# SMAC

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# SMAC

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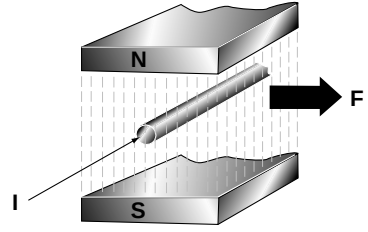
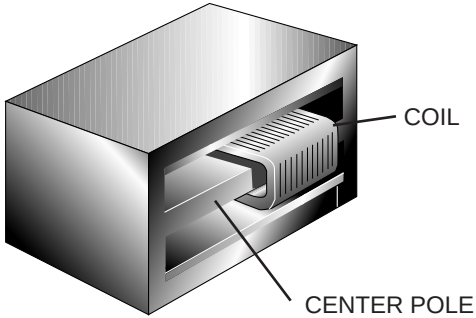
# SMAC

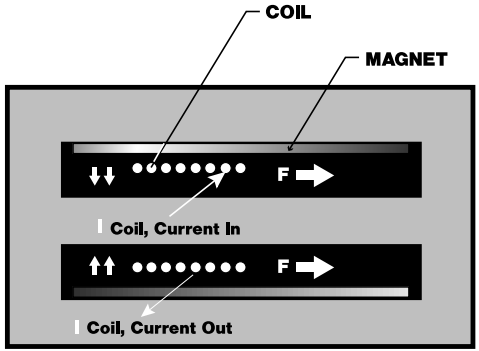
## MOVING COIL TECHNOLOGY




The force generated is proportional to **N I B** where:

**N** is the number of turns in the winding,
**I** is the current flowing through the winding and
**B** is the magnetic flux.




Current (**I**) circulates in coil
Crosses flux lines (**B**)
Develops Force (**F**)

**F = n I B**

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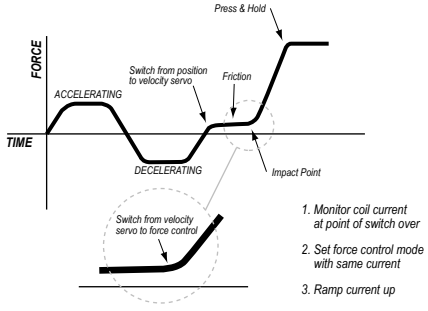
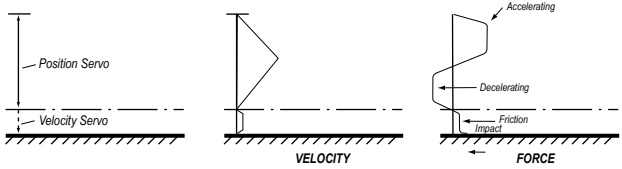
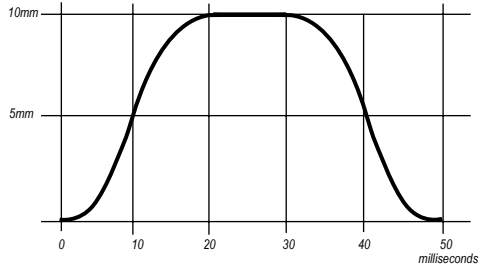
## SOFT LANDING




1. Monitor coil current at point of switch over
2. Set force control mode with same current
3. Ramp current up

## WORK PROFILE




Acceleration $a = \frac{2s}{t^2} = \frac{2 \times 5}{100} \times 10^6$

$= 10 \times 10^4 \ \frac{mm}{sec^2}$

$= 10\,g$

Max. Velocity $= at = 10^5 \times \frac{10}{10^3} = 1$ meter/sec

# Screen Printing

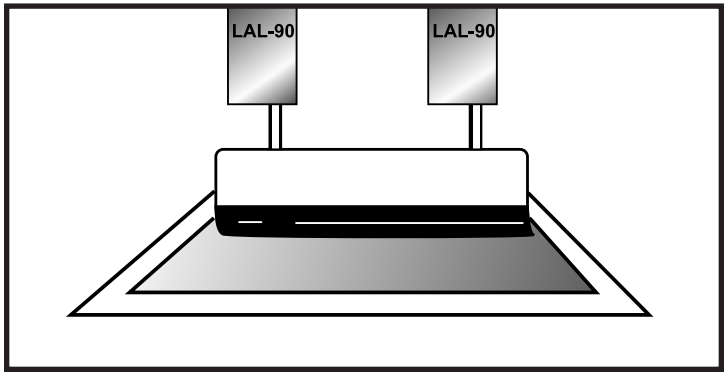
*Printing quality depends on good control of position and force.*

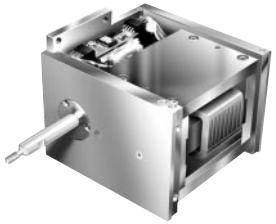
*As the squeegee lifts up on one end, the forces applied by the actuators on either end are adjusted to maintain constant (level) position and constant force.*

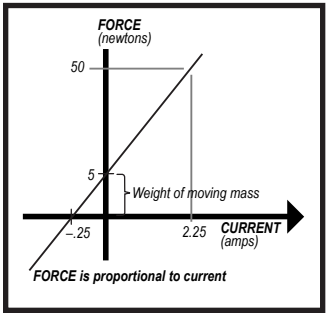
***Other Applications:***

*Screen printing for circuit boards*

*Large display panels*






***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

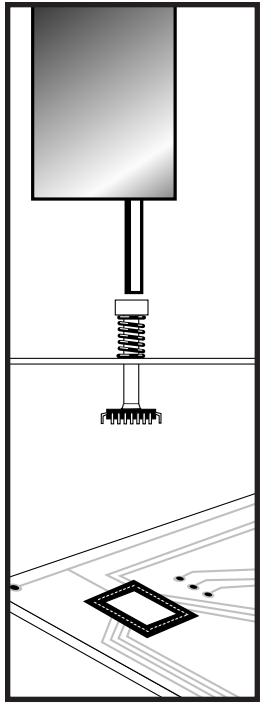
*The datum for the squeegee is established with the two actuators reading position and maintaining the proper force. As the squeegee is moved over the screen, the actuators track each other to maintain the proper position. The force applied by each actuator is dynamically adjusted.*

- *Force can be controlled to +/- 25 grams*
- *Position can be maintained to +/- 5 encoder counts*

***SMAC Advantages:***

*Instantaneous transition from position mode to force mode*

*Ability to monitor position in force mode and make decision to change programs*



# Chip Mounter

*Pick, place at high speed*

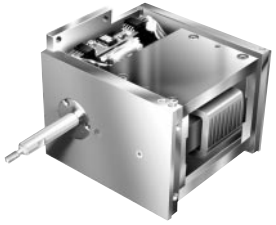
*Most chip mounters use mechanical cams and springs*

*To operate at 10 parts per second (100 millisecond per part) the up or down stroke needs to be made (stop to stop) in 30 milliseconds.*

*The actuator needs to be capable of high force and high acceleration. (e.g. LAL-90)*

***Other Applications:***

*Printed circuit board assembly*



***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*To place a chip, the actuator rod moves down, compressing a spring loaded nozzle.(elapsed time: 30 milliseconds)*

*Dwell 30 milliseconds*

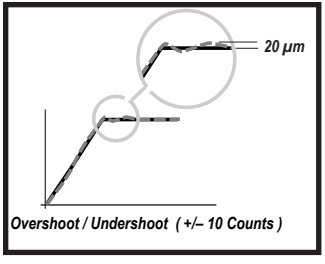
*Actuator rod moves up, 30 milliseconds*

*Next nozzle moves into position(10 milliseconds)*

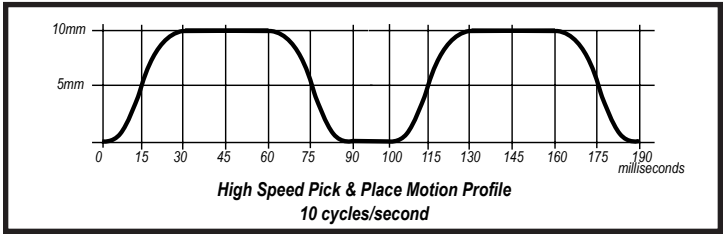
***SMAC Advantages:***

*High G-forces, fast settling time, 20 micron overshoot/undershoot*

*Separately programmable PID servo parameters for down stroke (working against the spring) and for up stroke*




***Overshoot / Undershoot ( +/– 10 Counts )***




***High Speed Pick & Place Motion Profile***
***10 cycles/second***

# Wire Bonding

***A. CONTACT***

*• High speed Approach*
*• Slow Down, soft land on pad*

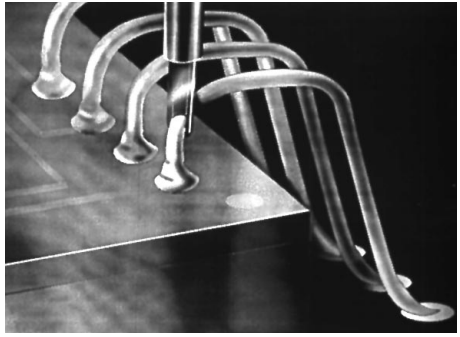
***B. HOT MELT***

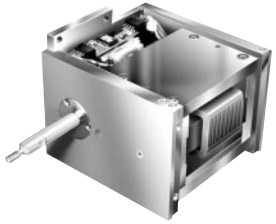
*• Increase force, follow wire as solder melts, maintain force at 200 - 500 gms*

*• Track wire position, maintain force profile to ensure no separation*
*• Hold*

***C. RETRACT***

*• High speed take-off*





***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*High speed approach, slow down, soft land on pad*

*Increase force, follow wire as solder melts, maintain force at 200 - 500 grams*

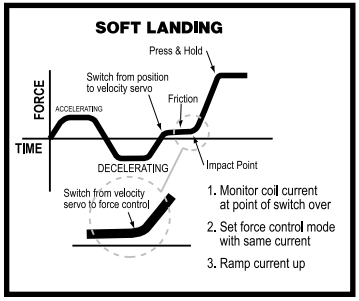
*Track wire position, maintain force profile to ensure no separation*

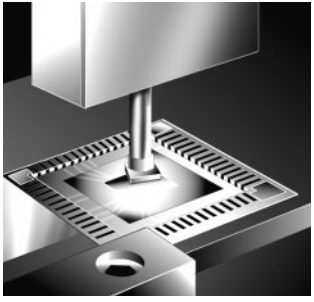
*High speed take-off*

***SMAC Advantages:***

*Instantaneous transition from position mode to force mode*

*Ability to monitor position in force mode and make decision to change programs*





# Die Bonding

***A. PICK UP***

- *High Speed Approach*
- *Slow down, soft land on part (pick-off height)*
- *Turn on vacuum, pick up*
- *High speed take-off*

***B. ORIENT***

- *Camera determines orientation*
- *Rotate*

***C. PLACE***

- *High speed approach*
- *Slow down, soft land on fixture*
- *Increase force to press & hold*
- *Release part*
- *High speed take-off*

***Actuator: LAR-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary axis resolution: 0.07 degrees*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on die, turn on vacuum, pick up, high speed take off*

*Camera determines orientation, rotary axis rotates to orient*

*Softland on substract, increase force to press & hold*

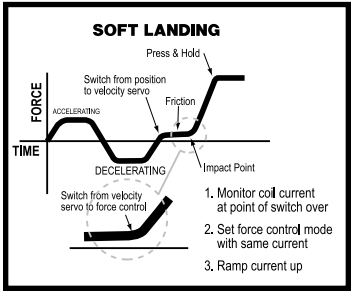
***SMAC Advantages:***

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Apply appropriate bonding force to effect reliable bond*



# Connector Pin Insertion

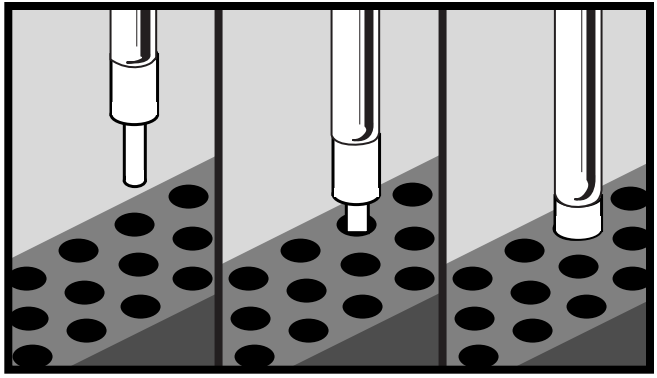
*No bent pins*

*100% inspection*

*Programmable for different sizes*

***OPERATION***

- *Pick up pin, locate hole*
- *Set force, press in*
- *Set lower force, drive in, check depth*
- *Report good / bad / missing pin*



***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Pick up pin, set low force, target top of hole to locate it,if alignment is no good, pin will not reach target position*

*If alignment is good, set full force, drive in, measure penetration*

*To check for missing pin, set lower force, attempt to drive in further,if pin exists, there should be no movement*

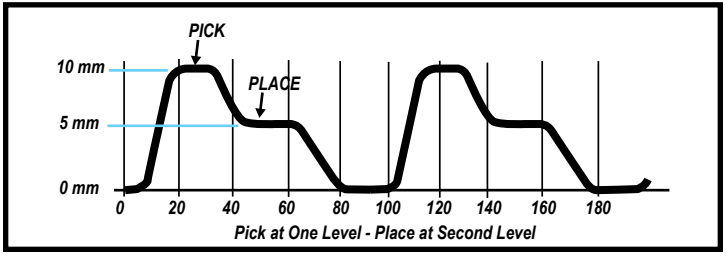
***SMAC Advantages:***

*Force can be selected in position servo mode*

*Position can be measured to 5 microns*

*Motion profile can be selected for different size pins*

*Assembly machine can be readily reconfig-ured for many types of connectors*

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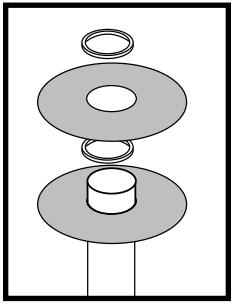
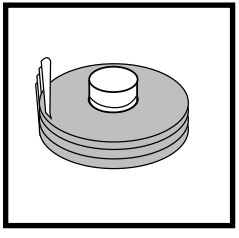




# Disk Drive Assembly

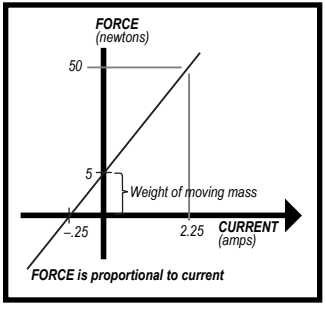
- *High volume (millions per month)*
- *Low prices (short assembly times)*
- *Very high reliability (strict process control)*

