Ultrasonics and PPE / Medical Devices

SONICS
Newtown, CT

Please wait while attendees join the webinar

Sonics personnel in attendance

Lauren Soloff - President

Brian Gourley – National Sales Mgr

Dave Krysiak – Metal Welding Technology Mgr

Bill Aurand – Packaging Technology Mgr

Due to the large number of attendees registered, microphones will be muted to minimize distractions.

Questions can be sent via the "Questions" tab and will addressed at the end of the presentation.

Note that any questions entered cannot be seen by other attendees.

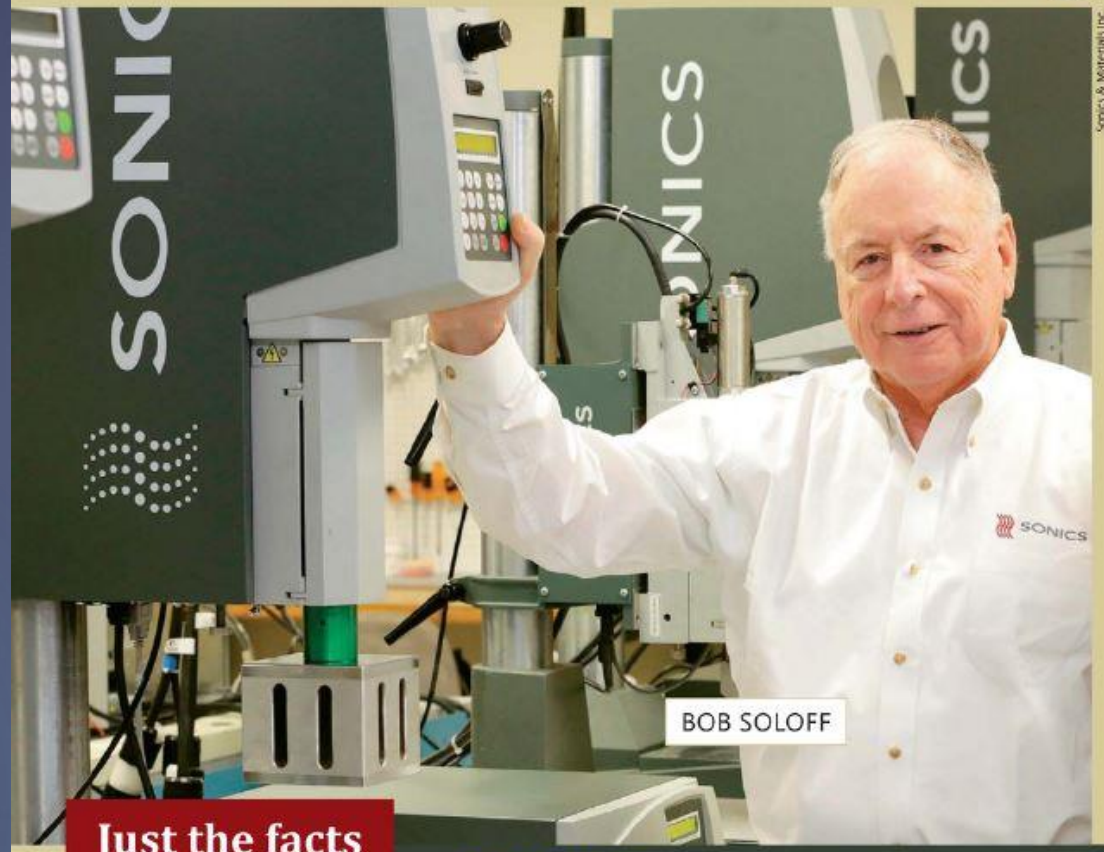
Questions of a sensitive or proprietary nature can be sent via email to webinars@sonics.com

Ultrasonic Welding Webinar for PPE and Medical Device Manufacturing

First, who is Sonics and Materials?

Technology leader in high power ultrasonic technology since 1969

Father of ultrasonic welding



Sonics & Materials Inc.

Just the facts

WHO IS HE: Bob Soloff, founder of Sonics & Materials Inc.

HEADQUARTERS: Newtown, Conn.

EMPLOYEES: 75

PATENTS: Sonic Method of Welding Thermoplastic Parts in 1965, plus 30 others in his company's name.

EDUCATION: Bachelor of Science in mechanical engineering, The Cooper Union for the Advancement of Science and Art, New York

A mechanical engineer by trade, Bob Soloff began creating his legacy in the plastics industry with his accidental invention of ultrasonic welding. Since the filing of that first patent, Soloff has patented numerous related tools and components and run a successful business, in which his daughter now also plays a significant part. He recently spoke with *Plastics Machinery Magazine* correspondent Lisa Jo Lupo.

Your invention of ultrasonic welding has been significant for the plastics industry. Can you tell us the story of the discovery?

Soloff: As unbelievable as it seems, it was one of those "aha moments." I was playing around with ultrasonics for different applications, so I was at my desk with an ultrasonic probe in my hand when I accidentally touched the probe to a Scotch tape dispenser. Lo and behold, the two halves welded together! That's when I had the "aha moment" that maybe it would work with other plastics, too.

So, I went out and bought a bunch of plastic toys from Woolworth's. They were already glued together — that was the primary method of assembly at that time. I cut the toys apart, then applied the probe to the toys. The vibrations welded them together.

How did you bring your invention to market?

SOLOFF, *Page 86*

Webinar Objectives

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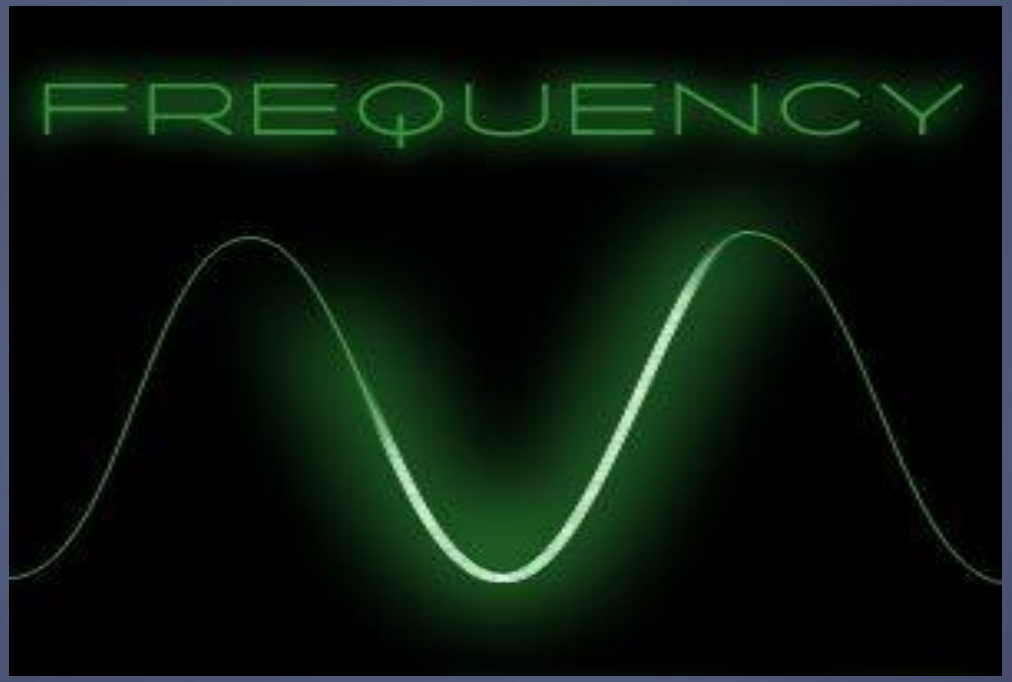
- Ultrasonic Welding Process Theory
- Main Components of an Ultrasonic Welding System
- Basic Principles of Ultrasonic Tooling Design
- Ultrasonic Welding Process Parameters
- Ultrasonic Bonding Applications for PPE and Medical Devices

Terminology / Definitions

What is ultrasound?

Ultrasound is defined as accoustical vibration above the range of human hearing.

Humans can hear frequencies as low as 20Hz and as high as 20kHz.

