



Multilayer Chip Beads for EMC measurement

Gigaspira Beads

MMZ-E, MMZ-V & MPZ-E series



A single chip solution for EMC and multiband noise issues

Smartphones and other mobile devices are becoming more sophisticated. FM radio, GPS, wireless LAN, and Bluetooth are now common features, and LTE models are rapidly gaining popularity. With the move toward multifunctional and multiband, the frequency range is reaching tens of MHz and even up to several GHz, raising the number of noise control components used in individual frequency bands. Balancing this with customer needs for smaller and slimmer mobile devices is a challenge.

TDK's multilayer chip beads, Gigaspira Beads, are the solution to this challenge. With its original multilayer structure and ferrite technologies, TDK has achieved higher impedance (AC resistance), enabling noise removal over wide frequency bands with just a single chip. TDK has added the following three new types to its products lineup: the MMZ-0603E, smaller in size from the existing MMZ-1005E; the MMZ-1005V with the industry's highest level impedance in the GHz band; and the MPZ-1005E featured with low direct-current resistance (Rdc), large-current compatible, and high impedance.

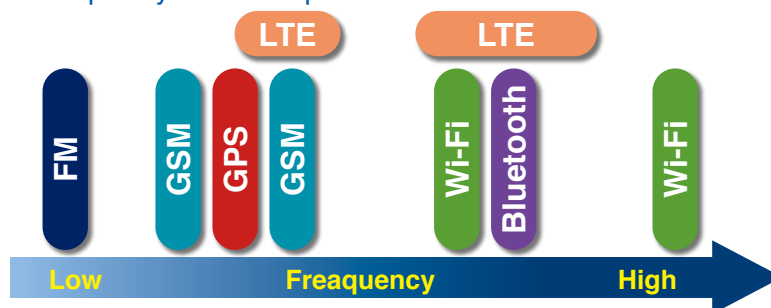
The need for noise control in multiple frequency bands

With the move toward multiband designs and various communication functions, smartphones and other mobile devices are using broad range of frequencies (Fig. 1). The collection of these communication functions in small-size mobile devices inevitably increases the density level of circuits, which are in closer proximity to each other. This means that antennas susceptible to noise, and circuits that easily become the source of noise radiation are in closer proximity as well, causing a problem called electromagnetic compatibility (EMC), where antennas pick up a noise generated from within the same device (Fig. 2). In recent years, signal frequency in the circuit

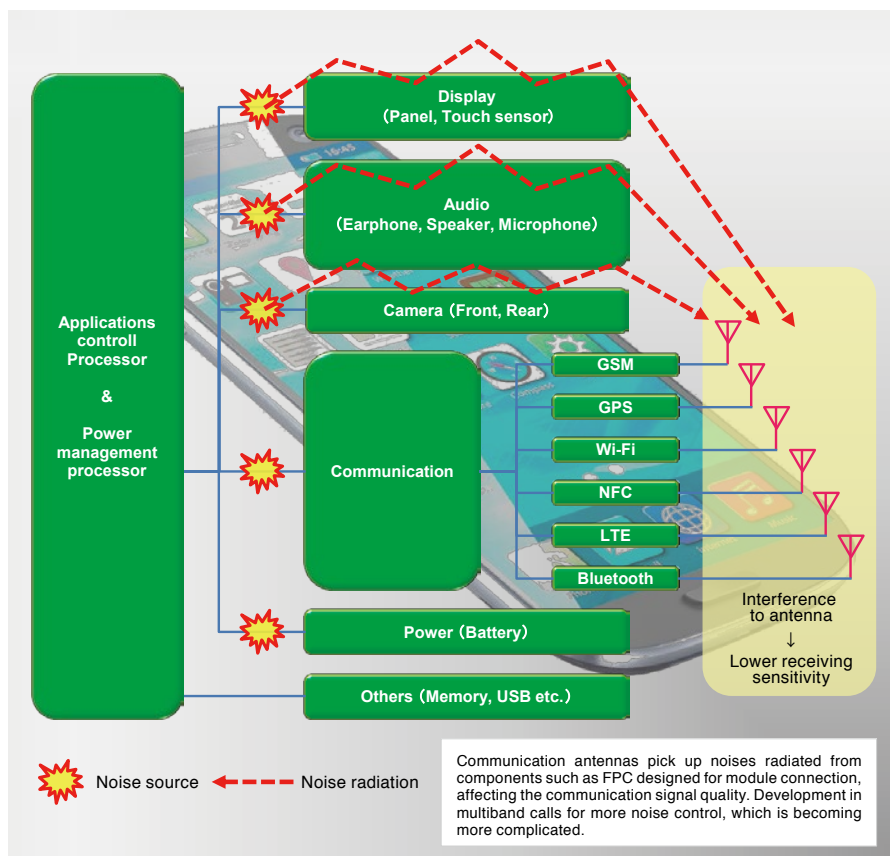
is moving toward the higher range, and more and more noise issues are noted in the higher frequency band. Noise control in the GHz band is becoming very important.