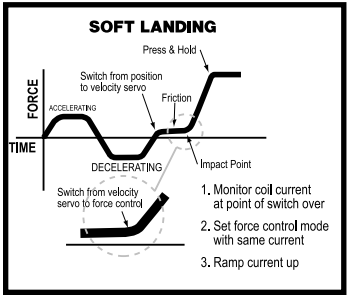
***Other Applications:***

*Press fit for motor hub*
*-check part size, check final part position*

*Press fit spacer & hub to secure disk platters*
*-check part size, check final part position*

*Load and secure read-head comb assembly*
*-check part size, orientation,*
*-check final part position*




***Actuator: LAL-150***
*Stroke (mm): 15*
*Resolution: 1 or 5 micron*
*Force: 200 newtons*
*Moving Mass: 350 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*Pick & Place motor hub, check part size, check final part position*

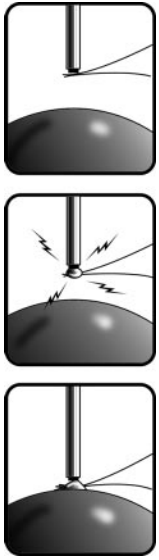
*Pick & Place spacer to secure disk platters*

***SMAC Advantages:***

*Multi-position moves to secure each platter*

*Soft landing capability to protect surface finishes*

*Control final part position to within 10 microns*



## Spot Welding

***1.*** *Spark melts joint material in mid air*

***2.*** *Molten joint is carried on surface in milliseconds and secured to bond*

*Conventional method sparks the joint on the surface. Since the surface is good conductor, the melt is poorly formed resulting in marginal welds.*

***Actuator: LAL-30 (low friction version)***

*Stroke (mm): 15*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 120 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Spark the junction, drive towards target while junction is molten*

*High speed approach, slow down, softland on part*

*Hold part on surface until weld is formed*

***SMAC Advantages:***

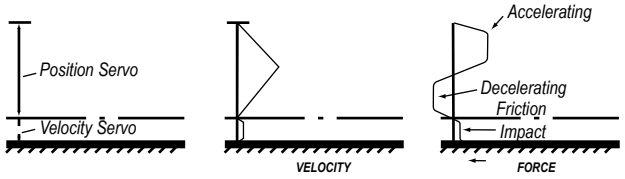
*Short drive time is required to keep the junction molten*

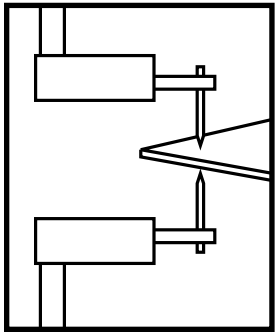
*LAL-30 has a low moving mass (high G-forces) to get short drive time*

*Direct drive (moving coil) controls force to softland and to hold junction on surface while weld is being formed*

*100% inspection for air bag parts possible*

**WORK PROFILE**





# Spot Welding, Soldering

*Highly repeatable joints depend on applying even and consistent pressure.*

*Soldering of inter-module connections in a solar array panel for space systems depends on a skilled work force and strict process controls.*

*SMAC actuators offer these new capabilities:*

- *Start from 10 mm above work surface*
- *Fast approach to within 1 mm of work surface*
- *Switch to very low speed (low impact) to contact work surface*
- *Detect contact, measure drive current at moment of contact (force is determined by drive current)*
- *Maintain drive current at the same value for a short time period. This eliminates any high frequency force spikes. Contact force can be held under 10 grams.*
- *Ramp force up to the desired value (even and consistent pressure) and start the soldering (or welding) operation. Force can be ramped up to 1 kgf in 100 ms.*
- *Hold force constant during soldering operation to assure a high quality joint.*
- *Take off to "park" position*

***Actuator: LAL-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on surface*

*Ramp force up to set value, weld (solder) part to surface*

***SMAC Advantages:***

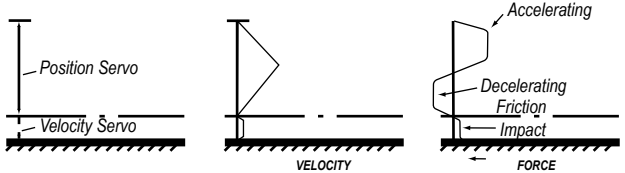
*Soldering terminals to space satellite solar cell panels requires good control of the contact force to avoid damaging the cells*

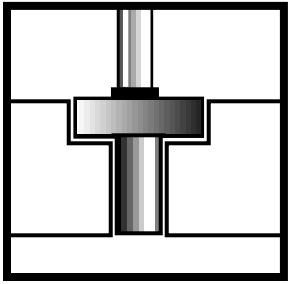
*SMAC Soft Landing profile uses a high speed approach to save time*

*Before contacting the solar cells, velocity is reduced to less than 1 mm/second to minimize the "impact" force to under 30 grams*

*Before switching to "force" mode, the current (amp) used to power the coil is monitored and force mode is initiated using the exact same current to maintain the same force.*

**WORK PROFILE**





# Ultrasonic Welding

1. *Actuator picks up part (part size/orientation verified at pick up).*
2. *Place part into cavity (location checked to verify proper penetration).*
3. *Ultrasonic energy turned on. Part moves as weld forms.*
4. *Part seated and held at proper height.*

**Actuator: LAL-50**

Stroke (mm): 100
Resolution: 1 or 5 micron
Force: 25 newtons
Moving Mass: 225 gms
Supply Voltage: 24 Volts

**Key Operational Details:**

Pick & Place part onto assembly

Turn on ultrasonic energy, maintain force as part "melts" into assembly

Monitor position and hold part at pre-selected position

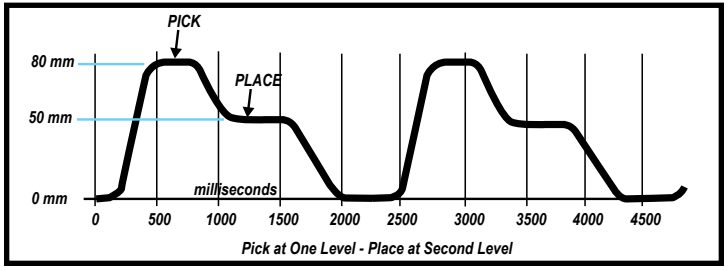
Turn off ultrasonic energy and wait until weld is complete

**SMAC Advantages:**

Force can be selected in position servo mode

Position can be measured to 5 microns in force mode, parts can be assembled precisely in the position specified

Assembly machine can be readily reconfigured for many types of parts



# Medical Assembly

*Medical devices manufacturers need to satisfy GMP, FDA...*

** SMAC actuators do the work*

** Perform 100 % inspection on the part and the assembly*

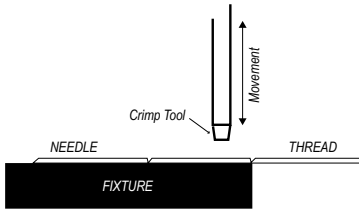
*• Inspection data can be collected for statistical process control*

***Other Applications:***

*Eyelets in catheters*

*Oval holes in catheters*

*Positioning needles to drill holes in them*




***Actuator: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 170 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Pick & Place part onto assembly*

*Apply force to crimp part (form hole, etc)*

*Check position of finished assembly*

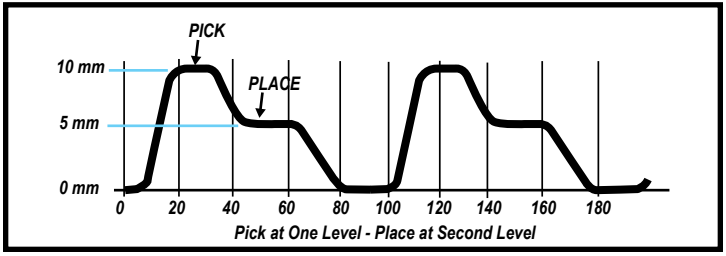
***SMAC Advantages:***

*Force can be selected in position servo mode*

*Position can be measured to 5 microns in force mode, parts can be assembled precisely in the position specified*

*100% inspection of part and assembly, data can be transferred and saved for GMP purposes*

*Assembly machine can be readily reconfigured for many types of parts*

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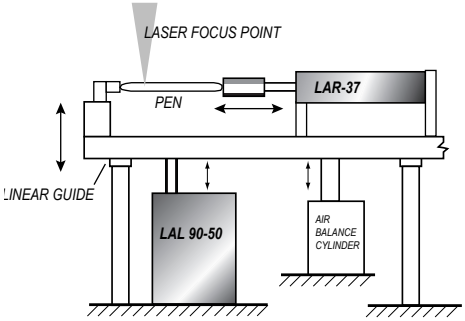
# Laser Cutting

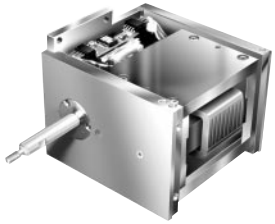
*Pens of different sizes an be positioned accurately in laser focus point*

*Rotary / linear actuator secures pen and rotates to proper orientation*

***Other Applications:***

*Etching logos on different sizes of pens*



***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Actuator: LAR-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 170 gms*
*Rotary Axis Resolution: 0.07 degrees*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

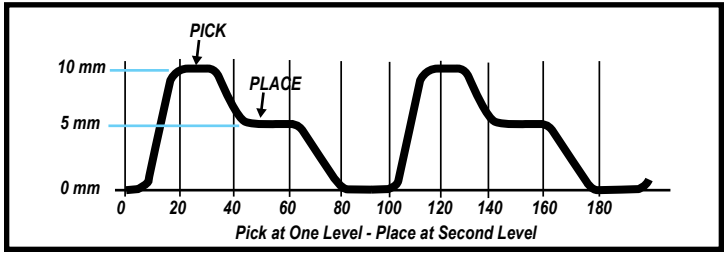
*Pens of different diameters are positioned by the LAL-90 (50mm stroke) actuator so the laser is focused onto the surface of the pen.*

*Rotary/Linear actuator secures the pen and rotates it.*

***SMAC Advantages:***

*Position can be measured to 5 microns, parts can be assembled precisely in the position specified*

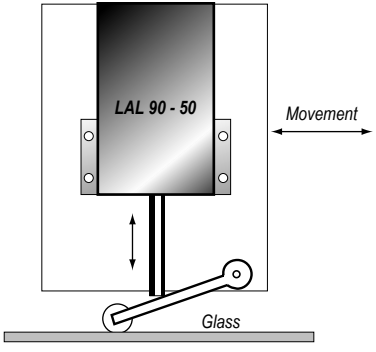
*Machine can be readily reconfigured for many types of parts*

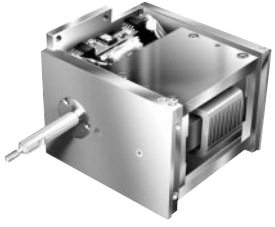


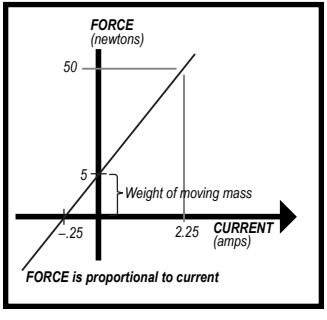
# Glass Cutting

*Glass cutter is held against glass surface with constant force*

*Improves quality of cut by eliminating bounce caused by uneven surface*






***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*Glass cutter is held against glass surface with constant force*

***SMAC Advantages:***

*SMAC monitors position and force to eliminate bounce*

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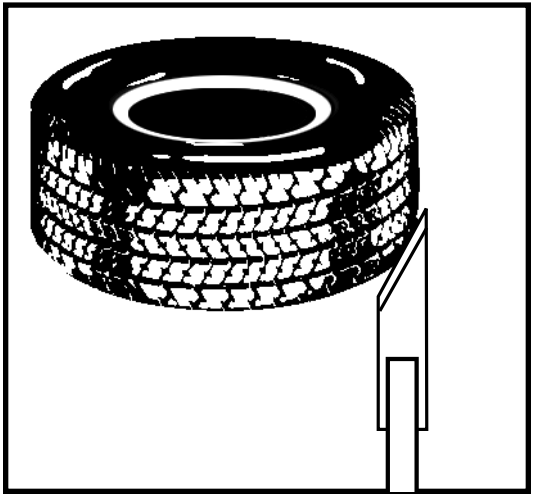
# Tire trimming
# Flash trimming



***Actuator: LAL-50***

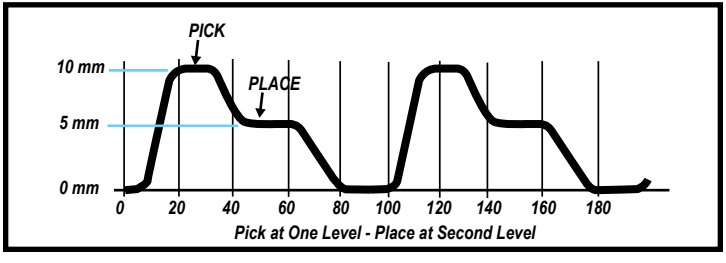
*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Cutting knife is stroked in and out to trim flash*

***SMAC Advantages:***

*Knife position can be instantaneously changed on demand*

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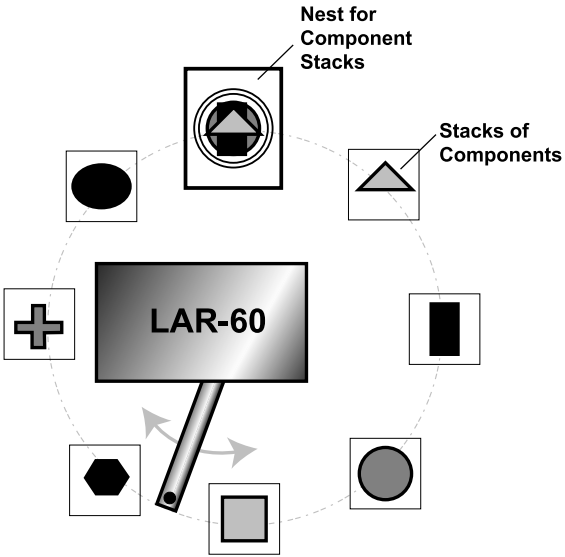
# Stacking of Components




PLAN VIEW

***Actuator: LAR-60***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Rotary Axis: 0.1 degree resolution*
*Torque: 1 newton-meter (145 in-oz)*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Rotary axis rotates to one of eight positions (in order of assembly)*

*Linear axis picks up part*

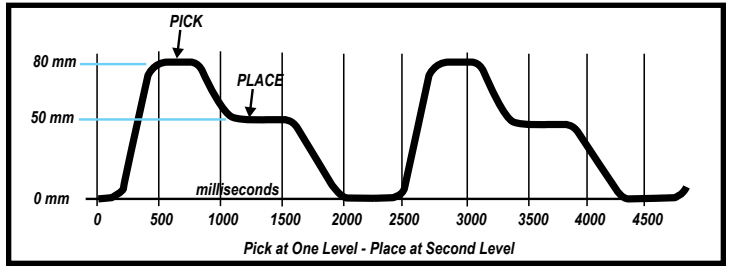
*Rotary axis rotates to "nest" position*