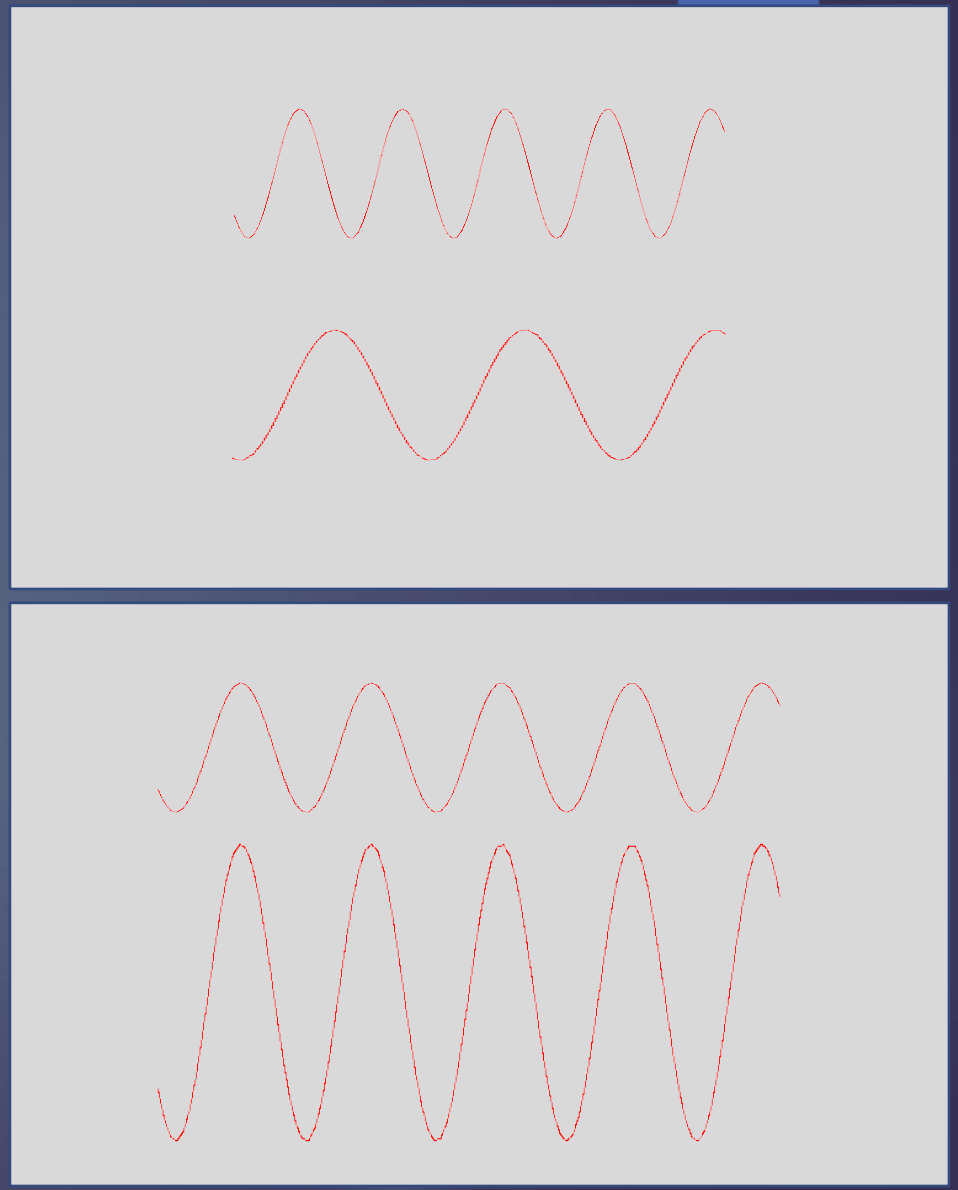


Sonics utilizes the following frequencies for various ultrasonic welding and cutting applications: 15kHz, 20kHz, 30kHz, 35kHz and 40kHz

Terminology / Definitions

FREQUENCY:
Frequency is the rate at which the Converter/Booster/Horn assembly expands and contracts (40,000 vibrations per second for 40kHz or 20,000 vibrations per second for 20kHz)

AMPLITUDE:
Amplitude refers to the specific distance that the face of a vibrating component travels during expansion and contraction. Typical welding amplitude requirements are between 30µm and 100µm (peak-to-peak) at the horn surface, depending upon the frequency and plastic material being bonded.



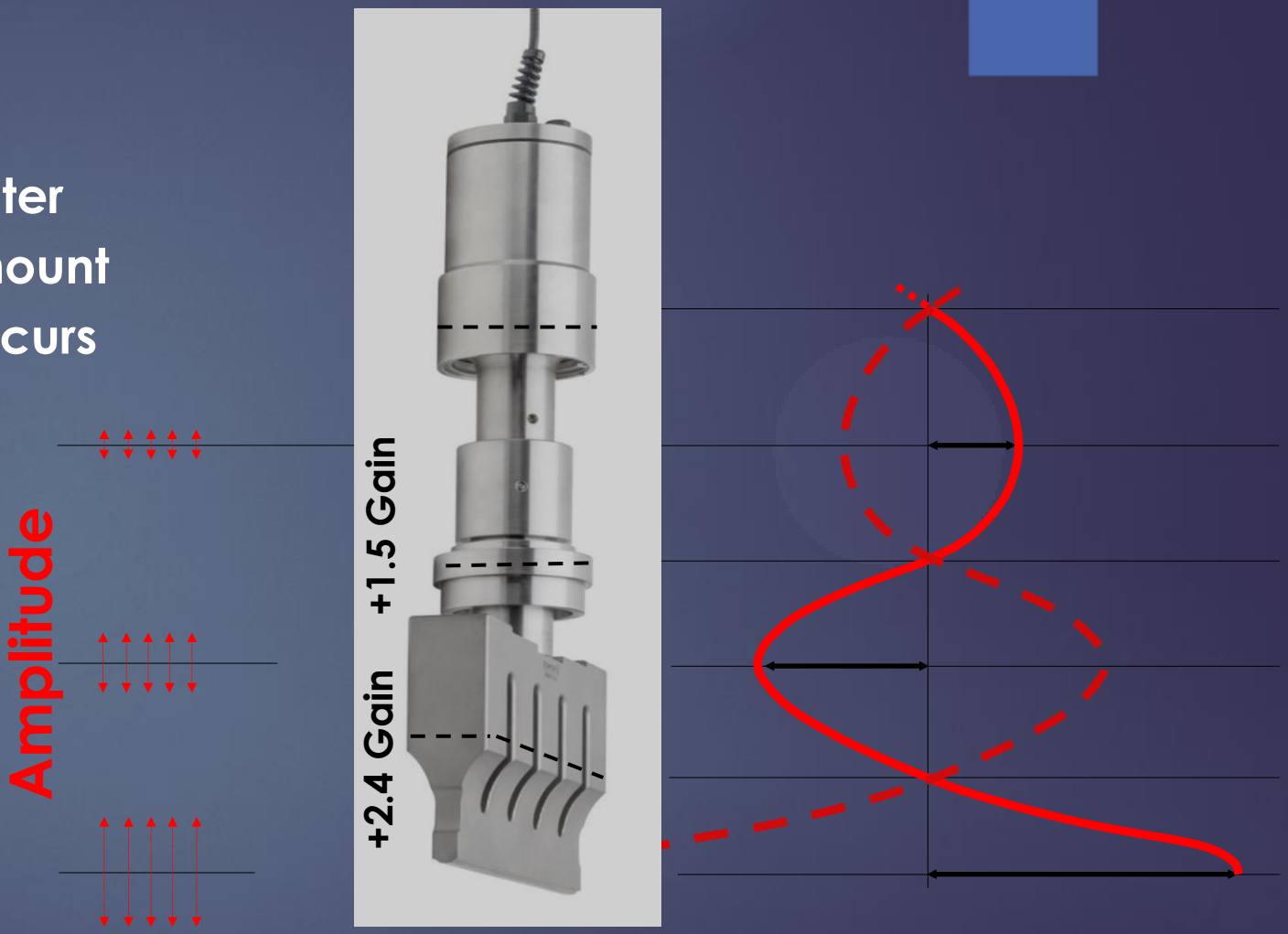
Terminology / Definitions

NODAL PLANE:

The Nodal Plane is the point near the center of each vibrating tool where the least amount of longitudinal expansion/contraction occurs and the greatest amount of radial expansion/contraction occurs.

GAIN:

Gain is the term used to described the amplification factor of a booster or horn. Gain is determined by the mass ratio on opposing sides of the nodal plane.



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What is Ultrasonic Sealing?

A secondary assembly process whereby high-frequency mechanical vibration is applied to thermoplastic materials under pressure to create intermolecular frictional heat, resulting in a molecular bond.

How Does The Process Work?

Clamp Force

Vibration

Friction

Heat

Melt

Weld

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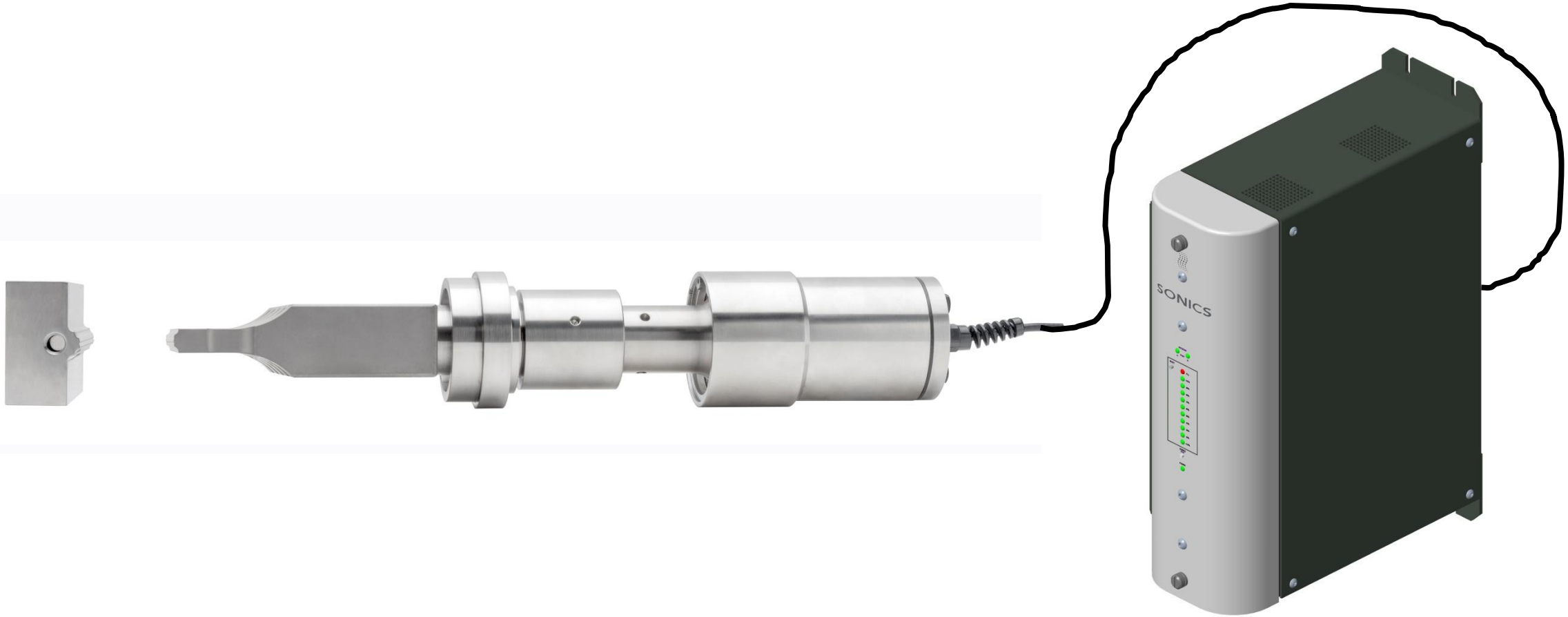
Components of an Ultrasonic Sealing System



Conversion Of Electrical To Mechanical

20,000 Hz
1300 volts

GX-Series Power Supply**

50 / 60 Hz
120 / 240 volts

Ultrasonic “stack”
(converter – booster – horn)

Ultrasonic Generator

Ultrasonic generators can be as simple as a PC board or as advanced as a microprocessor.

