

# Kulicke and Soffa Model 4526 Wire Bonder Users Manual



**Coral name:** Wire Bonder  
**Model:** Kulicke and Soffa 4526  
**Location:** NanoFab Post-Processing Lab, Building 215  
**Contact:** nanofab\_postprocess@nist.gov  
**Version:** 1.0

## **DESCRIPTION: Model 4526 Auto-Stepback Wedge Bonder**

The Model 4526 Auto-Stepback Wedge Bonder is used with aluminum wire, gold wire and ribbon. It is especially appropriate for your high quality applications requiring tight control of wire length and loop formation.

The 4526 offers control of individual bond parameters and programmable loop formation along with the capability of using a wide variety of wires. The new bonding head, with the deep access option and tail adjust system, makes it ideal for deep cavity microwave applications where tight control over the tail length is required.

### **1. CONTROLS AND INDICATORS**

This chapter describes the K&S 4500 Series Manual Wire Bonders controls and indicators.

#### **1.1 The Multi Mouse**

The Multi Mouse is located on the base either to the right or the left of the workholder table.

The Multi Mouse has two functions:

☐☐ Control of the bonding cycle.

☐☐ Fine positioning of the bonding pad under the wedge/capillary.

The Multi Mouse has three pushbuttons

**SEMI/AUTO Left pushbutton** on the top side of the Multi Mouse. It operates the semi-automatic bonding cycle.

**MANUAL Z Sidebutton** located on the left side of the Multi Mouse. It activates the Manual Z mode, enabling manual control of bonding head movement

**STITCH Right pushbutton** on the top side of the Multi Mouse. Pressing and holding this pushbutton after performing the first bond activates the Stitch mode. The bonder continues making stitch bonds until this pushbutton is released (not applicable for ball bonding). In addition, pressing the Stitch pushbutton when the bonding head is in the Reset position displays the bond cycle mode of the bonder. The bonding mode indications are

#### **1.2 The Left Control Panel**

The left control panel, located on the left side of the base, is common for all K&S 4500 Series Bonders. It has the following switches and indicators

**POWER Switch** for powering on the bonder. When the switch is in the up position (ON), power from the AC wall outlet is applied to the bonder.

**CLAMP Switch** for opening the wire clamp for wire loading. When the switch is in the up

position, the clamp is open. When the switch is in the down position, the clamp is closed.

**TEST** Momentary switch. Pressing this switch tests the tuning of the ultrasonic generator.

**LIGHT** Switch for turning the area light on and off.

**1st indicator** When on, this indicator signals the start of the first bonding cycle. The bonding head is in the Reset position. The indicator remains on until the completion of the first bond.

**2nd indicator** When on, this indicator signals that the bonder is operating in the second bonding cycle. The bonding head is at the Loop height. The indicator remains on until the completion of the second bond.

**U/S indicator** When on, this indicator signals that the ultrasonic transducer is active. When the TEST switch is pressed up, this indicator turns on, signaling that the ultrasonic circuit is properly tuned. On the left control panel, the top row dials are used for setting the parameters of the first bond, and the bottom row dials are used for setting the parameters of the second bond.

The dials that set the bonding parameters are:

**SEARCH** Controls the Search height of the bonding head.

**FORCE** Controls the downward force exerted by the bonding head during bonding.

**TIME** Controls duration of the ultrasonic energy and bonding force.

**POWER** Controls the electrical power level of the ultrasonic energy. A high power setting increases the mechanical ultrasonic vibration of the tool tip.