*Linear axis places part at the height of the partial assembly*

***SMAC Advantages:***

*2-axis coordinated motion, linear axis programmed to pick & place at different heights*

*Built-in through the rod vacuum*



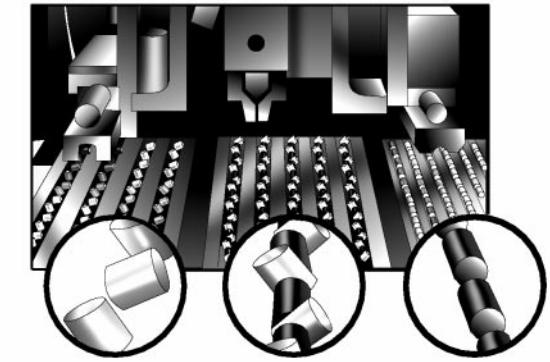

Pick at One Level - Place at Second Level

# Automatic Assembly

*Cross roller linear guides are made by encapsulating a combination of rollers and spacers in the V-groove between the guides. An automatic assembly machine is designed to fixture the guides, grease the V-groove, load rollers and spacers into the V-groove. Since it is desirable to build a machine that can build cross roller linear guides of different dimensions, the loading mechanisms must be settable to different positions to pick up different sized components.*

***Solution***

*The SMAC LA-50 linear actuator has a lifting capability of 2.5kg force. Since it can be programmed to move to different positions, a different cross roller part number can be used to select a different motion profile.*



***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Parts (rollers or spacers) picked up from pallet*

*Pallet holding "final assembly" moves under the actuator*

*Parts are placed onto pallet*

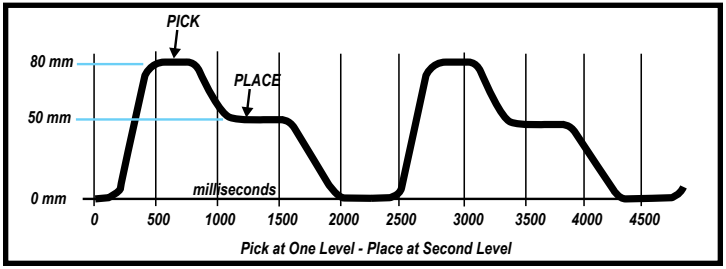
*Next component gets picked and placed*

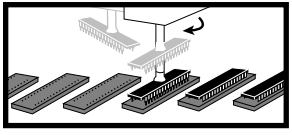
***SMAC Advantages:***

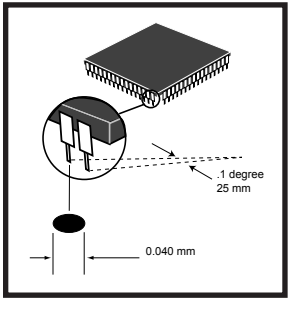
*SMAC actuator can be programmed to pick and place at different heights*

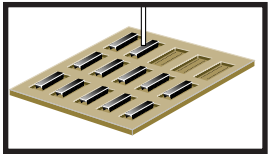
*By reading a part number code on the pallet, the proper positions are established for the next operation*

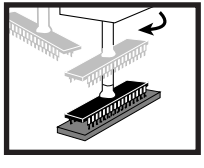
*Many part numbers can be produced using a single assembly machine*

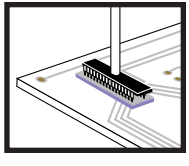










# High Resolution Rotary

- *50,000 counts/rev encoder —> 0.0072 degree resolution*
- *Encoder mounted on output shaft, no backlash*
- *High speed rotary - 5500 rpm*
- *Rotary axis carried by linear axis - 6-G acceleration*

***Other Applications:***

*Pick, orient and place Multiple chip modules (MCMs)*

*Pin Grid Array*

***Actuator: LAR-40***

*Stroke (mm): 40*
*Resolution: 1 or 5 micron*
*Force: 30 newtons*
*Moving Mass: 500 gms*
*Rotary Axis: 0.0072 degree resolution*
*Torque: 0.03 newton-meter*
*Direct drive, no gear*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on chip, turn on vacuum, pick up, high speed take off*

*Camera determines orientation, rotary axis rotates to orient*

*Softland on substrate, increase force to press & hold*

***SMAC Advantages:***

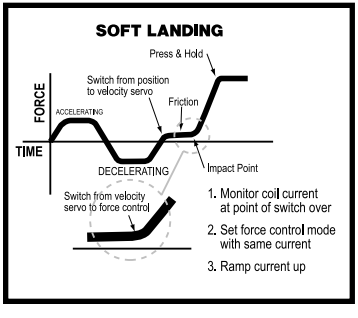
*Direct drive (no gear, no backlash) with 50,000 count/rev encoder*

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

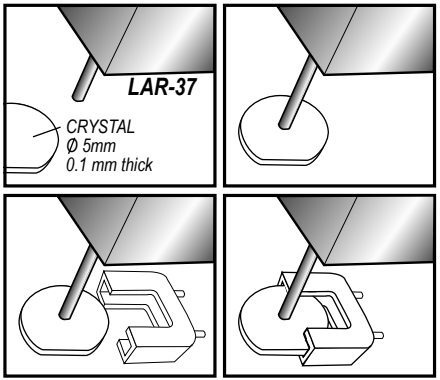
*Programmable profile to handle delicate part*

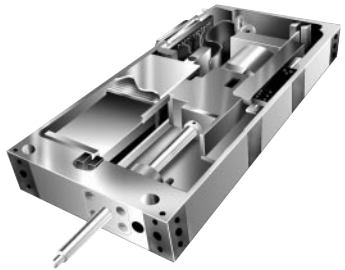
*Apply appropriate bonding force to effect reliable bond*



# Pick, Orient & Place

- *Quartz crystals for cellular phones are small, fragile and need to be assembled in a clean room.*
- *SMAC LAR-37 actuators are used to assemble 1000 parts/hour.*



***Actuator: LAR-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 250 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on crystal, turn on vacuum, pick up, high speed take off*

*Camera determines orientation, rotary axis rotates to orient*

*Linear axis aligns crystal with the socket*

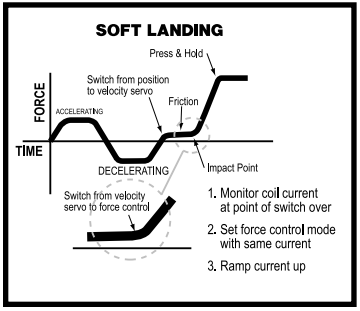
***SMAC Advantages:***

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

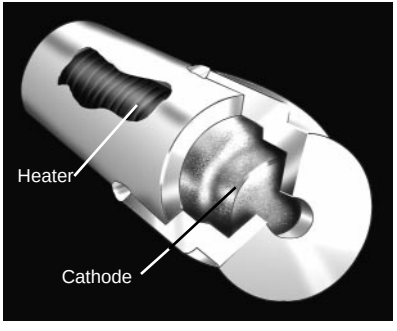
*Rod runout less than 20 micron to achieve good alignment*

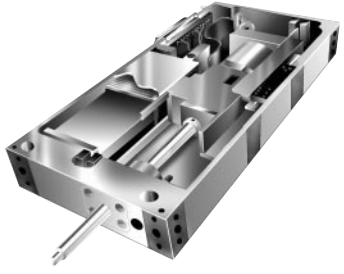


# Hot Cathode for TV Tubes

*Super bright TV tubes use a hot cathode. 3mm diameter cathode is encapsulated by an end cap and a heater can:*

*SMAC actuators are used to pick, orient, place and assemble the parts*



***Actuators: LAL-37 and LAR-37 (for rotating the final assembly)***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 250 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured to check for correct orientation, turn on vacuum, pick up, high speed take off*

*Next nest comes into position under the actuator, part is placed into nest and the partial assembly is measured to check proper assembly*

*Final assembly is picked up, rotated to allow a laser beam to weld a seam between the heater and the cap*

***SMAC Advantages:***

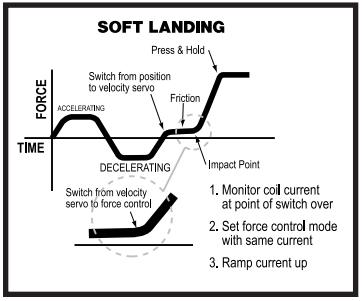
*Pick & place operation with 100% parts inspection*

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

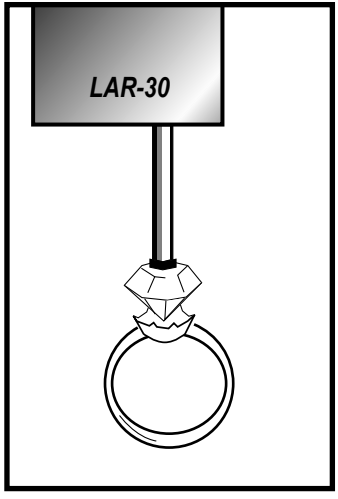
*Programmable profile to handle delicate part*

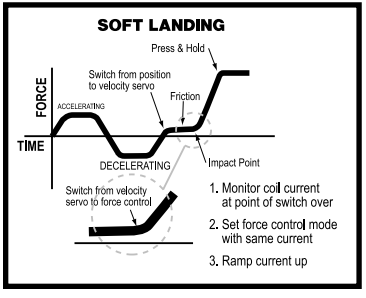
*Rod runout less than 20 micron to achieve good alignment*



# Pick, Orient, Press

*Clasps for mounting precious stones are picked, oriented and pressed into ring*




***Actuators: LAR-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured to check for correct orientation, turn on vacuum, pick up, high speed take off*

*Clasp for mounting the precious stone is orented to one of three directions*

*Next nest comes into position under the actuator, part is placed into nest and the partial assembly is measured to check proper assembly*

***SMAC Advantages:***

*Pick & place operation with 100% parts inspection*

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

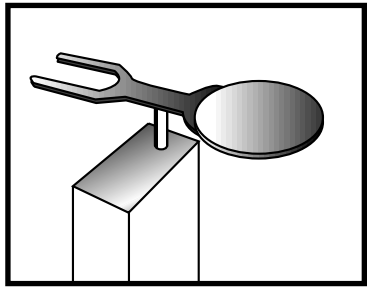
*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

# Wafer Transport

*Wafers are moved from one processing cell to another using a "robotic" arm.*

*Force applied to the wafer can be controlled to under 10 grams.*



**Actuator: LAR-50**
**(Special modification using stepper motor)**

Stroke (mm): 50
Resolution: 1 or 5 micron
Force: 25 newtons
Moving Mass: 500 gms
Supply Voltage: 24 Volts
Rotary Axis: Stepper Motor

**Key Operational Details:**

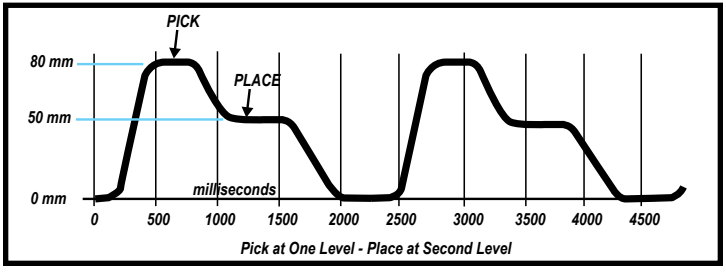
Wafer is lifted, rotated 180 degrees

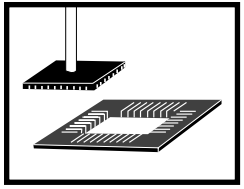
Wafer is lowered

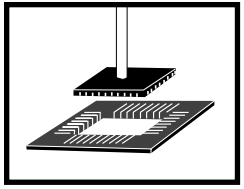
**SMAC Advantages:**

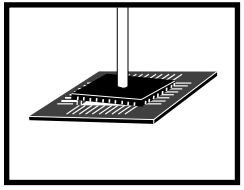
Force is programmable

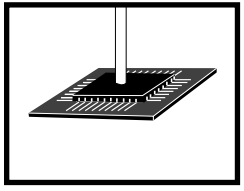
Contact force can be controlled to less than 30 grams











# IC Test Handler Upgrade

***THEN:***

- *IC's are automatically inserted by air cylinder*
- *Insertion position fixed once it is set*
- *Contactor wears out after a short period of time*
- *Bad parts need retesting to confirm*

***NOW:***

*IC's are "positioned" by SMAC moving coil actuator:*

- *IC moved to starting position (high speed move)*
- *Approach contact at very low speed (low impact)*
- *Softland on contactor*
- *Check position and force of contact*
- *If force is higher than limit, back off, start over (will not damage contactor)*
- *If force is within limits, drive forward into contactor, measure position and force*
- *If position is within limits, start test*
- *If position is beyond limits, abort (will not overdrive into contactor)*

***Other Applications:***

*Loading oscillator onto printed circuit board*

*Loading small PCB onto test fixture*

*Loading spring fuse into fuse holder*

*Loading strain gauge onto PCB*

***Actuators: LAL-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

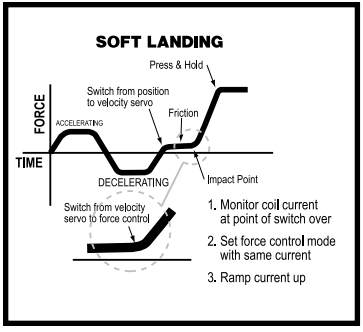
*High speed approach, slow down, softland on part, part is measured to check for correct location*

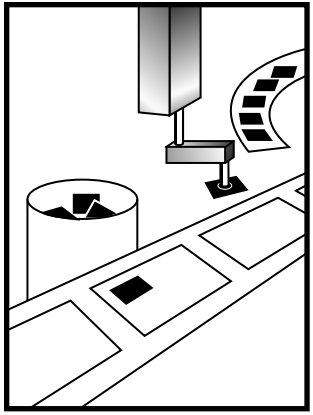
*Force is increased in steps, position and force measured to determine if part is inserted correctly*

***SMAC Advantages:***

*By monitoring the insertion force and position the contactor is not subjected to undue stress*

*Preserves the expensive contactor and gets good test results so parts do not need to be re-tested*





## *2-Axis Robot*

- *Pick up bad IC from conveyor, rotate to "dump" station, dump IC.*
- *Rotate to IC parts feeder, pick up good IC*
- *Rotate to conveyor, deposit good IC.*

***Other Applications:***

*IC Test*

*Die Attach*

*Tray to tape*

*Tray to tape with part orientation*

**Actuators: LAR-30**

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, turn on vacuum, pick up, high speed take off*

