



surface mount EMI filters



SPECTRUM CONTROL INC.
Signal & Power Integrity Group



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In 1968, Spectrum Control was founded as a solutions-oriented company designing and manufacturing products to suppress or eliminate electromagnetic interference (EMI). In the years that followed we adapted our core EMI filter technology into a complete line of capacitors, discrete filters, filtered arrays, filtered connectors, power filters, gaskets and shielding, microwave filters and power management products. Today, Spectrum Control offers the most experienced team of EMI engineering specialists and most extensive line of EMI filter products and packaged filter solutions.

Spectrum products are used in virtually all industries worldwide, including telecommunications, medical, government, military, aerospace, computer and industrial controls. In addition, we've secured preferred supplier status with many of the leading electronics OEMs around the world.

surface mount EMI filters



With many years of experience in the design and manufacture of filters, Spectrum Control has a unique perspective on EMI and its control. We are now extending our filter expertise to the board level with our introduction of a complete line of surface mount EMI filters. Our family of surface mount inductors, low pass filters, high frequency filters and power filters is designed to offer high performance EMI filtering with a minimal PCB footprint.

Spectrum Control surface mount EMI filters are ideal for a wide range of PCB applications, including automotive electronics, digital A/V equipment, computers, peripherals, telecommunications, switching power supplies and high current buss lines.

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ISO 9001
CERTIFIED

www.specemc.com

Spectrum Control's expertise

Spectrum Control is unique in providing an integrated approach to EMC problem solving by offering customer consulting, diagnostic testing, design and manufacturing services. As a fully integrated manufacturer, we are able to respond to short lead times and develop cost-effective solutions to satisfy your performance and budgetary needs.

test

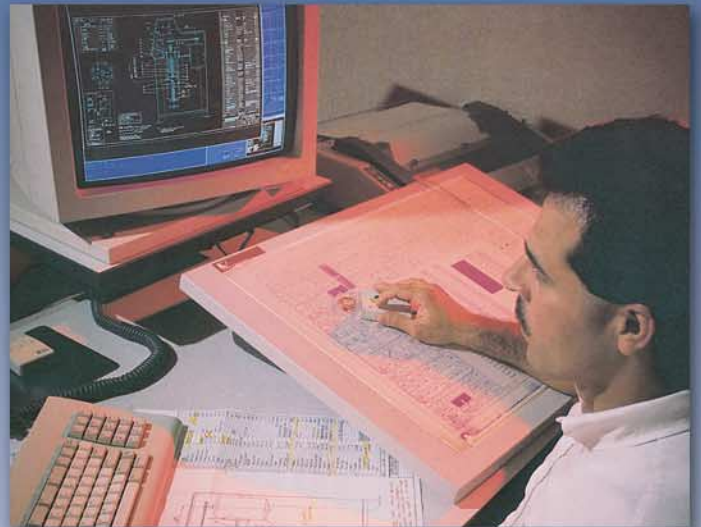
- Spectrum Control's Test Facility provides a total solution for your compliance issues
- In-house anechoic chamber and shielding room
- NARTE certified engineering staff
- Tests available for:
 - European emission and immunity regulations (CE Mark)
 - FCC Part 15
 - MIL standard testing

design

- In-house EMI and power conditioning specialists
- Comprehensive computer modeling
- Designs are "in-house" compliance verified
- Custom assemblies:
 - Incorporate EMI filtering, circuit breaker protection, transient suppression, voltage cut-off, power factor correction, harmonic suppression, remote sensing and other options to meet your specific requirements
 - Plug-and-play designs
 - Reduce your time to market
 - Lower your inventory needs

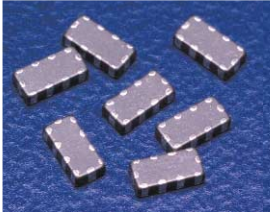
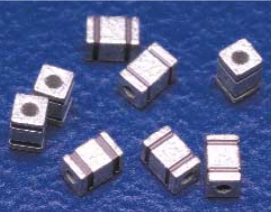
manufacture