**LOOP** Sets the height to which the bonding head rises after performing the first bond.

**TAIL** Sets the tail length.

### **1.3 The Right Control Panel**

The right control panel, located on the right side of the base, is specific for each model of the K&S 4500 Series

#### **1.3.1 Common Right Panel Controls**

The following right panel controls are common to all 4500 Series Bonders:

**SET UP/RESET** Three-position switch used for measuring bond forces, for normal operations and for resetting the system. Setting the switch to the SET UP position applies the bond force to the bonding head. The switch in the mid-position permits normal operation. Setting the switch to the RESET(momentary) position resets the bonder. In addition, pressing this switch to RESET allows you to change the bond cycle mode

**SEMI AUTO/MAN Z** Switch for selecting the bond cycle mode to Semi/Auto or Manual Z. Setting the switch in one of the positions enables bonding in the selected mode. However, bonding head movement is only activated when the corresponding Multi Mouse button is pressed

### 1.3.2 Temperature Controller

The temperature controller, common to all 4500 Series Bonders, has the following controls and indicators:

**SET** Pushbutton to enable setting of the workholder temperature.

**UP** Pushbutton for increasing the set point 1 value during temperature setting.

**DOWN** Pushbutton for decreasing the set point 1 value during temperature setting.

**LED I** Status light which blinks when set point 1 is displayed or changed.

**LED II** Status light which is not used by the bonder.

**TC Display** Three-digit display that shows the temperature (°C) of the workholder. When the SET pushbutton is pressed, the set-point temperature appears in the TC display.

### 1.3.3 Right Panel Controls . 4526

**TEAR** Dial for setting the length of the tear motion after performance of the second bond.

**RESET LEVEL** Switch for selecting the height of the Reset position (HIGH or LOW).

**STEP BACK** Dial for setting the motorized Y table's backward motion from the first bonding pad to the second bonding pad.

**Y SPEED** Dial for setting the motorized Y table speed.

**KINK HEIGHT** Dial for setting the height to which the bonding head rises after performing the first bond. This setting affects loop formation.

**REVERSE** Dial for setting the motorized Y table's forward motion. This setting affects loop formation.

## 2. OPERATION

This chapter explains how to operate your K&S 4500 Series Manual Wire Bonder. The 4500 Series Bonders have common operation principles and bonding methods. However, each model also has specific process parameters and operation procedures.

### 2.1 Common Operation - 4500 Series

Common operation principles and bonding methods for the 4500 Series may be classified in the following categories:

- ?? Bonding Parameters
- ?? Process Parameters
- ?? Modes of Operation

#### 2.1.1 Bonding Parameter

Wire bonding is a function of three main bonding parameters:

- ?? Power
- ?? Time
- ?? Force

The left control panel contains the controls for setting these bonding parameters. The upper bank of dials is for setting the parameters of the first bond. The lower bank of dials is for setting the parameters of the second bond.

##### 2.1.1.1 Power

Bonding power is the amount of ultrasonic energy applied to the bond. High POWER dial settings result in high ultrasonic vibration amplitude and lower settings result in low vibration amplitude.

The POWER dial has two scales - LOW and HIGH. The current scale depends on whether the ultrasonic generator has been set to LOW or HIGH. The LOW scale is used for wire thicknesses of up to 50  $\mu\text{m}$  (2 mil). The HIGH scale is used for wire thicknesses ranging from 50 to 75  $\mu\text{m}$  (2 - 3 mil). The position of the HIGH/LOW switch on the logic board sets this scale.

##### 2.1.1.2 Time

Bonding time is the amount of time that the ultrasonic power and force

are applied. The TIME dial scale depends if the time has been set to Standard Bonding Time or Long Bonding Time. These settings are further explained in section 6.1.3.1.

### 2.1.1.3 Force

Bonding force is applied to the wire while the ultrasonic energy is being applied. This force consists of the following:

☐☐ Static force, which is set by the position of the counterweights on the bonding head cover.

☐☐ Amount of force applied by the electromagnetic coil (set by the FORCE dial).