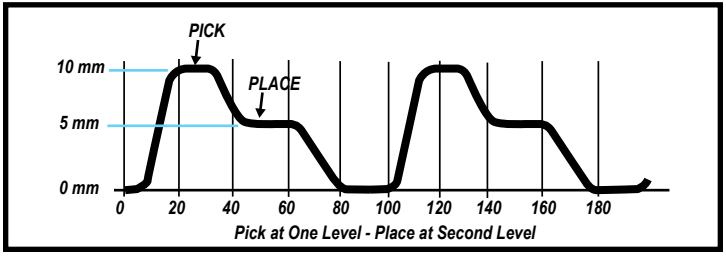
*Rotate to second location to place part*

***SMAC Advantages:***

*Pick & place operation using a Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Multi-position, programmable profile to handle delicate part*

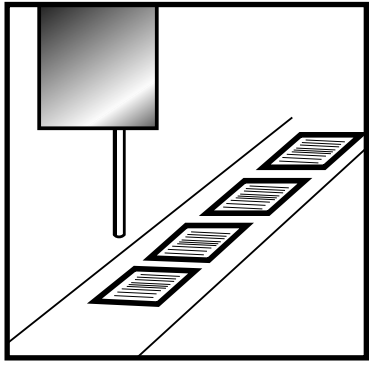


# Labeling machine

*Pick & place*

*Vacuum suction to pick up*

*Custom motion profile to peel labels*



***Actuators: LAL-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, soft land on part, turn on vacuum*

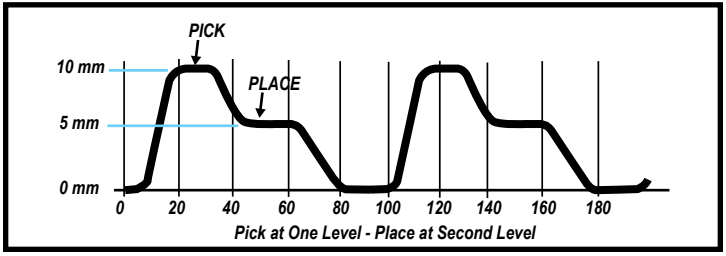
*Reverse direction to peel label off, controlling force and velocity to maintain contact with label*

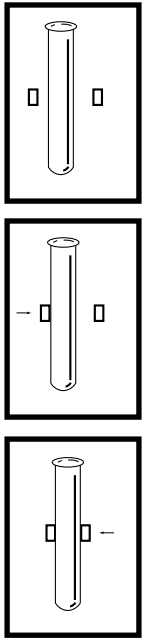
*Place label on part*

***SMAC Advantages:***

*Built in, through the rod vacuum*

*Controls force and velocity to peel label from adhesive backing*





# Picking Test Tubes From Rack

- *Delicate touch and feel*
- *Each finger can soft touch and then ramp up force to secure part.*
- *Parts need not be precisely located*
- *Fingers independently locate part before pick up, parts don't get knocked over*
- *Parts can be centered after pick-up*
- *After part is picked up, both fingers can move in unison to locate part for subsequent assembly*
- *Each part is measured for size, orientation.*
- *Missing parts or dropped parts are automatically sensed and reported*

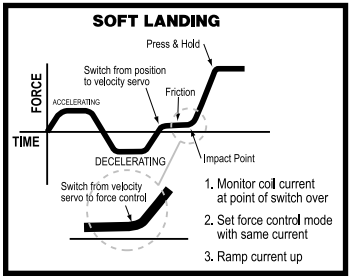
***Other Applications:***

*Pick & Place*
*Medical Device Assembly*
*Irregular Shaped Parts*
*Parts with soft sides*

***Actuator: GRP-02 Gripper***

*Gripper with Independent Fingers*

*Maximum Opening: 15 mm*
*Resolution: 1, 5 micron*
*Force (newton): 12*
*Payload (gm): 500*
*Weight (kg): 0.75*
*Operating Voltage: 24 Volts*



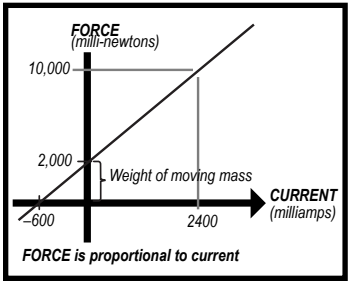

***Key Operational Details:***

*Each finger is driven by an independent linear actuator*

*Each finger is programmable in position and force*

*Each finger performs a soft landing profile to engage the test tube*

*Then both fingers can operate in unison to locate the test tube*




***SMAC Advantages:***

*Independently operated fingers means that parts need not be precisely located*

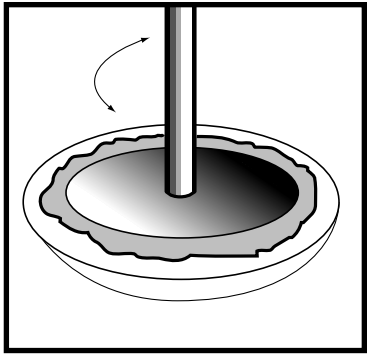
*Delicate touch and feel means that contact surfaces can be different shapes, texture or compressibility*

*Part can be measured for type of material, size, orientation*

# Lens Polishing

*Glass lens is picked up and rotated*

*Vacuum through hole is integral to the lens pick up head*



***Actuator: Special, rotary only***

*DC-servo motor, 5000 rpm*

*Torque: 1 newton-meter*

*Through-the-rod vacuum connection (rotary seal)*

***Key Operational Details:***

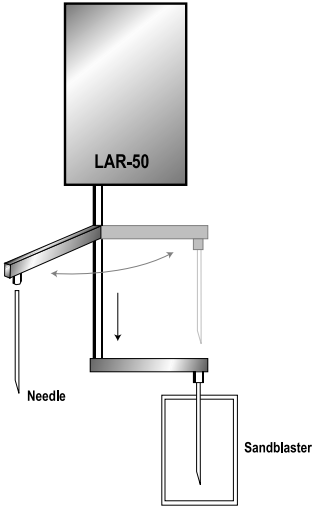
*Vacuum pick up*

*Rotate*

***SMAC Advantages:***

*Through-the-rod vacuum with rotary seal*

*Quick delivery of custom configurations to offer solution to customer*




# Sandblasting Surgical Needles

1. *Pick up needle*
2. *Rotate*
3. *Insert into sandblasting chamber*
4. *Retract*
5. *Rotate to place needle in finished bin*

***Actuator: LAR-50***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 275 gms*
*Supply Voltage: 24 Volts*
*Rotary Axis: Resolution 0.07 degree*
*Torque: 0.1 newton-meter (14 oz-in)*

***Key Operational Details:***

*Needle is lifted, rotated 90 degrees*

*Needle is lowered into sandblaster*

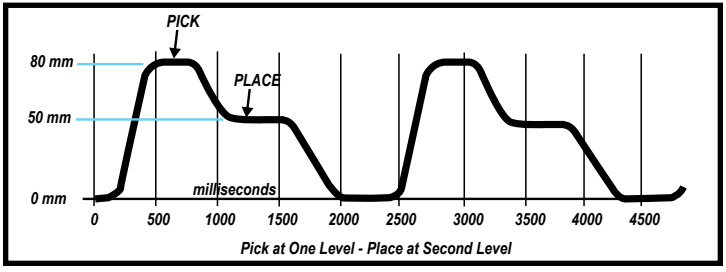
*Needle is lifted, rotated 90 degrees, needle is placed*

***SMAC Advantages:***

*Pick & place operation using a Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Multi-position, programmable profile to handle delicate part*



# Placing Cover Glass on Microscope Slides

*Microscope slides are fragile*

*Cover glasses are even more fragile*

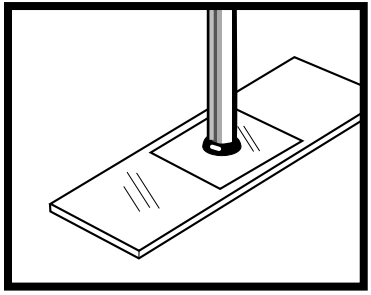
*SMAC actuators (LAL-30, low friction modification) can control touch-down force to under 10 grams*

*1. Soft land on cover glass*

*2. Turn on vacuum to pick up*

*3. Transport*

*4. Soft land on microscope slide*



***Actuator: LAL-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on cover glass*

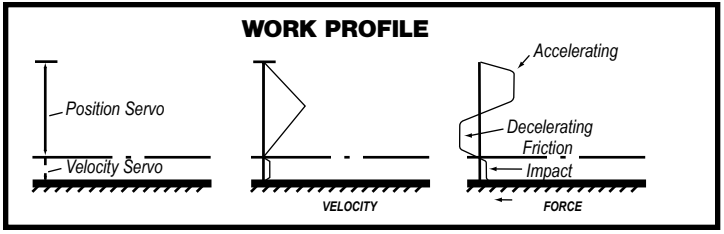
*Turn on vacuum, pick up cover glass, take off*

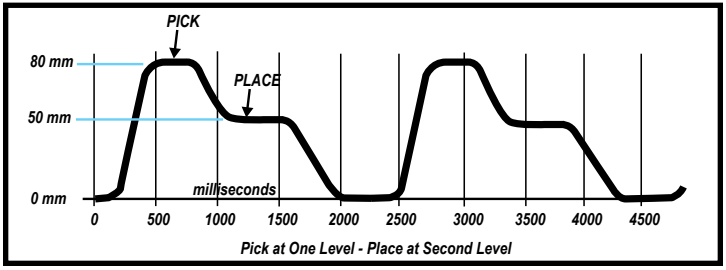
*Transport, high speed approach, slow down, softland on microscope slide*

***SMAC Advantages:***

*Direct drive (moving coil) controls force to softland on cover glass*

*Force controlled to under 10 grams using low friction option, proven not to break glass*

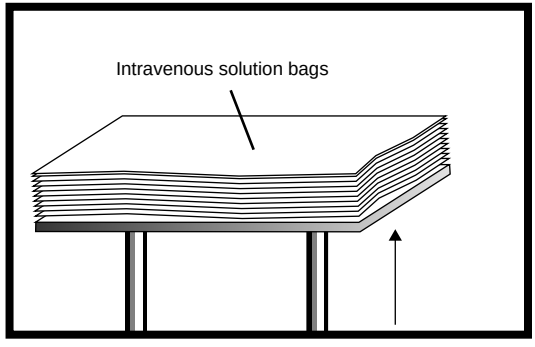


# Precision Elevators

*Bags are picked off one-at-a-time from elevator for electrostatic discharge (EDS) processing prior to filling.*

*SMAC actuator is used to lift the stack of bags into position.*




***Actuator: LAL-30 (low friction version)***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on IV bags*

*Turn on vacuum, pick up one IV bag, take off*

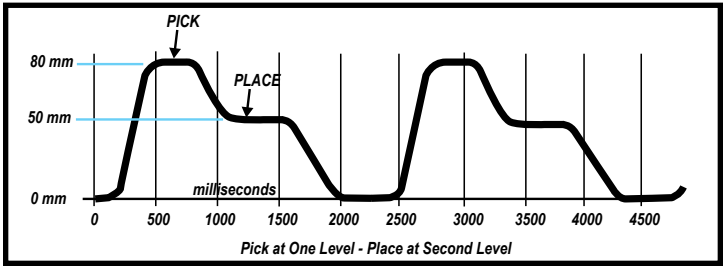
*Transport, high speed approach, slow down, present bag to next operational step*

***SMAC Advantages:***

*Pick & place operation using a linear actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Multi-position, programmable profile to handle delicate part*

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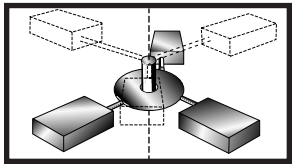
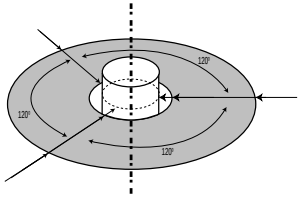


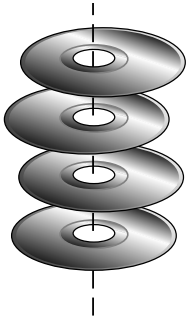
# Dynamic Balancing of Disk Platters

- *Disk platters need to be dynamically balanced*
- *Each platter is measured for size (ID, OD) and location*
- *From these measurements, each platter is positioned to get a balanced disk drive.*




***Other Applications:***

- *Measure CD thickness using SMAC Gripper*



***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*

*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Measure O.D. of hub*

*Softland on rim of diskette and push against hub to determine I.D. & O.D. of diskette*

*Calculate size of each diskette and determine center of gravity*

*Calculate best location of each diskette to get a dynamically balanced disk drive*

*Move diskettes into position*

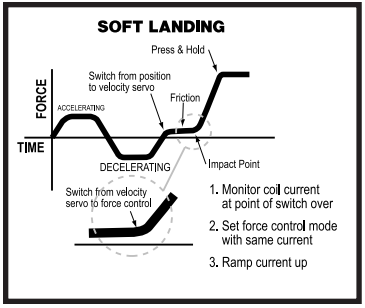
*Clamp platters and lock them in place*

***SMAC Advantages:***

*Force can be selected in position servo mode*

*Position can be measured to 1 micron resolution. In force mode, parts can be precisely measured with a reproducible contact force*

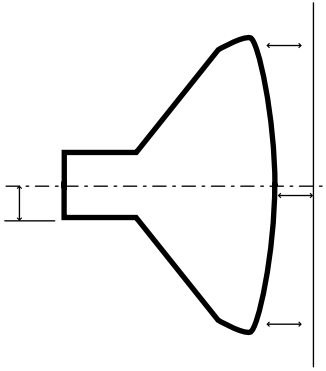
*Measurements can be transferred to a host computer to make the calculations*

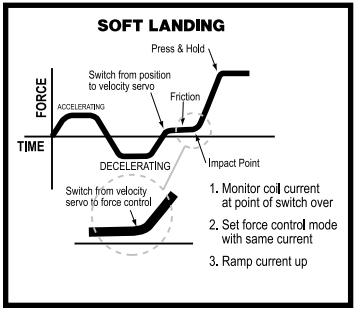


# TV Tube Inspection

*Better products through SPC (Statistical Process Control)*

*TV tubes are measured in gaging fixture using SMAC actuators which make the measurements and report the results to a central manufacturing computer.*






***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Softland on TV tube face and make measurements*

***SMAC Advantages:***

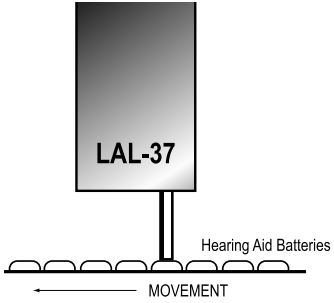
*Force can be selected in position servo mode*

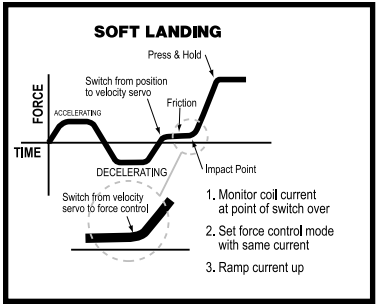
*Position can be measured to 1 micro resolution. In force mode, parts can be precisely measured with a reproducible contact force*

