ORTHODYNE ELECTRONICS

Model 20 Semiautomatic Ultrasonic Large Wire Bonder

TO-3
TO-220
TO-202
TO-218
TO-3P
SOT 93
Hybrid

OPTIONAL INDEXER

- ☐ Automatic wire feed
- ☐ Consistent looping
- ☐ 500 to 600 devices an hour
- ☐ Multiple stitch option
- ☐ Indexing
- ☐ Bond analysis available

The Model 20 Large Wire Bonder combines a unique bonding-tool design, an array of options and Orthodyne's field-proven ultrasonic generator and transducer to bond up to 600 devices an hour. With a throughput of 6 times the industry average and bonding yields of over 98%, the Model 20 offers the manufacturers of power semiconductors and power hybrids significant increases in production and cost savings.

The Model 20 automatically feeds the wire off a 4-inch spool, through clamps to the bonding tool. The tool, in turn, secures the first bond and forms a loop to the second bond; after cutting the wire, the bonding tool is again fed wire in preparation for the next bonding sequence. This entire bonding sequence is achieved in approximately one second.

Bonding with 3- to 20-mil wire eliminates the use of multiple small wires to carry the large current loads of power devices. Single-wire connections not only eliminate extra time-consuming connecting steps, but reduce potential bond failure rates—fewer bonds, fewer failures.

Wire cutting after bonding, a major problem associated with large-wire bonding, is accomplished with Larrison bonding tools, patented and used exclusively on Orthodyne's ultrasonic bonders. The unique design allows cutting to occur during bonding, with no damage to the device and no stress on the bonded wire. For manufacturers using resistance spot welding for connecting to posts, the bonder automatically steps back to any programmed length up to 300 mils; greater wire lengths may be obtained by operator manipulation.

The Model 20 format allows the operator the option of either manual or semiautomatic modes. By electronically locking out stops in the bonding sequence (e.g., home, first search, loop and second search), the operator can increase the bonding rate.

Orthodyne offers an optional indexer, that automatically feeds TO-3, TO-220 or TO-66 and, in some cases, hybrid power devices. Device positioning is precisely controlled by electronic circuitry and a photo cell. The indexer is moved by a Geneva drive.

Included in the options are multiple stitch bonding, ribbon bonding and a manual z (in development).

Manual workholders are available for a variety of hybrids and discrete packages. Consult the factory for the one most suited for your application.

BONDING TOOLS

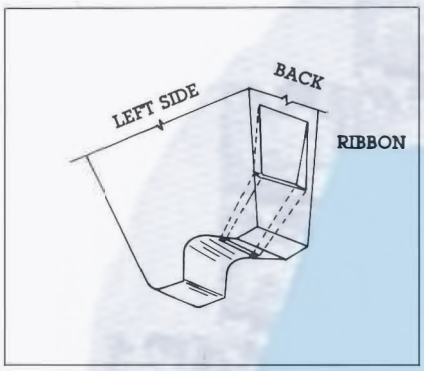
Configured expressly to overcome the problems associated with bonding large wires, Larrison Polyplanar Bonding Tools provide advantages found in no other bonding tools. Orthodyne offers three basic types of this unique tool to enable Model 20 application on a wide range of power device configurations, in a variety of bonding operations, using 4- to 20-mil (125- to 500-micron) wire.

Model 20 uses a unique wire cutoff method (Patent #3,954,217). When pressure is applied to the wire at the second bond, the sharp heel behind the second bond groove captures the wire on the post or other bonding surface. The wire clamp closes and the wire feed lever is then automatically actuated to apply a tensile force to the wire behind the heel of the tool. This tensile preload greatly decreases the pulling force required to break the wire, thus decreasing the gripping force required at the clamps, which results in wire free of clamp marks and nicks. Cutoff occurs during bonding.

Wires bonded with the Larrison Bonding Tools are free of heel cracking, which normally occurs at the transition region adjacent to the first bond. Cracking at the heel is usually the result of one or a combination of conditions: high power levels, sharp back radius on the tool, metallurgical properties of the wire and machine misadjustments.

