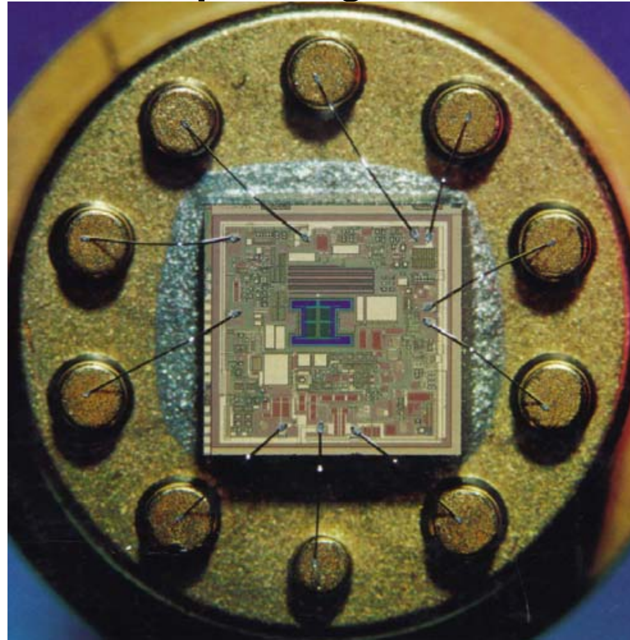
K&S Model 4129 Universal Wedge Bonder
Basic Operating Procedures



1.0 Introduction

The K&S Model 4129 is a wedge-wedge wire bonder that uses a metal wedge to form the bonds at both ends of wires that connect a semiconductor die to a package. The wedge holds the bonding wire in place during bonding and applies a combination of mechanical force and ultrasonic stimulation to fuse the wire to the metal bond pad on the die or package.

This document provides the basic information required to operate the K&S Model 4129 universal wedge bonder using Al bonding wire. For additional, more detailed information on this tool, refer to the K&S Model 4129 universal wedge bonder operation manual.

2.0 Tools and Supplies

The following tools are required to setup and operate the K&S 4129:

• Broad-tip (non-serrated) tweezers for wedge replacement.(Digikey part number EROP2A-SA recommended)

• 0.9 mm (0.035 in) hex key for wedge replacement. (Available as part of set. Digikey part number 431-1009-ND)

• Precision-tip (needle-point non-serrated) tweezers for bond wire threading. (Digikey part number EROP3C-SA recommended)

The following bonding supplies are also required:

• Al bonding wire.
(K&S part number **XXX** recommended)

• Bonding wedges compatible with Al wire
(tungsten carbide for Al wire, titanium carbide for Au wire).
(K&S part number 4WNV0-4030-W5C-M00 recommended)