*Measurements can be transferred to a host computer to make the calculations*

# Height Gage

- *Measure each part against go-no-go window*
- *Measure each part and store part height data (transmit to PC)*
- *Measure each part, sort into good/bad parts*




***Actuators: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured*

*Measurement is compared against GO/NO-GO window*

*Good/Bad part signal is turned on*

***SMAC Advantages:***

*100% parts inspection*

*Linear actuator in a single ready to mount package*

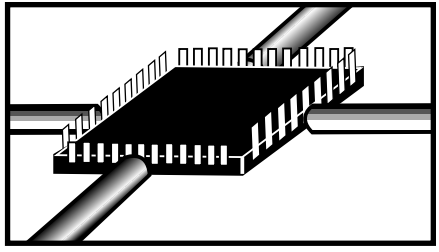
*High speed, long life design for continuous operation*

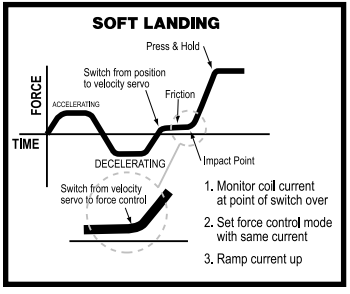
*Programmable profile to handle delicate part*

*Rod runout less than 20 micron to achieve good alignment*

# Lead Inspection Machine

*To accommodate chips of different sizes, the scanning of the leads can be programmed using SMAC moving coil actuators.*






***Actuator: LAL-30 (low friction version)***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Actuator: LAR-40***

*Stroke (mm): 40*
*Resolution: 1 or 5 micron*
*Force: 30 newtons*
*Moving Mass: 500 gms*
*Rotary Axis: 0.0072 degree resolution*
*Torque: 0.03 newton-meter*
*Direct drive, no gear*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on chip, turn on vacuum, pick up*

*Camera determines orientation, rotary axis rotates to orient*

*Linear Actuators are used to position the inspection lasers*

***SMAC Advantages:***

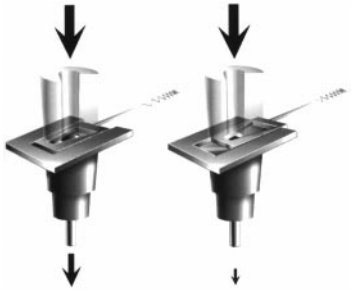
*Direct drive (no gear, no backlash) with 50,000 count/rev encoder*

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Linear actuator, resolution: 1 micron*



# Qualifying Fuel Injectors

*Fuel is metered by sliding a valve. Full travel is 11mm. Any restriction along the travel is indicative of a bad fuel injector. Inspection: Set a sliding force of 3 ounces and move the slider forward and backward. If the slider moves 11mm, the injector is good. If it stops, reject the injector and report the location.*

1. *Calibrate the actuator to set a sliding force of 3 oz.*
2. *Slide the valve forward 11mm, record position of stop.*
3. *Slide the valve backward 11mm, record position of stop.*

***Actuators: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*

*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, engage slider valve*

*Set force to 3 oz (90 grams), check position*

*Reverse direction and repeat*

*Measurement is compared against GO/NO-GO window*

*Good/Bad part signal is turned on*

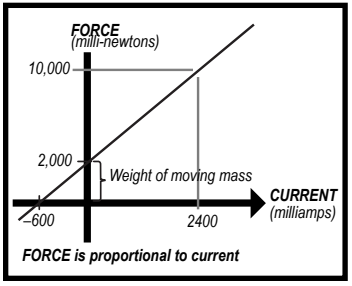
***SMAC Advantages:***

*100% parts inspection*

*Linear actuator in a single ready to mount package*

*High speed, long life design for continuous operation*

*Programmable profile to set force*



# Soft Contact Lens Mold

*Each prescription for a soft contact lens is embodied in a single plastic mold. The mold costs less than one dollar but by the time a lens is made, several dollars may have been expended. It is prudent to check the mold for the correct measurement before it is used to make a lens.*

*The critical dimension is the distance from plane of the parting line to the spherical surface of the lens. Since the parting line is very sharp and the mold material is quite soft, it is necessary to make that measurement with a controlled light touch.*

***Solution***

*SMAC linear actuators can measure with a resolution of 1 micron and the force used can be set.*

***Work Profile***

***1.*** *The SMAC actuator is equipped with a tip which is the same diameter as the parting line plane. The actuator rod can be driven through a hole in the center of the tip.*

***2.*** *A second actuator with a spherical seat on its tip is used to contain and raise the mold up against the tip of the first actuator. The force used to seat the mold against the tip can be set at 30 gms.*

***3.*** *With the mold in place, the rod from the first actuator is driven towards the spherical surface of the mold and soft lands on the mold. A measurement is made.*

***Actuators: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*

*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Bottom actuator lifts up, softlands (30grams) on measuring tip*

*Top actuator extends, softlands on contact lens mold*

*Measurement is taken*

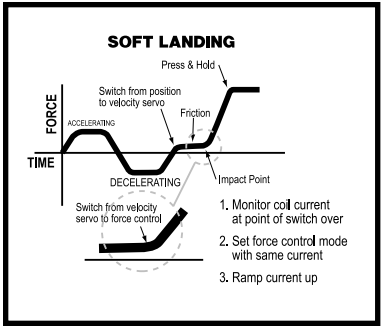
*Good/Bad part signal is turned on*

***SMAC Advantages:***

*100% parts inspection*

*Linear actuator in a single ready to mount package*

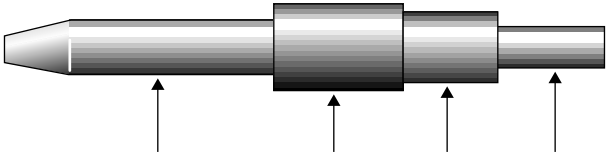
*Reproducible force setting to get consistent measurement*

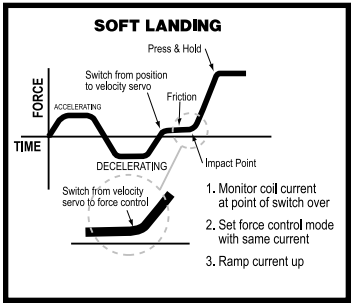


# Rod Eccentricity Inspection

*Automotive rod is machined, heat-treated and inspected for eccentricity of four diameters.*

*Four SMAC actuators are used. The rod is rotated. Each actuator measures the maximum / minimum travel and compares with the go-no-go values stored. An accept / reject indicator is turned on for the operator.*






***Actuator: LAL-30 (low friction version)***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, engage rod*

*Set force to 100 grams, check position as rod is rotated*

*Register maximum & minimum readings and calculate eccentricity*

*Measurement is compared against GO/NO-GO window*

*Good/Bad part signal is turned on*

***SMAC Advantages:***

*100% parts inspection*

*Linear actuator in a single ready to mount package*

*High speed, long life design for continuous operation*

*Programmable profile to set force*

# Screw Thread Checking

*1. SMAC actuator **(LAR-30)** carries a tap which engages the tapped hole.*

*2.The rotary axis turns if the hole is properly tapped.*

***Actuators: LAR-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part*

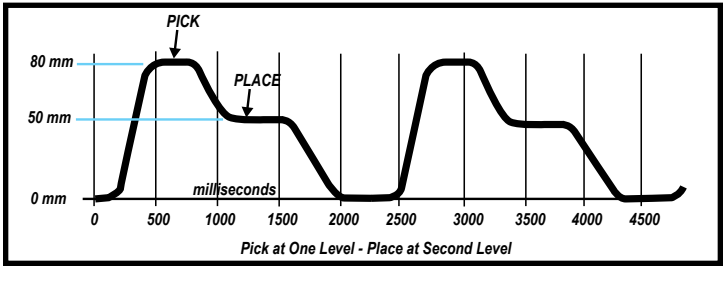
*Rotate to engage thread*

*Check number of turns, linear distance travelled*

***SMAC Advantages:***

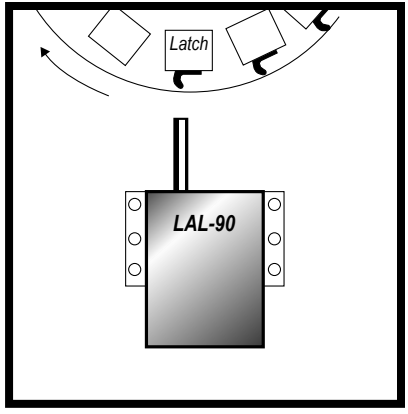
*Torque used to rotate thread gage can be monitored*

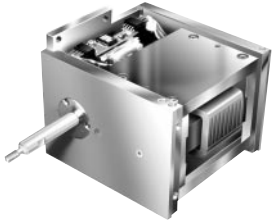
*Checks presence of thread and condition of threads*

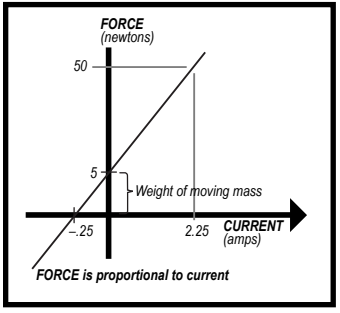


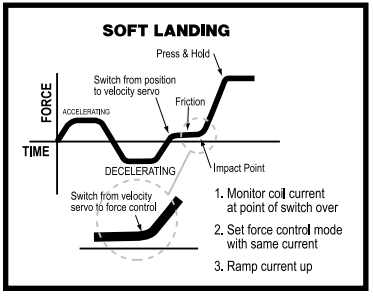
# Latch Inspection

*Force used to compress the spring to close the latch is checked using an SMAC **LAL-90** actuator*






***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured to check for correct location*

*Force is increased in steps, position and force measured to determine proper latch operation*

***SMAC Advantages:***

*Force can be selected in position servo mode*

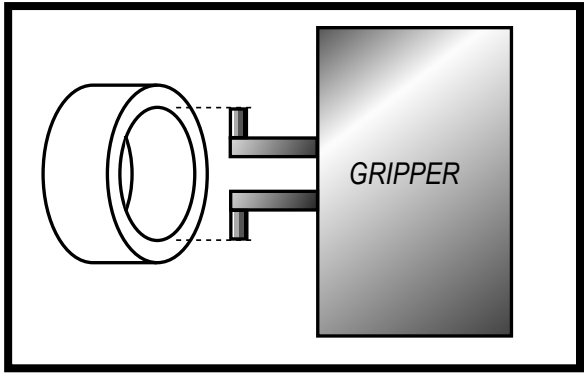
*Position can be measured to 1 micron resolution. In force mode, parts can be precisely measured with a reproducible contact force*

*Force can be measured with a resolution of 20 grams*

*Measurements can be transferred to a host computer to make the calculations*

# Internal Diameter Check

*Also: Thickness check (caliper measurement)*




***Gripper with Independent Fingers***

*Maximum Opening: 15 mm*
*Resolution: 1, 5 micron*
*Force (newton): 12*
*Payload (gm): 100*
*Weight (kg): 0.75*
*Operating Voltage: 24 Volts*

***Key Operational Details:***

*Each finger is driven by an independent linear actuator*

*Each finger is programmable in position and force*

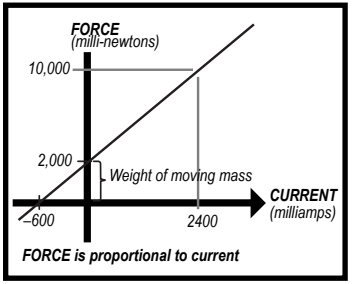
*Each finger performs a soft landing profile to engage the inside wall surface*

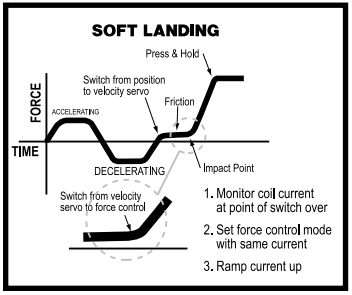
***SMAC Advantages:***

*Independently operated fingers means that parts need not be precisely centered*

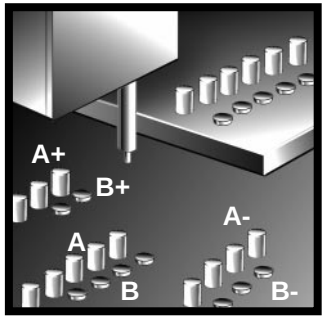
*Delicate touch and feel means that contact surfaces can be different shapes, texture or compressibility*

*Part can be measured for type of material, size, orientation*



# Gauging and Sorting Plastic Parts




***Actuators: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured*

***SMAC Advantages:***

*100% parts inspection, accuracy +/- 1 micron*

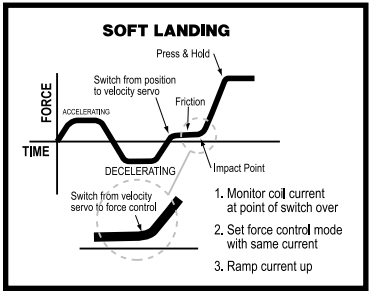
*Parts sorted into categories so assemblies can be made using matched parts*

*Actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Rod runout less than 20 micron to achieve good alignment*



# Switch Testing

***SMAC actuators are used for checking:***

- *Stroke, to make/ to break contact*
- *Force, to actuate switch*
- *Spring constant*
- *Life time cycling*

*TYPICAL SWITCHES:*

*Automobile*
*Thermostats*
*Instrumentation*
*Household*
*Relays*

***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured to register location of the switch*

*Force is increased in steps, position and force measured to determine stroke and force at the point contact is made*

***SMAC Advantages:***

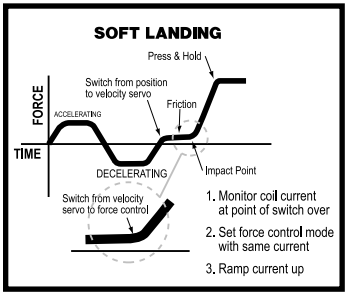
*100% parts inspection*

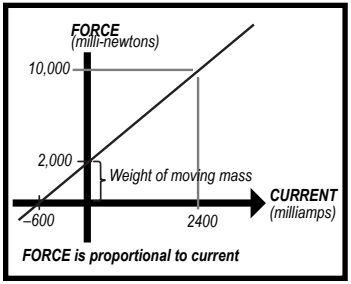
*Z-theta actuator in a single ready to mount package*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Rod runout less than 20 micron to achieve good alignment*



# Forming Spring Strips To Specified Force

*Aligning an optical assembly depends on equal forces from three leaf springs. Customer needs to verify that the three leaf springs produce equal forces after they are installed.*

