Flex-Coils™

Telemetry coils with integrated flex circuits for critical communication

Flex-Coils™

Overview

• Antenna coils and circuitry in one component

• Hi-rel, high density electronic packaging

• Qualified for medical, MIL, aerospace use

• Rugged laminated construction

Flex-Coils are flexible printed circuits containing integral inductive coils. They result from Minco's unique combination of etching and wire-winding expertise. By uniting pickup coils and associated circuitry in one component, Flex-Coils improve reliability, simplify assembly, and allow more compact package design.

Specify Flex-Coils whenever a critical electronic assembly requires an inductive coil. For example, implanted cardiac pacemakers commonly contain Minco Flex-Coils, allowing doctors to reprogram functions through the skin. Other coils pick up control signals in drug pumps. Non-destructive pipe testers rely on Flex-Coils to detect eddy currents and pinpoint hidden flaws.

A common factor in these applications is size limitation. Because Flex-Coils are wound in a plane, they are much thinner than bobbin-wound coils. This allows miniaturization of medical devices, and flexing of long coils to fit pipe curves.

Despite their compact size, Flex-Coils are more rugged than open windings. Coils, conductors, and the connections between them are laminated between polyimide or PTFE layers for protection against environmental exposure and abrasion. Damage to fragile wires during installation and in use is nearly impossible. This means that critical devices like pacemakers need less reliability testing after assembly.

Flex-Coils are repeatable. Because conductors are photo-etched, circuits fit only one way and wiring errors are virtually eliminated. And coils maintain a precise orientation for tight control of inductance.

Consider Flex-Coils to be complete three-dimensional packaging solutions. Minco can supply them with stiffeners for component insertion, pins, or connectors. All you need to do is mount components, solder, fold to fit the geometry of your package, and plug the circuit into other electronic modules. In many medical implants, all circuitry is mounted on a single Minco Flex-Coil.

Minco is certified to ISO 9001:2000 / AS9100B. Our quality assurance program meets MIL-Q-9858, NHB5300.4 (1B), and FDA Regulation Part 820: Good Manufacturing Practice for Medical Devices. We specialize in conformance to demanding specifications.

Specifications

In general, you may incorporate a coil into any flex circuit design. Minco's circuit manufacturing capabilities are as follows:

Number of layers: Single layer, double layer with plated through-holes, multilayer, or rigid-flex.

Materials: Insulation: polyimide film or FEP PTFE and rigid materials.

Conductors: 1/2 oz., 1 oz., 2 oz., or 3 oz. copper; 0.000625", and 0.0026" cupronickel.

Termination: Through-holes, plated pads, connectors, pins, eyelets, or fingers.

Maximum size: 1 or 2-layer: 24" x 72" (610 x 1830mm).

Multilayer: 10" x 16" (254 x 406mm).

See TechSpec FC302 – Flex-Circuit Design Guide for more information about flex circuits.

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Coil Dimensions

Maximum outside dimension: Round: 4.50" (114mm) max. diameter (O).

Rectangular: 4.50" (114) max L; up to 5.0" (127mm) for coils less than 2.0" (51mm) W.

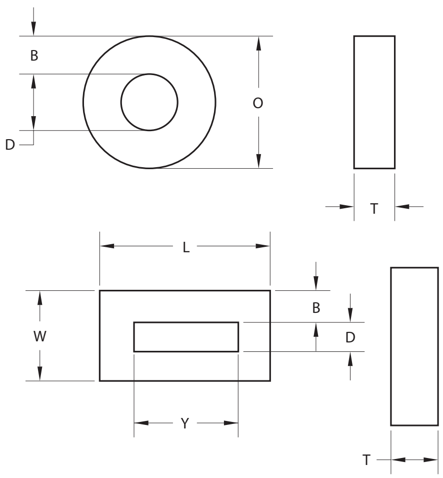
Minimum center opening: Round: 0.04" (1,0mm) min. D.

Rectangular: 0.18" (4,6mm) min. D; down to 0.005" (0,13mm) D if length Y is greater than 0.50" (13mm).