To set the bonding force:

1. Ensure that the bonding head is in the Reset position (the 1st indicator only is on).
2. Remove the workholder from the workholder table.
3. Set the SET UP/RESET switch to SET UP.
4. Set both SEARCH dials to 0.
5. Press and hold the SEMI/AUTO pushbutton.
6. Using a gram gauge (see Figure 6-1), lift the bonding head until the gauge reading starts to rise.
7. Read the gram gauge. This is the force required for the first bond. Set the upper FORCE dial accordingly (see the recommended values for each specific wire type).
8. Release the SEMI/AUTO pushbutton.
9. Press and hold the SEMI/AUTO pushbutton. The bonding head moves to the second Search height.
10. Using a gram gauge, lift the bonding head until the gauge reading starts to rise.
11. the lower FORCE dial accordingly. (see the recommended values for each specific wire type).
12. Release the SEMI/AUTO pushbutton.
13. Set the SET UP switch to the mid-position for normal operation.

**Note:** If the required bonding force appears to be lower than the minimum force (FORCE = 0) or higher than the maximum force (FORCE = 10), readjust the static force (see section 9.2.3).

### 2.1.2 Process Parameters

The common process parameters of wire bonding are:

☐☐ Loop Height

## Search Height

### 2.1.2.1 Loop Height

The Loop height is the position of the loop after performing the first bond. The Loop height is determined by the wire diameter and the specific application.

### 2.1.2.2 Search Height

The Search height is the position at which the bonding head stops above the bond site. At the Search height, you can perform fine positioning (by the Multi Mouse) of the device before bonding the wire. The Search height is set to 75 - 100  $\mu\text{m}$  (3 - 4 mil) above the bond site.

To set the Search height:

1. Power on the bonder. Ensure that the 1st indicator is on.
2. Move the workholder with the device to the first bond site. Set the upper SEARCH dial to a high value, so that the wedge/capillary does not hit the device's surface. Press and hold the SEMI/AUTO pushbutton. The bonding head descends to the first Search height. Set the upper SEARCH dial to the required Search height, 75-100  $\mu\text{m}$  (3 - 4 mil). Use a feeler gauge to determine the Search height setting.
3. Release the SEMI/AUTO pushbutton. The bonding head descends to the bond site and completes the first bond. It then rises to the Loop height, and the 2nd indicator turns on.
4. Set the lower SEARCH dial to a high value. Move the workholder with the device to the second bonding site. Press and hold the SEMI/AUTO pushbutton. The bonding head descends to the second Search height
5. Repeat step 3 for the lower SEARCH dial.
6. Release the SEMI/AUTO pushbutton. The bonding head descends to the second bonding site, and then rises to the Reset position.

### 2.1.3 Modes of Operation

The common modes of bonding operation are:

- Short/Long Bond Time
- High/Low Ultrasonic (U/S) Power



### 2.1.3.1 Short/Long Bond Time

The K&S 4523, 4524, 4526 are factory-set to a maximum standard bonding time of 120 ms, which is suitable for most applications. The time scale of the TIME dials can be switched to provide a maximum bonding time of 1000 ms. Longer bonding times may be needed for high temperature bonding, for applications where low ultrasonic energy is required, or for bonding wires other than gold.

To switch the TIME scale between standard and long bonding time:

1. Set the SET UP/RESET switch to the RESET position and then release.
2. Immediately press and hold the STITCH pushbutton and the SEMI/AUTO pushbutton simultaneously until the 2nd indicator turns off. Release both pushbuttons.
3. To identify the active mode, press the STITCH pushbutton. The 1st or 2nd indicator shows the mode as follows:  
☐☐Indicator blinks rapidly - Standard Bonding Time Scale.  
☐☐Indicator blinks slowly - Long Bonding Time Scale

### 2.1.3.2 High/Low Ultrasonic (U/S) Power

The high/low U/S power is the ultrasonic vibration required to bond the wire. This power level is determined by the setting of the HIGH/LOW switch on the logic board.

☐☐LOW setting is used for bonding wires of up to 50  $\mu\text{m}$  (2 mil) diameter.

☐☐HIGH setting is used for bonding wires of 50 - 75  $\mu\text{m}$  (2 - 3 mil) diameter.