Conventionally though, a selection of different noise control components was required for individual frequency bands, increasing the number of built-in components as a result. Gigaspira Beads is the solution to this problem, providing noise control over wide frequency bands with a single chip, thus contributing to the reduction of the number of mounted components.

□ Fig. 1 Communication frequency of a smartphone



□ Fig. 2 EMC problem of a smartphone



Electronic properties of Gigaspira Beads with high added-value

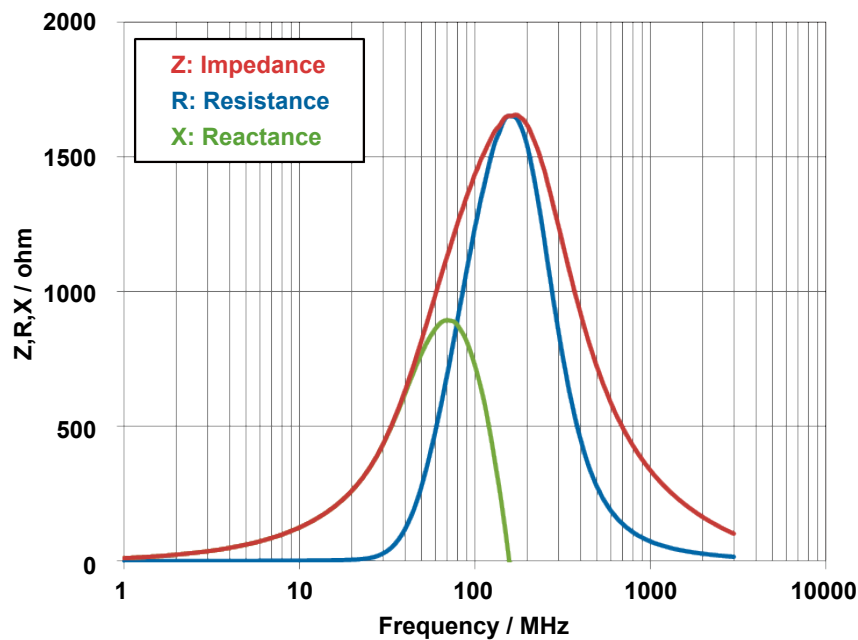
Chip beads are elements that easily bring noise removal effects by inserting them in series in the transmission lines, which are often sources of noise radiation. Chip beads are applied in a wide variety of instruments because of the convenience that they provide.

Impedance Z , the main property of chip beads, is a combined resistance of the reactance component X and the resistance component R . The frequency characteristics of the chip beads show that the reactance component is dominant in the low frequency domain functioning as an inductor to reflect noise, whereas the resistance component becomes dominant in

the high frequency domain, converting noise into heat for absorption. These are the basic principles of noise removal by chip beads.

Since chip beads are characterized by noise absorption with the resistance component, greater noise removal effect can be achieved with a larger resistance component (or larger impedance (Fig. 3). TDK's Gigaspira Beads deliver high impedance characteristics even above the 1GHz frequency band, an effective solution for noise control especially for smartphones and other mobile devices that use various communication frequency bands.

□ Fig. 3 Typical frequency properties of chip beads



Gigaspira structure chip beads with a longitudinally wound internal conductor

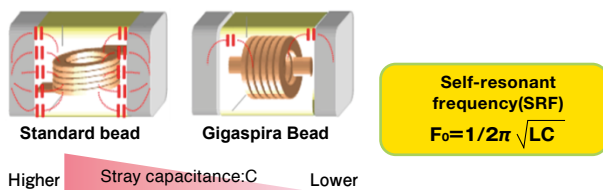
The Gigaspira Beads are designed with two main features regarding electrical characteristics; the impedance is extended to the high frequency band, and the beads have higher impedance than general chip beads.