- Flexible factories
- Custom designs
- Spectrum Control, Inc. ISO 9001 certified
- Schedule sharing programs available
- Vertically integrated supplier



Surface Mount EMI Filter Selection Guide

SURFACE MOUNTED LOW PASS FILTERS

	SF SERIES <i>Three Terminal Chip</i>	LC/LZ SERIES <i>LC Type Chips</i>	SA SERIES <i>SM Filter Arrays</i>	MSM SERIES <i>Mini Surface Mount Filters</i>	SSM SERIES <i>Square Surface Mount Filters</i>
					
Applications	Cellular telephones and base stations, telecommunication equipment, computer and peripheral equipment, digital AV equipment such as TV, VCR and DVD	Cellular telephones and base stations, telecommunication equipment, computer and peripheral equipment, digital AV equipment such as TV, VCR and DVD	Cellular telephones and base stations, telecommunication equipment, computer and peripheral equipment, digital AV equipment such as TV, VCR and DVD	Automotive car electronics, cellular telephones and base stations, microwave transmission, test equipment, DC power supply lines, DC-DC converter, medical equipment	Power amplifiers, power supplies, temperature and motor controls, high current buss lines and driver circuits
Features/Benefits	■ Easy installation Nickel barrier with solder coated termination offers excellent solderability ■ Design flexibility Available in EIA (EIAJ) sizes 0603 (1608), 0805 (2012), 1206 (3216), 1806 (4516) Tape and reel packaging Non-polar, surface mountable ■ Performance Small footprint and low residual inductance provides superior filtering at higher frequencies	■ Easy installation Nickel barrier with solder coated termination offers excellent solderability. ■ Design flexibility Available in EIA (EIAJ) sizes 0603 (1608), 0805 (2012), 1206 (3216) 2 terminal variations available Tape and reel packaging Non-polar, surface mountable ■ Performance Steep insertion loss is ideally suited for high frequency signal lines	■ Easy installation Nickel barrier with solder coated termination offers excellent solderability ■ Design flexibility Common ground across four lines in one chip controls cross talk Compact footprint ■ Performance Small footprint and low residual inductance provide superior filtering at higher frequencies	■ Easy installation Superior solderability and heat resistance due to multilayer electrode structure ■ Design flexibility Simple structure and high withstanding voltage ■ Performance Self-resonant frequency extends to the microwave band Extreme elimination of residual inductance	■ Easy installation Square mechanical geometry enhances soldering to a PCB ■ Design flexibility Compact footprint for densely populated PCBs Tape and reel packaging along with bulk packaging ■ Performance Excellent performance in GHz applications Eliminates thru-hole filters thus eliminating costly RFI bulkheads
Performance Characteristics	■ Capacitance From 22 to 220,000 pF ■ Rated voltage 50 to 100 VDC ■ Max. current range 0.3 to 2 Amps ■ Temperature range -55°C to +125°C	■ Cut-off frequency From 10 to 220 MHz ■ Rated voltage 25 VDC ■ Rated current 100 mA ■ Temperature range -40°C to +85°C	■ Capacitance From 22 to 22,000 pF ■ Rated voltage 25 to 50 VDC ■ Max. current range 0.3 Amps ■ Temperature range -55°C to +125°C	■ Capacitance From 47 to 1,000 pF ■ Rated voltage 50 VDC ■ Rated current 10 Amps ■ Temperature range -55°C to +125°C ■ Circuit Feed thru	■ Capacitance From 100 to 4,000 pF ■ Rated voltage 100 VDC ■ Rated current 5 to 10 Amps ■ Temperature range -55°C to +125°C ■ Circuit Pi
	Pages 35-40 www.specemc.com/sf	Pages 41-44 www.specemc.com/lc	Pages 45-46 www.specemc.com/sa	Page 48 www.specemc.com/msm	Pages 49-50 www.specemc.com/ssm

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EMC Testing Services

Spectrum Control has the EMC expertise and in-house filter solutions you need to meet worldwide EMC standards.

