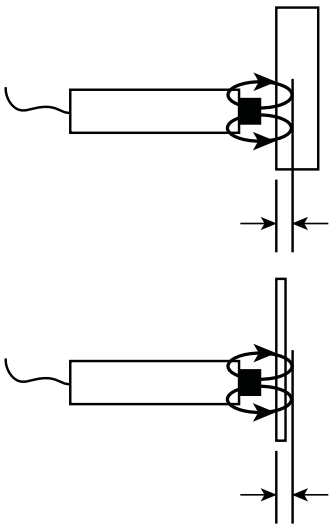
Minimum Recommended Target Thickness



Applicable Equipment:

Eddy-Current displacement measurement systems.

Applications:

Eddy-Current measurements using thin target materials.

Summary:

An Eddy-Current sensor's field penetrates the target to a certain depth; therefore, there is a minimum target thickness for optimal results. This document lists the minimum thicknesses of many common materials and discusses the determining factors and calculation of minimum thickness.

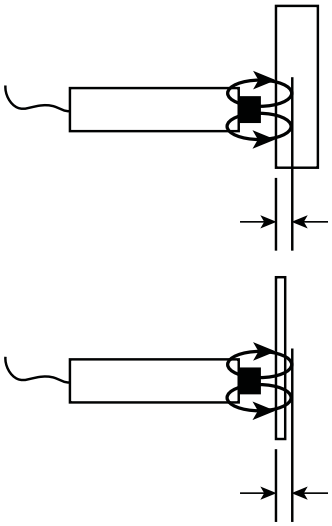


Figure 1. Penetration of magnetic field into target material.

Minimum Recommended Target Thickness:

Field Penetration

Eddy-current sensing requires a minimum target thickness to allow sufficient penetration of the probe's electromagnetic field (fig. 1). The depth of penetration is determined by three factors:

- Eddy-current probe excitation frequency,
- target material electrical resistivity, and
- target material magnetic permeability.

Lion Precision eddy-current sensors' excitation frequencies are dependent on the material, the probe size, and the range. Excitation frequencies range from 0.5MHz to 1.25MHz. Details on next page.

Calculating Minimum Thickness

Minimum target thickness is three times the target material's "skin-depth."

Skin-depth (δ):

$$\delta = 1.98[\rho/(f\mu_r)]^{1/2} \text{ inches}$$

$$\delta = 50.3[\rho/(f\mu_r)]^{1/2} \text{ mm}$$

$$\text{minimum target thickness} = 3\delta$$

where:

ρ= material electrical resistivity, μ-ohm - cm

f = oscillation frequency, hertz

μ_r = material magnetic permeability

Field density decreases exponentially with depth (1/e). At three skin-depths eddy current density is about 5% of the surface density. Three skin-depths is the minimum target thickness suitable for optimum performance.

Exceptions

With proper system calibration and application, a target thickness less than three skin-depths might be measured effectively. Contact Lion Precision for details and testing.

See next page for detailed list of minimum thicknesses.

Minimum Thickness of Sample Materials:

Nonferrous Materials					
				Minimum Thickness	
Material	ρ	μ_r	Probe (fMHz)	mm	mils
Silver	1.59	1	U3 to U8 (1.0)	0.19	7.5
			U12 to U50 (0.5)	0.27	10.6
Copper	1.71	1	U3 to U8 (1.0)	0.20	7.8
			U12 to U50 (0.5)	0.28	11.0
Gold	2.21	1	U3 to U8 (1.0)	0.22	8.8
			U12 to U50 (0.5)	0.32	12.5
Aluminum	2.65	1	U3 to U8 (1.0)	0.25	9.7
			U12 to U50 (0.5)	0.35	13.7
Zinc	5.97	1	U3 to U8 (1.0)	0.37	14.5
			U12 to U50 (0.5)	0.52	20.5
304 SST	72	1.01	U3 to U8 (1.0)	1.27	50.2
			U12 to U50 (0.5)	1.80	70.9
Lead	20.8	1	U3 to U8 (1.0)	0.69	27.1
			U12 to U50 (0.5)	0.97	38.3
Brass	6.4	1	U3 to U8 (1.0)	0.38	15.0
			U12 to U50 (0.5)	0.54	21.3
Tin	11.5	1	U3 to U8 (1.0)	0.51	20.1
			U12 to U50 (0.5)	0.72	28.5
Titanium	47	1	U3 to U8 (1.0)	1.03	40.7
			U12 to U50 (0.5)	1.46	57.6
Ferrous & Magnetic Materials					
				Minimum Thickness	
Material	ρ	μ_r	Probe (fMHz)	mm	mils
Nickel	6.4	1240	U3 (1.25)	0.01	0.4
			U5 (1.5)	0.01	0.3
			U8 (1.0)	0.01	0.4
			U12 to U50 (0.5)	0.02	0.6
416 SST	57	700	U3 (1.25)	0.04	1.5
			U5 (1.5)	0.04	1.4
			U8 (1.0)	0.04	1.7
			U12 to U50 (0.5)	0.06	2.4
Iron	11	100	U3 (1.25)	0.04	1.8
			U5 (1.5)	0.04	1.6
			U8 (1.0)	0.05	2.0
			U12 to U50 (0.5)	0.07	2.8