Key features of a Sonics ultrasonic generator:

- Continuous ultrasonic signal or with stop conditions as required by the application
- Automatic frequency tracking to maximize efficiency and process stability
- Line and load regulation provide constant amplitude
- Amplitude adjustment
- Horn start rate adjustment

Ultrasonic Converter

The converter is a device that converts electrical energy into mechanical movement.

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Ultrasonic Converter

Within the converter, piezoelectric ceramic discs are compressed between tuned front and rear drivers. These ceramic crystals expand and contract when the high voltage from the generator is applied, producing mechanical vibration.

20 µm peak-to-peak in 20 kHz

PZT (Lead Zirconate Titanate)

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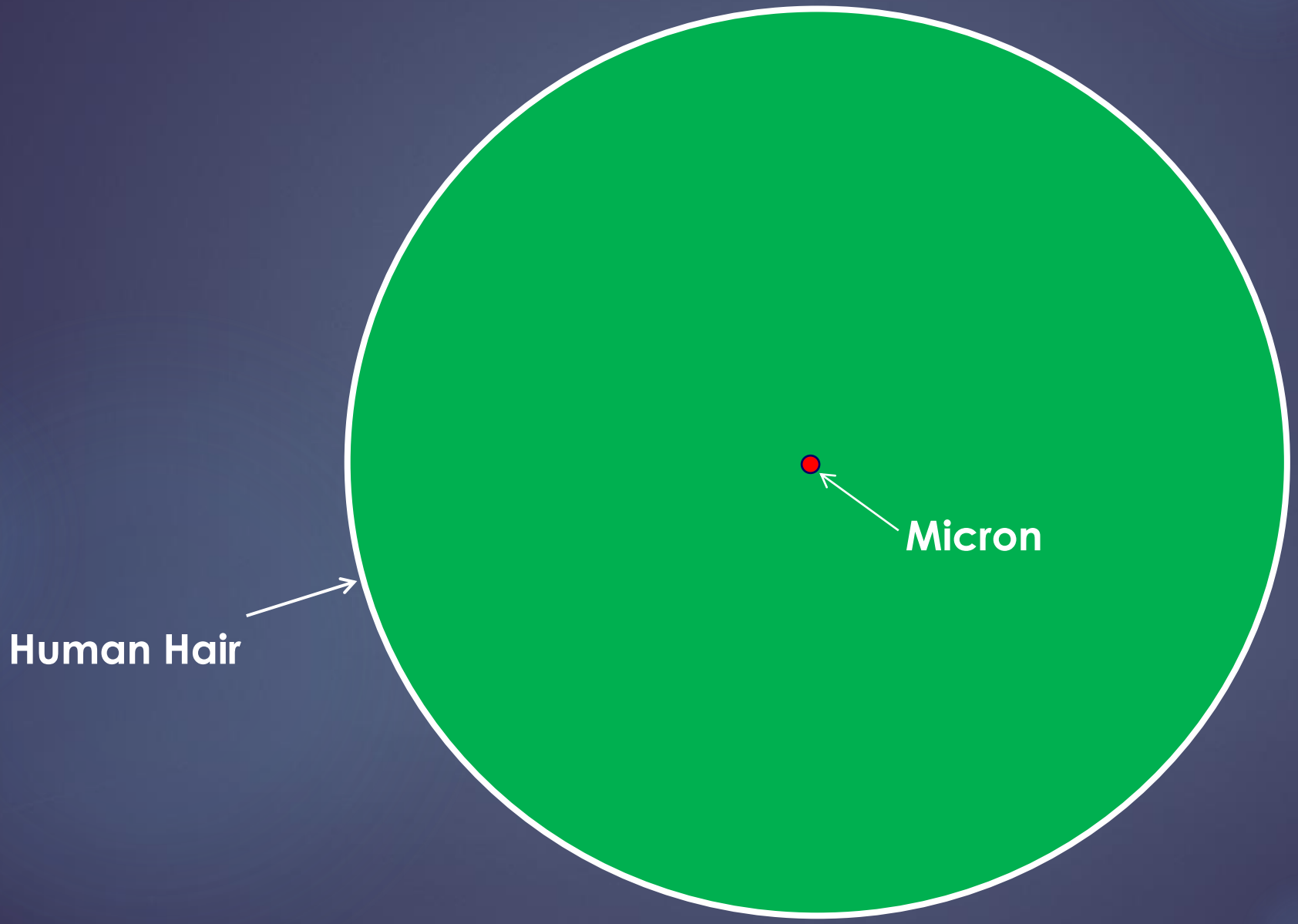
How big is a micron?



Ultrasonic Converter

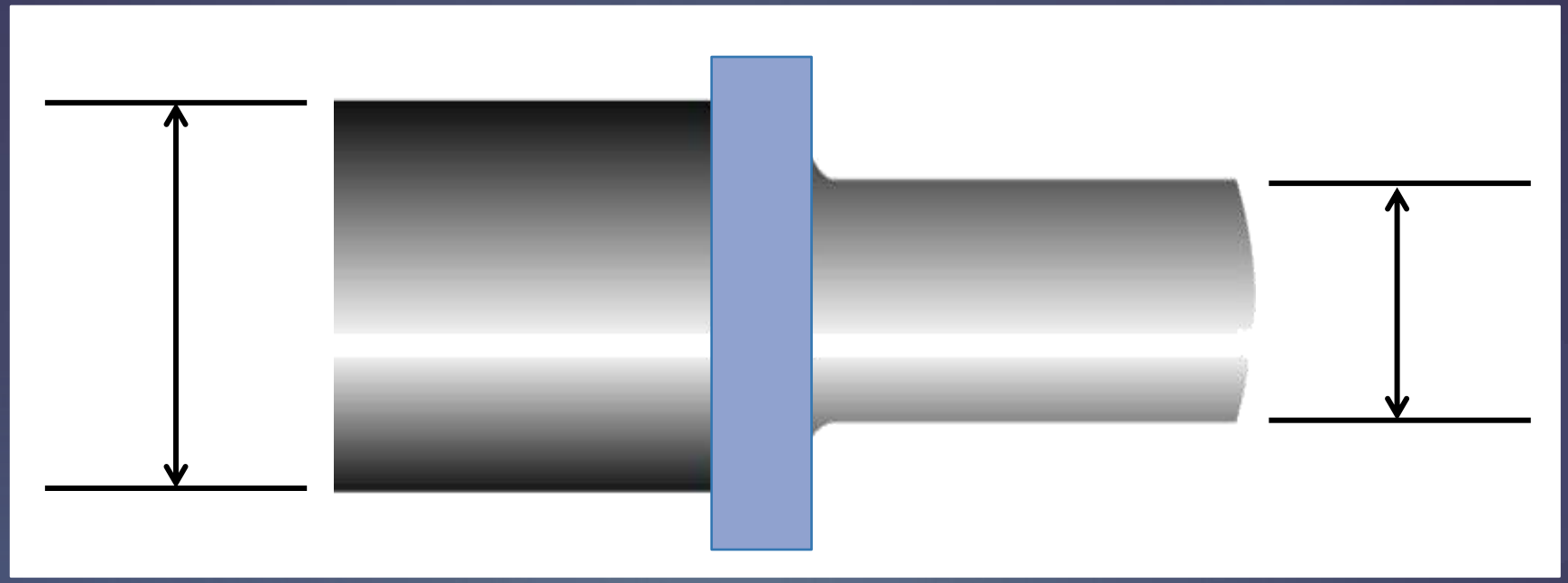
Converters come in many configurations, depending upon the application.

Note: A converter functions in both directions. For this reason, metal to metal contact should be avoided as it can potentially deliver a high voltage electrical charge back into generator.

Booster

- Boosters are available in a variety of amplification values
- In addition to amplitude adjustment, boosters also provide a non-vibrating clamping point for mounting the ultrasonic stack

How a booster works



Boosters function based upon the amount of mass on opposing sides of the nodal area.

Depending on this mass relationship, boosters can increase or decrease the amplitude from the converter.

Note: Newer technology generators are also capable of increasing or decreasing the process amplitude via a digital setting.