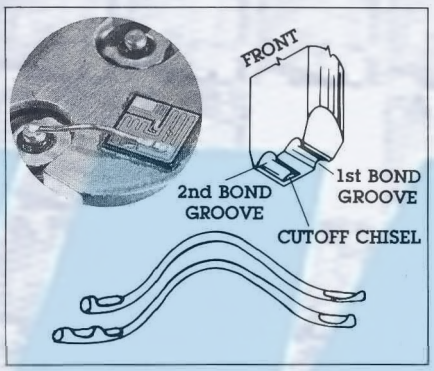
Stitch and high first search options may be incorporated in the bonder to enable these tools to make multiple first bonds for current spreading (shown below) or for bussing a number of points together.

RIBBON TOOLS



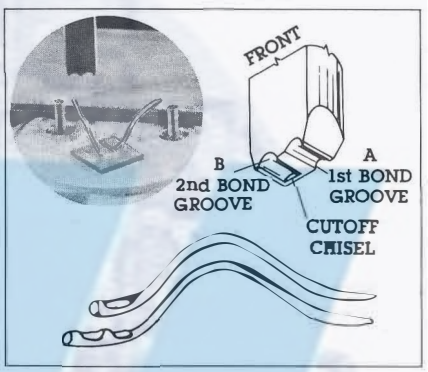
Orthodyne's ribbon tools are available for various ribbon widths and thicknesses, 1x5 to 3x30 mil. In conjunction with the Model 20R Ribbon Bonder, the tool is equipped with a guide slot to aid looping and positioning the ribbon. Tools for applications requiring special foot and groove configurations as well as tools without guide slots available. Consult the factory for specific information.

LARRISON TOOL TYPE 2 (P/N 127041)



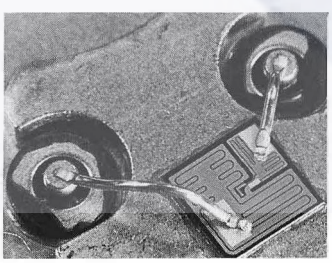
The Type 2 Tool is used for wire larger than 4 mils (125 microns). The two tool geometries are configured for optimum bonding at both first and second bond sites. The first bond groove (see figure) is cut clear through the tool. The front and back radii of the groove provide smooth transitions to the rounded portion of the wire, whereas the center of the groove provides an optimum scrubbing coupling to the wire. The second groove incorporates a cutoff chisel that provides wire-weakening at the cutoff point. In pull tests of wires bonded in the Model 20, wires break randomly in the span—not in the bond.

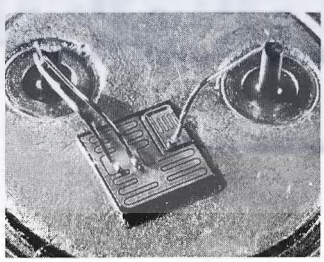
LARRISON TOOL TYPE 4 (P/N 127019)



Type 4 is designed for bonding operations in which flying leads are required. Groove B (see figure), the cutoff groove, is oversize to avoid deformation of the wire as the cutoff ridge severs the wire lying on the nonbondable flat surface. The tool is ultrasonically vibrated during cutoff at a lower power setting than that used for conventional second bonds to achieve very clean cut ends.

ADVANTAGES OF SINGLE LARGE-WIRE OVER MULTIPLE SMALL-WIRE BONDS

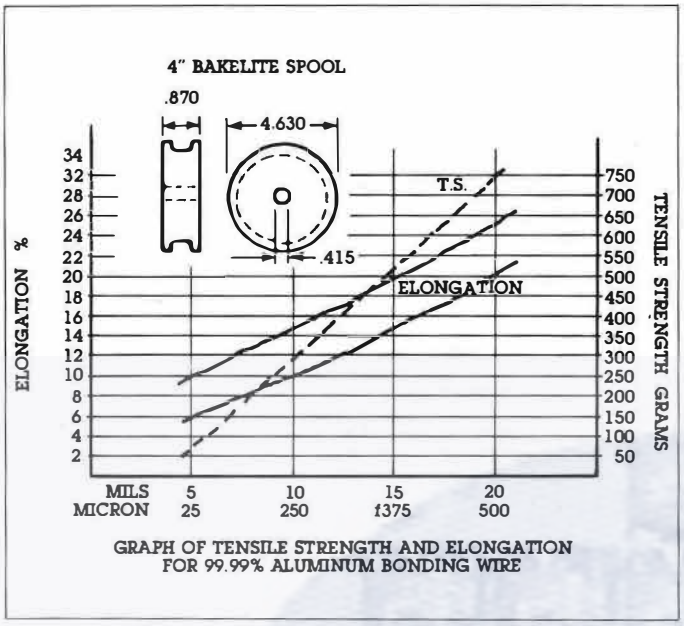




Because of past difficulties in bonding power semiconductor devices with large wire, manufacturers have used two or more small wires in parallel to provide current capacity. Extra wires were sometimes added to improve device reliability, the redundant wire providing an alternate connection in the event of primary wire bond failure. These added bonds required extra handling, slowed throughput and reduced yields.

