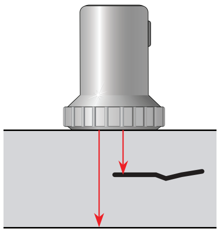
Transducer Selection Criteria and Performance

General Information

The ultrasonic transducers in this catalog are divided into two general categories, Contact and Immersion.

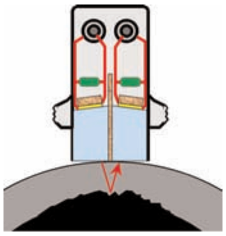
Transducers for the Contact Inspection Method

Straight Beam—Single Element



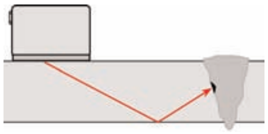
- Parts with regular geometry and relatively smooth contact surface
- Flat or curved contact surface
- Flaw or backwall parallel to surface or detectable with beam normal to surface
- Preferred for penetration of thick sections
- Delay line types improve near surface resolution
- Requires couplant layer, typically a gel, oil, or paste
- Typically used for manual inspection

Straight Beam—Dual Element (TR)



- Transmit and receive elements separated by crosstalk barrier
- Flaw or backwall parallel to surface or detectable with beam normal to surface
- Best for thin sections, near surface resolution
- Requires couplant layer, typically a gel, oil, or paste
- Typically used for manual inspection

Angle Beam



- Element mounted on integral or replaceable wedge
- Uses refraction to transmit shear or longitudinal wave at a predetermined angle
- Most standard transducers generate shear waves by mode conversion
- Preferred for parts with inclined flaws, such as welds
- Available in both single and dual element types
- Requires couplant layer, typically a gel, oil, or paste
- Sometimes used in mechanized or automated testing

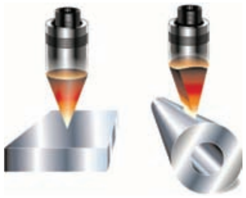
Transducers for the Immersion Method

Immersion Transducers

- Acoustically matched for best efficiency in water
- Suitable for parts with irregular geometries
- Commonly used in mechanized or automated testing
- Best method for consistent coupling and reproducible results
- Large parts can be tested using probe holders, bubblers, or water jets
- Transducers can be focused to improve results

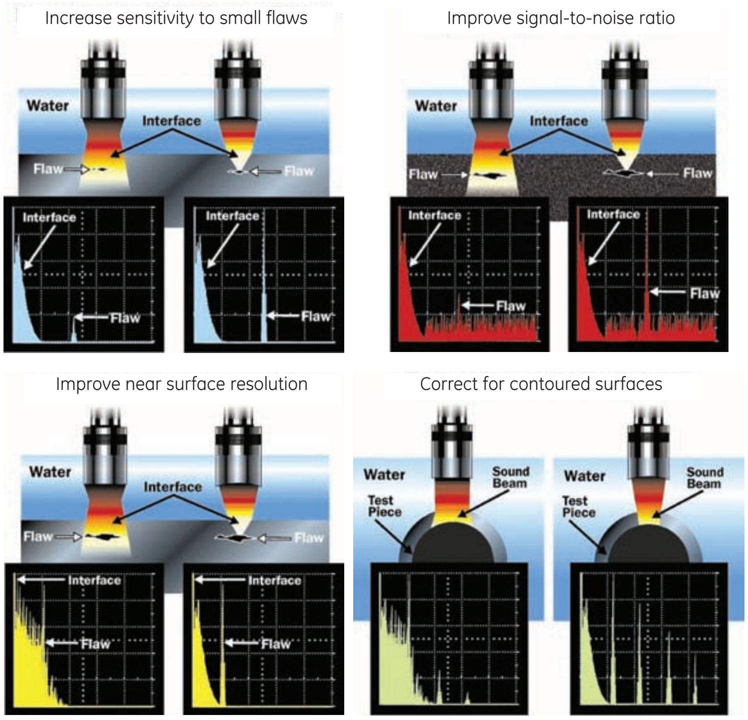
Focused Immersion Transducers

- Spherical focus forms a point or spot
- Cylindrical focus forms a line



Spherical (Spot, Point) Focus   Cylindrical (Line) Focus

Advantages of Focusing

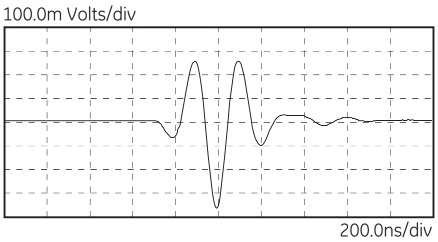


Transducer Selection Criteria—North American Standards

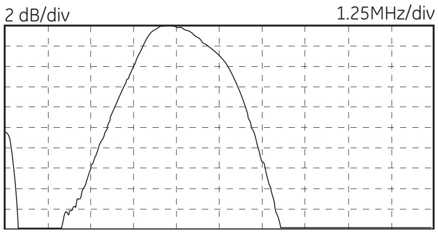
For transducers manufactured to North American standards, GE Inspection Technologies offers three performance ranges: **Alpha, Benchmark,** and **Gamma Series.** Waveform and frequency certification, per ASTM E-1065, are supplied with all flaw detection transducers at no charge.