Booster

In some applications rigid mount, one-piece boosters are used for the enhanced rigidity they provide. Further, their titanium construction complies with the sanitary and wash-down requirements of the food packaging industry

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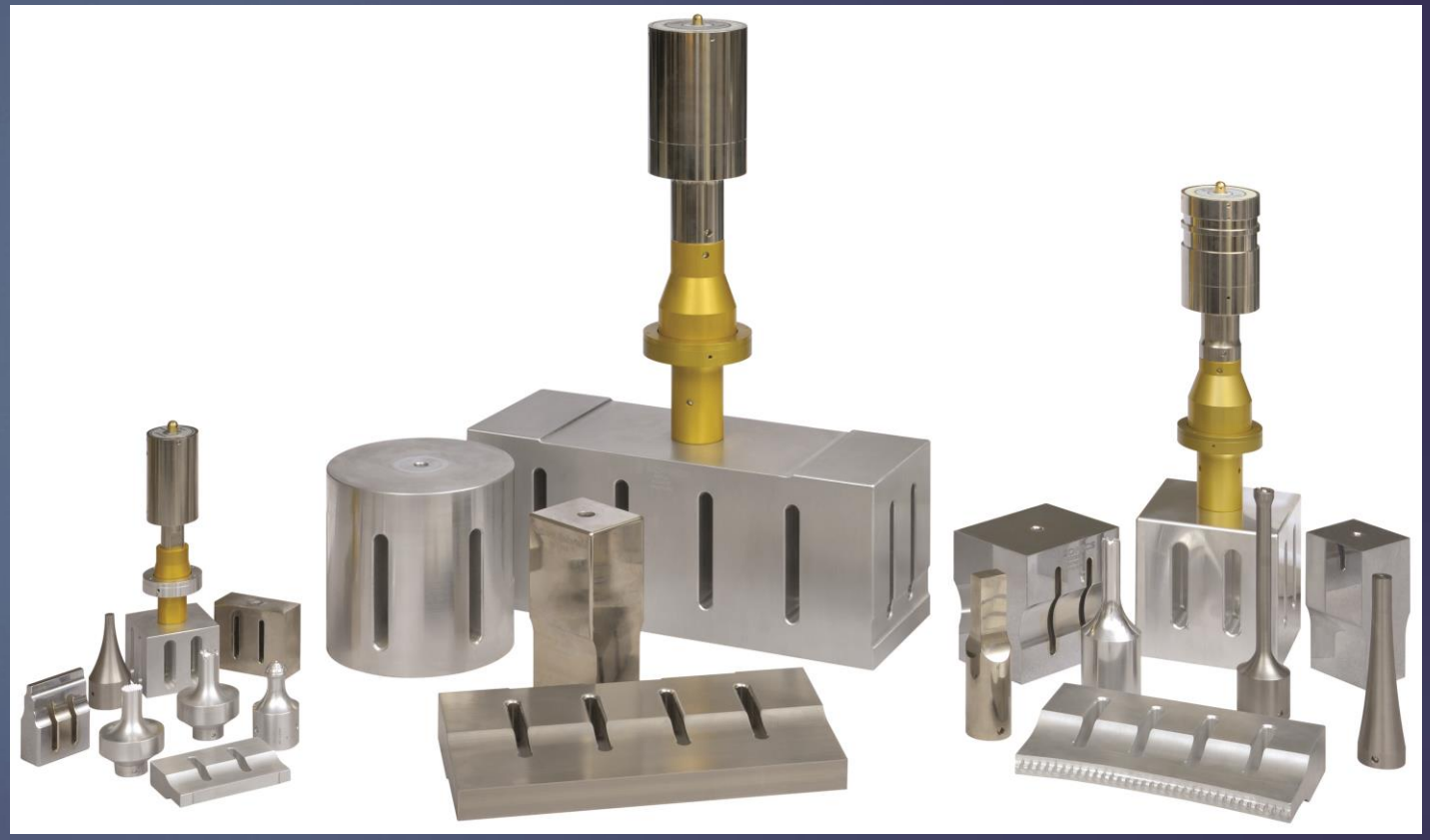
Ultrasonic Horns

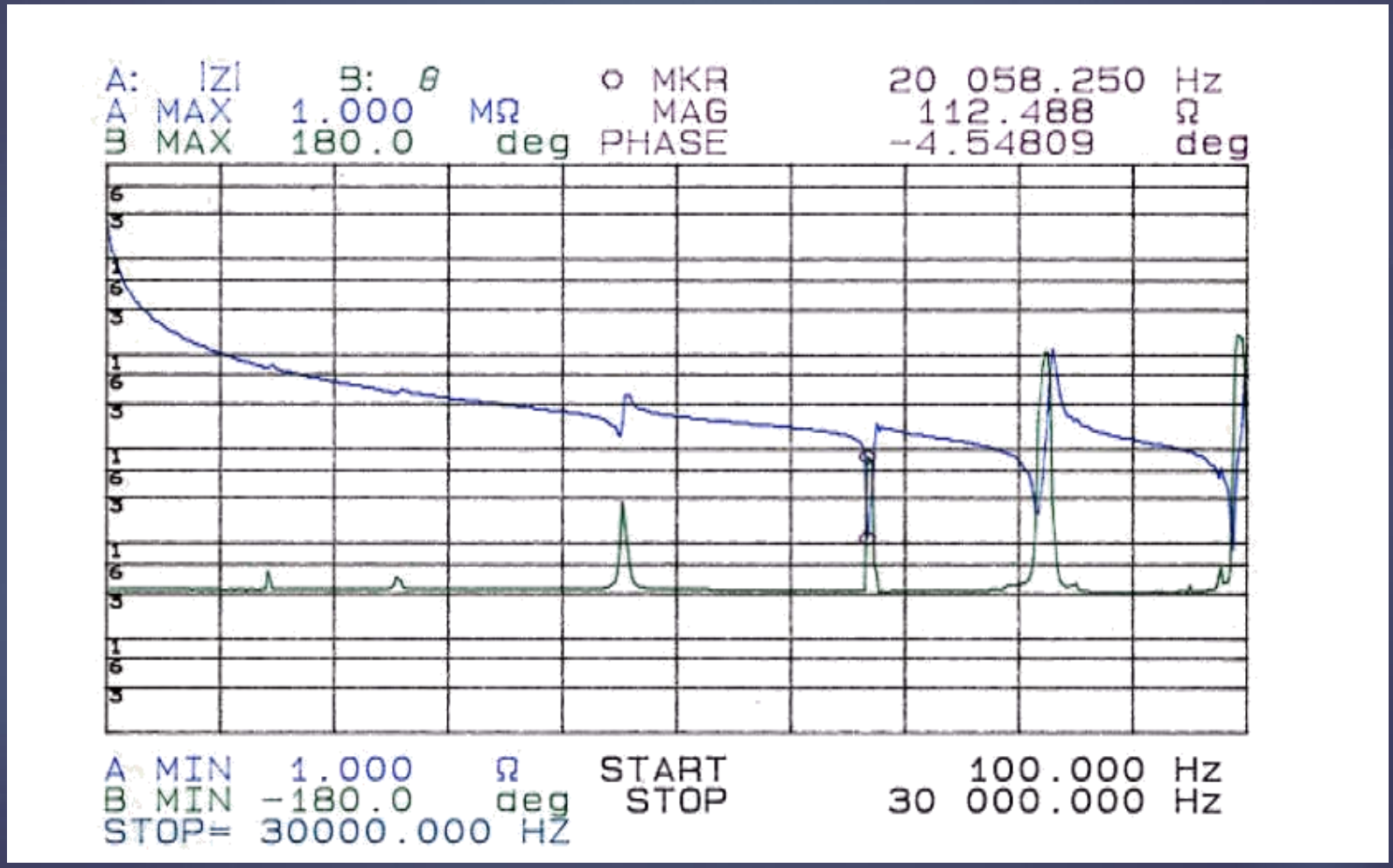
Ultrasonic horns, (also called Sonotrodes) are acoustical tools that are custom-designed and tuned for each application.

Horns transfer the ultrasonic vibration to the parts under force.



Ultrasonic Horns

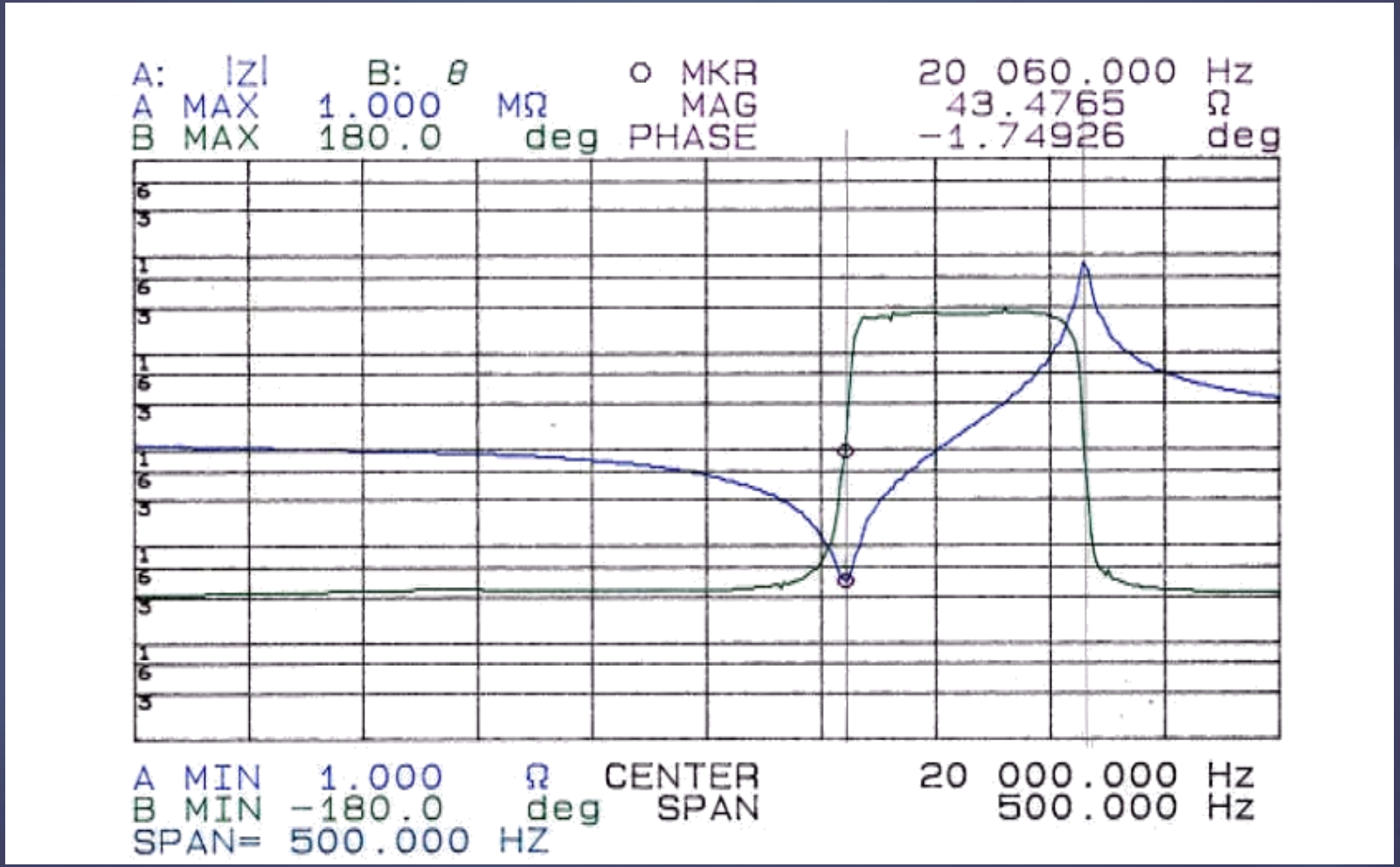
Horns are manufactured and analyzed using sophisticated measurement technology to confirm their functional capability.