Chip beads generate self-resonance (LC resonance) from the coil component of the internal conductor and the stray capacitance between the internal conductor and external electrode, and impedance drops when frequency range is higher than the self-resonant frequency (SRF). Internal structure of standard chip beads has a high stray capacitance, and is susceptible to LC resonance. The Gigaspiral Beads, however, are wound in the longitudinal direction of the product to reduce

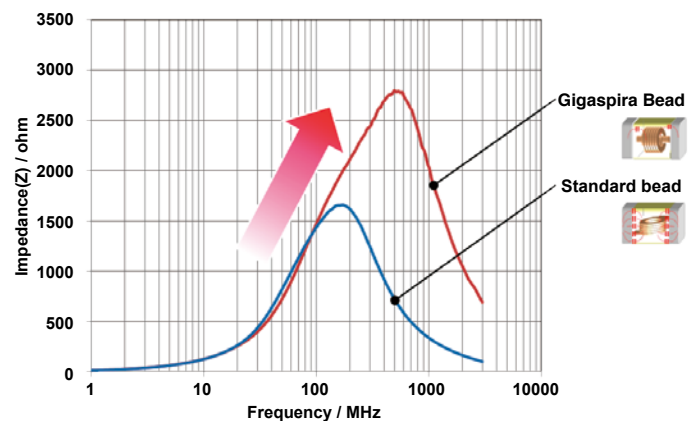
stray capacitance, shifting SRF to a higher frequency range than standard chip beads (Fig. 4).

Furthermore, winding in a longitudinal direction can increase the number of coil windings, which in turn generate higher impedance than standard chip beads (Fig. 5). As a result of these effects, the impedance is extended to the higher frequency range, enabling the Gigaspira Beads to remove noise components in the high frequency band, of which the standard chip beads could not provide. The EMI level measurement results also confirm the excellent noise suppression effect of the Gigaspira Beads (Fig. 6).

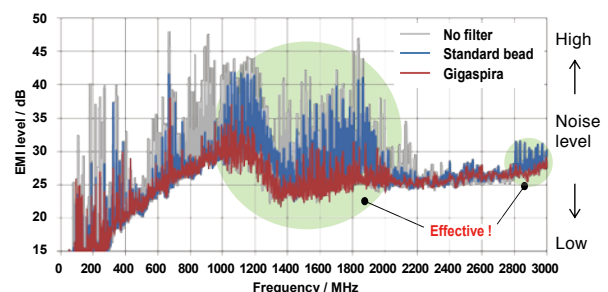
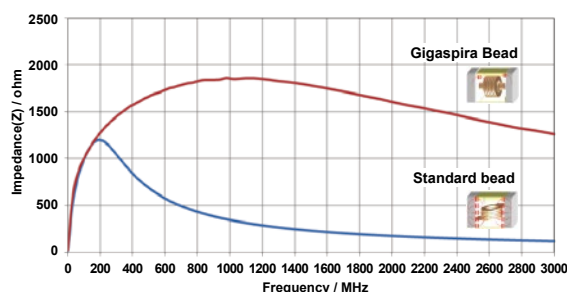
□ Fig. 4 Relationship of the internal structure to the SRF



□ Fig. 5 Comparison of standard chip beads and Gigaspira Beads: impedance and frequency characteristics



□ Fig. 6 Comparison of standard chip beads and Gigaspira Beads: noise suppression effects



The MMZ-E series lineup adds the 0603 type with a broad range of frequency characteristics

