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Model 4530E Series, Motorized Step-Back Wire Bonders

Last revised 09/19/18 - microscope

Prologue

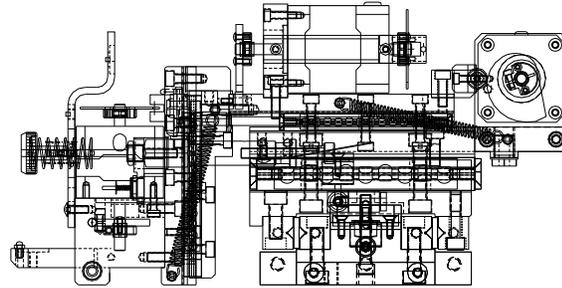
West-Bond's new "E" Version starts the twentieth year of the Model 4500 tradition. This machine was revolutionary at its inception as the first to make a wire bond connection fully under programmable software control executed digitally by motors, thus making possible the manufacture of high frequency, high power semiconductor devices where connections must be identical. The original design, with digiswitches for input and with LED's to display individual data lines by binary value, remained unchanged by customer insistence until finally supplanted by the current 4500 Model of the "B" Series. Now, Model 4~00E brings forward the new advances of the "E" Series, notably the placement of all machine mechanism above the work plane to allow unlimited access, and the setting of axis brakes to lock on target. In this model the tool, rather than the work, is moved, both for alignment and for bonding, with the work pre-rotated. There is choice of alignment by either microscope or video. New bond heads are built around a 110 kHz ultrasonic transducer and provide full three-way convertibility.

Application

Machines of this series bond aluminum or gold wires from 0.0007 in. to 0.002 in. diameter, primarily to stitch bond a succession of parallel multi-arch wires, but useful for bonding any program of shaped connections. Three bond methods are available by tool head conversion; angled-feed wedge bonding, vertical-feed wedge bonding, and Negative EFO ball bonding. The feed methods for wedge bonding are effected by change of clamps only, while ball bond method is effected by exchange of the tool head. Both wedge bond methods require front-to-back wire progress, hence pre-rotation of the work piece. Wherever possible, angled feed wedge bonding is recommended because clamps very near the bond foot can have the best effect to work the wire into arches. Even complex motions can similarly shape ball bond connections, if rotation is pre-set. This machine is also uniquely capable of making a succession of spaced single-ball bonds. Further, a machine of this series can be assembled with 63Khz ultrasonic components to Tab Bond a pattern of connections, such as on the flex circuits of computer disk read heads.

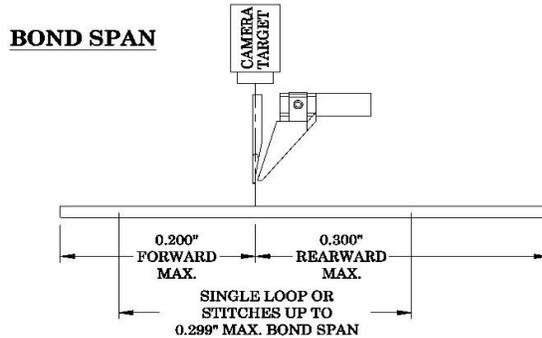
Mechanical

Bonding mechanism is constructed of four axes, straight-line and orthogonal, stacked in an array. Two axes, X and Y, are driven by micromanipulator for positioning, then held by pneumatic brakes for bonding. Two axes, W (in Y direction) and Z, are driven by programmed motors to create and arch the connection. The vertical view video camera is mounted atop the X-Y axes so that the manipulator moves its target crosshairs. When video method is chosen, the tool is withdrawn along the W axis during alignment. When aligning by microscope, target is judged by an angled view of the tool at a search elevation just above the work. Approach to search and then down to contact can be controlled by a separate manual encoder that generates clocks to drive the Z Motor directly, or can be controlled at the keypad or by a push-button on the right-hand control. These different methods can be used interchangeably in any sequence. Similarly, alignment by microscope or video is optional. Video alignment allows bonding of the entire connection after a single input accepting the targeting of the critical bond, though requiring extra runs on the W axis to hide the tool. Microscope alignment allows direct view of and placement of all bonds with minimum movements. The work piece is aligned front-to-back on a fixed platform. Optional rotating and adjustable height platforms are available.



