Ultrasonic Testing Formula Sheet

General UT Equations

Wavelength	= V / F
Near Field	= $(D^2 \times F) / (4 \times V)$
Half Angle Beam Spread	= (K x V) / (D x F)
Snell's Law	$(\sin\theta_1 / \sin\theta_2) = (V_1 / V_2)$
Amplitude to dB	$dB = 20 \times \log(A_2 / A_1)$
Acoustic Impedance (Z)	= $\rho \times V$
Impedance Ratio	= Z_2 / Z_1
Reflected Energy (%)	= $[(Z_2 - Z_1)^2 / (Z_2 + Z1)^2] \times 100$
V - Path	= (2 x w.t.) / Cos(θ)
Skip Distance	= 2 x w.t. x Tan(θ)
Period	= 1 / F
Pulse Interval	= 1 / Pulse Repetition Rate
Circumference of Circle	= ∏ x Diameter
Pythagorean Theorem	$a^2 + b^2 = c^2$
Distance	V x Time
Inches to Millimeters	Multiply times 25.4

Symbols

F	Frequency
λ	Wavelength
D	Diameter
θ	Angle
dB	Decibels
A	Amplitude
ρ	Density
V	Velocity
Z	Impedance
w.t.	Wall Thickness
a, b, c	Side lengths of triangle

Ultrasonic Pneumonic Aid

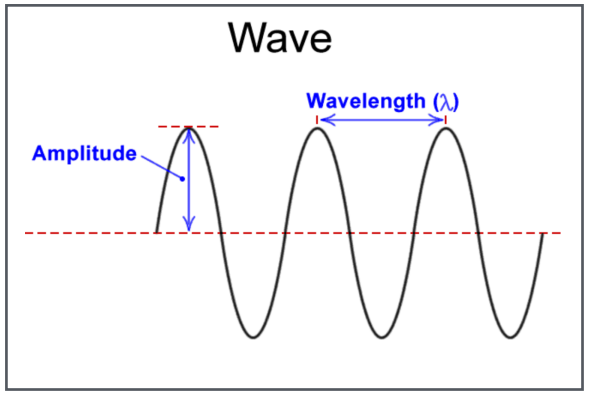
⬆️	**F**	Frequency
⬇️	**P**	Penetration
⬆️	**A**	Attenuation
⬇️	**D**	Divergence
⬆️	**S**	Sensitivity
⬇️	**C**	Crystal Thickness
⬆️	**R**	Resolution
⬇️	**Y**	Wavelength
⬆️	**N**	Near Field Distance

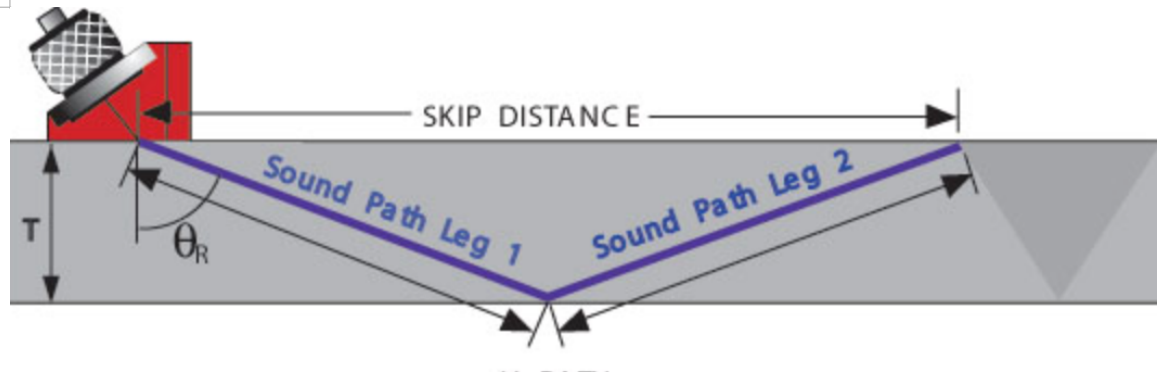
SI Units

Mega	10^6	1000000
Kilo	10^3	1000
Centi	10^1	10
1	1	1
milli	10^{-3}	0.001

Beam Spread Constants

K	dB
1.22	0
1.09	-20
0.93	-12
0.87	-10
0.7	-6
0.51	-3





Acoustic Properties Of Materials

Material	Ultrasonic Velocity				Impedance
	Longitudinal (Compression)		Transverse (Shear)		
	mm/us	in/us	mm/us	in/us	Z
METALS					
Aluminium 1100-0	6.229	0.248	3.073	0.121	17.1
Aluminium 2024-T4	6.375	0.251	3.15	0.124	17.6
Aluminium 6061-T6	6.299	0.248	3.15	0.124	17
Beryllium	12.878	0.507	8.89	0.35	23.5
Brass	4.369	0.172	2.108	0.083	37.1
Bronze	3.531	0.139	2.235	0.088	31.3
Copper	4.75	0.187	2.337	0.092	42.5
Gold	3.251	0.128	1.194	0.047	62.6
Inconel	7.823	0.308	3.023	0.119	64.5
Iron - Cast	3.505-5.588	0.138-0.220	2.210-3.200	0.087-0.126	24.3-41.2
Lead	2.159	0.085	0.813	0.032	23.5
Magnesium	5.461-5.791	0.215-0.228	3.023-3.099	0.119-0.122	9.24-10.6
Monel	5.359	0.211	2.718	0.107	47.2
Nickel	5.639	0.222	2.972	0.117	50
Silver	3.607	0.142	1.6	0.063	37.8
Steel	5.93	0.233	3.251	0.128	45.4
Titanium	6.172	0.243	3.302	0.13	27.3
Zircaloy	4.724	0.186	2.362	0.093	44.2
Zirconium	4.648	0.183	2.261	0.089	30.1
POLYMERS					
Acrylics	2.667-2.769	0.105-0.109	1.118-1.448	0.044-0.057	3.15-3.51
Cellulose Acetate	2.438	0.096			3.19
Nylon	2.692	0.016			

Material	Ultrasonic Velocity				Impedance
	Longitudinal (Compression)		Transverse (Shear)		
	mm/us	in/us	mm/us	in/us	Z
Phenolic	1.422	0.056			1.9
Polycarbonate	2.286	0.09			2.71
Polyethylene	2.667	0.105			2.94
Polystyrene	2.388	0.094	1.143	0.045	2.52
Rubber	1.549	0.061			1.74
Silicone	0.94	0.037			1.4
Teflon	1.372	0.054	6.35	0.25	3
COMPOSITES					
Fiberglass	3.15	0.124	1.727	0.068	6.04
Graphite/Epoxy	2.972	0.117	1.956	0.077	4.65
Boron/Epoxy	3.327	0.131	1.829	0.072	6.38
OTHER SOLIDS					
Alumina (Al_2O_3)	10.846	0.427			43.1
Concrete	4.242-5.258	0.167-0.207	3.429	0.135	12.4
Glass	5.766	0.227			14.5
Granite	3.962	0.156	1.93	0.076	10.9
Tungsten Carbide	6.655	0.262			67.6
LIQUIDS					
Ethylene Glycol	1.626	0.064			1.8
Glycerin	1.93	0.076			2.42
Oil	1.753	0.069			1.51
Water	1.473	0.058			1.48
Gases					
Air	0.356	0.014			0.00041