



Murata's 0603 HF Chip Coils Cover Wide Inductance Range

The past few years have seen the growing popularity of compact, slim mobile phones. High-end handset models, which are usually multi-functional, come with high-quality picture LCD panels and camera modules. This has led manufacturers to scale down the sizes of the radio frequency (RF) block, and modules including power amplifier and voltage-controlled oscillator (VCO).

Consequently, the sizes of the high-frequency inductors used in mobile phones and modules also need to be scaled down to miniature levels.

To meet this demand for ultra-small high-frequency inductors, Murata Manufacturing Co., Ltd. is mass-producing and supplying the LQP03T film-type 0603-sized (0.6 × 0.3mm) high-frequency chip coil. This product is one of the smallest in the industry.

The company, using its proprietary thick-film micro-processing technology, has designed the LQP03T series to include these features.

Wide Range of Inductance Variation

The LQP03T series offers a full lineup of products with inductance values ranging from 0.6 to 10nH. Products with 0.6 to 3.9nH inductance start mass-production compatibility in 0.1nH steps.



Photo 1: High Q-type chip coil from the LQP03T series

Meanwhile, products with 3.9 to 10nH inductance values are compatible in E-24 steps.

Narrow-Deviation Compatibility

A pattern can be processed with high precision using the thick-film micro-processing technology developed by Murata. The process obtained a narrow-deviation compatibility (Table 1). For products with 0.6 to 3.9nH inductance values, deviation is $\pm 0.1\text{nH}$, while for products with 4.3 to 27nH, deviation is reported as ± 3 percent.

On the other hand, deviation is usually $\pm 0.3\text{nH}$ ($\sim 5.6\text{nH}$)/ ± 5 percent (6.8nH) for a commercially available representative monolithic-type high-frequency chip coil, in which an internal electrode pat-

tern is formed and is accumulated on a ceramic sheet by screen printing.

High Q Levels

The LQP03T series represents a high-frequency chip coil that is produced on a commercial scale.

High Q-Type Chip Coils From the LQP03T Series

A high-frequency chip coil is used for impedance matching and power line high-frequency chokes in the RF circuit of mobile phones and modules. There is a growing need for a high-performance, high frequency chip coil for use in reducing power consumption as well as in scaling down the sizes of electronics to miniature levels.

To satisfy such needs, a chip coil with high Q value is produced on a commercial scale.

External Dimensions

The external view (Photo 1) and the external dimensions (Fig. 1) of the high Q-type chip coil from the LQP03T series are the same as those of the existing LQP03T series.

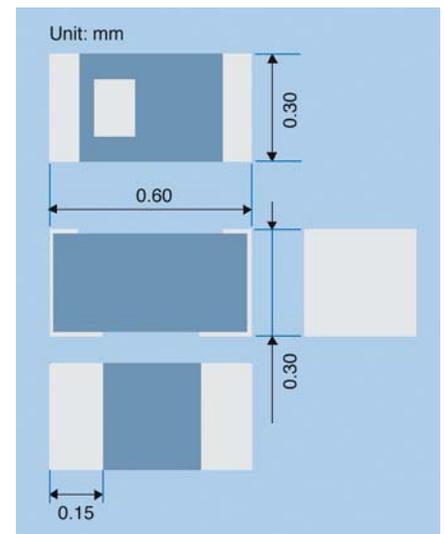


Fig. 1: External dimensions of high Q-type chip coil from the LQP037 series

Table 1: Comparison of deviation values and product lineups

Model no.	Inductance value						
	0.6nH	1.0nH	3.9nH	5.6nH	10nH	27nH	56nH
LQP03T	(Series)	0.1nH steps		E-24	E-12		
	(Deviation)	$\pm 0.1\text{nH}$		$\pm 3\%$		$\pm 5\%$	
Commercially available representative monolithic-type high-frequency inductor	(Series)	E-12 series					
	(Deviation)	$\pm 0.3\text{nH}$			$\pm 5\%$		