***Solution***

*1 Bend leaf spring to specified dimension.*

*2 Check spring force at the installed dimension.*

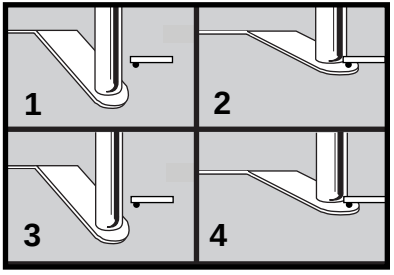
*3 If the force is not correct, bend to next specified dimension.*

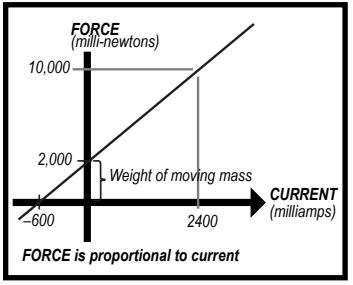
*4 Check spring force again at the installed dimension.*

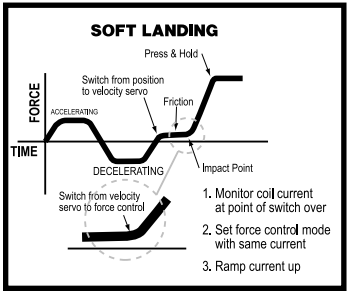
***Other Applications:***

*Catheters*

*Silicone tubing*




***Actuator: LAL-50***

*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 volt*

***Key Operational Details:***

*High speed approach, slow down, softland on part, part is measured to register location of the spring*

*Force is increased in steps, position and force measured to determine stroke and force at the installed position*

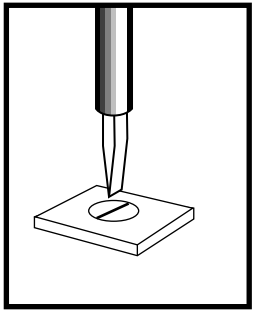
***SMAC Advantages:***

*100% parts inspection*

*Linear actuator in a single ready to mount package*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*



***Screw Adjusting***

*Adjusting a trimpot requires a good pair of eye-balls and a steady hand:*

- *Locate the screw head (X, Y & Z)*
- *Locate the screw slot (Z & theta)*
- *Rotate the screw (theta)*

*SMAC rotary/linear actuators do it this way:*

- *Softland on screw*
- *Switch to force mode, counterbalance to allow screw driver to settle down with a light force*
- *Rotate slowly to locate slot, screw driver falls into slot, stop rotation*
- *Increase force to engage slot, rotate to adjust trim pot*

***Other Applications:***

- *Variable Capacitor*
- *Variable Resistor*
- *Thermostat Set-screw*

***Actuator: LAR-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary axis resolution: 0.07 degrees*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on trimpot,*

*Set light force, rotate until screw driver tip engages slot, slot is sensed by change in linear position*

*Rotate to adjust trimpot*

***SMAC Advantages:***

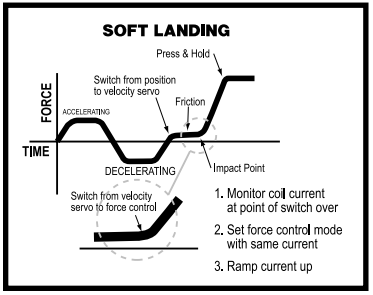
*100% parts inspection, accuracy +/- 1 micron*

*Actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

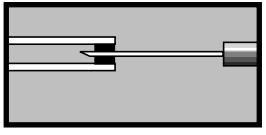
*Rod runout less than 20 micron to achieve good alignment*

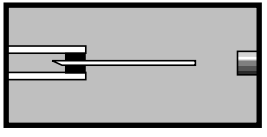


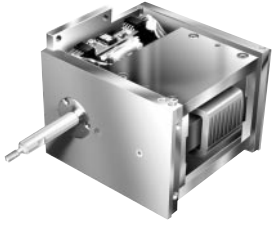
# Pull Test for Hypodermic Syringe Needles

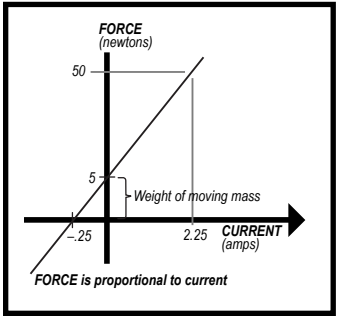
*Hypodermic needles are 100% tested to make sure that the needles are secured to the hub. The force is 4 lbs. The rate is one per second.*

*The needles are assembled on a rotary index table. When the needle comes into the station, a gripper grips the needle. A 4 lb force is applied to the needle and a position measurement is made. If the needle separates, a bad part is indicated.*










***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*Position is registered with the gripper affixed to the needle*

*Force is ramped up and position is monitored to check for any movement*

*If needle separates, indicate good/bad part*

*Force can be controlled to +/- 25 grams*
*Position can be maintained to +/- 5 encoder counts*

***SMAC Advantages:***

*Instantaneous transition from position mode to force mode*

*Ability to monitor position in force mode and make decision to change programs*

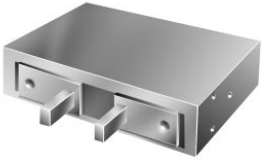
# Medical Materials Testing

*A medical device manufacturer needs to test a heart valve material for long term fatigue. They wish to duplicate the heart beat profile to simulate actual conditions.*

*SMAC actuators can be programmed to develop the heart beat motion profile. By measuring the force used to stretch the material to the prescribed length, the gradual degradation of the material an be continuously monitored.*

***Other Applications:***

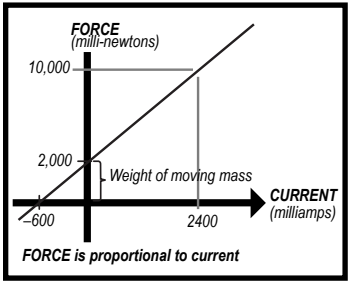
- *Creep test for material under temperature & time*
- *Human motion simulation for Carpal tunnel check*

***Actuator: GRP-02 Gripper***

*Gripper with Independent Fingers*

*Maximum Opening: 15 mm*
*Resolution: 1, 5 micron*
*Force (newton): 12*
*Payload (gm): 500*
*Weight (kg): 0.75*
*Operating Voltage: 24 Volts*




***Key Operational Details:***

*Each finger is driven by an independent linear actuator*

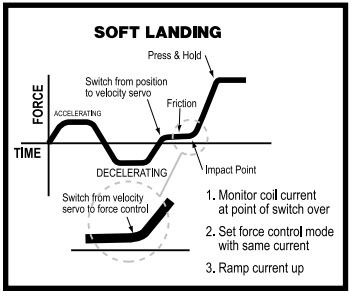
*Each finger is programmable in position and force*

***SMAC Advantages:***

*Independently operated fingers means that parts need not be precisely centered*

*Complicated motion profile can be generated to accurately simulated heart beat*

*Force can be monitored, so as material degrades, the resulting change in force as the material is exercised can be used to indicate a failure mode without stopping the test.*



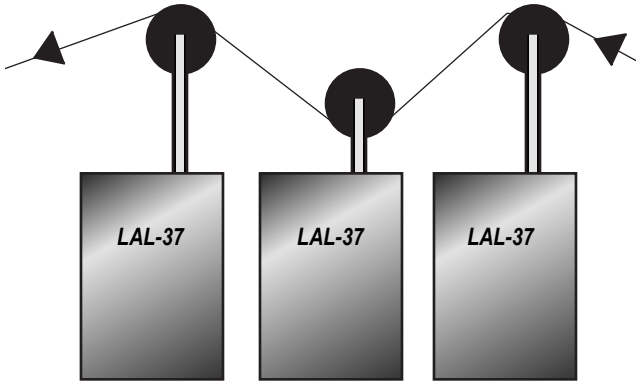
# Tension Control

*Stents inserted in blocked arteries have been proven superior in keeping them open. Stents are wound from fine wires and it is important to control the tension of the wire.*

*Three SMAC actuators (LAL-37's) are used to control tension.*

***Other Applications:***

- *Maintaining constant tension as balloons are formed in catheters for angioplasty*
- *Checking drag force on fishing line.*




***Actuators: LAL-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

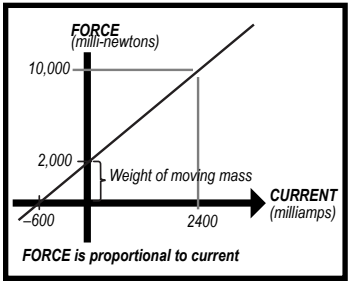
*Each actuator is operated in "force" mode with a pre-selected setting to maintain proper tension*

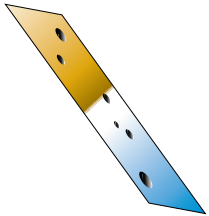
*As the stents are being wound, the "current" used to drive each moving coil is monitored and adjusted to maintain a constant tension*

***SMAC Advantages:***

*Direct drive moving coil design means force is proportional to current*

*Programmable controller with current feed back allows a readily programmable force feedback operation to control force*



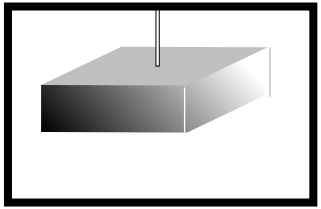


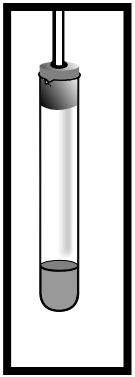
# Simulating Impact Damage on Satellite Skins

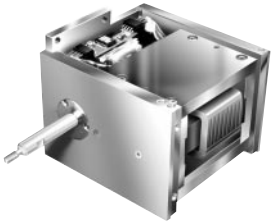
*Impact damage on different skin material is investigated using different forces and end tip diameters*

***Other Applications:***

- *Force to drive surgical needle into a fixed distance is measured*
- *Force to secure cork in test tubes*







***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

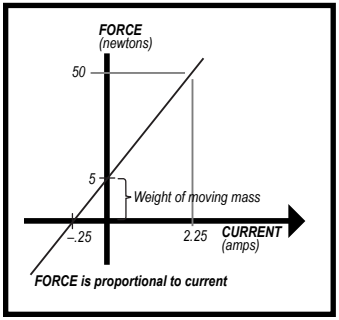
*Force can be controlled to +/- 25 grams*

*Position can be maintained to +/- 5 encoder counts*

***SMAC Advantages:***

*Instantaneous transition from position mode to force mode*

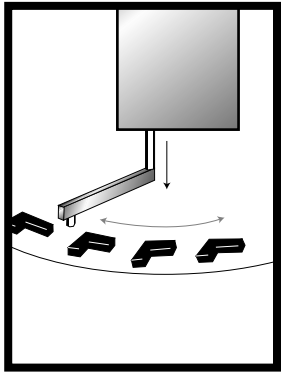
*Ability to monitor position in force mode and make decision to change programs*



# Grease Dispensing

*Switch elements are individual greased.*

*1. Land on contact surface*
*2. Retract to specified height*
*3. Dispense grease as tip rotates*
*4. Lift up*
*5. Repeat for all contacts*



***Actuators: LAR-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, turn on grease dispenser, pick up, high speed take off*

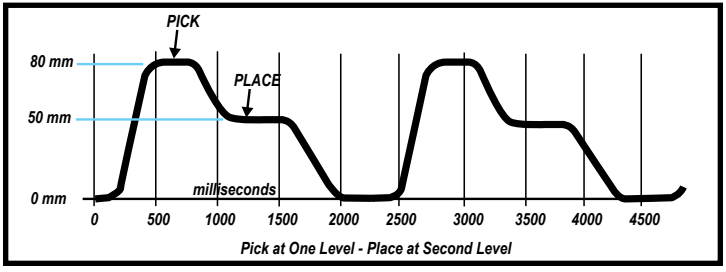
*Rotate to second location to repeat operation*

***SMAC Advantages:***

*Pick & place operation using a Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Multi-position, programmable profile to handle delicate part*



# Glue Dot Dispensing

*Placement of surface mount devices using glue dots. Glue dots must be perfect in size and shape. Perfection can be achieved by fixing dispense height. Circuit board is flexible and surface is wavy.*

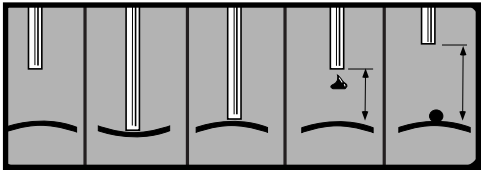
***Solution***

*1. Select best distance for each composition of glue.*
*2. Locate top of surface*
*3. Move up a fixed distance from surface*

***Work Profile***

*1. Start from 10mm above circuit board*
*2. Fast approach to within 1mm of nominal board surface*
*3. Soft land on board (board flexes)*
*4. Make rod weightless, to allow board to flex. Register top surface of board*
*5. Back-off fixed distance (e.g. 0.5mm)above surface*
*6. Dwell for fixed duration to dispense glue or solder paste*
*7. Blast off to 10mm above circuit board for new cycle*

*Conventional approach: 3 dots per second*
*SMAC:* ***5 dots per second***



***Actuator: LAL-30 (low friction version)***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, engage circuit board*

*Set force to make rod weightless to determine the location of circuit board*

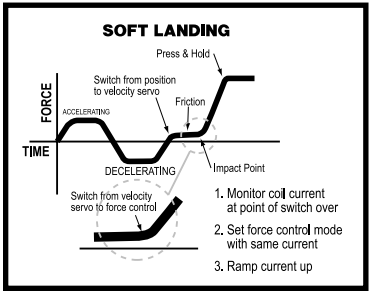
*Move up a predetermined distance to dispense glue dot*

***SMAC Advantages:***

*Linear actuator in a single ready to mount package*

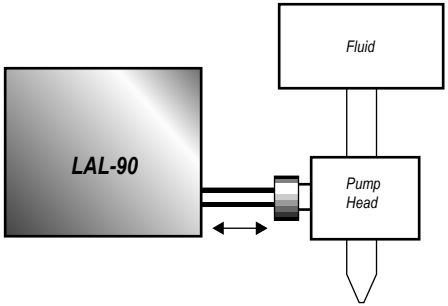
*High speed, long life design for continuous operation*

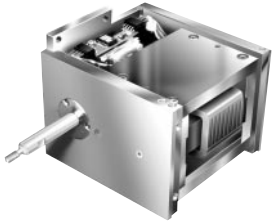
*Programmable profile to set force*

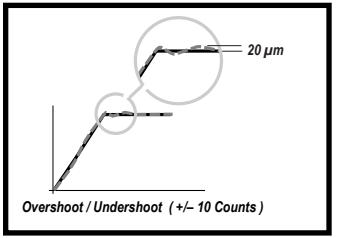


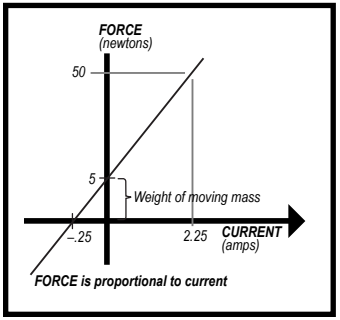
# Coloring Dispensing

*A displacement pump adds coloring to beer. As beer flow varies, SMAC actuator (LAL-90) adjusts the amount of coloring to be dispensed.*