Our EMC testing services offer you a flexible resource to assist in product development by identifying and correcting EMI susceptibility and/or emission problems. Spectrum Control has a fully equipped EMC test laboratory and experienced engineering staff ready to solve demanding EMC challenges. For a modest daily fee we can test your equipment, determine state of compliance, and work with you in developing a viable solution. It is not uncommon for clients to leave our lab with a prototype in hand.

EMC Lab Highlights

- NARTE Certified Staff
- Semi-anechoic chamber
- Computer controlled instrumentation
- Graphical data presentation in multiple formats
- Fiber optic video monitoring system

Testing Capabilities

MILITARY

MIL-STD-461 A/B/C/D/E

MIL-STD-1399

AUTOMOTIVE

CISPR 25 Test Methods

COMMERCIAL

FCC-Part 15

RTCA/DO-160 A/B/C/D

GR-1089-CORE

INTERNATIONAL

EN55011/CISPR 11

EN55014/CISPR 14

EN55022/CISPR 22

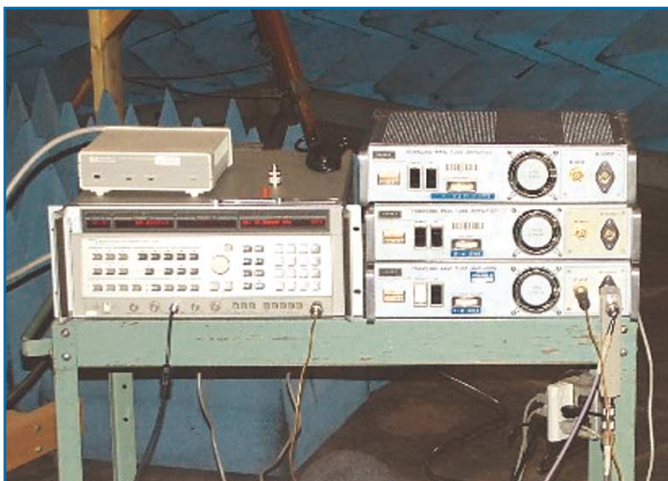
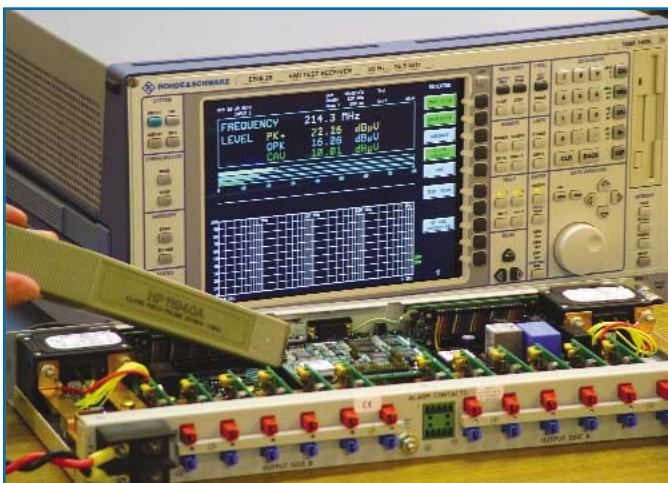
EN61000-4-2 Electrostatic Discharge