With the introduction of Orthodyne's Model 20 Large Wire Bonder, manufacturers are now able to connect with 20-mil (500 micron) wire, which has a cross-sectional area equal to four 10-mil (250 micron) wires. In addition to providing required current capacity, large wire has greater rigidity than small wire, yet provides sufficient flexibility to withstand extensive power cycling without fatigue.

The superiority of large wire over small wire connections is now well established. Extensive field testing of Model 20 bonds on all types of power devices to establish large wire bond integrity has also produced conclusive results: The large wire bond has proven to be stronger than the wire itself.



GRAPH OF TENSILE STRENGTH AND ELONGATION FOR 99.99% ALUMINUM BONDING WIRE

Specifications for bonding wire vary with size. Orthodyne recommends 99.99% aluminum, sometimes called "four nines," for most applications. Fully annealed wire has a maximum elogation near 30%, which is excellent for bonding directly to silicon surfaces without metallization (as SCR's are sometimes constructed). Oxidized surfaces (nickel plate), on the other hand, require a harder wire to assist in breaking through the oxide. Wire that is too hard will tend to heel crack at the rear of the first bond because of the flexing occurring when the tool lifts and steps back during looping. A very acceptable compromise elongation specification for a wide range of device surface materials is shown in the graph (left). The tensile strength shown is a minimum specification. Orthodyne engineers are prepared to work with customers everywhere in selecting the correct wire or ribbon for each application.

ORTHODYNE TRANSDUCER

The ultrasonic transducer used in the Model 20 adapts to moderate variations in bond-site conditions, which enables optimum bonding action regardless of the surface at the bond site. Most commercial systems now in use subject the bond to relatively constant vibration amplitude throughout the bond period, which results in overbonding on clean surfaces and underbonding on rough or contaminated surfaces. The result is weak, unreliable and unpredictable bonds.

The mechanical impedance at the tip of the Orthodyne transducer is optimized for ultrasonic wire bonding in widely varying conditions. This unique device features electrostrictive ceramic (sometimes called piezoelectric) construction which is neither subject to physical wear nor loss of activity (depoling).

This transducer automatically adjusts to each bonding condition through interaction with the wire. Bonding tool tip amplitude is high at the beginning of the bonding period, decreasing as the wire surface under the tool expands. When an optimum bond is achieved, scrubbing amplitude reaches equilibrium—a feature termed **demand control**.

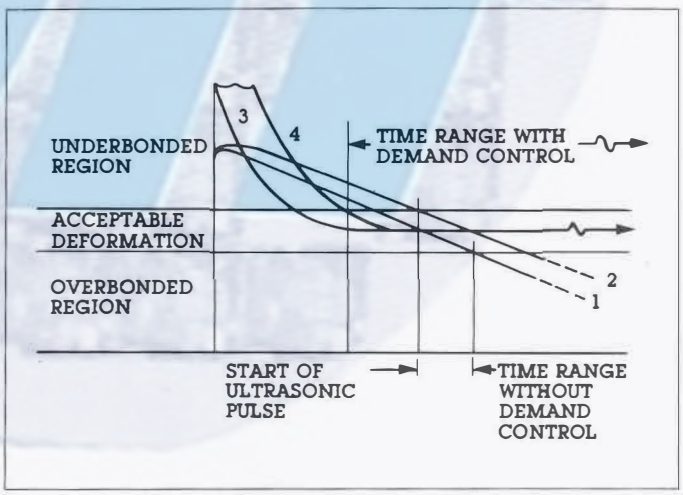
ORTHODYNE GENERATOR

The ultrasonic generator is a key component in the Model 20 bonder. It supplies short bursts of ultrasonic energy to the transducer, which converts them to microinch-scale excursions of the bonding tool. Because the transducer operates at resonance where bonding tool motion is greatest, the generator tracks any changes resulting from thermal or mechanical conditions. Bonder lights and workstage heaters can slowly shift the resonant frequency of the transducer, which in other systems, must be compensated for with changes in power level or by returning.