Ultrasonic Horns

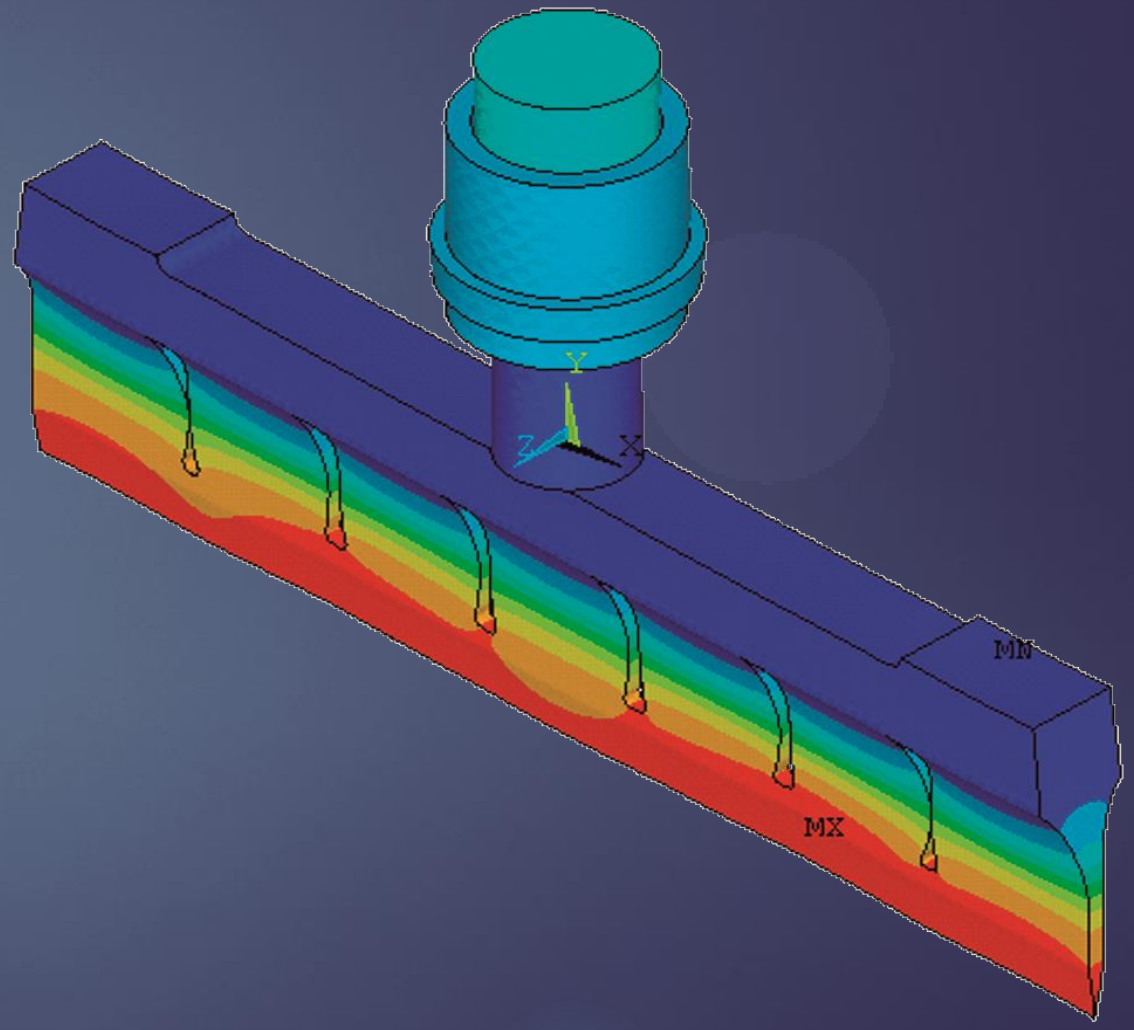
Properly manufactured horns provide:

- Single frequency within the operating range of the generator
- Wide bandwidth to facilitate generator tuning and frequency tracking



Horn Design Optimization (FEA)

Finite Element Analysis (FEA) computer modeling systems are used for state-of-the-art horn design.



FEA allows us to:

- Optimize the resonant frequency of a horn by eliminating secondary frequencies that would cause the horn to vibrate in an unproductive mode.
- Minimize the mechanical stress in the horn, providing longer tool life.
- Create horns with even amplitude distribution throughout the entire weld surface.

Amplitude increase

Amplitude

Ultrasonic Horn Materials

Titanium – provides excellent fatigue resistance. Titanium is the material of choice for most ultrasonic horns.

Aluminum – has excellent heat transfer properties but usually requires a coating to enhance wear resistance.

CPM10V – is a sintered steel that also provides excellent wear resistance

Ultrasonic Horn Coatings

Aluminum horn coatings to improve their wear characteristics

- Nickel
- Chrome
- Hard Anodized
- Carbide

Sealing Anvil

- Support the weld by opposing the vibrating horn with sufficient mass to stop the ultrasonic vibration

- In sealing flexible materials, the anvil must also focus the frictional energy via a seal bead pattern across the length of the material

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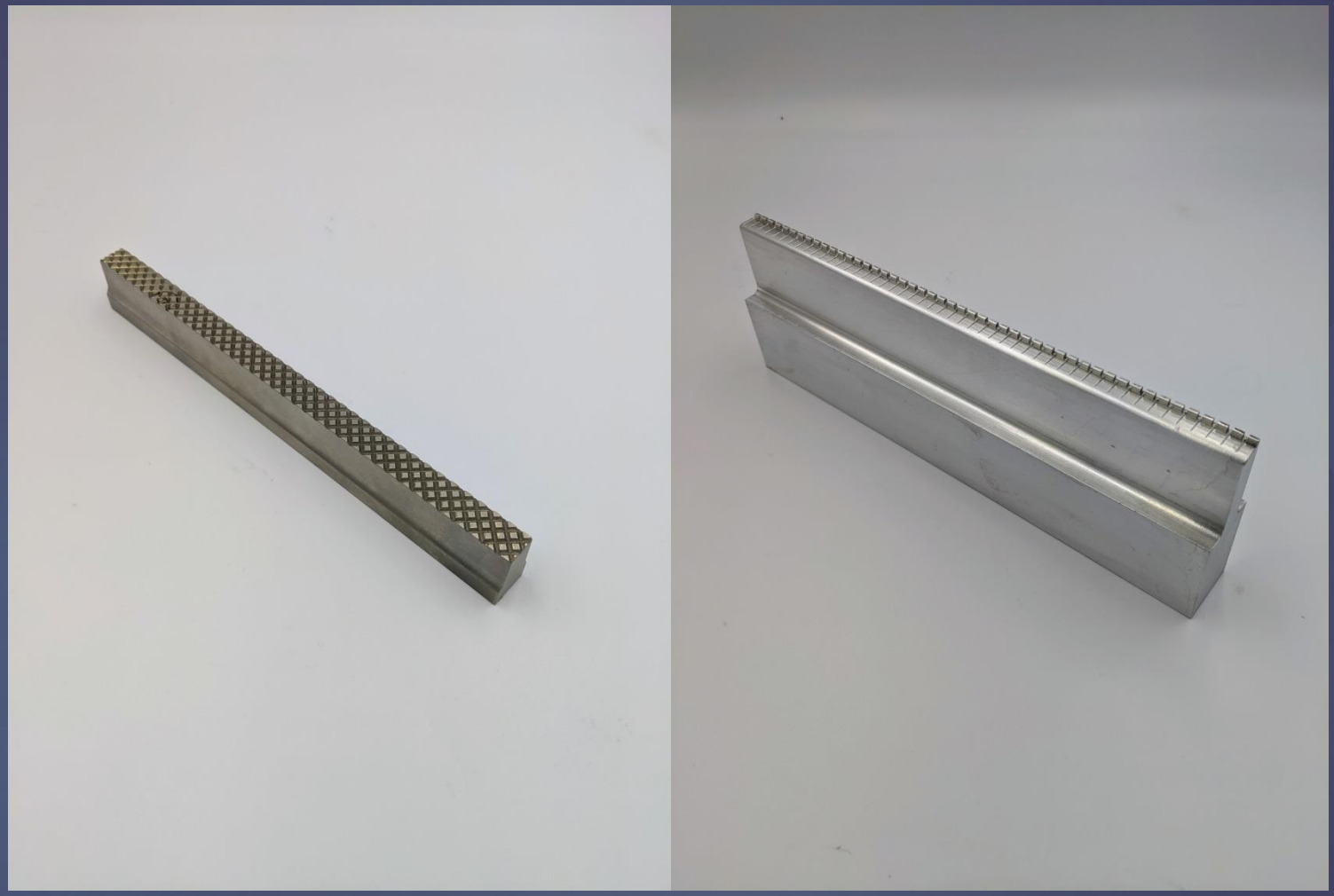
Sealing Bead Design



Sealing Anvil

- Support the weld by opposing the vibrating horn with sufficient mass to stop the ultrasonic vibration
- In sealing flexible materials, the anvil must also focus the frictional energy via a seal bead pattern across the length of the material
- Means of Leveling

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The Ultrasonic Welding Process

The process variables in ultrasonic sealing are closely related to those in conventional heat sealing: Seal Time, Seal Force, Seal Temperature (Amplitude)