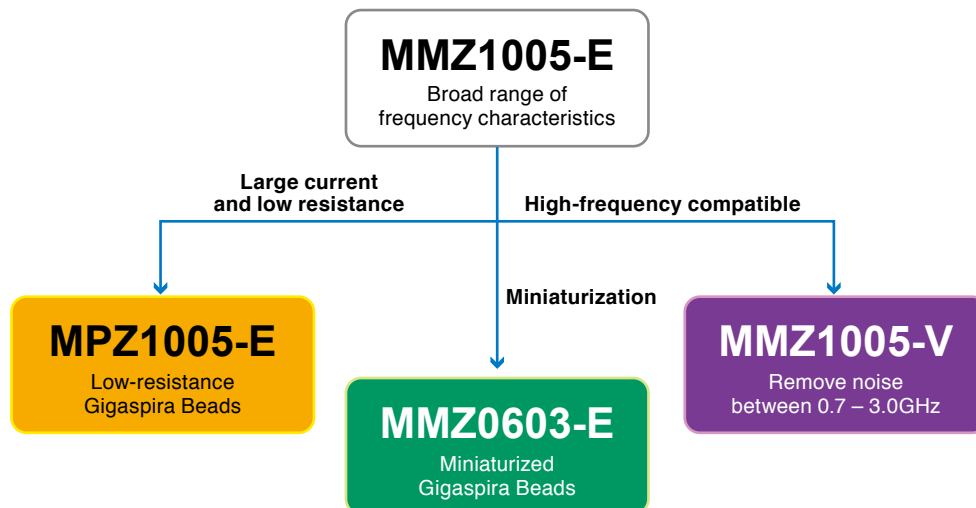
The MMZ1005-E type of Gigaspira Beads, which began production in June 2006, won the Nippon Brand Award in the “Cho Monodzukuri Award” 2010 (hosted by the Nikkan Kogyo Shimbun). Accumulating its own original miniaturization technology through the world’s first mass production of the 0402 type chip beads, TDK has also developed new products to meet customers’ diversified needs.

At present, TDK offers four types of Gigaspira Beads (Fig. 7). The first is the MMZ1005-E type with a broad range of impedance lineup. TDK’s original ferrite material technology was used to achieve high impedance and wide range of frequency characteristics. The frequency characteristics can be divided into 2 main types; high impedance in broad frequency bands, and an especially high impedance in the GHz range (Fig.

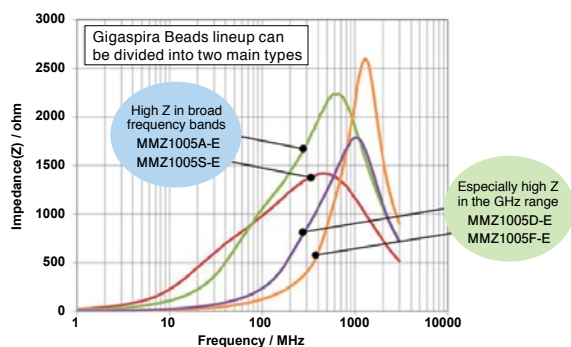
8). These can be further subdivided into 14 types based on 4 different materials, providing the most appropriate component according to different EMC issues to ensure effective EMC measurement and noise removal in the GHz range.

The second is the MMZ0603-E type Gigaspira Beads, a miniaturized version of the MMZ 1005-E type. Leveraging its miniaturization and material technologies, TDK has succeeded in miniaturizing the MMZ 1005-E type while maintaining its features. Although smaller, the MMZ0603-E type has higher impedance characteristics than the MMZ 1005-E type (Fig. 9), thus even more reasons to use the Gigaspira Beads in smaller and slimmer mobile devices. With a lineup of broad range of frequency characteristics, TDK offers best solutions to enhance receiving sensitivity of mobile devices.

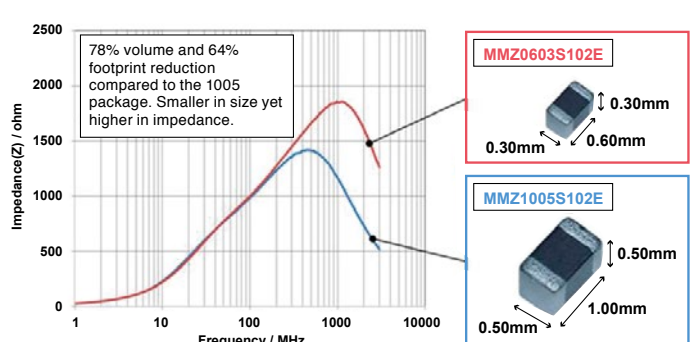
□ Fig. 7 Product category of the Gigaspira Beads