3.0 Controls

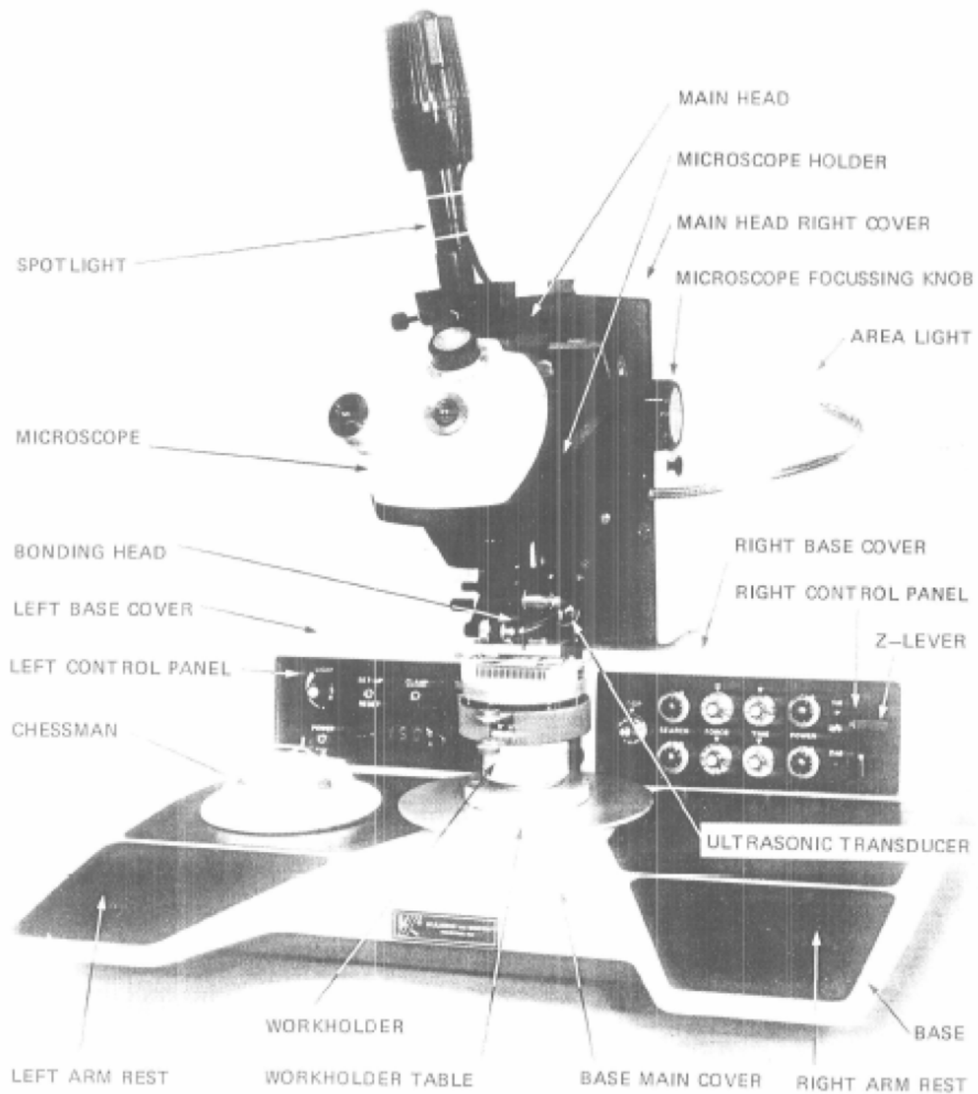


Figure 1. Major components of the K&S Model 4129.

3.1 Left Control Panel

The left control panel consists of a set of switches used to control power to various bonder components.

Power switch – controls all power to bonder. Also used to reset the bond-cycle during operation.

Light dial – controls brightness of bonding area light.

Clamp switch – momentarily opens the wire clamp on the bonding head.

Set-up / reset switch – does not work. Use the power switch to reset the bond-cycle during operation.

Motor switch – controls power to the bonding head motor. Turn-off when adjusting any components of the bonding head in to prevent unexpected bonding cycle actuation.

Heating unit controller – sets and displays temperature of the work holder (not used in the procedure described in this document).

3.2 Right Control Panel

The right control panel consists of two sets of bonding parameter adjustment dials, the bonding-cycle and ultrasonic power indicators, and the manual-z-cycle lever. Other than the loop setting, each bonding parameter has two adjustment dials, corresponding to the first and second bonds on each boning wire.

Loop dial – sets the height of the bonding head between bonds which, in turn, controls the shape of the bonding wire loop and the angle of departure of the bonding wire from the first bond. *Settings for this adjustment are described in detail in Section 5.2.*

Search dial – sets the height of the bonding head while the chessman button is depressed (before the bond is formed) to aid in precise bond location. *Settings for this adjustment are described in detail in Section 5.2.*

Force dial – sets the force applied to the bonding head during bond formation. *Settings for this adjustment are described in detail in Section 5.2.*

Time dial – sets the duration of bond formation. *Settings for this adjustment are described in detail in Section 5.2.*

Power dial – sets the power applied to the piezoelectric transducer during bond formation. *Settings for this adjustment are described in detail in Section 5.2.*

1st and 2nd indicators – indicate if bonder is ready to form first or second bond.

U/S indicator – indicates when power is applied to the piezoelectric transducer.

Manual-z-cycle lever –controls bonder during manual-z-cycle operation (not used in the procedure described in this document).

3.3 Main Head

All controls on the main head are located on the left-side panel of the main head. Note that the left-side panel must be open to observe the phase of the tear and feed adjuster cams and to obtain the full range of motion of the lifter handles.

Tool lifter handle – lifts the complete bonding head for workholder installation and removal. *This handle must be set to the fully lowered position during normal bonder operation.*

Clamp lifter handle – pulls the wire clamp away from the bonding head for wedge threading. *This handle must be set slightly below contact with the bonding head during normal bonder operation.*

Tear and Feed adjuster – sets the position of the tear and feed cams located behind the adjuster knob, which, in turn, control the movement and timing of the wire clamp after

forming the 2nd-bond. Turn the tear and feed adjuster knob to simultaneously set the phase of both the inner and outer cams. Pull the knob and turn to set the phase of the outer cam only. *Settings for this adjustment are described in detail in Section 4.4.*

3.4 Bonding Head

The controls on the bonding head are located near the bonding wire clamp.

