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DIRECT

Electronics Tech.

(TRAL)

Thin-Film RF Inductors

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▶ Product Introduction**Chip Thin-Film RF Inductors****Provide Small-Format Protection.****Features :**

- A Photo Lithographic Single Layer Ceramic Chip.
- High SRF, Excellent Q, Superior Temperature Stability.
- Self Resonant Frequency Controlled within 10%.
- Stable Inductance in High Frequency Circuit.
- Highly Stable Design for Critical Needs.
- Tight Tolerance of $\pm 1\%$ or $\pm 0.1\text{nH}$.

Applications :

- Cellular Telephone, Pagers and GPS Products.
- VCO, TCXO Circuit and RF Transceiver Module.
- Wireless LAN, Bluetooth Module.
- Communication Appliances.

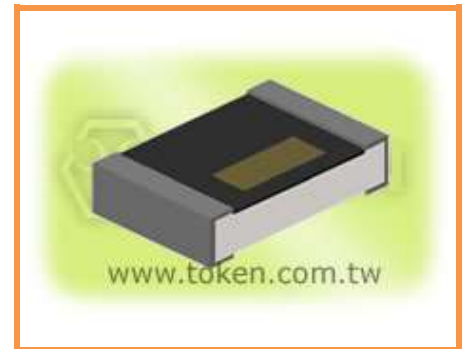
Direct (TRAL) chip inductors provide reliable protection against challenging EMI problems in high frequency filtering applications. This miniature wire wound inductor features a low seated height that stands only 0.23mm above the circuit board. It protects sensitive electronic circuitry and ensures high performance operation in a wide range of compact devices that are shrinking ever smaller in physical size.

Direct (TRAL) series uses a thin-film technology for high reliability and precision tolerances to 1% or $\pm 0.1\text{nH}$. The (TRAL) thin-film inductor series is available in 0603, 0402, and 0201 sizes, in inductance values from 0.1 to 100nH, in tolerances down to 0.1nH or 1%, and with SRF (self-resonant frequency) tightly controlled.

The technology characteristics make it ideal for the latest cellphone and PDA applications in addition to wireless network and Bluetooth enabled devices.

Application of specific designs also available including different inductance values and Q specifications adjusted to frequency requirements. Customized designs and tighter tolerances are available on request. Thin Film Inductor is mounted in a surface mount package which assures mechanical stability, excellent lead planarity, and suitable for automatic pick and place equipment.

The (TRAL) series is lead-free and RoHS compliant. Detailed specifications, both mechanical and electrical, please contact Direct sales representative or link to Direct official website "[RF Inductors](#)" for more information.



► **Config. & Dim.**

Configurations & Dimensions (Unit: mm) (TRAL)

Codes	A	B	C	D
TRAL01 (0201)	0.6 ± 0.05	0.3 ± 0.05	0.23 ± 0.05	0.15 ± 0.05
TRAL02 (0402)	1.0 ± 0.05	0.5 ± 0.05	0.32 ± 0.05	0.2 ± 0.10
TRAL03 (0603)	1.6 ± 0.10	0.8 ± 0.10	0.45 ± 0.10	0.3 ± 0.20

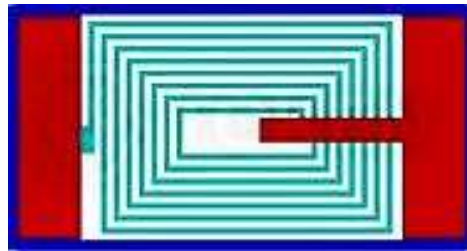
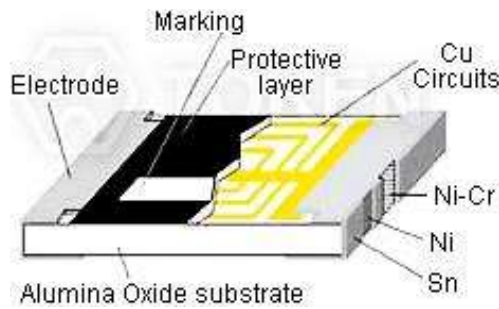
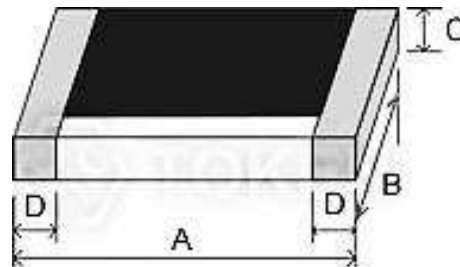