□ Fig. 8 The MMZ 1005-E type: main impedance – frequency characteristics



□ Fig. 9 Impedance – frequency characteristics and size per product shape

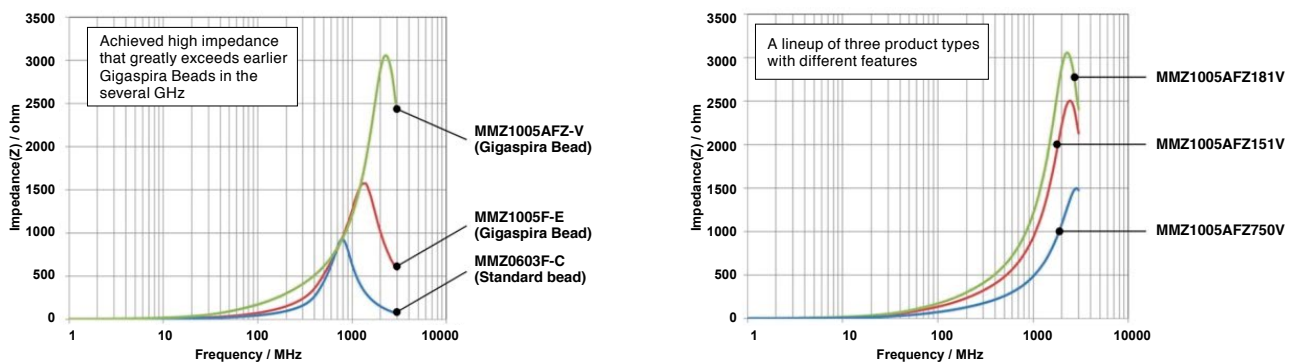


The MMZ-V series with effective noise control solutions for 0.7 – 3.0 GHz range

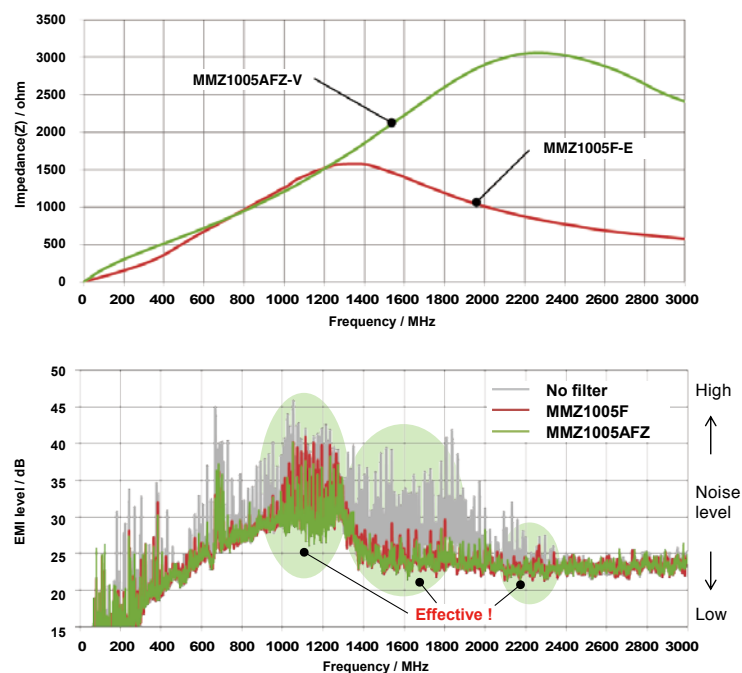
The third is the MMZ 1005-V type, with higher impedance in GHz range than the earlier MMZ-E type. A newly developed material was used to provide industry-leading impedance in 2.5 GHz range, delivering excellent results in removing noise and high-frequency noise that could interfere especially with LTE, Wi-Fi, and other operations in the several GHz range (Fig. 10). LTE and other communication systems are making rapid progress, and signal frequency is reaching high-speed as well. A finely-tuned noise control is vital to secure receiving sensitivity, which is important for making telephone calls. The

MMZ 1005-V type provides exceptional results especially with high-speed communication noise control. A single component with high impedance in the 0.7 to several GHz range can cover GSM and LTE bands, as well as GPS, Wi-Fi, and other main communication bands used in smartphones. Unlike the MMZ1005-E type with only a limited effect, the MMZ 1005-V type delivers excellent noise suppression in the several GHz range (Fig. 11). The MMZ 1005-V type provides effective results in various applications including Smart Grid, radio communication between electric appliances, and many others.