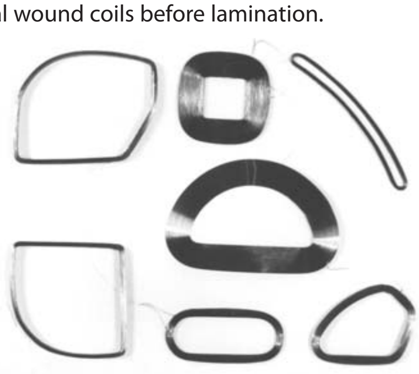
Maximum thickness: 0.04" (1,0mm) max. T for laminated coils insulated with polyimide; 0.07" (1,8mm) max. T for FEP Teflon. Thicker coils may be laminated, but require rigid spacers in the center and around the edges of the coil. Typical spacer material is epoxy glass. Coils may be wound to a thickness (T) of 3.0" (76mm) but not laminated. Such coils are typically insulated with an epoxy or silicone coil impregnant. Minco can attach laminated flex circuit subassemblies to these freestanding coils for interconnection.

Minimum thickness: Coil thickness: 0.005" (0,13mm) min.

Overall circuit thickness: 0.009" (0,23mm) T, except where the inner turn crosses over the coil to the outer edge. Add 0.003" (0,08mm) min. to the total thickness at the crossover area.



Coil shape: Coils may have round, rectangular, oval or irregular shapes. Coils with reverse radius of curvature (banana shaped) must be formed after winding, so their B dimension must be thin enough to be bent without straining wires. Shown below are typical wound coils before lamination.



Physical Specifications

Temperature range: -200 to 100°C for most laminated coils fabricated with wire insulated with solderable material. -200 to 150°C for coils wound with polyimide insulated wire.

Chemical resistance: Will withstand most organic solvents. No detrimental loss of physical properties when immersed for 15 minutes in acetone, methyl alcohol, toluene, or trichloroethylene.

Handling: Laminated coils can withstand rough handling with no damage. The wires are protected by tough, abrasion-resistant polyimide or FEP PTFE films. Other insulating materials such as glass-reinforced epoxies may be used.

Electrical Characteristics

Wire size: AWG 50 to AWG 30 for wound, laminated coils; larger for unsupported coils.

Inductance: Typical air core inductance values range from 10 microhenries to 30 millihenries depending on size, number of turns, and coil configuration.

Inductance tolerance: ± 5% standard; ±1% available at extra cost

Resistance tolerance: ±10%

Calculating Coil Inductance vs Size

The formulas below will help you determine inductance and resistance for a given coil size. Note that the formulas only yield approximate values; Minco must usually wind sample coils and determine inductance empirically before final specifications are established. If your design sets limits on inductance, size, and resistance, you may have to calculate values for several wire sizes in order to satisfy all constraints.

All dimensions must be in inches for the given formulas. Inductance from coil size and number of turns:

Inductance from coil size and number of turns:

Round coils: $I = \dfrac{0.8(RN)^2}{6R + 9T + 10B}$, Where

I = inductance in microhenries,

N = number of turns,

R = the mean radius = $\dfrac{(D + B)}{2}$, and

T = thickness (see drawing).

Rectangular coils: $I = \dfrac{0.07(CN)^2}{1.908C + 9T + 10B}$, Where

I = inductance in microhenries,

N = number of turns,

C = half the rectangular mean perimeter = $D + Y + 2B$

Number of turns from size and inductance:

Round coils: $N = \frac{\sqrt{5I(6R + 9T + 10B)}}{2R}$

Rectangular coils: $N = \frac{\sqrt{14.3I(1.908C) + 9T + 10B}}{C}$

Wire size from coil size and number of turns:

The formula below yields approximate wire size in circular mils. Look up this size in the table below to determine the AWG number.

$S = 64{,}000 \frac{(BT)}{N}$

S = wire size in circular mils

Coil resistance:

After determining wire gauge, use ohms/ft. for that gauge in the proper formula below to determine total coil resistance.