Alpha Series Features

Real Time



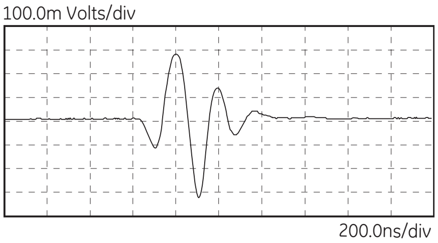
Spectrum



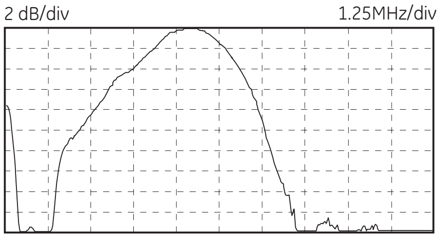
- Recommended for applications where resolution is the primary consideration.
- Suitable for applications such as thickness measurement and near-surface flaw detection.
- Very short pulse—mechanically damped to the limit of current technology.
- Gain is usually lower than that of the Gamma and Benchmark Series.
- Broadband—typical 6 dB bandwidths range from 50% to 100%.
- Typical Alpha waveforms (right) exhibit one to two full ring cycles, depending on frequency, size and other parameters.

Benchmark Series Features

Real Time



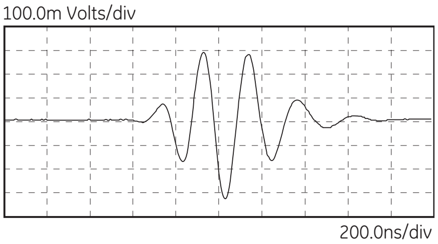
Spectrum



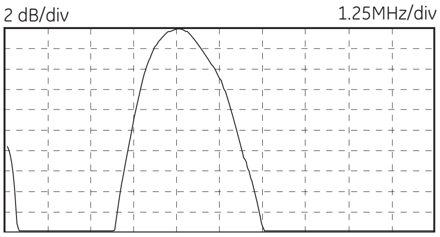
- Proprietary **BENCHMARK COMPOSITE®** (piezocomposite) active elements.
- Penetration in attenuative materials is far superior to conventional transducers.
- High signal to noise on coarse grain metals, fiber reinforced composites, et al.
- Short pulse—resolution usually superior to Gamma Series.
- Gain is usually higher than that of the Gamma and Alpha Series.
- Very broadband—typical 6 dB bandwidths range from 60% to 120%.
- Low acoustic impedance element improves performance of angle beam, delay line, and immersion probes—excellent match to plastic and water.

Gamma Series Features

Real Time



Spectrum



- General purpose transducers, recommended for the majority of applications.
- Medium pulse, medium damping—best combination of gain and resolution.
- Matching electrical network ensures maximum gain and optimum waveform for general use.
- Medium bandwidth—typical 6 dB bandwidths range from 30% to 50%.
- Typical Gamma waveform exhibits three to four full ring cycles, depending on frequency, size and other parameters.

Transducer Selection Criteria—European Standards

For transducers manufactured to European standards, technical and performance information is provided throughout this catalog based on the definitions below. A comprehensive data sheet is supplied with most flaw detection transducers at no charge.

Description	Explanation
Element size D or a x b	Diameter D or length x width a x b of the transducer element. The size of the element strongly affects the shape of the transmitted sound field. Slight deviations, (e.g., imperfect shape or positions with reduced radiation due to poor bonding) cause considerable evaluation errors, even when calibrated to a reference flaw.
Nominal frequency f	The mean frequency of all probes of the same type. The frequency has a great influence on the evaluation of reflectors. Even the shape of the sound field and the reflection behaviour of angled reflectors are strongly dependent on the frequency. With increasing frequency, the echo height from non-vertically positioned reflectors to the sound beam decreases. This is why each probe is checked by our Quality Control to see if its frequency coincides with the nominal frequency, according to the identification label, within very narrow tolerances. This is entered into the probe data sheet.
Bandwidth B	The range of frequencies in the echo pulse whose amplitude, at the most, is 6 dB less than the maximum amplitude. $B = \frac{f_o - f_u}{f} \times 100\%$ f_o = upper, f_u = lower frequency limit for a 6 dB drop in amplitude. With B = 100%, a 4 MHz, probe for example, has an f_o of 6 MHz and an f_u of 2 MHz. Large bandwidths mean shorter echo pulses, which mean high resolution and a good penetration power, because the lower frequencies of the pulse become less attenuated than the nominal frequency. At high attenuation, the frequency of reflected signals decreases, compared to the nominal frequency, as the distance increases. This must be taken into account with flaw evaluation. The bandwidth of each probe is therefore checked and must, within narrow tolerances, coincide with the mean value of all probes.
Focal distance F	The distance of a small reflector from the probe producing the highest possible echo. Probes are focused in order to detect small reflectors and produce a high echo amplitude. Focusing is only possible within the near field of the probe.
Near field length N	The near field length N is the focal distance of the unfocused probe which constitutes the sound pressure maximum at the largest distance from the probe. N is determined by D, c and f. For $D \gg \lambda$ is: $N = \frac{D^2_{eff}}{4\lambda} = \frac{D^2_{eff} \cdot f}{4c}$ λ = wave length c = sound velocity D_{eff} = effective element diameter Focal point and near field length are the distances with the best sound concentration and reflector recognition. Therefore, when a probe is selected for a critical test, the flaw expectancy range must be in the focal area or near field length. The data in the tables refers to steel with the exception of immersion testing in water.
Focal diameter FD_6	Diameter of the sound field in the focal distance or near field length with a 6 dB drop of the echo indication. For $D \gg \lambda$ is: $FD_6 = \frac{F \cdot c}{f - D_{eff}} = \frac{1}{4} k \cdot D_{eff}$ with $k = \frac{F}{N}$
Pulse shape	The presentation of signals, as they are at the instrument input coming from plane reflectors.
Spectrum	Display of all the frequencies in the echo pulse. The frequency amplitudes are shown over the frequency.
Beam angle ß	The angle between the main beam and the normal axis of the test surface.