Caution: The U/S power level is preset in the factory. The HIGH/LOW switch should be set by authorized service personnel only.

## 2.2 Operation - Model 4526

This section describes specific process parameters, bond cycle modes and operation principles of the K&S Model 4526 Auto Stepback Wedge Bonder.

### 2.2.1 Process Parameters

In addition to the common process parameters (see section 6.1.2), Model 4526 requires the following settings:

☐☐Tail ☐☐Reverse

☐☐Tear ☐☐Stepback

☐☐Kink Height ☐☐Y Speed



### 2.2.1.1 Tail and Tear Settings

The TAIL dial sets the length of tail produced after tearing. The TEAR dial sets the tear point of the wire.

The tear point motion and tail length motion of the wire clamp are controlled by a linear motor.

### 2.2.1.2 Kink Height

The Kink height is the length of wire protruding from the wedge after the bonding head rises following performance of the first bond. This length is set by the KINK HEIGHT dial on the right control panel.

### 2.2.1.3 Reverse

In standard bonding modes, the Reverse parameter is the amount of reverse motion of the motorized Y table following the first bond (which influences looping). This value is set before bonding by the REVERSE dial on the right control panel.

After the bonding head rises to the Kink height, the Y table moves backwards according to the REVERSE setting. The bonding head then rises to the Loop height.

In Lange Coupler mode, the Reverse motion is used to create low loops. After making the first bond, the bonding head rises to the Loop height and the motorized Y table returns. At the second Search height, the motorized Y table performs the reverse motion. This reverse motion presses the wire backward, creating a low loop.

### 2.2.1.4 Stepback

The stepback is the distance of the motorized Y table motion between the first and the second bond pads. This distance is set by the STEP BACK dial on the right control panel.

The stepback travel saves manipulation time. It is useful for applications requiring a series of parallel wires having equal distances between the first and second bonds.

☒☒ In the Semi/Automatic Bonding Cycle mode, the maximum stepback setting is 6.4  $\mu\text{m}$  (160 mil).

☒☒ In the Lange Coupler mode, the recommended stepback setting is 0.8  $\mu\text{m}$  (20 mil).

### 2.2.1.5 Y Speed

The Y speed parameter is the speed of the motorized Y table. This value is used in very fine bonding applications.

### 2.2.2 Bond Cycle Modes

The 4526 can operate in the following bonding modes:

- ☐☐ Semi-automatic bonding using the SEMI/AUTO pushbutton.
- ☐☐ Manual bonding using the MANUAL Z sidebutton.
- ☐☐ Stitch bonding in the Semi/Auto Cycle or Manual Z mode.
- ☐☐ Lange coupler bonding.
- ☐☐ Long tail length.

#### 2.2.2.1 Semi/Auto Mode Bonding Cycle

To set the bonder for Semi/Auto Mode Bonding:

1. Press the SET UP/RESET switch to the RESET position and release.
2. Immediately press and hold the SEMI/AUTO pushbutton of the Multi Mouse until the 2nd indicator turns off.

3. Release the SEMI/AUTO pushbutton

4. When the bonding head is in the Reset position, press the STITCH pushbutton of the Multi Mouse. The indicators on the left control panel indicate the Semi/Auto Bonding Cycle mode as follows:

1st Blinks  
U/S Off  
2nd Off

To perform Semi/Auto Mode Bonding:

1. Ensure that the bonding head is in the Reset position.
2. Position the workholder so that the bonding pad is under the wedge. Ensure that the wire clamp is closed.
3. Press and hold the SEMI/AUTO pushbutton of the Multi Mouse. The bonding head descends to the first Search height and stops.
4. While still holding the SEMI/AUTO pushbutton, move the Multi Mouse to position the first bonding pad precisely under the wedge.
5. Release the SEMI/AUTO pushbutton. The bonding head descends to

the first bonding pad. The first bonding force and ultrasonic energy (set by the upper FORCE and POWER dials, respectively) are applied for the time set by the upper TIME dial. The first bond is performed and the wire clamp opens.