□ Fig. 10 The MMZ1005-V type: major impedance – frequency characteristics



□ Fig. 11 EMI suppression effects between the MMZ 1005-V type and standard Gigaspire Beads



The MPZ-E series with three high add-values: low direct-current resistance / large-current compatible / high impedance

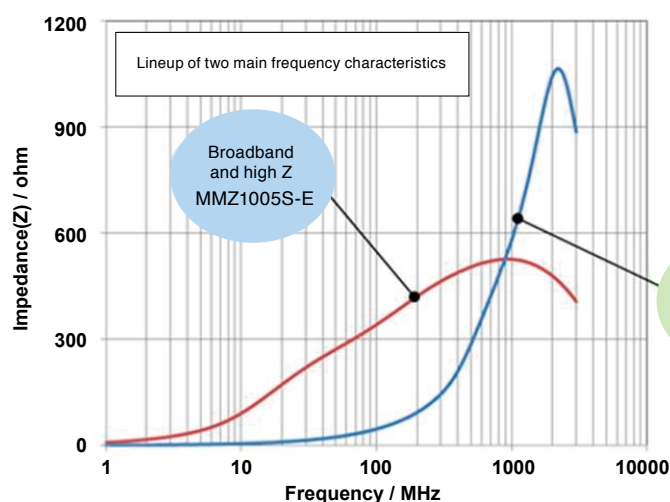
The forth type is the MPZ 1005-E type Gigaspira Beads, developed for use in power lines. As mentioned above, EMC cause a serious problem in power lines of smartphones, which are packed densely with many functions. In addition, a multilayer circuit board is becoming more popular, raising concerns over noise radiation from FPC (Flexible printed circuits). The MPZ-E series offer three high added-values; low direct-current resistance, large current compatible, and high impedance. Its internal structure is designed at optimum level for a significant reduction of direct-current resistance, and is reliable even under a large-current.

The MPZ 1005-E lineup comes in 2 types; one with wide impedance range from relatively low to high frequencies, and another with steep impedance curve in the several GHz range

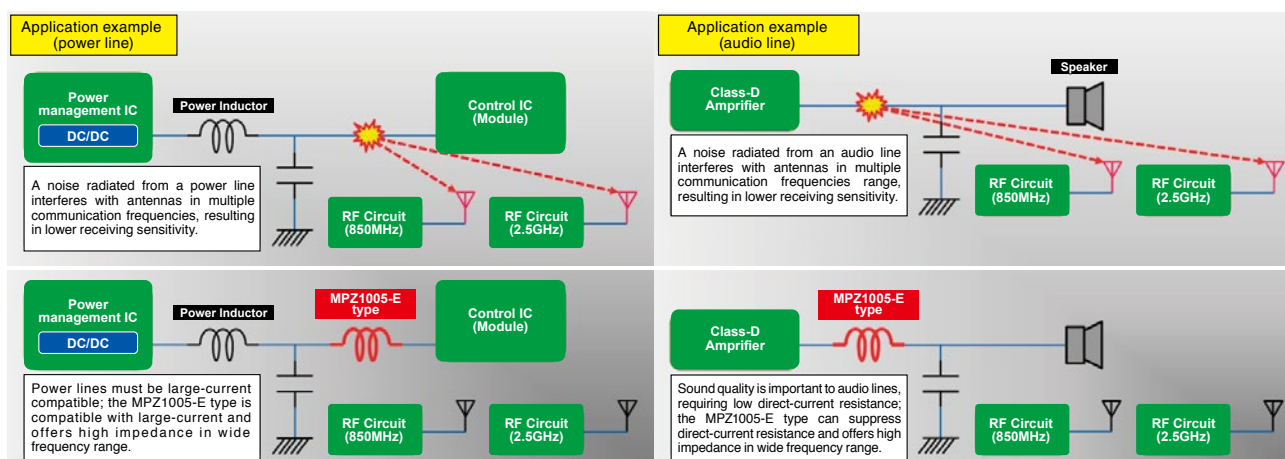
(Fig. 12). The former is effective in removing low frequency noise generated by power lines, and can be applied to standard signal lines that do not require a large-current. Utilizing its low direct-current resistance, the MPZ 1005-E lineup controls power consumption and extends battery life, and can even be used in speakers and earphones as well (Fig. 13).