***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*

*Supply Voltage: 48 Volts*

***Key Operational Details:***

*Use Analog-to-Digital converter to sense the color readout*

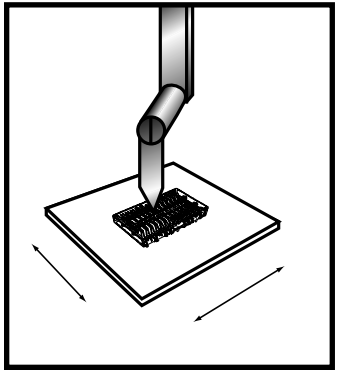
*Use converted value to determine location of actuator rod*

*Move to that position*

***SMAC Advantages:***

*Position Accuracy: +/- 2 encoder counts*

*Flexible "cam" allows instantaneous feed-back to control beer color*



# X-Y

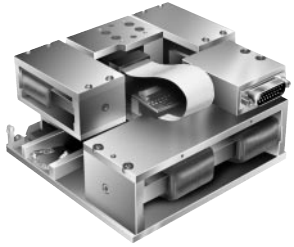
- *High speed, high resolution X-Y stages driven by moving coils*
- *5 micron encoder standard, 1 micron optional*
- *High force/low moving mass (high G), up to 10-G*
- *Low profile, small foot print*
- *Long life, moving coils supported and guided by linear guides*
- *Uses no ball screws, no rotary bearings, no motor brushes*

***Applications:***

*Wire Bonding*
*moves 0.5 mm (stop to stop) in 4 milliseconds*

*moves 2 mm (stop to stop) in 9 milliseconds*

*Connector pin-loading*



***Actuator:***

***LXY-10***

*X-axis*
*Stroke: 25 mm*
*Resolution: 1, 5 micron*
*Force: 42.5 newtons*
*Moving Mass: 250 grams*

*Y-axis*
*Stroke: 25 mm*
*Resolution: 1, 5 micron*
*Force: 80 newtons*
*Moving Mass: 1.250 kg*

***Key Operational Details:***

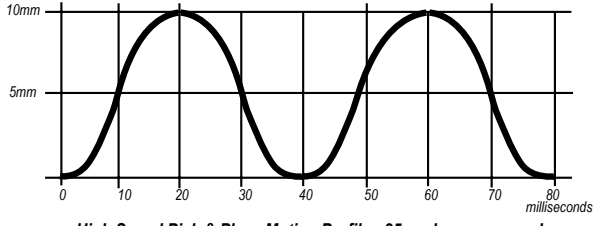
*High speed position servo*

***SMAC Advantages:***

*High G-forces*

*Low moving mass*

*Low friction*




***High Speed Pick & Place Motion Profile - 25 cycles per second***

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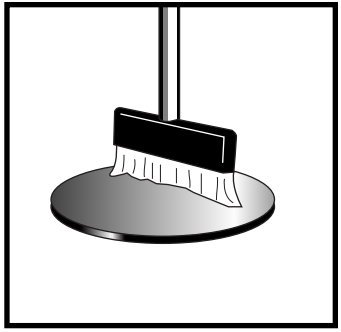
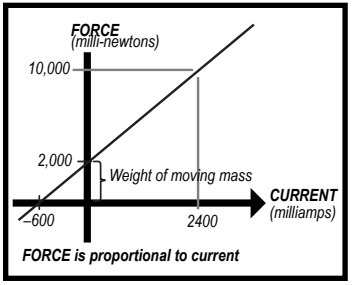
# Wafer Scrubbing Actuator

- *Brush is carefully lowered onto wafer (softland)*
- *Contact force is held under 10 grams*
- *Contact force is controlled during scrubbing operation*
- *Force (instead of position) is controlled*

***Other Applications:***

*Wafer Scrubbing*






***Actuator: LAR-50***
***(Special modification using stepper motor)***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 500 gms*
*Supply Voltage: 24 Volts*
*Rotary Axis: Stepper Motor*

***Key Operational Details:***

*Wafer is lifted up to the brush*

*Force is controlled so the net force on the wafer is less than 10 grams*

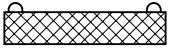
*Brush is rotated*

***SMAC Advantages:***

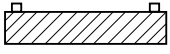
*Force is programmable*

*Contact force can be controlled to less than 10 grams*

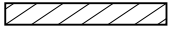
# Flip Chip Mounter



CHIP



CIRCUIT BOARD



CONDUCTIVE FILM

*The electronics industry develops high density mounting technology to meet the demands of higher functionality in more compact sizes.*

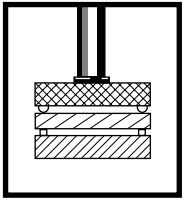
*The Flip Chip can be mounted directly onto a circuit board using a number of proven techniques: ESC (encapsulated solder connection), ACFC (anisotropic conductive film connection), CPC (conductive paste connection) and C4 (controlled collapse chip connection). Since the connections are made under the chip with no bonding wires that need to be protected, a number of processes needed to encapsulate the chip are no longer necessary.*

*However, to get good connections, the contact force needs to be precisely controlled.*

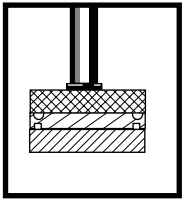
*SMAC actuators are driven directly by moving coils which allow the contact force to be controlled to less than 10 grams for pick & place of delicate chips. After the chip is precisely located, this force can be ramped up to any specified value to hold, press and maintain good contact throughout the curing process.*

***Other Applications:***

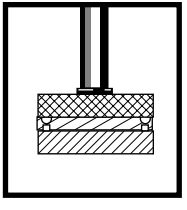
*BGA (Ball Grid Arrays)*



**Flip Chip Mounting**



**Press to Make Contact**



**Press & Cure**

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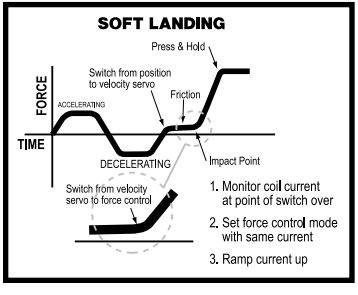



***Actuator: LAR-40***

*Stroke (mm): 40*
*Resolution: 1 or 5 micron*
*Force: 30 newtons*
*Moving Mass: 500 gms*
*Rotary Axis: 0.0072 degree resolution*
*Torque: 0.03 newton-meter*
*Direct drive, no gear*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on chip, turn on vacuum, pick up, high speed take off*

*Camera determines orientation, rotary axis rotates to orient*

*Softland on substrate, increase force to press & hold*

***SMAC Advantages:***

*High resolution rotary axis for accurate orientation of fine pitch device*

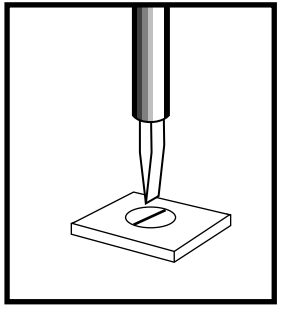
*Direct drive (no gear, no backlash) with 50,000 count/rev encoder*

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Apply appropriate bonding force to effect reliable bond*



# Tuning of Delicate Capacitors

*A number of small capacitors are used in Pagers. Since the capacitance changes when touched, human operators treat them with great care so once tuned, they will stay tuned.*

*Prices of pagers have come down and volume has gone up, SMAC actuators have been pressed into the service.*

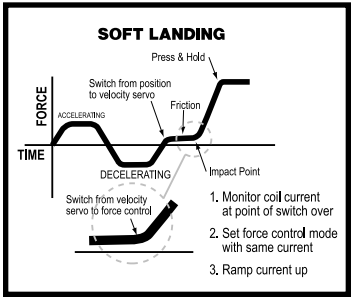
*SMAC actuators have a light touch (less than 30 grams)*

*AND*

*They can also be programmed to "not touch" so there is no force exerted on the capacitor during the tuning process. Pagers, once tuned, will stay tuned.*

***Other Applications:***

*Calibrating & setting thermostats*
*Setting variable resistors*




***Actuator: LAR-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 250 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, soft land on capacitor body*

*Set light force, rotate until screw driver tip engages slot*

*Slot is sensed by change in linear position*

*To exert zero force on capacitor plates during tuning the screw driver tip is retracted half the depth of the slot so it is raised above the capacitor plates*

*Rotate to tune*

*When done, retract to home position*

*In the event that the screw driver tip landed on the slot on the first approach, turning the tip to find the slot would change the capacitance. A signal can be provided by the tuning sensor that the slot is already engaged*

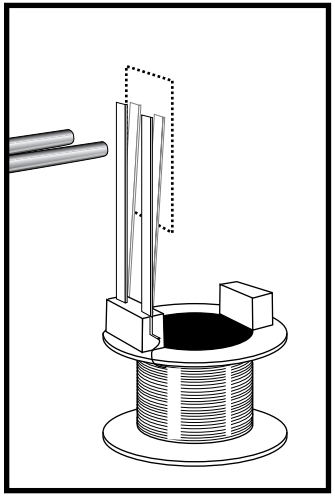
*Again, to exert zero force, the screw driver tip is first retracted half the depth of the slot before tuning operation is resumed*

***SMAC Advantages:***

*Programmable profile to handle delicate part*

*Light force contact, zero force during tuning operation*

*Rod runout less than 20 micron to achieve good alignment*



# Checking & Reworking Contact Leaf Springs

*Two leaf springs are molded into a plastic housing to be used as contacts for an electric coil.*

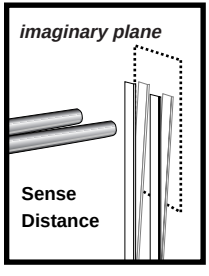
*The leaf springs must be within a set tolerance within the vertical plane of the contacts.*

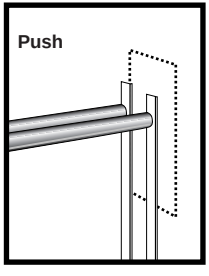
*Since each of the leaf springs is long and slender, a remote sensor (laser) is first brought up to (but not touching) the spring to measure its position. The measurement (0-10Volts) is input to the SMAC controller. The actuator tip is driven a distance determined by the measurement to set the spring into the correct position.*

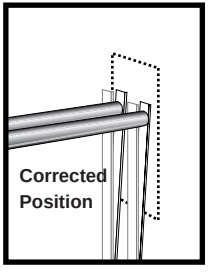
*Two actuators are used, one for each spring*

***Other Applications:***

*Feedback for position control using "load-cell" to measure force. Feedback using vision system to measure position*

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***Actuator: LAL-30***

*Stroke (mm): 25*
*Resolution: 1 micron*
*Force: 15 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Carry laser sensor to stand-off location to make measurement*

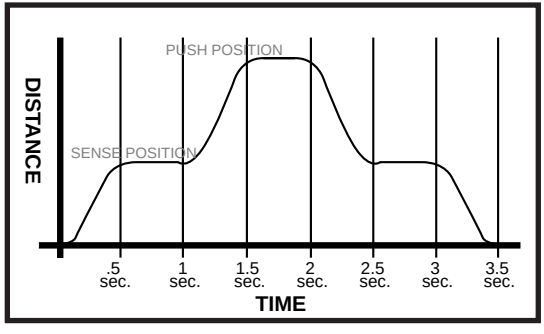
*From measurement, drive (calculated distance) forward to form spring*

*Retract to stand-off positon to make another measurement*

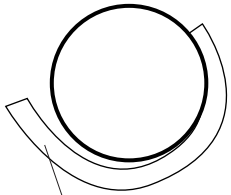
***SMAC Advantages:***

*Small, ready to mount package*

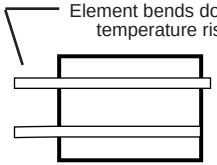
*Accepts analog measurement to calculate next servo position*



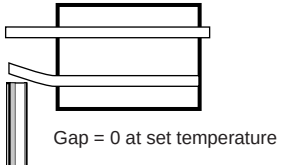

**MOTION PROFILE**




**TOP VIEW**




**SIDE VIEW**




**SIDE VIEW**

# Adjusting Thermostat by Iterative Sensing and Correction

A thermostat turns on when two contacts come together. One of the contacts is a bi-metallic element which changes position with temperature. The gap between the contacts needs to be set so when the set temperature is reached, the gap will close.

The gap is set by positioning the bi-metallic contact using the desired temperature setting and then "bending" the other contact.

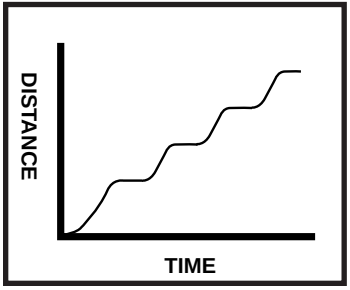
Since metallic leaf spring elements have memory, the contact needs to be "bent", recheck and then "bent" again in an iterative process until the gap is in the right position.

To speed this up in an automatic thermostat assembly line, this customer has worked out a process method that uses a continuous measurement (vision system) that would determine the next "bending" position based on the measured position.

SMAC actuator & controller combination provides this solution by accepting a new target data point in servo positioning loop.