Wire clamp positioning nut – sets the lateral position of the wire clamp relative to the wedge. The clamp has ~2 mm of play, so this adjustment is approximate. *The position nut should be set such that the wire feeds straight through the wedge.*

Wire clamp adjustments – sets the clamp gap and clamp force. A*djustments only need to be made after changing the bond wire diameter or type and should be set as per instructions in section 6.1.6 of the K&S Model 4129 universal wedge bonder operation manual.*

3.5 Chessman

The chessman moves the work holder (chuck) for precision positioning of the die and package under the bonding head using a mechanical reduction mechanism. The two buttons mounted on the chessman control the chessman bonding cycle.

Chessman switch (black) – initiates the bonding process using the chessman cycle. Press and hold to go to the search position and release to complete the bond.

Stitch switch (red) – press to form a 2nd bond without terminating the bond wire (not used in the procedure described in this document).

4.0 Setup

4.1 Wedge Handling and Installation

The wire bonding process is highly dependent on the quality of the wedge surface where it contacts the wire. It is therefore imperative to handle the wedge with tweezers, to avoid contacting the working end of the wedge, and to inspect the wedge before each bonding session.

The wedge is typically stored in a protective case when not in use and must therefore be installed prior to operation of the bonder. The position of the wedge in the transducer arm is critical, as it has a direct effect on the resonance of the complete assembly.

However, the bonder includes a test function to check that the wedge is installed correctly before attempting to form a bond.

1. Using the 0.9 mm hex key, ensure the wedge set screw on the end of the transducer arm is loosened.
2. Using tweezers, insert the wedge into the bottom of the transducer arm. The flat side of the wedge should face the set screw and the wire opening should be at the bottom.
3. If using a 750 mil wedge (such as 4WNV0-4030-W5C-M00), the top of the wedge should be flush with the top of the wedge opening in the transducer arm.
4. Tighten the wedge set screw using minimal force. *Do not over-tighten the set screw.*
5. Check the wedge position using the test switch. The U/S indicator should be illuminated only when the switch is closed. There should be no noticeable noise when the transducer is activated.
6. If the indicator is not illuminated or stays illuminated after the switch is released, adjust the position of the wedge in the transducer arm.

Refer to section 6.1.2 of the K&S Model 4129 universal wedge bonder operation manual for installation of 750 and 828 mil wedges using insertion gauges.

4.2 Wire Handling and Threading

The bonding process is also dependant on the surface properties of the bonding wire. Only handle the wire with tweezers and avoid touching the wire on the spool.

The bonding wire typically remains installed in the bonder when not in use. However, the bonding wire may have to be rethreaded periodically during use if bond formation is not consistent. Figure 2 shows a correctly threaded bond head.

1. Ensure the bonder is ready to make the 1st bond. Reset the bonder using the power switch if necessary.
2. Remove the work holder from the bonder.
3. Place the bonding wire spool on the spool support with the wire coming off the top of the spool, towards the front of the bond head.
4. Feed the wire through the hole near the center of the transducer arm.
5. Lift the wire clamp lifter handle to move the clamp away from the back of the wedge.
6. Hold the wire clamp open by pressing and holding the clamp switch.
7. Using tweezers, lift the wire over the wire guide under the wire clamp and ensure it passes between the two arms of the clamp.
8. Release the clamp switch to close the clamp.
9. Tear-off the end of the bonding wire to reveal a straight, clean section of wire by pulling on the wire with tweezers while the clamp is closed.
10. Grab the bonding wire ~3 mm from the end using tweezers.
11. Hold the wire clamp open by pressing and holding the clamp switch.
12. Feed the wire through the back of the wedge. *The hole in the back of the wedge is not visible from the front of the bonder. This is the most difficult step in the threading process and may require multiple attempts. If the wire end becomes bent, repeat steps 7 through 9 to expose a clean section of wire.*
13. Release the clamp switch to close the clamp.
14. Lower the wire clamp lifter handle. *This handle must be set slightly below contact with the bonding head during normal bonder operation.*

After threading, ensure the wire feeds straight out of the wedge. This can be checked by moving the focus point of the microscope up to the reset position of the wedge. Adjust the wire clamp positioning nut if necessary.

