BRANSON

Ultrasonic Welding

Amplitude Reference Guide

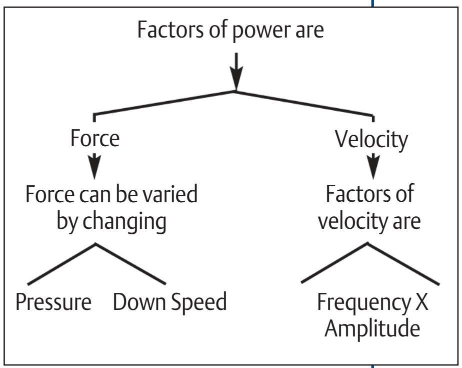

Fig. 1

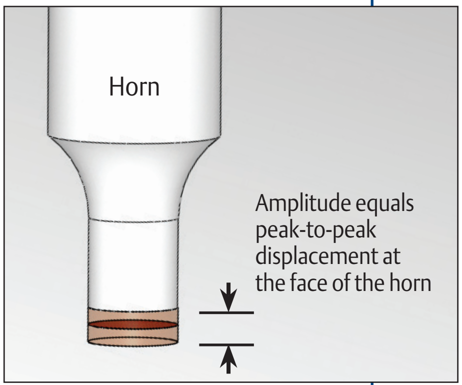

Fig. 2

An ultrasonic weld is governed by the following formula: E = P x T, where E = energy, P = power, and T= time. Power is a function of force times velocity: P ≈ F x V. Force is derived from pressure and down speed, and velocity is derived from frequency and amplitude. (*See Figure 1.*)

Amplitude is defined as the peak-to-peak longitudinal displacement at the face of the horn. (*See Figure 2.*) It has the most impact on the ultrasonic process, in that the heat generated at the joint interface is based on the *square* of the amplitude.

Therefore, small increases or decreases in amplitude have a greater affect than changes to other parameters, because the results are magnified by the square rather than incrementally.

One can calculate amplitude by using static gain factors of the components that make up an acoustic stack: the converter, booster, and horn. (Gain is the ratio of output amplitude to input amplitude of a horn or booster.) To arrive at approximate stack amplitude, multiply the amplitude of the converter by the gain factors of the booster and horn. (*See Figure 3.*) For example:
Amplitude output =
Amplitude converter X Gain booster X Gain horn

Depending on the material and ultrasonic process utilized, different amplitudes will be necessary. Amplitude can be measured in either thousandths of an inch or microns (0.001" = 25 microns).

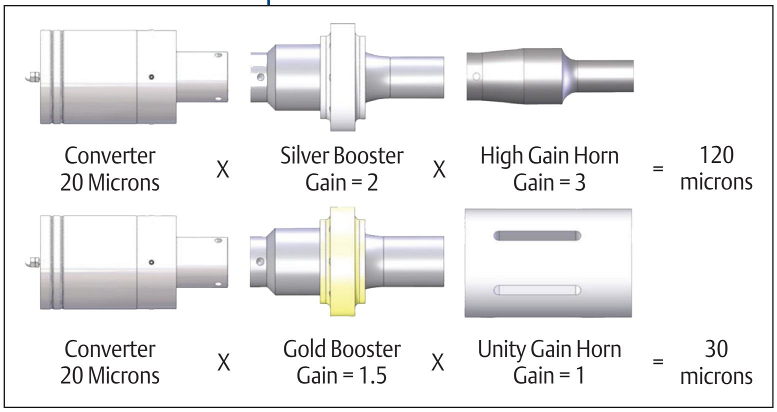

Fig. 3

15kHz converter output = 30 microns

20 kHz converter output = 20 microns

30 kHz converter output = 15 microns

40 kHz converter output = 8 microns

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Amplitude guidelines based on material and process have been arrived at through research and practical experience. The matrix below should be used as a ***guideline*** to determine amplitude for the setup of your particular application, based on the frequency of the equipment.

AMPLITUDE REFERENCE GUIDE for ULTRASONIC WELDING (in Microns (µm)

RESIN	FREQUENCY			
Amorphous	**15 kHz**	**20 kHz**	**30 kHz**	**40 kHz**
Acrylonitrile Butadiene Styrene (ABS)	36-84	30-70	24-56	18-42
Acrylonitrile Styrene Acrylate (ASA)	36-84	30-70	24-56	18-42
Polycarbonate (PC)	48-96	40-80	32-64	24-48
PC/ABS	72-120	60-100	48-80	36-60
Polycarbonate/Polyester	60-120	50-100	40-80	30-60
Polyetherimide (PEI)	84-120	70-100	56-80	42-60
Polyethersulfone (PES)	84-120	70-100	56-80	42-60
Polymethyl Methacrylate (Acrylic, PMMA)	48-84	40-70	32-56	24-42
Polyphenylene Oxide (PPO)	60-108	50-90	40-72	30-54
Polystyrene (PS)	36-84	30-70	24-56	18-42
Polysulfone (PSU)	84-120	70-100	56-80	42-60
Polyvinyl Chloride (rigid PVC)	48-96	40-80	32-64	24-48
Styrene-Acrylonitrile (SAN)	36-84	30-70	24-56	18-42
Semi-Crystalline	**15 kHz**	**20 kHz**	**30 kHz**	**40 kHz**
Cellulosics (CA, CAB, CAP)	72-120	60-100	48-80	36-60
Liquid Crystal Polymer (LCP)	84-144	70-120	56-96	42-72
Copolyester	84-144	70-120	56-96	42-72
Polyoxymethylene, Polyacetal (POM)	84-144	70-120	56-96	42-72
Polyamid (Nylon, PA)	84-144	70-120	56-96	42-72
Polybutylene Terephthalate (Polyester, PBT)	84-144	70-120	56-96	42-72
Polyethylene Terephthalate (Polyester, PET)	96-144	80-120	64-96	48-72
Polyetheretherketone (PEEK)	84-144	70-120	56-96	42-72
Polyethylene (PE)	108-144	90-120	72-96	54-72
Polyphenylene Sulfide (PPS)	96-144	80-120	64-96	48-72
Polypropylene (PP)	108-144	90-120	72-96	54-72

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