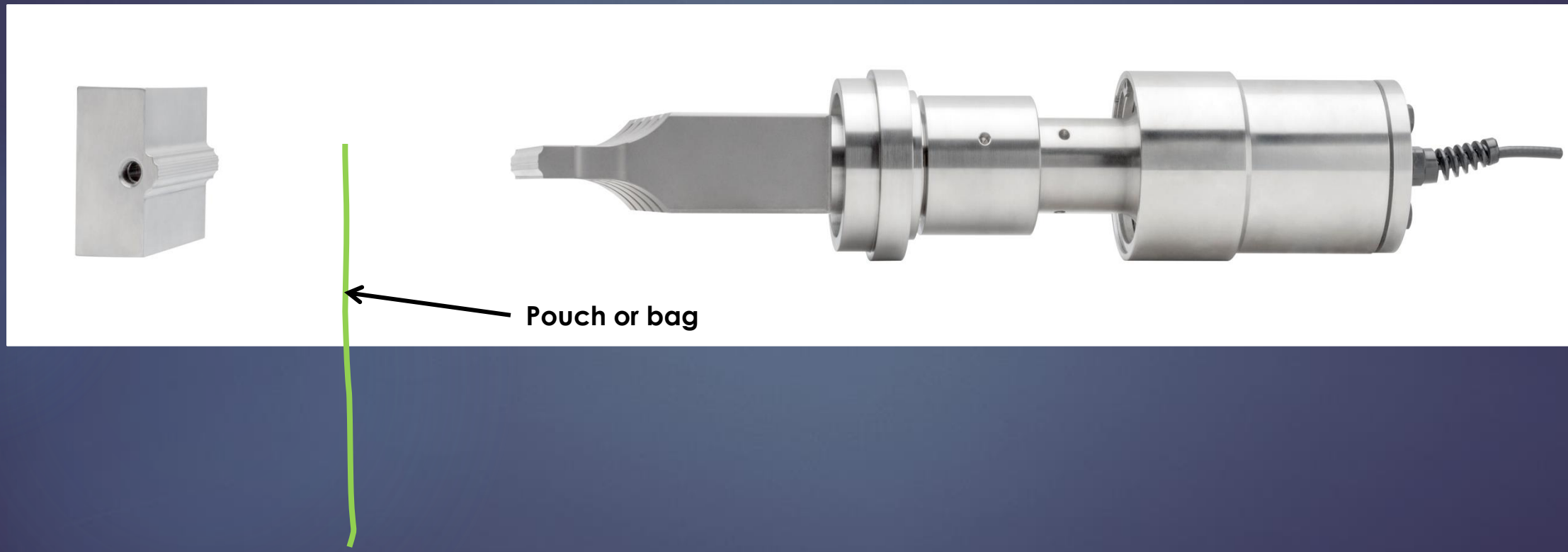
- **Seal Time - How long the ultrasonic vibration is applied to the material**
- **Seal Force – Clamping force between the vibrating horn and non-vibrating anvil**
- **Seal Amplitude – Distance of vibration at the face of the weld horn**

A programmed weld parameter determines the duration of vibration.