Photo Lithographic Pattern



Material Construction



(TRAL) Dimensions (Unit: mm)

Standard Electrical Specifications

Standard Electrical Specifications (TRAL) - EIA 0201

Part No.	Inductance (nH)	Tolerance (% or nH)	Q (min)	DCR (Ω)(max)	IDC (mA)(max)	SRF (GHz)(min)
TRAL01*TR0N1	0.1	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.20	400	9
TRAL01*TR0N2	0.2	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.20	400	9
TRAL01*TR0N3	0.3	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.20	400	9
TRAL01*TR0N4	0.4	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.25	350	9
TRAL01*TR0N5	0.5	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.25	350	9
TRAL01*TR0N6	0.6	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.25	350	9
TRAL01*TR0N7	0.7	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.30	300	9
TRAL01*TR0N8	0.8	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.30	300	9
TRAL01*TR0N9	0.9	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.30	300	9
TRAL01*TR1N0	1.0	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.30	300	9
TRAL01*TR1N1	1.1	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.35	300	9
TRAL01*TR1N2	1.2	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.35	300	9
TRAL01*TR1N3	1.3	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.45	250	9
TRAL01*TR1N4	1.4	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.45	250	9
TRAL01*TR1N5	1.5	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.45	250	9
TRAL01*TR1N6	1.6	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.55	200	9
TRAL01*TR1N7	1.7	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.55	200	9
TRAL01*TR1N8	1.8	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.55	200	9
TRAL01*TR1N9	1.9	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.55	200	9
TRAL01*TR2N0	2.0	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.70	200	8
TRAL01*TR2N1	2.1	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.70	200	8
TRAL01*TR2N2	2.2	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.70	200	8
TRAL01*TR2N3	2.3	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.80	150	8
TRAL01*TR2N4	2.4	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.80	150	8
TRAL01*TR2N5	2.5	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.80	150	8
TRAL01*TR2N6	2.6	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.80	150	8
TRAL01*TR2N7	2.7	± 0.1, 0.2, 0.3nH	8 / 500MHz	0.80	150	8
TRAL01*TR2N8	2.8	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR2N9	2.9	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR3N0	3.0	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR3N1	3.1	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR3N2	3.2	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR3N3	3.3	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.00	150	6
TRAL01*TR3N4	3.4	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR3N5	3.5	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR3N6	3.6	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR3N7	3.7	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR3N8	3.8	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR3N9	3.9	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR4N0	4.0	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.20	150	6
TRAL01*TR4N4	4.4	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.30	140	6
TRAL01*TR4N7	4.7	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.40	130	6
TRAL01*TR4N9	4.9	± 0.1, 0.2, 0.3nH	8 / 500MHz	1.60	130	6
TRAL01*TR5N6	5.6	± 2, ± 5%	8 / 500MHz	1.80	130	4
TRAL01*TR6N1	6.1	± 2, ± 5%	8 / 500MHz	2.00	120	4
TRAL01*TR6N8	6.8	± 2, ± 5%	8 / 500MHz	2.30	110	4
TRAL01*TR7N4	7.4	± 2, ± 5%	8 / 500MHz	2.80	110	4
TRAL01*TR8N2	8.2	± 2, ± 5%	8 / 500MHz	3.00	110	3
TRAL01*TR9N1	9.1	± 2, ± 5%	8 / 500MHz	3.25	100	3
TRAL01*TR9N2	9.2	± 2, ± 5%	8 / 500MHz	3.25	100	3
TRAL01*TR10N	10	± 2, ± 5%	8 / 500MHz	3.50	80	2

● Direct is capable of manufacturing the optional spec based on customer's requirement.