TDK's multilayer chip beads, the "Gigaspira Beads" lineup offers excellent characteristics and high added-values. Superb noise suppression is achieved with a single chip, thus contributing greatly in using less number of mounted components, which in turn saves housing space as well. TDK offers highly useful solutions for smaller, thinner, and more sophisticated smartphones and other mobile devices, as well as against various EMC issues.

□ Fig. 12 The MPZ1005-E type: main impedance – frequency characteristics



□ Fig. 13 Application examples the MPZ1005-E type



The MMZ-E series

□ Main Features

The MMZ 1005-Z type

- 1 Unlike the standard type, self-resonant frequency (SRF) is raised to the GHz band level. One element enables noise control over a wide frequency range.
- 2 Higher impedance in the GHz band than the standard type.
- 3 Noise reduction from general to high-speed signals: 4 materials with different characteristics offer various frequency properties (14 types).

The MMZ0603-E type

- 1 78% volume and 64% footprint reduction compared to the 1005 package, while keeping same level of impedance.
- 2 Optimized internal configuration gives a higher SRF than the 1005 shape product.
- 3 Noise reduction from general to high-speed signals: 3 materials with different characteristics give various frequency properties (8 types).

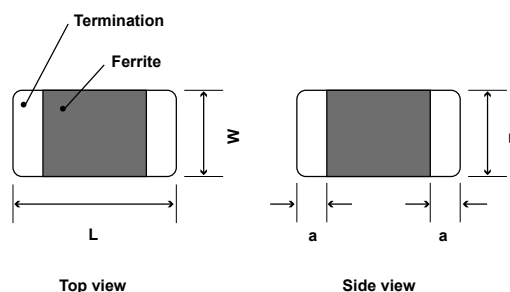
□ Main applications

- Remove noise for smartphones, tablets, and other mobile devices as well as various modules.
- Remove noise for PC, recorder, STB and other electric appliances as well as smart grid and industrial equipment.

□ Shape and size

Type [inch]	L	W	T	a	Weight
MMZ1005-E [0402]	1.00±0.05	0.50±0.05	0.50±0.05	0.1 min.	1.0 mg
MMZ0603-E [0201]	0.60±0.03	0.30±0.03	0.30±0.03	0.1 min.	0.3 mg

(in mm)



□ Main specifications

Part number	Z @100MHz [Ω] ± 25%	Z @1GHz [Ω] ± 40%	DC Resistance [Ω] Max.	Rated Current [mA] Max.
MMZ1005S601E	600	1000	0.65	300
MMZ1005S102E	1000	1400	1.00	250
MMZ1005S182E	1800	1800	1.50	200
MMZ1005A601E	600	1400	0.80	300
MMZ1005A102E	1000	2000	1.20	250
MMZ1005A152E	1500	2300	1.60	230
MMZ1005A182E	1800	2700	2.10	200
MMZ1005A222E	2200	3000	2.20	150
MMZ1005D121E	120	1000	0.70	300
MMZ1005D221E	220	1700	1.00	250
MMZ1005F470E	47	800	0.70	300
MMZ1005F750E	75	1500	1.00	250
MMZ1005F121E	120	2300	1.50	200
MMZ1005F181E	180	3200	1.35	150

Part number	Z @100MHz [Ω] ± 25%	Z @1GHz [Ω] ± 40%	Z @2GHz Typ. [Ω] (Reference)	Z @3GHz Typ. [Ω] (Reference)	DC Resistance [Ω] Max.	Rated Current [mA] Max.
MMZ0603S121E	120	200	200	200	0.37	250
MMZ0603S241E	240	400	400	400	0.71	200
MMZ0603S601E	600	1000	900	700	1.60	150
MMZ0603S102E	1000	1800	1200	900	2.60	125
MMZ0603A121E	120	300	300	300	0.44	250
MMZ0603A241E	240	600	700	700	0.86	200
MMZ0603D330E	33	200	300	320	0.60	250
MMZ0603D470E	47	300	400	450	0.76	200

The MMZ-V series

□ Main Features

- 1** Higher impedance in the GHz band than the MMZ-E series.
- 2** Delivers excellent results in removing noise and high-frequency noise that could interfere especially with LTE, Wi-Fi, and other operations in the several GHz range.
- 3** Unlike the earlier MMZ-E series, its high impedance especially in the 0.7 GHz to 3 GHz range effectively removes noise.