- **Time**
- **Energy**

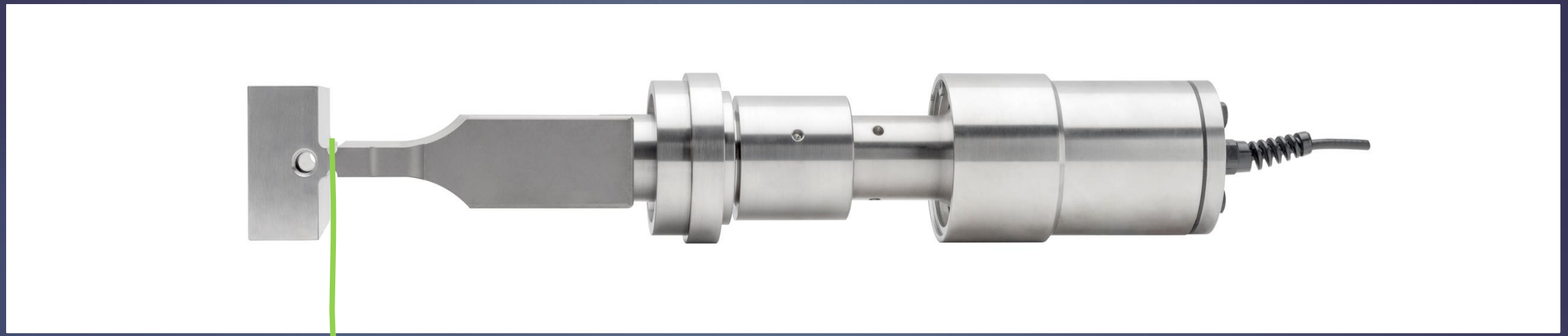
Sequence of Events

Material enters the seal area



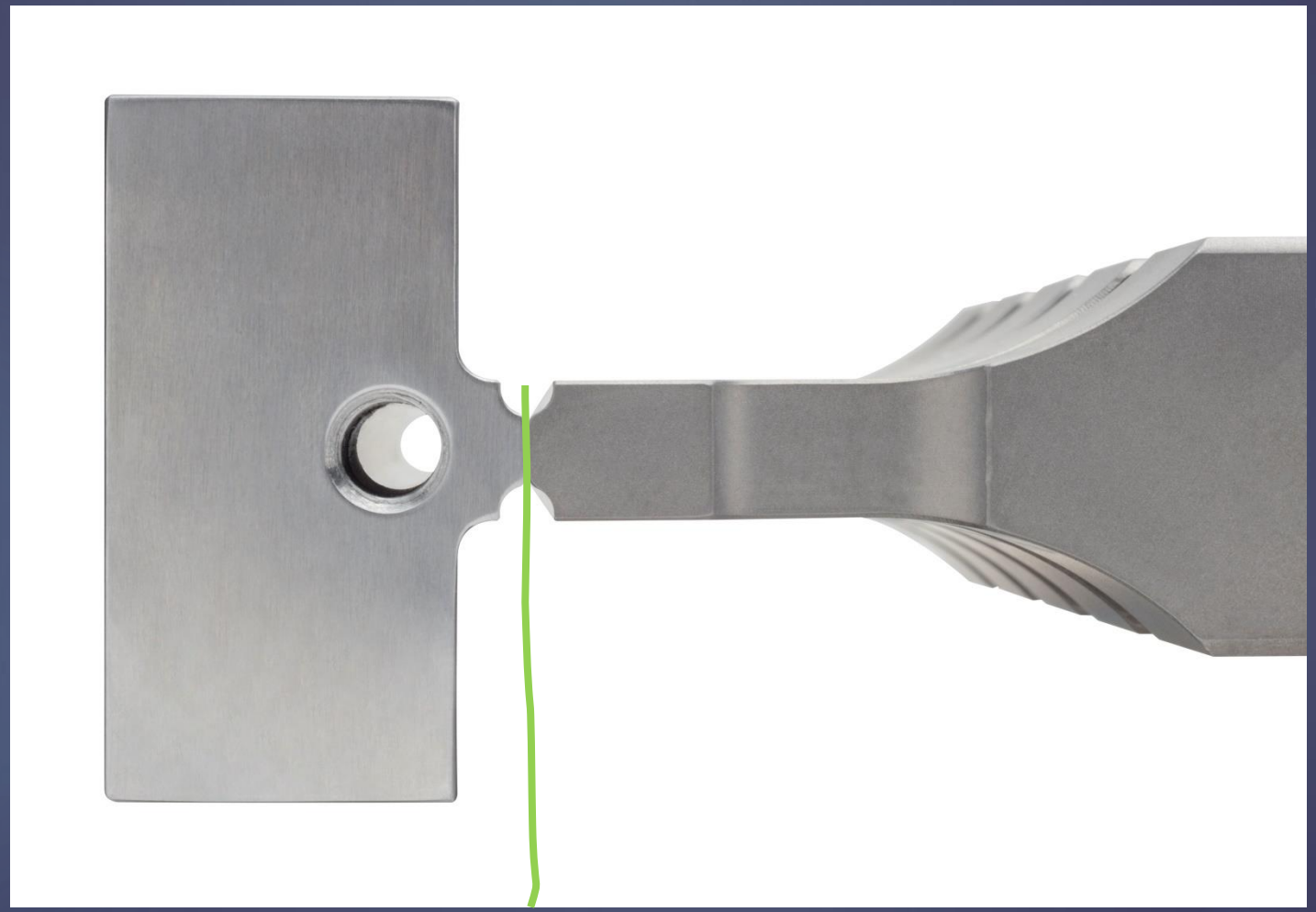
Sequence of Events

Tools close



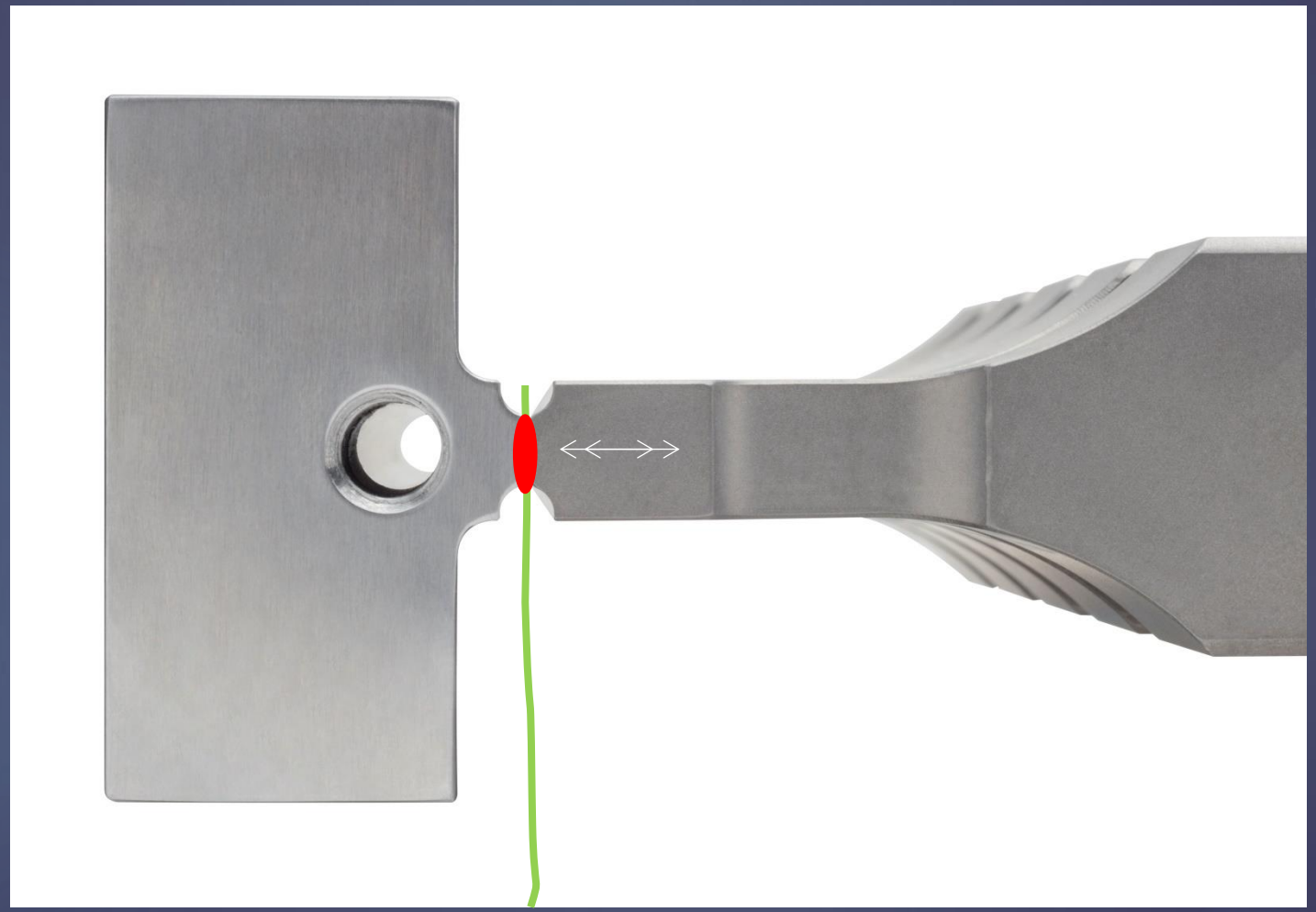
Sequence of Events

Force builds up without vibration



Sequence of Events

Ultrasonic vibration is applied



U/S Vibrations

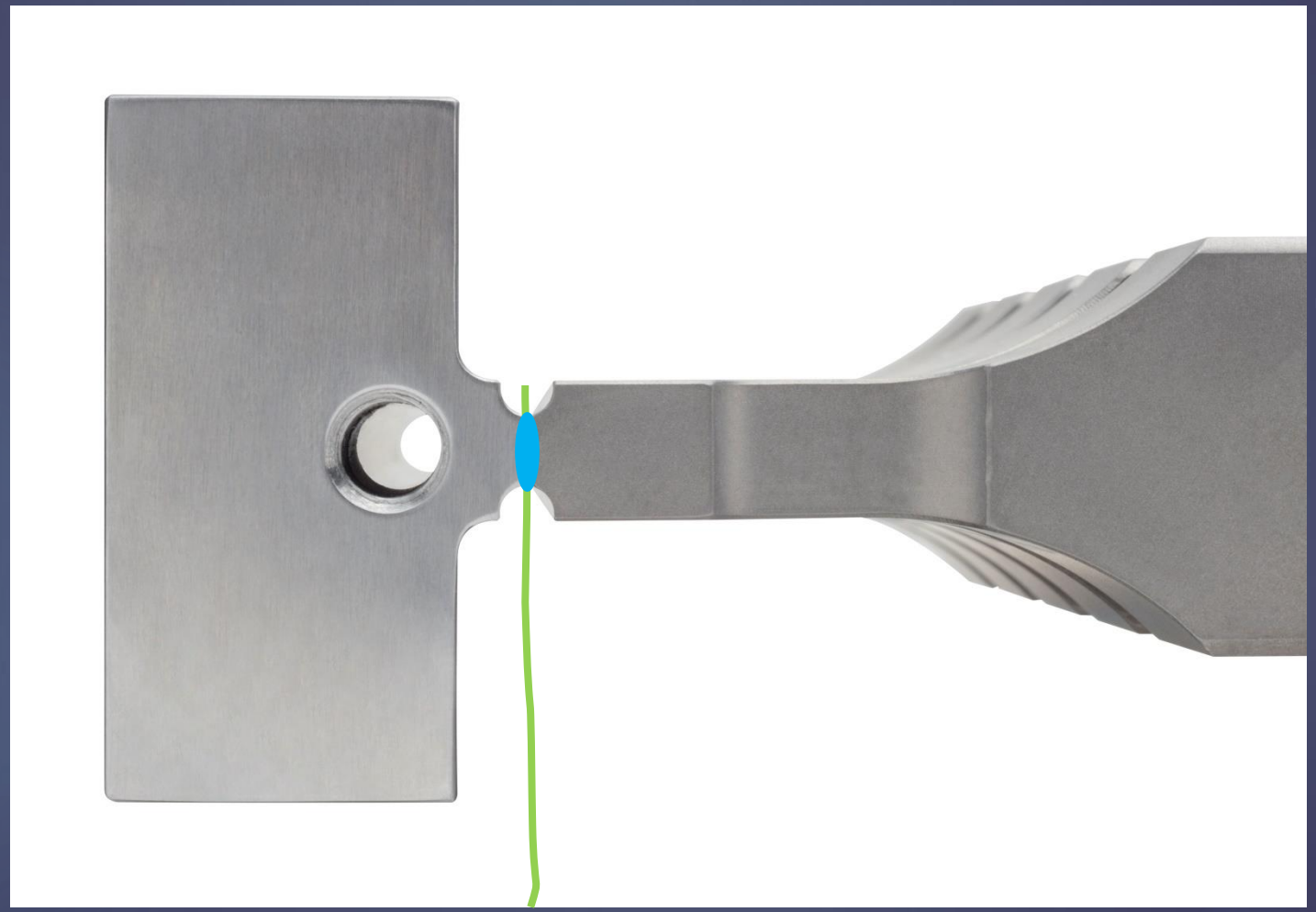
Friction

Heat

Melt

Sequence of Events

Vibration ceases



U/S Vibrations

Friction

Heat

Melt

Weld

How can ultrasonic equipment be used in manufacturing?

Ultrasonic Press Systems

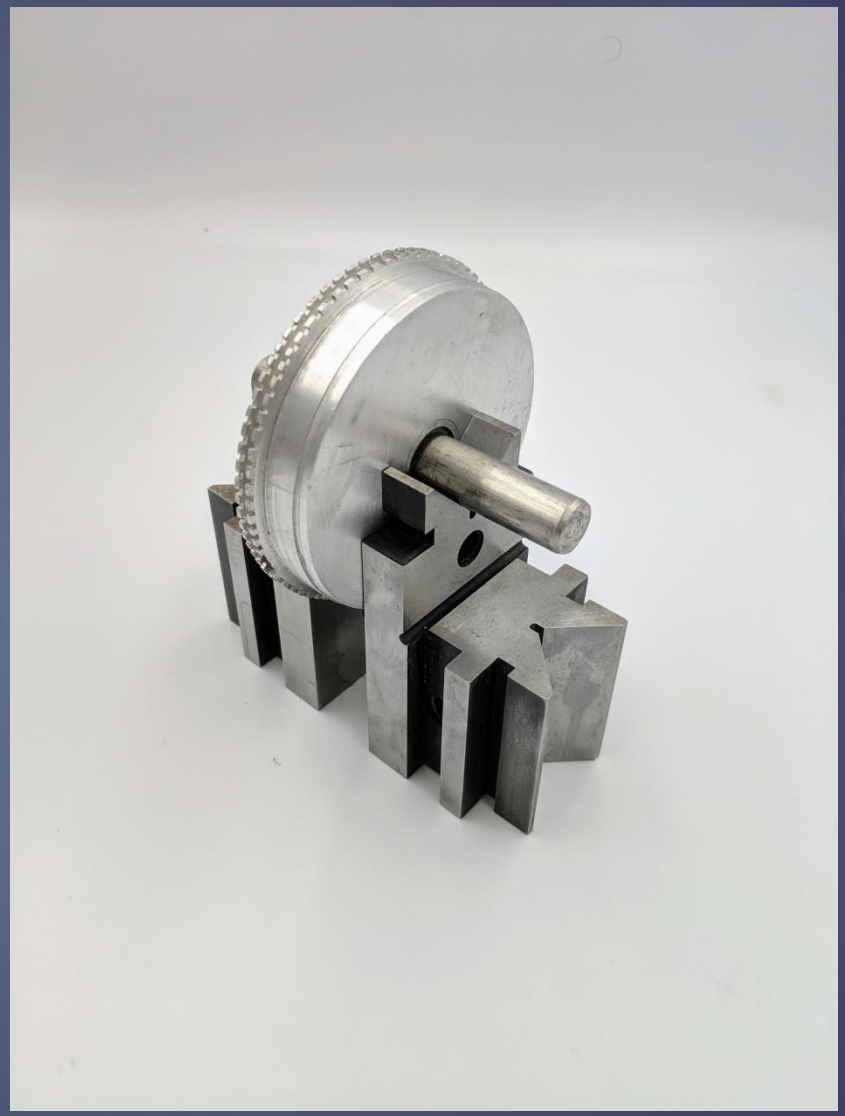
Ultrasonic benchtop press systems can be utilized for hand load/unload operations as well as some automated applications

Ideal for ear loop welding and plunge sealing straight stitch lines up to 12“ (320mm) long, as well as driving threaded brass inserts

Presses can also be used in continuous sealing applications with specialized tooling

Ultrasonic Press Systems

Simple rotating anvil components can be used to turn a benchtop welding press into a continuous sealing ultrasonic sewing machine



Ultrasonic Components

Ultrasonic components are an excellent way to achieve high speed continuous seals when integrated into custom automated machinery

*GX-Series Power Supply***

Ultrasonic Components

Ultrasonic components are an excellent way to achieve high speed continuous seals when integrated into custom automated machinery

Kit generators can be driven by the machine‘s PLC as an more cost effective way to apply ultrasonic technology

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Applications Videos

- Nonwoven bonding
- Face Mask Manufacturing
- Driving Brass Inserts

Face Mask Applications

The link below contains good information regarding the construction and requirements of face masks.

