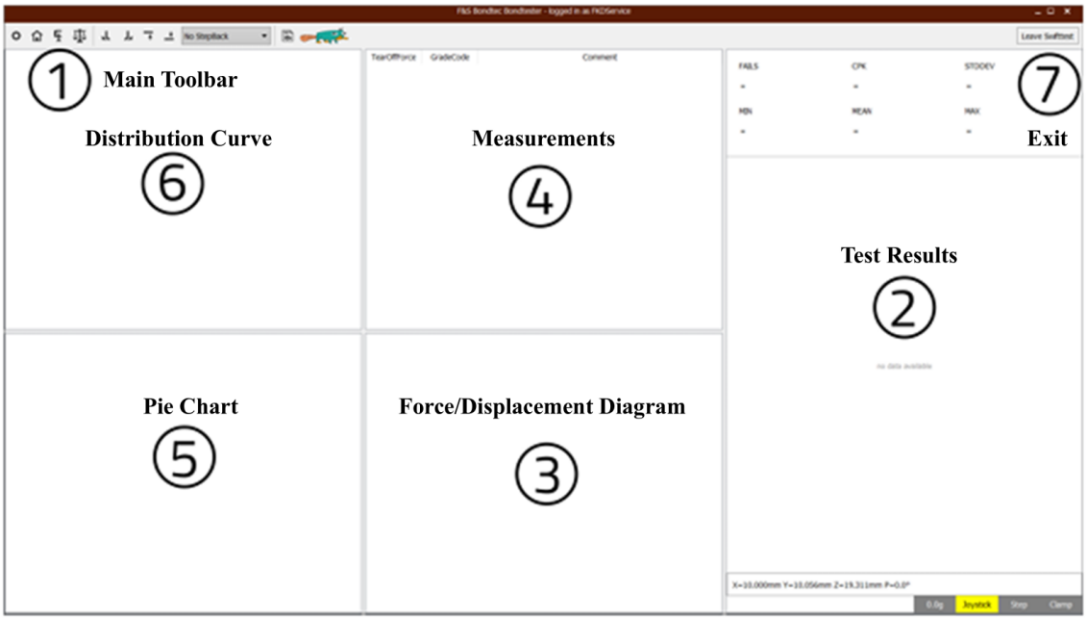
Beyond the settings in the "Learn Sample" dialog, global process influences are defined under Page>Global Settings>Test Behavior per definitions below.

- Random Sampling: If enabled, the system will test a specific quantity of modules selected at random by operator.
- Constant Lot Size: If enabled, the active lot will automatically close after the specified number of test cycles is reached.
- Loop Height Measurements (Pull Test Only): Determines the frequency of die surface height updates as reference for calculating loop height.
    - Disabled (Default): The surface height is not measured during the production run.
    - Per Die: The height of every programmed die is updated during the process.
    - One Point per Module: One surface height measurement is performed per module.
    - One Point per Substrate: Only the first die of the first module on the substrate / or carrier is remeasured.

6.2.5. Quick-Test Mode

The operator can switch to Quick-Test Mode at any time using the button located in the Production (Start) and Automatic (Auto) user interfaces. This mode enables the operator to perform manual ad-hoc test procedures quickly and efficiently without the need to generate a