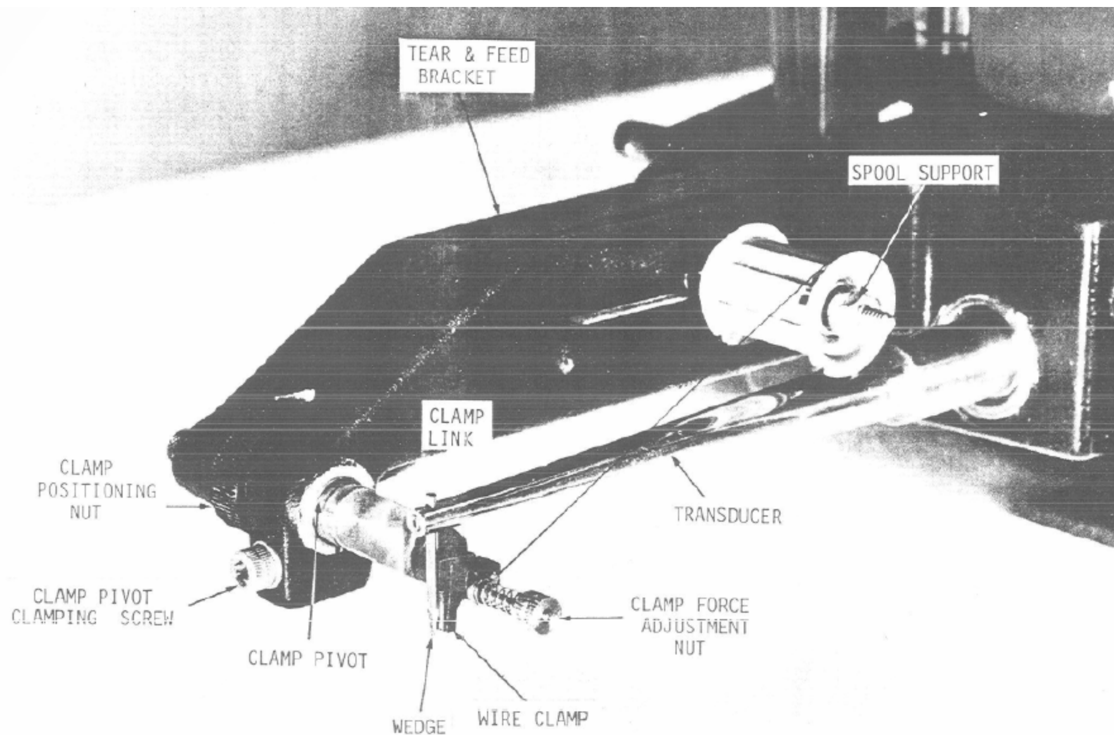


Figure 2. K&S Model 4129 bonding head

4.3 Workholder Position

The workholder height should be adjusted such that the end of the wedge just makes contact with the surface of the die or package when in the lowest search position.

1. Place the IC package in the workholder, securing it with the spring-loaded clamp or vacuum chuck.
2. Place the workholder on the workholder table. *Be very careful when moving the workholder so as to avoid any contact with the wedge, as this may destroy the bonding surface at the end of the wedge.*
3. Set the loop, 1st search, and 2nd search dials to zero.
4. Move the workholder until a bonding pad on the IC package is aligned with the bonding head.
5. Press and release the chessman button to place the bonding head in loop position.
6. Adjust the height of the work holder using the threaded workholder base adjuster such that the bond head just contacts the bond pad.
7. Reset the bonder using the power switch.

4.4 Tear and Feed Settings

There are two cams located behind the tear and feed adjuster knob on the main head of the bonder.

Inner cam – sets the tail length. This is the amount of wire protruding from the wedge after the bond wire is severed. A larger cam setting yields a longer tail. The recommended setting for this cam is 45º less than the maximum lobe position.

Outer cam – sets the tear action. This is the amount of wire clamp movement used to sever the bond wire after forming the second bond. A larger cam setting yields more clamp movement. The recommended setting for this cam is the maximum lobe position.

4.5 Bonding Parameter Settings

Successful bonding requires clean bond pads, precise bond wire positioning, and the appropriate amount of force, ultrasonic stimulation power and duration for a given type of wire. Optimum bonding conditions are typically derived by trial and error and thus require a significant commitment of time and materials to establish.

The bonding parameters associated with the bond head height are set by moving the through bonding cycle and examining the location of the bottom of the wedge relative to the die and package surfaces using the microscope.

Loop – typically set to ~2.0 for a moderate bond length. Increase the loop height for longer bonds and reduce for shorter bonds in order to obtain a smooth bond profile.