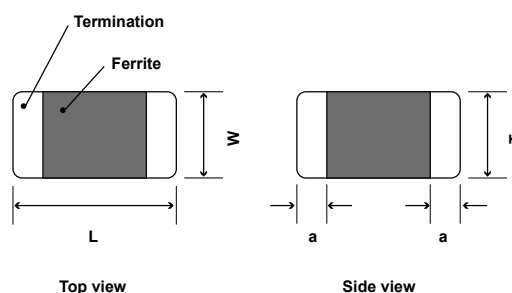
□ Main applications

- Secure radio communication sensitivity for LTE and Wi-Fi that use high-speed signals.
- Remove noise for smartphones, tablets, and other mobile devices as well as various modules.
- Remove noise for PC, recorder, STB and other electric appliances as well as smart grid and industrial equipment.

□ Shape and size

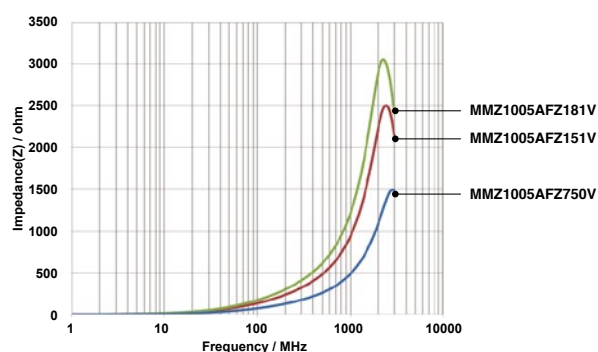
Type [inch]	L	W	T	a	Weight
MMZ1005-V [0402]	1.00±0.05	0.50±0.05	0.50±0.05	0.1 min.	1.0 mg

(in mm)



□ Main specifications

Part number	Z @100MHz [Ω] ± 25%	Z @1GHz [Ω] ± 40%	Z @ 2.5GHz Typ. [Ω] (Reference)	DC Resistance [Ω] Max.	Rated Current [mA] Max.
MMZ1005AFZ750V	75	500	1400	0.90	250
MMZ1005AFZ151V	150	1000	2500	1.30	200
MMZ1005AFZ181V	180	1200	3000	1.60	150



The MPZ-E series

□ Main Features

- 1** Lower direct-current resistance than the MMZ-E series is ideal to control power consumption in power lines or signal lines.
- 2** Higher impedance in the GHz band than the MPZ standard type.
- 3** Lineup includes the S type built with impedance that covers wide frequency range from low to the GHz band, and the F type with steep impedance curve in the several GHz range.

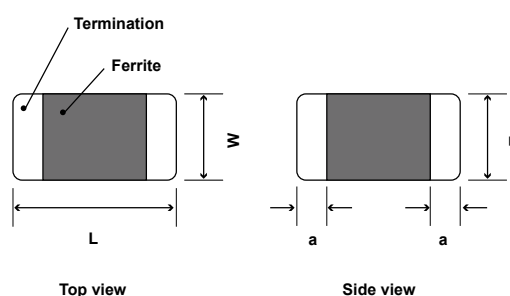
□ Main applications

- Remove noise of various power lines.
- Remove noise for smartphones, tablets, and other mobile devices as well as various modules.
- Remove noise for PC, recorder, STB and other electric appliances as well as smart grid and industrial equipment.

□ Shape and size

Type [inch]	L	W	T	a	Weight
MPZ1005-E [0402]	1.00±0.05	0.50±0.05	0.50±0.05	0.1 min.	1.0 mg

(in mm)



□ Main specifications

Part number	Z @100MHz [Ω] ± 25%	Z @1GHz [Ω] ± 40%	Z @ 2GHz Typ. [Ω] (Reference)	DC Resistance [Ω] Max.	Rated Current [A] Max.
MPZ1005S121E	120	200	220	0.095	1.50
MPZ1005S221E	220	350	330	0.220	0.90
MPZ1005S331E	330	550	470	0.280	0.70
MPZ1005F330E	33	400	700	0.350	0.55
MPZ1005F470E	47	600	1100	0.450	0.45