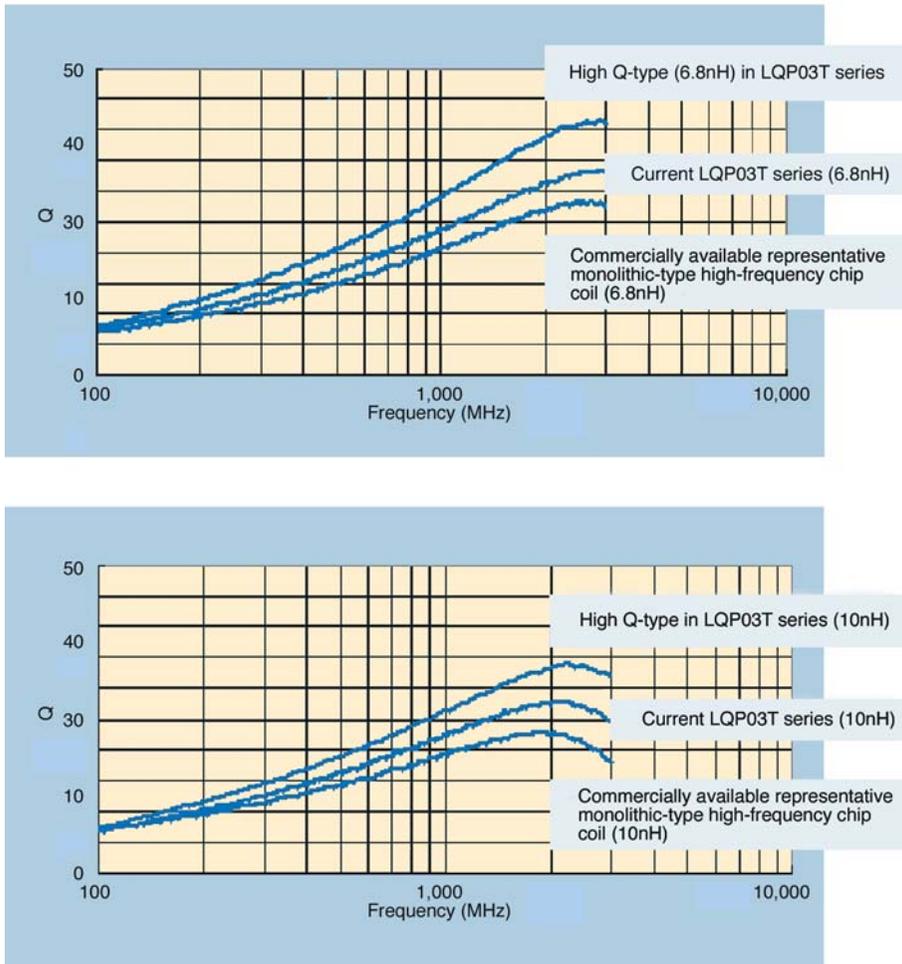


Fig. 2: Comparison of the Q - f characteristics of an LQP037 high Q-type chip coil with those of a representative monolithic-type high-frequency chip coil

Q - f Characteristics

The Q - f characteristics of a high Q-type chip coil from the LQP03T series are compared with the characteristics of a representative monolithic-type high-frequency chip coil (Fig. 2) available in the market.

This demonstrates that LQP03T chip coils can have higher characteristics in the existing series. The present high Q-type chip coils have characteristics that are 15 to 40 percent better.

Rating List

The rating list of this product (Table 2) includes a narrow-deviation compatibility (± 3 percent). In the high Q-type product, the guaranteed Q value (500MHz) can be increased to 13. This value increases 20 percent as compared with the present series.

In the present LQP03T series, a performance equal to that of multilayer 1005-sized ($1.0 \times 0.5\text{mm}$) products is obtained for 4.7nH or less. Therefore, a chip coil with inductance ranging from 5.6 to 10nH is preferred for commercial scale production. This allows the creation of a lineup of products with high Q value for applications (10nH) requiring high Q characteristics for impedance matching.

In the future, Murata will aim to achieve higher Q characteristics for products with inductance lower than 5.6nH.

Table 2: Rating list of high Q-type chip coil from the LQP03T series

Model no.	Inductance			Q		DC resistance (Max.) (Ω)	Self-resonance frequency (Min.) (MHz)	Allowable current (mA)
	Nominal value (nH)	Tolerance	Measurement frequency	min	Measurement frequency			
LQP03TN5N6H	5.6	$\pm 3\%$	500MHz	13	500MHz	0.68	6,000	140
LQP03TN5N6J	5.6	$\pm 5\%$						
LQP03TN6N8H	6.8	$\pm 3\%$				0.75	6,000	130
LQP03TN6N8J	6.8	$\pm 5\%$						
LQP03TN8N2H	8.2	$\pm 3\%$				0.86	5,500	110
LQP03TN8N2J	8.2	$\pm 5\%$						
LQP03TN10NH	10	$\pm 3\%$				1.10	4,500	100
LQP03TN10NJ	10	$\pm 5\%$						

Model no.	Q (typ)				
	800MHz	900MHz	1.8GHz	2.0GHz	2.4GHz
LQP03TN5N6	26	28	36	38	40
LQP03TN6N8	26	28	36	38	40
LQP03TN8N2	26	28	34	36	36
LQP03TN10N	24	25	31	32	31

High Q Technology

The high Q technology used in this high-frequency chip coil has the following characteristics.

Use of thick-film micro-processing technology

In the screen-printing used for a monolithic method, the electrode cross-section becomes flat. In the thick-film micro-processing technology developed by Murata, however, low-loss electrode shape can be formed in a high-frequency band. As a result, high Q characteristics are obtained with this product.

Optimized electrode thickness

In a high-frequency band, current density is concentrated on the surface of an electrode. Known as the skin effect, this phenomenon also increases the resistance of the electrode. Therefore, an electrode was designed to have an optimum thickness in consideration of the skin thickness in the operating frequency band (of more than 800 MHz) of a mobile phone.

Consequently, high Q characteristics can be acquired.

The skin depth is obtained by the expression below.

$$=1/\sqrt{\pi f \mu \sigma}$$

(f: Frequency, μ : Magnetic permeability, σ : Conductivity)

Optimized internal structure

An electromagnetic analysis was performed to optimize the wiring pattern, and monolithic structure to realize high Q characteristics. (Murata has applied for a patent covering this technology.)

Summary

The growing consumer demand for compact and multi-function mobile phones has created a need for compact and high-performance high-frequency chip coil. To meet this demand, Murata has developed a high Q-type chip coil from the LQP03T series that can be produced on a commercial scale.

In the future, as high-density mounting technology is adopted by handset manufacturers, and mobile phones with built-in hard disc drives and advanced functionality are developed, the need for compact and high-performance high-frequency chip coils will grow further.

To pave the way for development of chip coils that are smaller (0402-sized), and with higher performance (narrow deviation and high Q characteristics), Murata plans to develop new improved materials, methods, and design. The company will propose products that are designed to meet the needs of its customers.

About This Article

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