EN61000-4-3 Radiated RF Immunity

EN61000-4-4 Electrical Fast Transient

EN61000-4-5 Surge

EN61000-4-6 Conducted RF Immunity



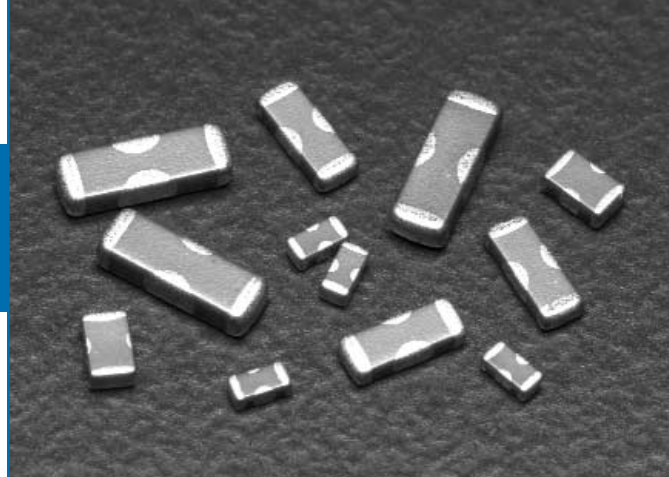
Surface Mount EMI Filters Three Terminal Chips

Features

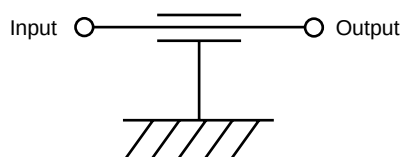
- Excellent performance in high current applications
- Non-polar, surface mountable
- Superior filtering characteristics
- Superb ability to withstand transient voltages and surge
- Offers exceptional solderability and resistance to solder heat
- Available in 0603, 0805, 1205 and 1806 body size
- Two amp current rating available
- Available lead free/RoHS Compliant

Applications

- Cellular telephones and base stations
- Telecommunication equipment
- Industrial electronic interface or programmable controllers
- Electronic automotive equipment
- Computer and peripheral equipment



Circuit Schematic



Typical Electrical Characteristics

Capacitance Range COG (NPO) 22 pF to 470 pF
 X7R 470 pF to 47,000 pF
 YV5 100,000 pF and 220,000 pF

Capacitance Tolerance COG (NPO) +50/-20%
 X7R +50/-20%
 Y5V +80/-20%

Temperature Coefficient COG (NPO) 0 $\pm$ 30 ppm/ $^{\circ}$ C,
 -55 to +125 $^{\circ}$ C
 X7R $\pm$ 15%,
 -55 to +125 $^{\circ}$ C
 Y5V -25 to +85 $^{\circ}$ C

Insulation Resistance up to 22,000 pF 10000 M Ω
 47,000 pF 5000 M Ω

DC Resistance 0.4 Amp or less 0.3 Ohm max.
 1 Amp 0.08 Ohm max.
 2 Amp 0.04 Ohm max.

Rated Voltage up to 100 VDC

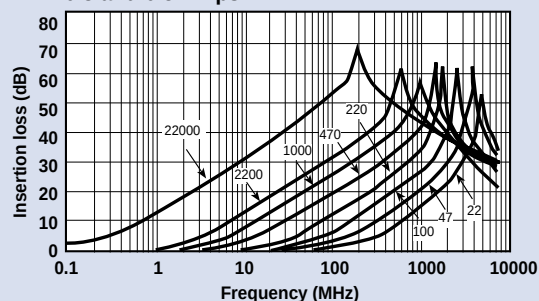
Rated Current up to 2 Amps

Surface Mount EMI Filters Three Terminal Chips

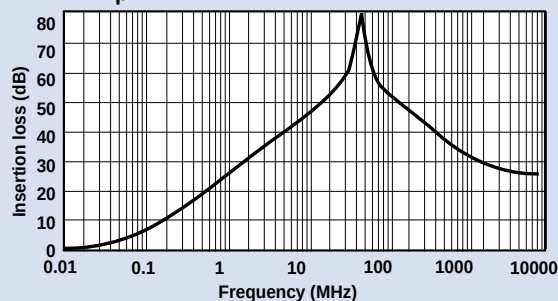
Insertion Loss (Per MIL-STD-220)