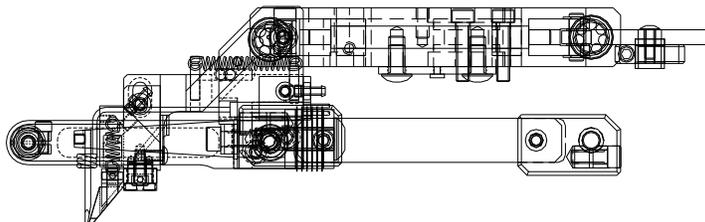
Ranges, Ratios and Resolutions

X-Y Positioning, by Manipulator	0.625" Total, +/- 0.3125" @ 8/1 Ratio
Y Stroke (W axis), by Motor	0.500" Total, 0.200" Forward, 0.300" Rearward from Target Point
Maximum Bond Span	0.299" Maximum Wire Length
Resolution	0.00333" per half-step, 0.000208" per micro-step
Z Stroke, by Motor	0.500" Total, 0.460" Up, 0.040" Down
Resolution	0.00333" per half-step, 0.000208" per micro-step
Z Encoder, Manual	0.125" Touchdown from Search @ 8/1 Ratio
Resolution	0.001" per encoder transition
Work Platform, by Thumbscrew	0.625" Total, 0.500" Up, 0.125" Down



Bond Tool Head Assemblies

The new forward-pivot tool assemblies of this series are built around K~Sine Transducer, Model No. 34-W, operated at 110 KHz. It is driven by K~Sine Part No. 9060 Ultrasonic Power Supply, three Watts, dual channel, with power and time set as program values. This transducer uses a bond tool of



0.828125" length dropped 0.750" below center. Vertical clearance is a full 0.46875" everywhere under these tool heads and all other mechanism except for wire presentation at 45° for angled feed. Wire Clamps are air-opened and spring-closed, and have self-contained closure pivots. A separate pivot about an axis located to serve both overhead and angled feed generates the clamp motions along their lines of feed action. To change between angled feed and overhead feed, it is necessary only to exchange the small clamp assemblies and to change the wire drag means. Alignment of clamps to the tool is facilitated by individual adjustments along three axes. Actuation of all clamp motion is by the same spiral cam of an inboard motor and is transferred through the pivots of the four-bar linkage. Appropriate clamp motion settings for each method are configured in software and are retained in non-volatile memory. Motions toward the tool are spring-driven, while the more powerful motor drives away from the tool – to ease concerns during set-up.

Rigid bearing mounts, rather than taper loading, fix the strut bar of this assembly so that any required bond force can be applied. The standard set of force springs generates 15 to 150 grams, and together with the work-sensing firing switch, is built into the four-bar linkage. A dual force mechanism, operated pneumatically, acts to change between two pre-set force values, and either high or low force may be programmed for any bond. Radiant tool heat with panel mounted, constant current control is included.

Machine Configuration

The mechanism of this series was designed to mount above a customer's work handling system, to be confined entirely above the work plane, and so not to have any base or work platform. In this configuration, a model of this series is designated as "4~~~EX". For use as a stand-alone complete bonding machine, the mechanism will be completed with a plain base having a bolted-on, adjustable height, rotating, work platform, and will be designated as "4~~~E".

In either the "E" or the "EX" configurations, optional control arms are included to move both the manipulator control point and the Z axis encoder control point five inches vertically from their normal positions near the machine base to new locations above the work plane. When the high control arrangement is used, the customer must provide suitable operator's forearm rests. This is essential both for the operator's safety and comfort, and to provide a stable platform from which to direct control motions with the accuracy required for wire bonding. The manual Z Encoder method of controlling tool descent is optional.

Mounting points for the "EX" version of this mechanism are provided at two foot locations at the work plane elevation 5.000 in. above table surface, approximately 22.312 in. apart, and 8.734 in. to the rear left, and 13.093 in. rear right, of the work point.

Electrical Software and Hardware

A software program controls operation of motors and other actuators, as configured by setup values, in response to operator's inputs. It accepts entry of data about User's Devices to create different Types of connections. These Types may have any number of Bonds, up to 100, and may be repeated for any number of Wires up to the maximum of 6000 individual Bonds. Data to define all the motions required to create the connections are stored in Buffers that are selected by the keypad. Default values are 30 Types of 5 Bonds per Type that yields 40 Device Buffers. West-Bond Part No 8100 CPU, containing a Motorola 68000 microprocessor and 256 KB of nonvolatile RAM executes the software program.

A keypad is provided for direct entry and editing of both configuration and user data and for selection of operation options. Entry and execution is prompted at the machine panel by a series of "screens" displayed on a 4-line 40-character LCD. All programmed values are displayed during bonding. At "home", various options are enabled including a patented self-threading routine for the angled feed method.

Operating Controls.

1. *Keypad.* Twelve-key pad for entry of program data, setting of Modes, and direct control of machine actions. At left hand.
2. *Z Encoder.* Generates Z-Axis motor step clocks: A home sensor parallels the G Key and the Ball Button. At left hand with both high and low control arms.
3. *X-Y Manipulator.* Moves tool head, TV camera, and motorized slides atop X-Y-Axes with 8/1 mechanical advantage. At right hand with both high and low control arms.