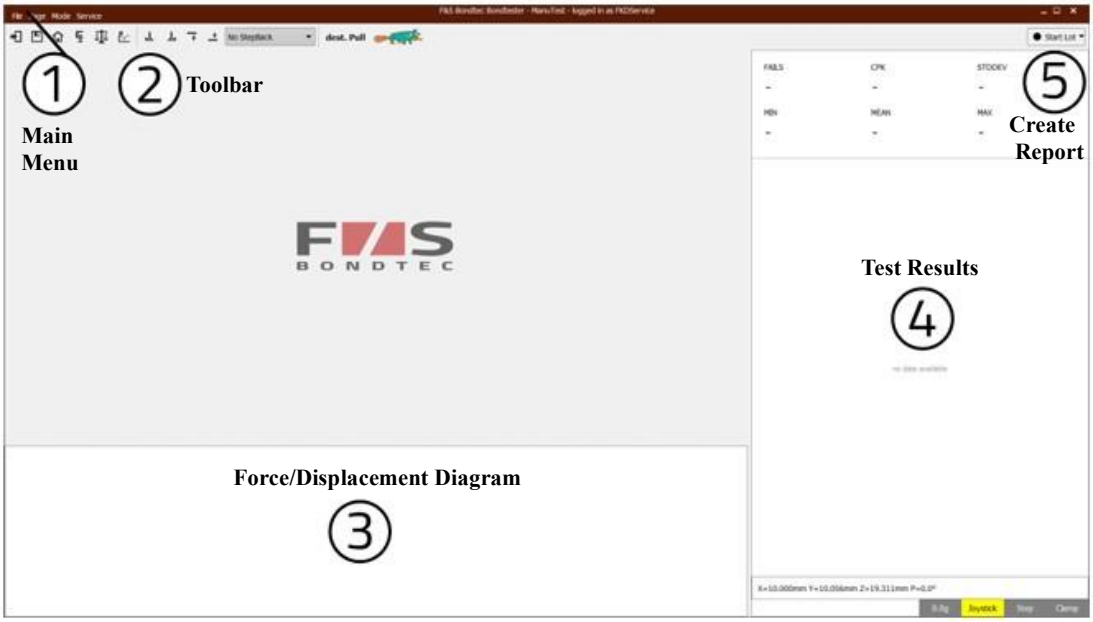
formal test program. Upon initialization, the system prompts the operator to define the safety clearances. The key on the keypad is used to teach-in the upper, lower, and joystick Z-axis travel limits. Once these parameters are defined, the Quick-Test User Interface is displayed.



6.2.5.1 Main Toolbar Buttons:

- **Settings** : The button opens the Quick-Test Settings dialog, organized into three configuration pages. These pages allow the operator to modify the test technique, specific test parameters, clearance heights, and failure codes.
- **P-Axis Positioning** **:** The “Rotate Hook Right/Left” buttons are used to rotate the P-axis (and consequently the test tool) by 90° in the specified direction.
- **Z-Axis Positioning** **:** The “Move to Upper/Lower Limit” buttons automatically drive the Z-axis to the predefined clearance positions. These movements can also be executed via the keypad using (Retract to Upper Limit) and “Flameoff/Wirefeed” (Advance to Lower Limit).
- **Post-Test Sequence (Step-Back Options):** The selection window in the Main Tool Bar defines the system behavior upon test completion.
  - NoStepBack: All axes remain at the detected failure/break point.
  - StepBack: All axes return to the test origin (start position).
  - StepBack Rotate (+/-): All axes return to the test origin, and the P-axis performs a positive or negative rotation.
- **Reporting** **:** The button generates a comprehensive test report in PDF format for the current measurement series.

6.2.6. Manual-Test Mode



The Manual-Test Mode utilizes software architecture similar to Automatic-Test and Quick-Test modes. The primary distinction is that test results in Manual-Test Mode are logged to the database, enabling comprehensive post-test analysis. Consequently, defining a product is a prerequisite for operation in this mode.

- User Interface: The Main Menu mirrors that of the Automatic-Test Mode, though specific automated functions are disabled.
- Main Toolbar: The toolbar layout is adapted from the Quick-Test interface.
- Reset/Clear Force Chart : The button clears all force-displacement plots from prior tests.
- Configuration: A new product is initialized using the Lot Field Description. Predefined test parameters can be modified within the Global Settings menu.

6.3 Shutdown

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

7. Process recipes

- Default recipe(s): WIP.
- To perform a Quick-Test or Manual-Test, follow the instructions and notes on Section 8 of the User's manual as well as Section 6.2.5 and Section 6.2.6 of this SOP document.
- To perform an "Automatic-Test" and operations on programs, follow the instructions and notes on Section 10 of the User's manual.
- Refer to Section 9 of the User's Manual for notes on recipe 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 gf/um^2.
- Example minimum force: 2.2mil (56um) dia is 15.5gf and 3.5mil (89um) dia is 43.4gf.

Ball Shear Testing

- Minimum Force Requirements (per MIL-STD-883 Method 2019) is determined by the die area.

- Small Die (< 0.32mm^2 or 5x10^{-4} in^2): Requires a minimum force on a factor of 0.04kg per 0.065mm^2 or 10^{-4} in$^{2.}$
- Medium Die: Force increases linearly with die area up to a maximum cap.
- Large Die (>64x10^{-4} in^2 or 4.13mm^2): The minimum required shear force is typically capped at 2.5kgf.

11. Change log

- Date / author / summary