The bonding head rises automatically to the Kink height position, and travels in a reverse motion to form the loop. The bonding head then automatically performs loop height again and stepback to the second bond position.

Note: Perform wedge bonding in the direction of the wire. If necessary, rotate the device so that the first bond and the second bond pads are aligned with the wire feed line.

6. Press and hold the SEMI/AUTO pushbutton. The bonding head drops to the second Search height and stops. As the bonding head starts its descent, the wire clamp closes momentarily to prevent the wire from feeding back into the wedge feed hole (helping to create a stable loop).

7. While still pressing the SEMI/AUTO pushbutton, move the Multi Mouse to position the second bonding pad precisely under the wedge.

8. Release the SEMI/AUTO pushbutton. The bonding head descends to the second bond site. The second bonding force and ultrasonic energy (set by the lower FORCE and POWER dials, respectively) are applied for the time set in the lower TIME dial. After the bond is performed, the wire clamp closes and rises (as set by the TEAR dial), tearing the wire.

The bonding head rises to the Reset position. The wire clamp drops from the Tear position, feeding a wire tail through the wedge feed hole to prepare for the next bond.

#### 2.2.2.2 Manual Z Bonding

The Manual Z bonding mode enables you to maneuver the bonding head manually. The MANUAL Z sidebutton of the Multi Mouse provides you with full control of the bonding head motion.

To perform Manual Z bonding:

1. Set the SEMI AUTO/MAN Z switch on the right control panel to the MAN Z position.

2. Press and hold the MANUAL Z sidebutton of the Multi Mouse. Lower the bonding head as close as you want to the bonding pad. Move the Multi Mouse to maneuver the first bonding pad precisely under the

wedge.

3. Continue pressing the MANUAL Z sidebutton to drop the bonding head to the bonding pad and perform the bond as in the Semi/Auto mode. The bonding head rises automatically to the Kink height, and then travels in a reverse motion to the Loop height.
4. Release the MANUAL Z sidebutton slowly to raise the bonding head to the Loop height.
5. Move the Multi Mouse to position the second bonding pad directly under the wedge.
6. To perform the second bond, repeat steps 2 and 3.
7. Release the MANUAL Z sidebutton to raise the bonding head to the Reset position.

#### 2.2.2.3 Stitch Bonding

The Stitch Bond mode enables the bonder to automatically perform one or more successive bonds without tearing the wire.

To perform stitch bonding:

1. Press and hold the STITCH pushbutton of the Multi Mouse after performing the first bond. The bonder performs the second bond without tearing the wire as in step 8 of the Semi/Auto Cycle Bonding Cycle (see section 6.5.2.1). The bonder then continues making bonds until you release the pushbutton.
2. After making one or more stitch bonds, release the STITCH pushbutton and make one more bond. The bonding head then rises to the Reset position and the wire tail is formed.

#### 2.2.2.4 Lange Coupler Mode

Lange couplers may be present in some high frequency microwave amplifiers. A typical Lange coupler requires a series of extremely short and low wire loops connecting thin film leads. Regular wedge bonding cannot achieve loop heights that are low enough. Therefore, the 4526 has a special Lange coupler bonding capability. In Lange Coupler mode, bonding may be performed semi-automatically as in regular wedge bonding. For very small Lange couplers, however, Manual Z bonding is recommended.