Orthodyne's proprietary phase-lock circuit, developed specifically for bonding applications, samples the operating frequency of the transducer and continuously corrects the oscillator frequency in the ultrasonic generator. The capture range is sufficiently large to eliminate the need for manual tuning.

A short pre-bond time delay incorporated into the Model 20 generator ensures that all mechanical motions of the bonder will be fully damped before the onset of the ultrasonic pulse.

The output circuit of the generator is designed to match Model 20's electrostrictive ceramic transducer. The output circuit and the transducers combine to produce **demand control**, which produces higher yields and much less readjusting to accommodate varying material parameters.



Curve 1 represents a bonding system with low sensitivity to loading by the bond (damping) as the bond interface increases. Curve 2 is the same system when surface films at the interface inhibit bonding.

Curves 3 and 4 represent tip amplitude in Model 20. The large tip motion is rapidly damped as the bond interface grows in area. Note that tip amplitude reaches equilibrium where it is not able to further increase deformation.

SPECIFICATIONS

GENERAL

Type of Bond	Ultrasonic Wedge
Wire Size	3 to 20 mil
Cut-Off Method	Cut/Pull
Mode of Operation	Manual/Semiautomatic
Operator Control	Tap button or Foot switch
Target System	Dual adjustable light dots superimposed
Manipulator	5:1 ratio
Working range	1 inch
Type	True pantagraph
Weight	60 lbs.
Dimensions	24x24x19 inches
Machine Stops	Home-1st search-Loop 2nd search
Power	115/230V 3/15 Amp 50 to 60 Hz 1 phase (100V option)

ULTRASONIC GENERATOR

Type	Orthodyne Model 300 Series
Channels	Two, continuously adjustable 10 turn dials to 25 watts
Frequency	60 Khz phase locked
Power Output	0 to 25 watts
Time Range	0 to 500 ms
Test Pushbutton	System check
Time Duration	0 to 500 ms 30 ms prebound delay
Transducer	Orthodyne electrostrictive ceramic

MICROSCOPE

Type	Bausch & Lomb Stereo Zoom or American Optical Stereo Zoom
Eyepieces	10x

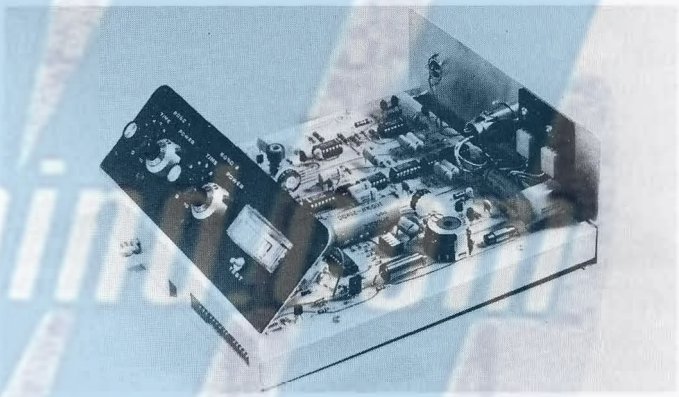
BONDING HEAD

Bonding Direction	Front to Back
Tool Type	Polyplanar design
Wire Handling	Free Reel
Bonding Force	95 to 1100 gms
Cut-off preload	0 to 500 gms
Stepback Range	Adjustable 0 to .300 inch
Loop & Search Height	Adjustable
Bonding Plane	
Height Differential	Up to ±0.100 inch

OPTIONS

Multiple Stitch Bonding
Workholders
Ribbon Conversion Kit
Indexer
Wire Dereeler (motorized)
Manual z (in development)
Chuck Rotation

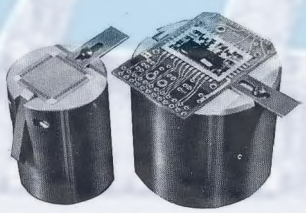
MODULARITY AND EASE OF MAINTENANCE



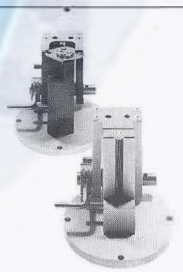
WORKHOLDERS

Indexers

TO-3
TO-66
TO-39
TO-220



Hybrid Chucks



TO-3, TO-5, TO-60 Chucks

Represented By:

ORTHODYNE ELECTRONICS

851 West 18th Street
Costa Mesa, California 92627
Phone: (714) 631-7800
TWX 910 596-1367