Search – set so that the bottom of the wedge is 2x the bond wire diameter above the die or package surface when in search position. A typical setting is ~0.7 if the workholder height is adjusted correctly and the die and package bond pads are at the same height.

The bonding parameters associated with the bond formation are difficult to determine *a priori*, however, the following settings have been shown to work well with 35 um Al bonding wire. Typically the force is adjusted to compensate for small variations in bond performance while the other parameters remain fixed.

Force – set to 5.5.

Time – set to 5.3.

Power – set to 7.0.

A good bond will be ~50% wider than the bond wire and will be well adhered to the die or package bond pad. Avoid using too much force as this will result in a squashed bond that sticks well to the bond pad but has minimal mechanical strength in the wire near the bond.

Bond doesn't stick – increase force by 0.1 or 0.2.

Squashed bond – decrease force by 0.1 or 0.2.

The bond formation parameters should be very similar for the 1st and 2nd bonds. If the 1st bond consistently sticks while the second bond consistently tears off using roughly the same bond parameters, there is likely a problem with the tear and feed settings. Check the settings and try decreasing the tail length.

For Al wire bonding, the substrate heater is not used. For Au wire bonding the substrate must be heated to a temperature on the order of 120 C or greater.

5.0 Basic Bonding Procedure

5.1 Principles of Operation

Figure 3 shows the position of the wedge during the bonding process for the chessman and manual-z bonding cycles. Only the chessman cycle is discussed here.

1. The wedge is initially at the reset or resting height, and is brought to the first bond search height by pressing and holding the chessman button on the chessman. The search height brings the wedge close to the height of the substrate to aid in bond positioning.
2. Releasing the chessman button completes the first bond and brings the wedge to the loop height, establishing the shape of the bond wire in the completed bond.
3. Pressing and holding the chessman button a second time allows positioning of the second bond and releasing the chessman button completes the second bond bringing the wedge back to the reset position. The bond wire is automatically severed by the tear-and-feed mechanism after forming the second bond.

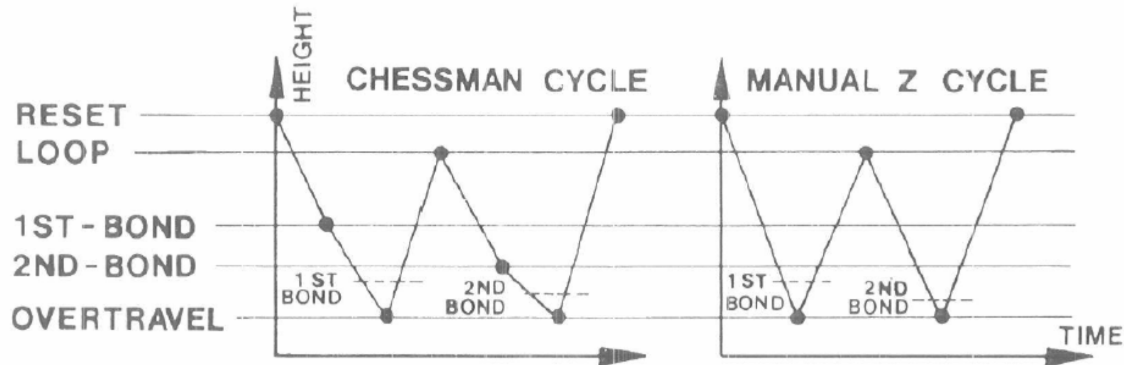


Figure 3. Wedge position during bonding process. Source: K&S Model 4129 universal wedge bonder operation manual.

5.2 Bonding Guidelines

The following guidelines should be followed for all bonding operations.

1. Make the first bond closest to the front of the bonder, and then move the workholder further towards the front of the bonder to make the second bond.
2. Only move the workholder in the direction parallel with the bonding arm between the first and second bonds. This allows the wire to remain aligned with the first bond, preventing unnecessary stress on the bond. Adjust the angle of the workholder to allow this direction of motion between bonds.
3. Avoid touching the bonding wire, wedge, and bonding pads to prevent contamination. Use alcohol to clean the bonding pads if necessary.
4. Only remove or replace the workholder when the bonder is in the 1st bond position. The bond head is only safely distant from the workholder when in this position.

ACKNOWELEGEMENTS
Thanks for the contribution from Jason Clifford, Chris Kim and Henry Lee.

Last Update
July 11, 2008 by Edward, Huaping XU