Standard Electrical Specifications (TRAL) - EIA 0402

Part No.	Inductance (nH)	Tolerance (% or nH)	Q (min)	DCR (Ω)(max)	IDC (mA)(max)	SRF (GHz)(min)
TRAL02*TR0N2	0.2	0.1/0.2/0.3(nH)	13 / 500MHz	0.10	800	14
TRAL02*TR0N4	0.4	0.1/0.2/0.3(nH)	13 / 500MHz	0.10	800	14
TRAL02*TR0N8	0.8	0.1/0.2/0.3(nH)	13 / 500MHz	0.15	700	14
TRAL02*TR1N0	1.0	0.1/0.2/0.3(nH)	13 / 500MHz	0.15	700	12
TRAL02*TR1N2	1.2	0.1/0.2/0.3(nH)	13 / 500MHz	0.15	700	12
TRAL02*TR1N5	1.5	0.1/0.2/0.3(nH)	13 / 500MHz	0.25	700	10
TRAL02*TR1N6	1.6	0.1/0.2/0.3(nH)	13 / 500MHz	0.25	560	10
TRAL02*TR1N8	1.8	0.1/0.2/0.3(nH)	13 / 500MHz	0.25	560	10
TRAL02*TR2N0	2.0	0.1/0.2/0.3(nH)	13 / 500MHz	0.35	560	8
TRAL02*TR2N2	2.2	0.1/0.2/0.3(nH)	13 / 500MHz	0.35	440	8
TRAL02*TR2N7	2.7	0.1/0.2/0.3(nH)	13 / 500MHz	0.35	440	8
TRAL02*TR3N1	3.1	0.1/0.2/0.3(nH)	13 / 500MHz	0.45	380	6
TRAL02*TR3N3	3.3	0.1/0.2/0.3(nH)	13 / 500MHz	0.45	380	6
TRAL02*TR3N6	3.6	0.1/0.2/0.3(nH)	13 / 500MHz	0.55	380	6
TRAL02*TR3N9	3.9	0.1/0.2/0.3(nH)	13 / 500MHz	0.55	340	6
TRAL02*TR4N7	4.7	0.1/0.2/0.3(nH)	13 / 500MHz	0.65	320	6
TRAL02*TR5N6	5.6	0.1/0.2/0.3(nH)	13 / 500MHz	0.85	280	6
TRAL02*TR5N9	5.9	0.1/0.2/0.3(nH)	13 / 500MHz	0.85	280	6
TRAL02*TR6N8	6.8	0.1/0.2/0.3(nH)	13 / 500MHz	1.05	260	6
TRAL02*TR7N2	7.2	0.1/0.2/0.3(nH)	13 / 500MHz	1.05	260	6
TRAL02*TR8N0	8.0	0.1/0.2/0.3(nH)	13 / 500MHz	1.25	220	5.5
TRAL02*TR8N2	8.2	0.1/0.2/0.3(nH)	13 / 500MHz	1.25	220	5.5
TRAL02*TR9N1	9.1	0.1/0.2/0.3(nH)	13 / 500MHz	1.25	220	5.5
TRAL02*TR10N	10	1/2/3/5(%)	13 / 500MHz	1.35	200	4.5
TRAL02*TR12N	12	1/2/3/5(%)	13 / 500MHz	1.55	180	3.7
TRAL02*TR13N8	13.8	1/2/3/5(%)	13 / 500MHz	1.75	180	3.7
TRAL02*TR15N	15	1/2/3/5(%)	13 / 500MHz	1.75	130	3.3
TRAL02*TR17N	17	1/2/3/5(%)	13 / 500MHz	1.95	100	3.1
TRAL02*TR18N	18	1/2/3/5(%)	13 / 500MHz	2.15	100	3.1
TRAL02*TR20N8	20.8	1/2/3/5(%)	13 / 500MHz	2.55	90	2.8
TRAL02*TR22N	22	1/2/3/5(%)	13 / 500MHz	2.65	90	2.8
TRAL02*TR27N	27	1/2/3/5(%)	13 / 500MHz	3.25	75	2.5
TRAL02*TR33N	33	1/2/3/5(%)	13 / 500MHz	3.75	75	2.5

