

Three-Terminal Filters with Steep Attenuation Characteristics

TDK Corporation Magnetic Business Group
Yutaka Abe

1 | LC Filters with Good Attenuation Characteristics

Three-terminal filters come into play when noise cannot be sufficiently reduced using capacitors or inductors. Three-terminal filters derive their name from the fact that they have three terminals, an input terminal, an output terminal, and a ground terminal.

Three-terminal filters are high-level LC filters in which a capacitor and an inductor are combined to form one chip, and they exhibit greater attenuation characteristics than filters made using a single capacitor or inductor. The inductor has high impedance at high frequencies and suppresses noise, and the capacitor has low impedance at high frequencies and transfers noise to the GND terminal.

2 | Types of Three-Terminal Filters

The attenuation characteristics of LC filters become greater as the number of capacitors and inductors increases; however, they cause ringing, overshoot, and undershoot to appear in digital pulse waveforms. To ensure the appropriate use of three-terminal filters, it is necessary to select filters according to the application or noise generation status.

As is shown in Figure 1, there are several different types of

three-terminal filters.

► T-type filter

This is the most typical third-order LC filter. This type is used when noise cannot be eliminated using a single ferrite bead. It has relatively low impedance (several tens of Ω or smaller), and is inserted into a signal line for which waveform quality is considered important.

The attenuation characteristics of the MEM2012S T-type filter series are shown in Figure 1 (a).

► π -type filter

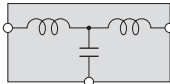

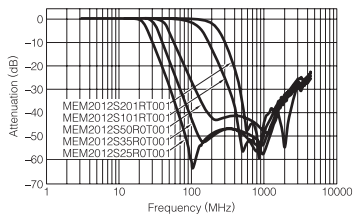
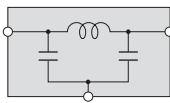

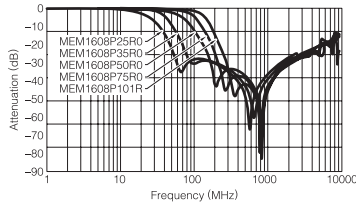
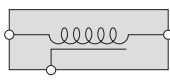

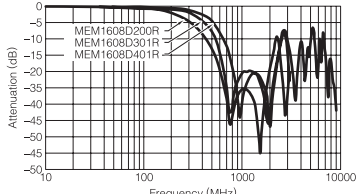
This is a third-order LC filter. This type is used into lines for which capacitors for high-frequency bypass capacitors are not sufficient, or into lines with relatively high impedance (several hundred Ω or greater), e.g., an IC power line.

The attenuation characteristics of the MEM1608P small π -type filter series are shown in Figure 1(b).

► Pulse response filter

A tree-terminal filter in which capacitors are disposed to face the inductor.

Figure 1 Types of Three-terminal Filters

Type / dimensions	Series / appearance	Part No.	Cutoff frequency (MHz)	Attenuation characteristics
(a) T-type filter L2.0 × W1.2 mm 	MEM2012S series 	MEM2012S25R0	25	
		MEM2012S35R0	35	
		MEM2012S50R0	50	
		MEM2012S101R	100	
		MEM2012S201R	200	
(b) π -type filter L1.6 × W0.8 mm 	MEM1608P series 	MEA2010P25R0	25	
		MEA2010P35R0	35	
		MEA2010P50R0	50	
		MEA2010P75R0	75	
		MEA2010P101R	100	
(c) Pulse response filter L1.6 × W0.8 mm 	MEM1608D series 	MEM1608D201R	200	
		MEM1608D301R	300	
		MEM1608D401R	400	

Since the transmission characteristics attenuate smoothly near the cutoff frequency, almost no distortion, such as overshoot or ringing, appears in the pulse response characteristics.

The attenuation characteristics of the MEM1608D small pulse response filter series are shown in Figure 1 (c).

3 | Space-Efficient Three-Terminal Filter Array

As is shown in Figure 2, array type products containing 4 three-terminal filters in one package are also available.

These types can be mounted in a space-efficient manner in places where there are multiple parallel digital signal lines.

Among small-sized filter arrays, the MEA2010L series is

available for general signal lines.

The attenuation characteristics are shown in Figure 2 (a).

For LCD and camera signal lines, the MEA1608 series is available.

Among the small-sized 1608 type products, there are filter arrays containing L-type circuits and filter arrays containing π type circuits that have different functions.

The attenuation characteristics of the MEA1608LC series for mobile phones are shown in Figure 2 (b), and the attenuation characteristics of the MEA1608PE series for devices that are compatible with terrestrial digital television broadcasts are shown in Figure 2 (c).

Figure 2 Types of Three-Terminal Filter Arrays

Type / dimensions	Series / appearance	Part No.	Cutoff frequency (MHz)	Attenuation characteristics
(a) L-type filter array L2.0 × W1.0 mm 	MEA2010L series 	MEA2010L50R0	50	
		MEA2010L75R0	75	
		MEA2010L101R	100	
(b) L-type filter array L1.6 × W0.8 mm 	MEA1608LC series 	MEA1608LC040	4	
		MEA1608LC060	6	
		MEA1608LC080	8	
		MEA1608LC100	10	
		MEA1608LC150	15	
		MEA1608LC220	22	
(c) π -type filter array L1.6 × W0.8 mm 	MEA1608PE series Compatible with terrestrial digital television broadcasts 	MEA1608PE150	15	
		MEA1608PE220	22	
		MEA1608PE270	27	
		MEA1608PE360	36	

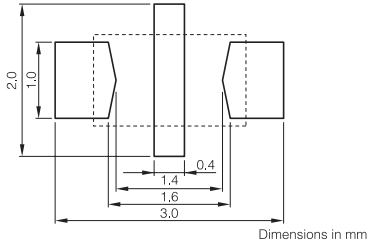
4 | Recommended Land Patterns

The recommended land patterns for each three-terminal filter are shown in Figure 3.

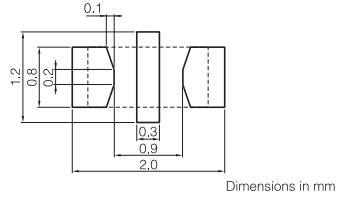
In order to achieve sufficient a noise reduction effect, it is necessary to reduce the impedance of the ground pattern as much as possible. Through holes should be made near the elements and should connect the elements to the ground layer.

Figure 3 Recommended Land Pattern for Three-Terminal Filters and Filter Arrays

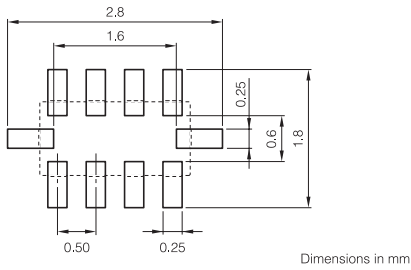
2012 type three-terminal filter



1608 type three-terminal filter



2010 type three-terminal filter array



1608 type three-terminal filter array