SF0603 Series

0.3 and 0.5 Amps

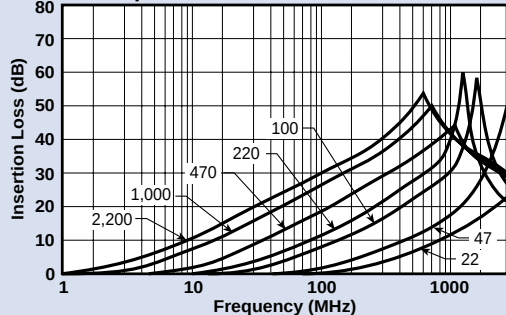


1 Amp

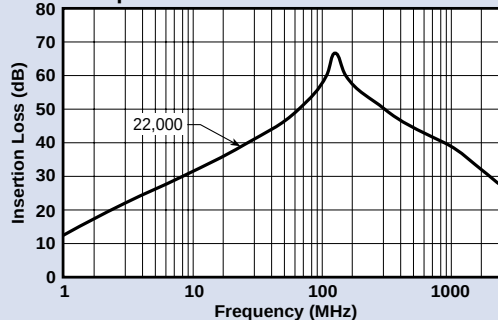


SF0805 Series

0.4 Amp

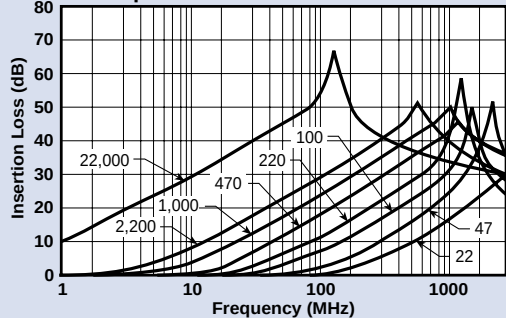


1 Amp

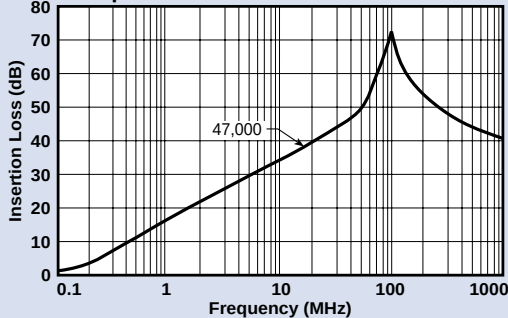


SF1205 Series

0.3 Amp

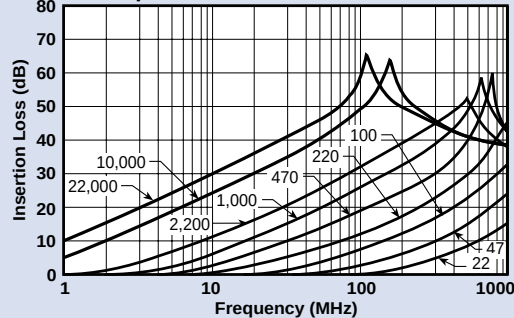


1 Amp

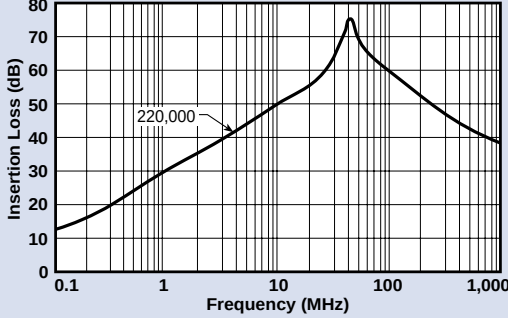


SF1806 Series

0.3 Amp



2 Amp



Surface Mount EMI Filters

Three Terminal Chips

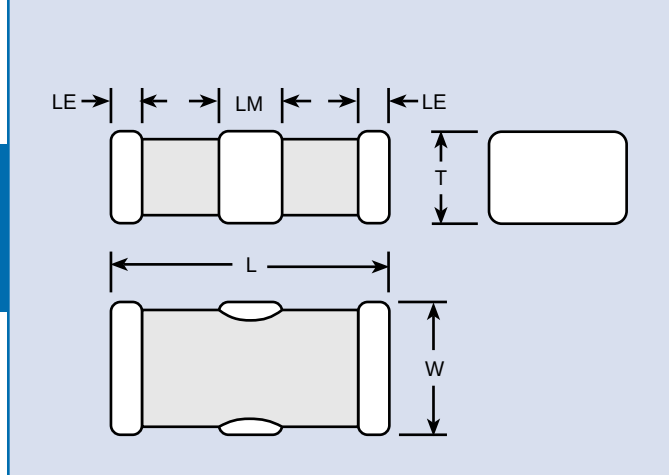
Selection Guide

Part Number	Body Size	Capacitance (in picofarad)	Capacitance Tolerance	Temp. Charact.	Rated Voltage (Volts DC)	Rated Current (Amps DC)	IR (Megohms Min.)	DC Resistance (ohm Max.)	Operating Temp.
SF0603C220SBNB-*	0603	22	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF0603C470SBNB-*	0603	47	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF0603C101SBNB-*	0603	100	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF0603C221SBNB-*	0603	220	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF0603X471SBNB-*	0603	470	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF0603X102SBNB-*	0603	1,000	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF0603X222SBNB-*	0603	2,200	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF0603X223SANC-*	0603	22,000	+50/-20%	X7R	25	0.5	10,000	0.15	-55/+125°C
SF0603Y104SAND-*	0603	100,000	+80/-20%	Y5V†	25	1	1,000	0.08	-25/+85°C