● Direct is capable of manufacturing the optional spec based on customer's requirement.



Standard Electrical Specifications (TRAL) - EIA 0603

Part No.	Inductance (nH)	Tolerance (% or nH)	Q (min)	DCR (Ω)(max)	IDC (mA)(max)	SRF (GHz)(min)
TRAL03*TR1N0	1.0	0.1/0.2/0.3(nH)	15 / 300MHz	0.35	800	13
TRAL03*TR1N2	1.2	0.1/0.2/0.3(nH)	15 / 300MHz	0.35	800	13
TRAL03*TR1N5	1.5	0.1/0.2/0.3(nH)	15 / 300MHz	0.35	800	10
TRAL03*TR1N8	1.8	0.1/0.2/0.3(nH)	15 / 300MHz	0.35	300	10
TRAL03*TR2N2	2.2	0.1/0.2/0.3(nH)	15 / 300MHz	0.35	300	8
TRAL03*TR2N7	2.7	0.1/0.2/0.3(nH)	15 / 300MHz	0.45	300	6
TRAL03*TR3N3	3.3	0.1/0.2/0.3(nH)	15 / 300MHz	0.45	300	6
TRAL03*TR3N9	3.9	0.1/0.2/0.3(nH)	15 / 300MHz	0.45	300	6
TRAL03*TR4N7	4.7	0.1/0.2/0.3(nH)	15 / 300MHz	0.55	300	5
TRAL03*TR5N6	5.6	0.1/0.2/0.3(nH)	15 / 300MHz	0.65	300	5
TRAL03*TR6N8	6.8	0.1/0.2/0.3(nH)	15 / 300MHz	0.75	300	5
TRAL03*TR8N2	8.2	0.1/0.2/0.3(nH)	15 / 300MHz	0.95	300	4
TRAL03*TR10N	10	1/2/3/5(%)	15 / 300MHz	0.95	300	4
TRAL03*TR12N	12	1/2/3/5(%)	15 / 300MHz	1.05	300	3
TRAL03*TR15N	15	1/2/3/5(%)	15 / 300MHz	1.35	300	3
TRAL03*TR18N	18	1/2/3/5(%)	15 / 300MHz	1.65	300	2
TRAL03*TR22N	22	1/2/3/5(%)	15 / 300MHz	1.95	250	2
TRAL03*TR27N	27	1/2/3/5(%)	15 / 300MHz	2.35	250	2
TRAL03*TR33N	33	1/2/3/5(%)	15 / 300MHz	2.75	250	1.5
TRAL03*TR39N	39	1/2/3/5(%)	15 / 300MHz	3.00	200	1.5
TRAL03*TR47N	47	1/2/3/5(%)	15 / 300MHz	3.00	200	1.5
TRAL03*TR56N	56	1/2/3/5(%)	15 / 300MHz	5.00	150	1
TRAL03*TR68N	68	1/2/3/5(%)	15 / 300MHz	5.00	150	1
TRAL03*TRR10	100	1/2/3/5(%)	15 / 300MHz	7.50	100	1

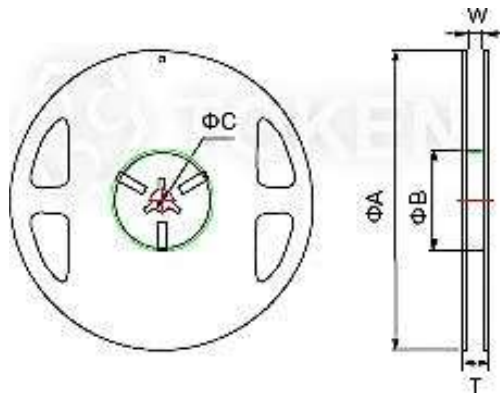
● Direct is capable of manufacturing the optional spec based on customer's requirement.