Round coils: $R_t = \frac{\pi RN R_w}{6}$, Where

R = mean radius,

N = number of turns, and

Rw = wire resistance from table below

Rectangular coils: $R_t = \frac{CNR_w}{6}$, Where

C = half the rectangular mean perimeter,

N = Number of turns, and

Rw = wire resistance from table below

AWG No.	Circular mils (S)	W/ft. At 20°C (Rw)
30	100	.104
31	79.2	.131
32	64.0	.162
33	50.4	.206
34	39.7	.261
35	31.4	.331
36	25.0	.415
37	20.2	.512
38	16.0	.648
39	12.9	.847
40	9.61	1.080
41	7.84	1.320
42	6.25	1.660
43	4.84	2.140
44	4.00	2.590
45	3.10	3.350
46	2.46	4.210
47	1.96	5.290
48	1.54	6.750
49	1.23	8.420
50	.980	10.600

Coil Worksheet

What inductance is required? ______________________________

What electrical resistance is required? ____________________

Other electrical requirements (Q, ring, etc.): ________________

What are the maximum outer dimensions and minimum inner dimensions of the coil? __________________________________

What is the maximum thickness? _______________________

Sketch coil shape in the graph space provided below.

What lead or termination is desired (through hole, surface mount, wires, pins, etc.)? ______________________________

Are there special considerations (aggressive chemicals, high temperatures, or mechanical stresses) during or after installation? ____

Quantity you would like us to quote (prototype and production series): ____

Additional notes: ____

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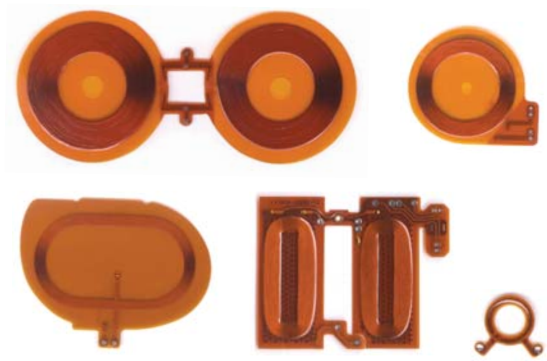
Coil Types



Wire-wound flat coils

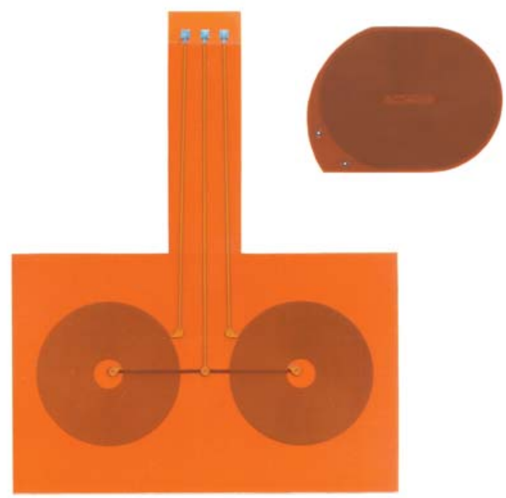
Used in pacemakers, defibrillators, drug pumps, hearing aids, systems for nerve stimulation, gyroscopes, oil well drilling equipment, and pipe inspection equipment. Combining a wound coil with flex circuit technology gives you the design flexibility to include added components or special connectors. The compact design can utilize available space better than discrete components. Reducing parts count with rugged polyimide laminated construction cuts your assembly time and minimizes lost or damaged components in your processing.

Non-laminated wire-wound coils with flex tabs

Low cost alternative to laminated coils. Used when cost is a factor and when the part will be covered by the end user.

Wire-wound rim coils

Commonly used as antenna coils in pacemakers and defibrillators. Use when space is limited to that available around the perimeter of a device or component.



Etched coils

Used when overall part thickness must be less than 0.009". This construction provides improved flexibility and durability at low cost, but allows fewer turns and lower inductance in a given area.

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