4. *Ball Button*. Push-button switch in the manipulator control ball. Parallels the G Key but also acts to lock only the X-Axis for scanning the bond path along the Y-Axis, front-to-back.
5. *Rotary Work Table*. Rotates about the center of tool motion range to pre-set the alignment of bonds front-to-back.

Modes of Operation.

1. *Monitor or Microscope.* When toggled by Key 9, the bond tool moves along the W-Axis between the target position above this bond, and a retracted position out of camera view.
 - Monitor -- Target the beginning bond of the sequence on the television monitor screen. Move the camera cross hairs to the bond point by the X-Y Manipulator.
 - Microscope -- Target all bonds by direct view of the tool through the microscope.
2. *Inhibit Auto.* Modifies only the Full-Auto Mode. It is set for each bond during Bond Edit.
 - On -- Full-Auto pauses at each search elevation for X-Y targeting while the key is held.
 - Off -- Full-Auto proceeds with no pauses.
3. *Full-Auto or Half-Auto.* Mode toggled by Key 8.
 - Full-Auto -- Start by G Key or Ball Button or Z Encoder. Lock manual X-Y slides and bond all bonds of this wire. Pausing is controlled by *Inhibit Auto* described above.
 - Half-Auto -- Controlled by G Key or Ball Button or Z Encoder. This is a press and release sequence with pauses at each search and loop elevation.
4. *Inch Mode.* Start by Zero Key. Executes Half-Auto mode except proceeds down in slow steps from each search to contact while key is held. Available any time tool is stopped.

ESD Protection

Protection against Electrostatic Discharge is implemented by finishing exposed tool assemblies and other moving parts by Electro less Nickel plating, which is conductive; and all exposed painted parts with a powder-coated paint that is dissipative.

Definitions Models of this Series:

- **Model No. 454630E.** This machine with single wedge bond tool head, Assy No. 9004, with angled clamp Assy No 9048 and overhead clamp Assy No 9049, for bonding by either wedge method.
- **Model No. 454630EX.** This machine, specified as Model 454630E, except without base.
- **Model No. 454730E.** This machine with two bond tool heads, Assy No 9004 with the two clamp assemblies for wedge bonding as above, and with tool head Assy No 9044 for Negative EFO ball bonding, all convertible.
- **Model No. 454730EX.** This machine specified as Model 454730E, except without base.
- **Model No. 4730E.** This machine with one tool head Assy No 9044 with K~Sine Transducer, Model No. 34-C, for spaced single-ball bonding, also Negative EFO.

Features available for "E" Models of this Series:

- **Feature No. 70.** Adjustable height workstation with a rotary platform to rotate work about the center of tool X-Y range. Assembly No. 8965. Recommended to pre-align bonds front to back. Not for "EX models.
- **Feature No. 79.** Adjustable height work platform. Assembly No. 8965. Not for "EX" models.

Accessories

The microscope recommended for this model is either the Olympus SZ51-60E with the "Luxuray" LED illuminator #10265.00. Neither microscope nor illuminator is included. One recommended bonding tool is included.

All work holders are priced separately, and should be ordered separately. A universal unheated work holder, capable of holding most common substrate devices between a pivoted clamp lever and adjustable backstops, is maintained in stock and is available for delivery in the same time span as the machine. Quite a large number of previously designed special work holders, both heated and unheated, are available but are not stocked, and cannot be promised for delivery with the machine. These should preferably be on an order separate from the machine order, but if not, the machine order must state that partial deliveries are allowed. Work holders for new work pieces requiring custom design and fabrication will be quoted upon receipt of drawings and samples: These must be ordered on separate purchase orders.

Services

Compressed air, regulated to 50 psig, is required. Connection is via 1/4-inch tubing.

Electrical service required is 50-60 Hz, single phase, either 115 VAC or 230 VAC; however, input must be configured at the factory for 230 VAC. A fuse and three-prong power cord connector are provided for 115 VAC: For 230 VAC, these must be changed to conform to local requirements.

Dimensions

"E" Series machine size is 24.218" wide x 22.297" deep x 11.000" high, exclusive of microscope, or 15.000" in height to scope eyepieces. Weight is 75 lb. uncrated, or 165 lb. accessorized and crated.

"EX" Series machine size is 22.312" wide x 16.500" deep x 6.000" high above work plane, exclusive of microscope, or 10.0" high from work plane to scope eyepieces. Weight is 55 lb. uncrated, or 140 lb. accessorized and crated.