► **Reel & Packaging**

Reel & Packaging Quantity (Unit: mm) (TRAL)

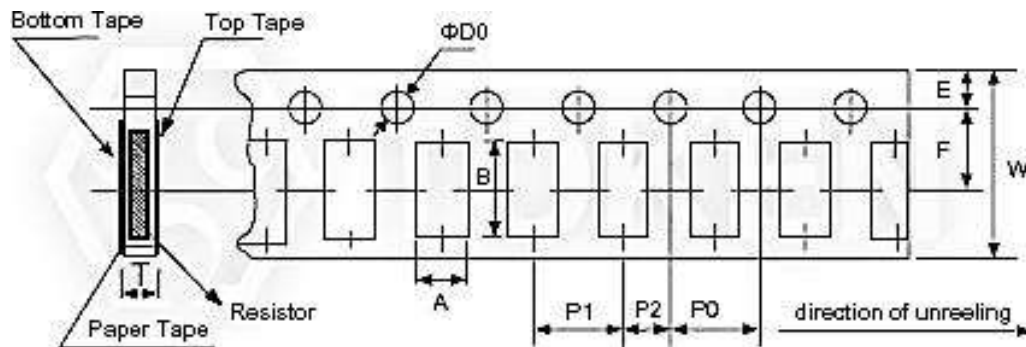
Codes	ΦA	ΦB	ΦC	W	T	Paper Tape (PCS)
TRAL01	178.0 ± 1.0	60 ± 1.0	13.5 ± 0.7	9.5 ± 1.0	11.5 ± 1.0	10,000
TRAL02	178.0 ± 1.0	60 ± 1.0	13.5 ± 0.7	9.5 ± 1.0	11.5 ± 1.0	10,000
TRAL03	178.0 ± 1.0	60 ± 1.0	13.5 ± 0.7	9.5 ± 1.0	11.5 ± 1.0	5,000



Reel Dimensions (Unit: mm)

Paper Tape (Unit: mm) (TRAL)

Codes	A±0.05	B±0.05	W±0.10	E±0.05	F±0.05	P0±0.10	P1	P2±0.05	ΦD0	T
TRAL01	0.40	0.70	8.00	1.75	3.5	4.00	2.00±0.05	2.00	1.55±0.03	0.42±0.02
TRAL02	0.70	1.16	8.00	1.75	3.5	4.00	2.00±0.05	2.00	1.55±0.05	0.40±0.03
TRAL03	1.10	1.90	8.00	1.75	3.5	4.00	4.00±0.10	2.00	1.55±0.05	0.60±0.03



Paper Tape Specifications (Unit: mm)

▶ Environ. Characteristics

Environmental Characteristics (TRAL)

Item	Specification	Test Method
Bending Test	As SPEC.	JIS-C-5202-6.1.4 Bending Amplitude 3mm for 10 seconds
Dielectric Withstand Voltage	>100V	MIL-STD-202F Method 301 Apply 100VA (rms) for 1minute.
Insulation Resistance	>1000MΩ	MIL-STD-202F Method 302 Apply 100VDC for 1minute.
Resistance to Soldering Heat	$\Delta L \leq 10\%$	MIL-STD-202F Method 210E 260±5°C, 10 seconds
High Temperature Exposure	$\Delta L \leq 10\%$	JIS-C-5202-7.2 85±2°C, 1000 +48/-0 hours
Moisture Resistance	$\Delta L \leq 10\%$	MIL-STD-202F Method 103B 40±2°C, 90~95%RH, 1000 +48/-0 hours
Low Temperature Storage	$\Delta L \leq 10\%$	JIS-C-5202-7.1 -40±3°C, 1000 +48/-0 hours
Temperature Cycle	$\Delta L \leq 10\%$	JIS-C-5202-7.4 -40/RT/85/RT, 10 cycles
Solderability	95% min coverage	MIL-STD-202F Method 208H 245±5°C, for 3 seconds