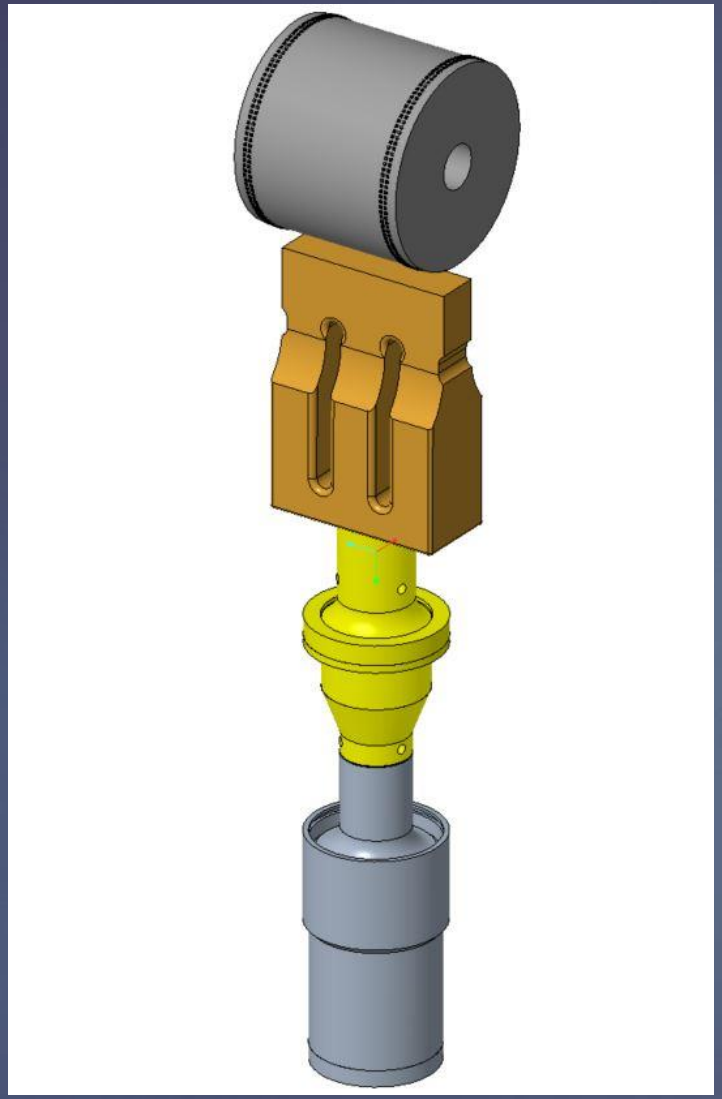
You can copy and paste it from the “Chat“ tab

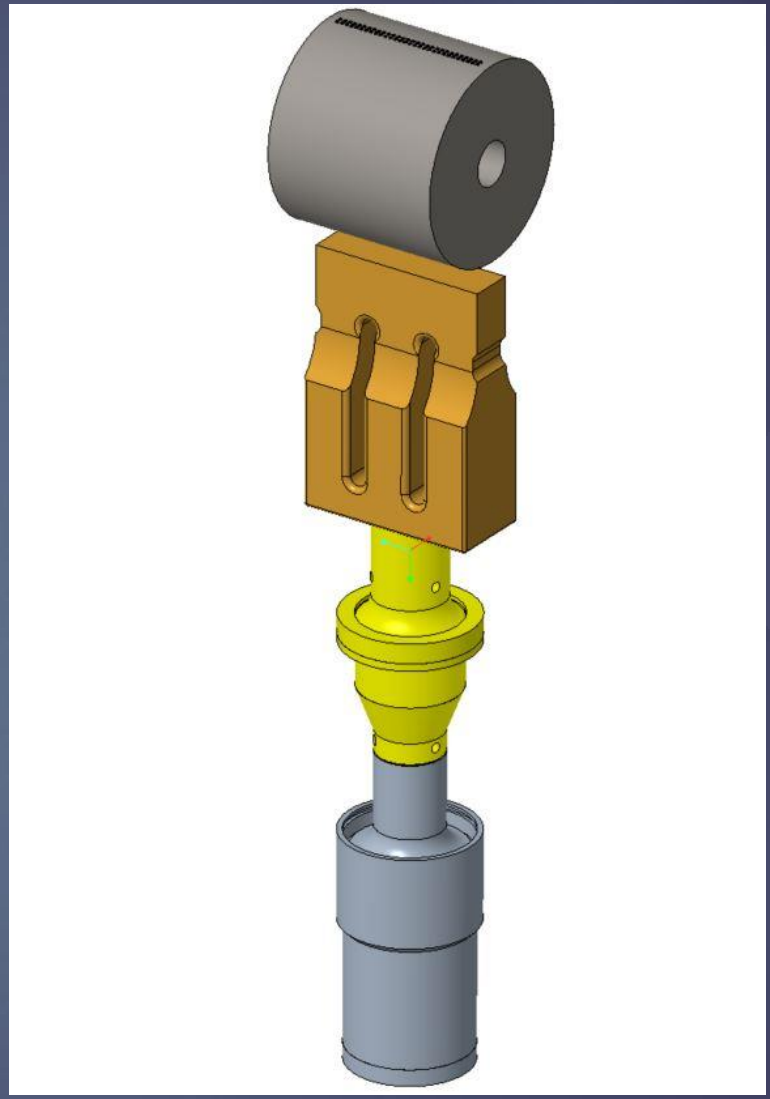
https://www.fda.gov/medical-devices/personal-protective-equipment-infection-control/n95-respirators-and-surgical-masks-face-masks#s3

Continuous stitching application requirements

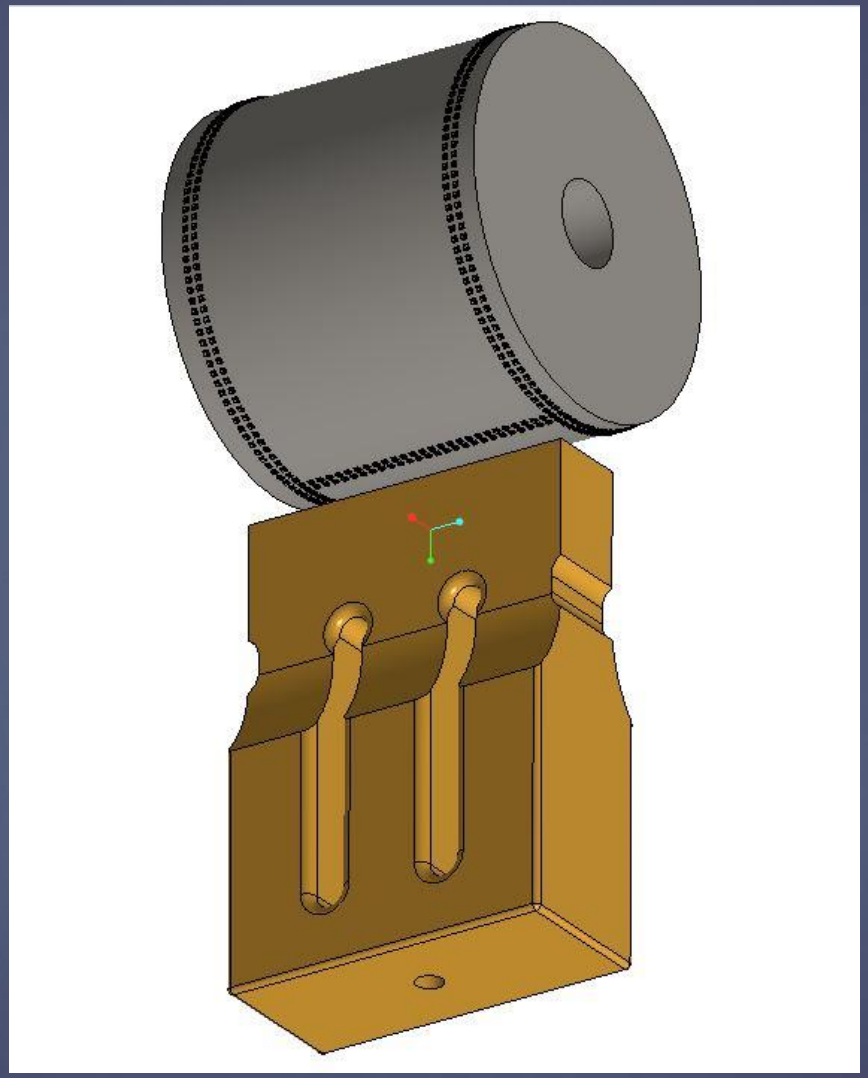
- Ultrasonic energy is continuously applied with flat faced vibrating tools
- Rotary anvils with stitch patterns or engraved drums oppose the weld horns (Flatness and runout must be held to tight specifications to ensure a uniform seal)
- Floating application of force in either the ultrasonic stack or rotary anvil
- Positive stop to prevent metal to metal contact of the tools

Face Mask Applications





Face Mask Applications



Face Mask Applications

Ear loop welding application requirements

- Plunge application of ultrasonic tools
- Timed ultrasonic weld start and stop
- Rigid steel anvil to oppose the vibrating tools

Driving brass inserts application requirements

- Plunge application of ultrasonic tools
- Ultrasonic weld start and stop controlled by time or position
- Positive stop may be engaged to hold precise insert height
- Rigid support beneath the plastic parts to eliminate loss of vibratory energy

Question discussion

Additional Questions?

Questions regarding sensitive or proprietary subjects can be addressed via email to webinars@sonics.com

Thank You