To set the bonder for Lange Coupler mode:

1. Press the SET UP/RESET switch to the RESET position and release.
2. Immediately press and hold the STITCH pushbutton of the Multi Mouse until the 1st indicator is on and the 2nd indicator turns off.
3. Release the STITCH pushbutton.
4. Press the STITCH pushbutton. The indicators on the left control panel indicate the Lange Coupler bonding mode as follows:

1st Off  
U/S Off  
2nd Blink

5. To return to the Semi/Auto Bond Cycle mode, repeat steps 2 and 3.

To perform Lange Coupler mode bonding:

1. Ensure that the bonding head is in the Reset position.
2. Position the workholder so that the bonding pad is under the wedge. Ensure that the wire clamp is closed, and that a wire tail protrudes from the wedge foot.
3. Press and hold the SEMI/AUTO pushbutton of the Multi Mouse. The bonding head descends to the first Search height and stops.
4. While still holding the SEMI/AUTO pushbutton, move the Multi Mouse to position the first bonding pad precisely under the wedge.
5. Release the SEMI/AUTO pushbutton. The bonding head descends to the first bonding pad. The first bonding force and ultrasonic energy (set by the upper FORCE and POWER dials, respectively) are applied for the time set by the upper TIME dial. The first bond is performed and the wire clamp opens.  
The bonding head rises to the Loop height, which should be a low setting (set by the LOOP dial). The Y table overshoots the second bond site by about half the lead width (set by the STEP BACK dial).  
Note: To achieve higher resolution in Lange Coupler mode, the maximum travel range of the stepback motion is reduced from 4.0 mm (0.160") to 0.5 mm (0.020").

6. Press and hold the SEMI/AUTO pushbutton. The bonding head drops to the second Search height and stops.

Note: The second Search setting should be such that the wire touches the substrate. Otherwise, the loop will be flattened and may cause shorts in the leads.

7. Release the SEMI/AUTO pushbutton. The Y table moves forward (as set by the REVERSE dial), bringing the bonding head back to the second bond site, and compensating for the overshoot of the stepback motion. The low setting of the SEARCH dial causes the flat loop to bend during the reverse movement. The second bond is performed and the clamp closes.

The Y table returns to its reset position. The bonding head rises to its Reset position and stops. The tail arm moves and feeds the wire for the next bond. The bonder is now ready for the next bond cycle.

#### 2.2.2.5 Long Tail Length

The Long Tail Length mode is used when bonding thick wires with diameters of 76  $\mu\text{m}$  (3 mil) or ribbon wires thicker than 25 x 125  $\mu\text{m}$  (1 x 5 mil).

To set the bonder for the Long Tail Length mode:

1. Press the SET UP/RESET switch to the RESET position and release.
2. Immediately press and hold the SEMI/AUTO pushbutton of the Multi Mouse until the 2nd indicator turns off.
3. Release the SEMI/AUTO pushbutton.

The indicators on the left control panel indicate the Long Tail Length mode as follows:

1st Blinks

U/S Off

2nd On

In Lange Coupler mode, the indicators on the left control panel indicate the Long Tail Length mode as follows:

1st On

U/S Off

2nd

## Practical Notes and Tips

### Force:

Static force: 20g

Force coil: 3g

Total: 23g

Plus: Force potentiometer range ~80g

### Solenoid clamp

Solenoid clamp force range: 90-110g

Polished sapphire good for 0.7-1.3mil wire and up to 0.5x3mil ribbon  
For anything bigger, needs ceramic clamp (increased friction)

### Time

Gold 10-1000ms, "long" time, slow blink of 1<sup>st</sup> LED

Aluminum 10-100ms, "short" time, fast blink of 1<sup>st</sup> LED

### To change from short to long time:

- Hit Reset
- Hold both mouse buttons while tool goes through reset sequence
- Release mouse buttons

**Tear:** best range 2.5-4.5

**Ultrasonic displacement** ~1.3 microns

**Note:** Before first bond in "Reset Low" position, tip-to-sample distance should be ~1/8"

### Right Hand Remote Controls

Loop, Tail, Search 1 and Search 2 are adjusted from this remote control. They are disabled on the left control panel on the main console.

### Parameters for 25- $\mu$ m gold wire to gold-coated silicon test pieces

	Power	Time	Force
Bond #1	3	3	3
Bond #2	4	3	4
Loop: 3			
Tail: 4.5			
Tear: 4.5			
Reset : Low			



## Typical Bonds Performed by Model 4526