● Note: Storage Temperature: 25±3°C; Humidity: <80%RH. **Order Codes**

Order Codes (TRAL)

TRAL	02			G		TR		10N	
Part Number	Dimensions (L×W) (mm)			Inductance Tolerance (%) or (nH)		Package		Inductance	
TRAL01	01	0.60×0.30mm	EIA0201	J	5%	TR	Taping Reel	1N0	1.0nH
TRAL02	02	1.00×0.50mm	EIA0402	H	±3%			10N	10nH
TRAL03	03	1.60×0.80mm	EIA0603	G	±2%			20N8	20.8nH
				F	±1%			R10	100nH
				S	±0.3nH				
				C	±0.2nH				
				B	±0.1nH				



► General Information

Direct Cuts Inductor Size and Cost

Direct utilizes the latest technology enabling the most cost-effective designs in manufacturing inductors. The 0402, 0603, 0805, 1206, 1210, to 1812 series of RF Miniature Inductors all contain wire wound or multi-layer technology with material substrate in ceramic or ferrite cores. Thus providing economic cost with the ultimate performance demanded by today's RF applications. Inductors feature high Q factor, SRFs (self-resonant or series resonant frequency), and I_{dc} (maximum current carrying capacity).

How to quickly search RF inductors for all of the characteristics?

Searching and comparing data sheets of inductor manufacturers can be time consuming. Direct's Parameter Sorting Search Mode allows selection of inductors based on different parameters. To enter Searching Mode:

- By entering just the inductance value,
- By sorting parameter to narrow down searching range,
- Or by enter keyword / part number / size dimensions L*W*H to partial or exact searching.

Inductors Selection Notes:

For choke applications, the SRFs (self-resonant or series resonant frequency) is the frequency that provides the best signal blocking.

- At the SRF, impedance is at its maximum.
- At frequencies below the SRF, impedance increases with frequency.
- At frequencies above the SRF, impedance decreases with frequency.

For higher order filter or impedance matching applications, in general, the choice of inductance value typically determines the SRF and vice versa. The higher the inductance value, the lower the SRF, due to increased winding capacitance. It is more important to have a relatively flat inductance curve (constant inductance vs. frequency) near the required frequency. This suggests selecting an inductor with an SRF well above the design frequency. A rule of thumb is to select an inductor with an SRF that is a decade (10X) higher than the operating frequency.

What is Q factor? High Q leads to low insertion loss, minimizing power consumption, and narrow bandwidth. It is important if the inductor is to be used as part of an LC (oscillator) circuit or in narrow band pass applications. In general, wire wound inductors have much higher Q values than multilayer inductors of the same size and value. Direct's material science and manufacturing expertise effectively bridges the gap between wire-wound performance and multi-layer inductors with its TRMF100505 (EIA 0402) and TRMI160808 (EIA 0603) series.

How does current requirement affect inductor? Higher current requires larger wire or more threads of the same wire size to keep losses and temperature rise to a minimum. Larger wire lowers the DCR and increases the Q factor. Using a ferrite core inductor with a lower turn count can achieve higher current capacity and lower DCR. Ferrite, however, may introduce new limitations such as larger variation of inductance with temperature, looser tolerances, lower Q, and reduced saturation current ratings. Direct's ferrite inductors with open magnetic structures, will not saturate, even at full rated current.