**Other Applications:**

*Dispensing solder paste. Amount dispensed varies with viscosity, temperature, humidity, etc. By sensing the amount dispensed a new setting can be entered into the SMAC controller to compensate for parameter variations*




***Actuators: LAL-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on contact, gap is measured to determine next position*

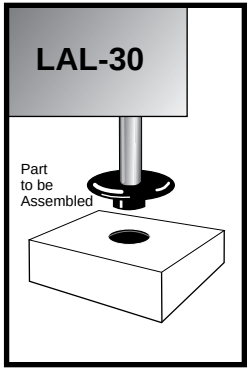
*Position is used as new target, gap is measured, new position is determined*

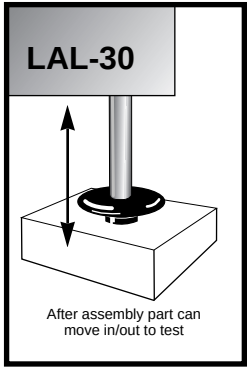
*Actuator rod retracts and final gap position is checked*

***SMAC Advantages:***

*Continuous closed loop operation results in higher speed operation in automatic assembly line.*

*Interrupt driven servo program allows new target data to be input and set in the middle of a motion profile*




# Switch Assembly & Test

*Many manufacturing organizations are aiming to achieve six sigma as a demonstration of the high quality of their products. One method is to perform 100% inspection of all subassemblies.*

*An automotive switch manufacturer has designed an assembly fixture using an SMAC actuator that would assemble the switch and measure the force and stroke to activate the switch.*

***Other Applications:***

*Inserting pins or sockets into connectors*

***Actuators: LAL-30***

*Stroke (mm): 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on part, signal if component is missing, if not, ramp force up to press component into body of switch*

*Retract to positon above switch to do the go/no go test*

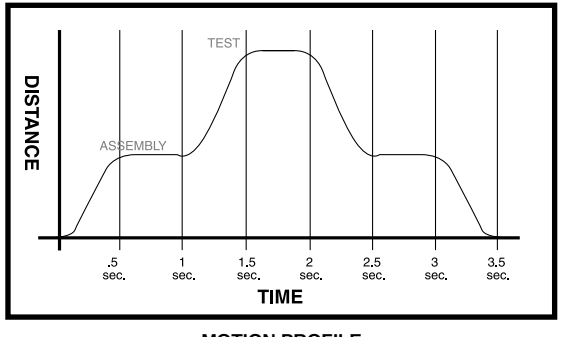
*Soft land on switch, register starting postion, apply force to turn on switch, register stroke and force at "on" position*

*Apply go/no go window to test results, accept or reject switch.*

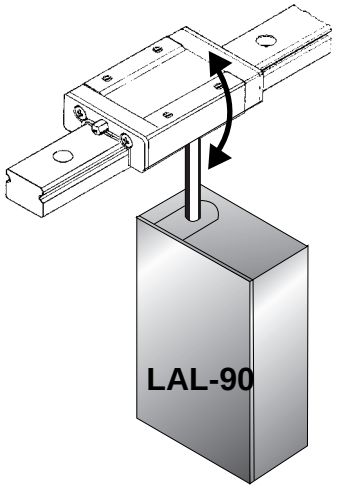
***SMAC Advantages:***

*Switch is assembled, tested and verified in one operation*

*SMAC actuators are ready to mount and programmed*




**MOTION PROFILE**



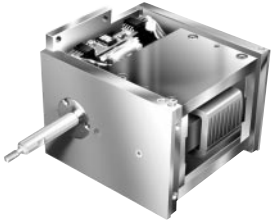

# Checking Pre-loading of Precision Linear Guides

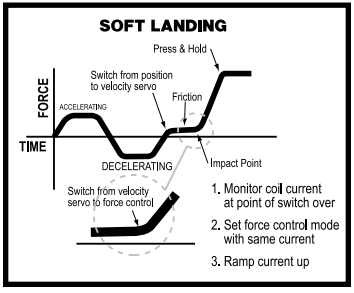
*Preloading of precision linear guides balances the load to maintain the designed four point contact structure. This makes the guides suitable for applications with minimum vibration. Material damage from rolling contact fatigue is also minimized.*

*The typical preload is 2 % of the static load rating of the linear guide so each model uses a different preload.*

*SMAC actuators can be used to measure the deflection of the slide unit as a prescribed force is applied to check the preload.*

*A single fixture built using an SMAC actuator can check different models.*






***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

*Softland on slide unit, register initial position, ramp force up to prescribed value, measure deflection*

*Compare deflection with allowable parameter, indicate good/bad part*

*Force can be controlled to +/- 25 grams*

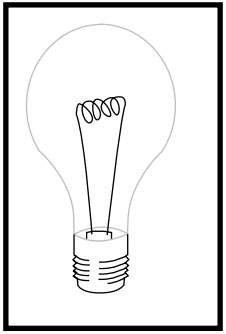
*Position can be maintained to +/- 1 encoder counts*

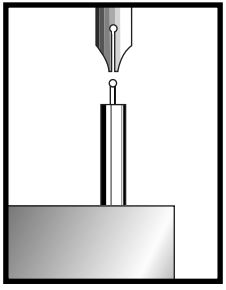
***SMAC Advantages:***

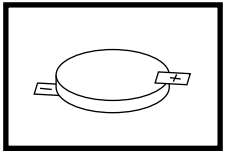
*Instantaneous transition from position mode to force mode*

*Ability to monitor position in force mode*

*Force can be varied from 0 to 100 newtons in small increments*







# Spot Welding

*Welding:*

*Ball to Pen Nib*

*Light Bulb Filament*

*Tab to Pacemaker Battery*

*Contact Wire to Motor Brush*

***Actuator: LAL-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 150 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

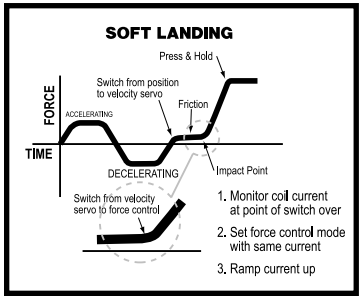
*High speed approach, slow down, soft land on surface*

*Ramp force up to set value, weld (solder) part to surface*

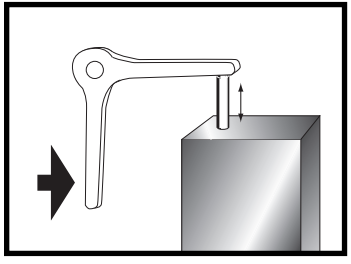
***SMAC Advantages:***

*SMAC Soft Landing profile uses a high speed approach to save time*

*Force is ramped up to desired value to hold part in place to get a good weld*



# Tactile Simulator for Automobile Door Latch

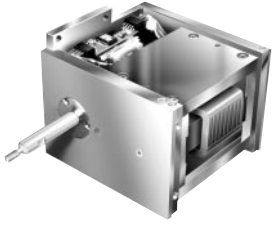


*Anyone who has broken a finger nail or got a finger pinched by a car door handle can appreciate the request from one luxury automobile manufacturer.*

*Before a complicated arrangement of springs and catches was designed, a simulator would offer up several examples of a working door handle so a number of people can try them out and comment on the merit of each working profile.*

*An SMAC actuator can be readily programmed to vary the force exerted at different portions of the stroke. For example, a light force as the door handle is "pried" loose (no pinching fingers) and a force sufficient to disengage the latch when the user has a good grip on the handle.*

*Several standard latch mechanisms as well as improved versions can be modeled using a single fixture.*



***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

***Key Operational Details:***

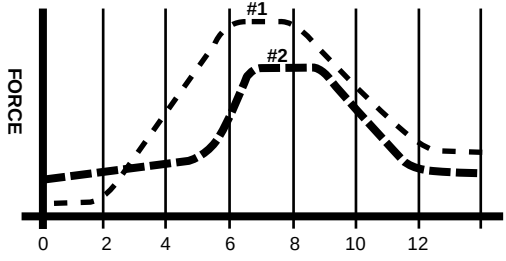
*Force profile can be programmed by varying the transition points and force magnitude*

***SMAC Advantages:***

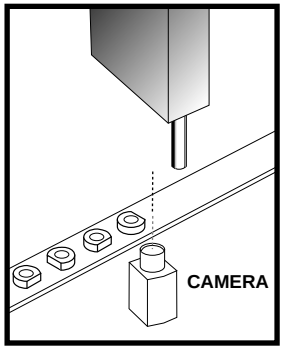
*Ability to monitor position in force mode*

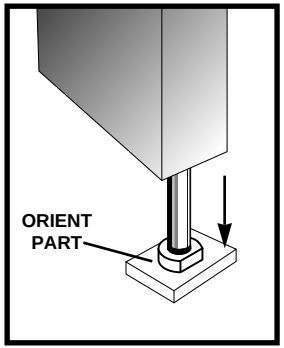
*At each selected position range, the force can be specified, more complex profiles can be set up with more positions*

*Force can be varied from 0 to 100 newtons in small increments*




**MOTION PROFILE**



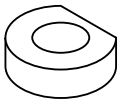




# Precision Assembly of Blood Testing Sensor for Diabetes

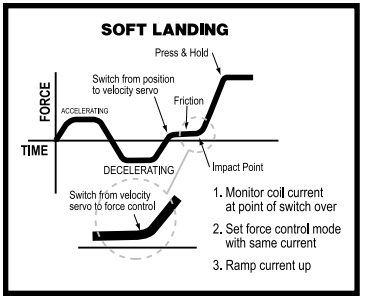
*In the electronics industry, a blood testing sensor would be classified as an odd-shaped part requiring special handling*

*SMAC actuators are ready-to-integrate mechanisms to handle such odd-shaped parts:*

- *Built in vacuum to secure part*
- *Light contact force to pick up and to place, ideal for delicate and expensive components*
- *Built-in rotary axis (with rotary vacuum seal) to orient part for assembly*
- *High resolution linear measurement (5 micron typical, 1 micron optional) to measure part before and after assembly*
- *Variable force controllable to assemble part (light touch to press-fit)*



PART




***Actuator: LAR-30***

*Stroke (mm): 15, 25*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 210 gms*
*Rotary axis resolution: 0.07 degrees*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*High speed approach, slow down, softland on sensor, turn on vacuum, pick up, high speed take off*

*Camera determines orientation, rotary axis rotates to orient*

*Softland on substrate, increase force to press & hold*

***SMAC Advantages:***

*Z-Theta actuator in a single ready to mount package with through the rod vacuum*

*High speed, long life design for continuous operation*

*Programmable profile to handle delicate part*

*Apply appropriate force to effect reliable assembly*

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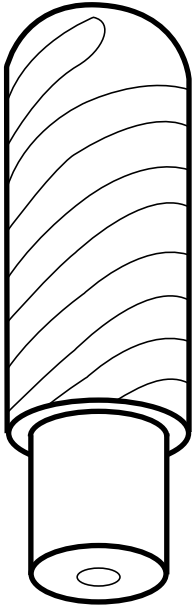


# Quadrupling gold paint striping of ceramic electrodes

*Two gold stripes need to be painted on a ceramic electrode within a tolerance of +/- 50 microns*

*Accurate coordination of the linear and rotary axis is necessary.*

*SMAC LAC-25 Controller has electronic gearing mode that allows the linear and rotary axis to be driven in consort.*

*Linear axis has a resolution of +/- 5 microns*

***Actuator: LAR-37***

*Stroke (mm): 50*
*Resolution: 1 or 5 micron*
*Force: 10 newtons*
*Moving Mass: 250 gms*
*Rotary Axis: 0.072 degree resolution*
*Torque: 0.1 newton-meter*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Linear moves to contact ceramic electrode (light force)*

*Gear rotary motion to linear motion and traverse electrode from tip to tail and back to put on first one stripe and then the second.*

***SMAC Advantages:***

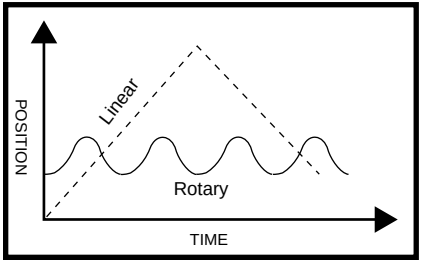
*Z-Theta actuator in a single ready to mount package*

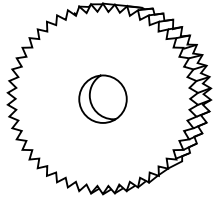
*Two axis motion coordinated by LAC-25 two axis controller*

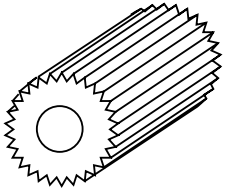
*High speed, long life design for continuous operation*

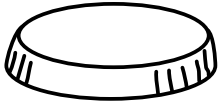
*Programmable profile to handle delicate part*

*Rod runout less than 20 micron to achieve good alignment*







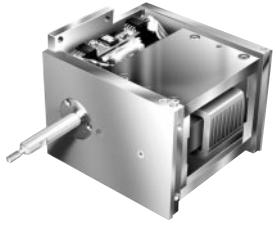


# Changing shot profiles in small injection molding machine

*Hydraulic cylinders are typically used to inject a shot of plastic resin into a mold under pressure.*
*Molding of small plastic parts needs to vary the shot for different parts. It is difficult to control a hydraulic cylinder but an electric actuator such as the SMAC LAL-90 is perfect for the job.*

*Other Application:*

*Volume of solder paste dispensed from a reservoir can be selectably changed by varying the stroke of the SMAC actuator*



***Actuator: LAL-90***

*Stroke (mm): 15, 50*
*Resolution: 1 or 5 micron*
*Force: 100 newtons*
*Moving Mass: 250 gms*
*Supply Voltage: 48 Volts*

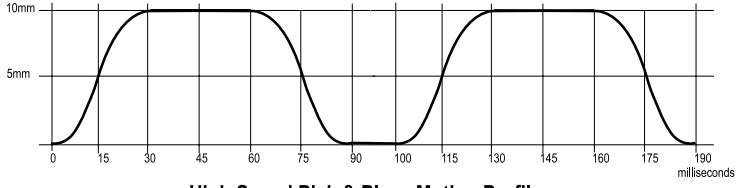
***Key Operational Details:***

*Injection profile (stroke) can be varied by a simple parameter change*

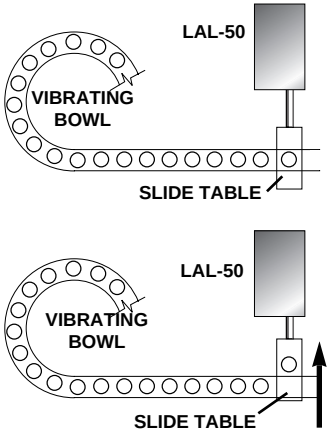
***SMAC Advantages:***

*SMAC now produces a number of actuator with forces approaching small hydraulic cylinders*

*The stroke of SMAC actuators can be easily programmed. For example, LAL-90 can inject a shot using a stroke from 5 mm to 50 mm. A shot of different volumes can be delivered to the injection molding machine allowing for much more flexible operation.*




**High Speed Pick & Place Motion Profile**
**10 cycles/second**




# Singulating parts from a vibratory shaker or conveyor

*After a part is sorted and oriented by a vibratory shaker (or conveyor), the part needs to be singulated for transfer to an assembly area. A number of mechanical stops, gates and pick & place mechanisms have been developed for this purpose. These typically need to be adjusted or interchanged to accommodate parts of different sizes.*

*SMAC actuators can be programmed to operate at different strokes, motion profiles so it is practical to select a different profile to handle a different part. Flexibility can be built-in at no extra costs.*

***Actuator: LAL-50***

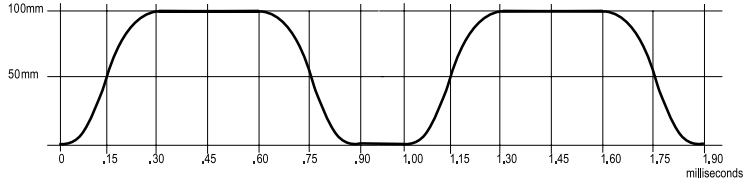
*Stroke (mm): 100*
*Resolution: 1 or 5 micron*
*Force: 25 newtons*
*Moving Mass: 225 gms*
*Supply Voltage: 24 Volts*

***Key Operational Details:***

*Pick & Place different sized parts by selecting different strokes*

***SMAC Advantages:***

*Assembly machine can be readily reconfigured for many types of parts*




**High Speed Pick & Place Motion Profile**
**10 cycles/second**