SF0805C220SBNC-*	0805	22	+50/-20%	COG	50	0.4	10,000	0.3	-55/+125°C
SF0805C470SBNC-*	0805	47	+50/-20%	COG	50	0.4	10,000	0.3	-55/+125°C
SF0805C101SBNC-*	0805	100	+50/-20%	COG	50	0.4	10,000	0.3	-55/+125°C
SF0805C221SBNC-*	0805	220	+50/-20%	COG	50	0.4	10,000	0.3	-55/+125°C
SF0805X471SBNC-*	0805	470	+50/-20%	X7R	50	0.4	10,000	0.3	-55/+125°C
SF0805X102SBNC-*	0805	1,000	+50/-20%	X7R	50	0.4	10,000	0.3	-55/+125°C
SF0805X222SBNC-*	0805	2,200	+50/-20%	X7R	50	0.4	10,000	0.3	-55/+125°C
SF0805X223SBND-*	0805	22,000	+50/-20%	X7R	50	1.0	10,000	0.08	-55/+125°C
SF1205C220SBNB-*	1205	22	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF1205C470SBNB-*	1205	47	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF1205C101SBNB-*	1205	100	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF1205C221SBNB-*	1205	220	+50/-20%	COG	50	0.3	10,000	0.3	-55/+125°C
SF1205X471SBNB-*	1205	470	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF1205X102SBNB-*	1205	1,000	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF1205X222SBNB-*	1205	2,200	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF1205X223SBNB-*	1205	22,000	+50/-20%	X7R	50	0.3	10,000	0.3	-55/+125°C
SF1205X473SBND-*	1205	47,000	+50/-20%	X7R	50	1.0	5,000	0.08	-55/+125°C
SF1806C220SDNB-*	1806	22	+50/-20%	COG	100	0.3	10,000	0.3	-55/+125°C
SF1806C470SDNB-*	1806	47	+50/-20%	COG	100	0.3	10,000	0.3	-55/+125°C
SF1806C101SDNB-*	1806	100	+50/-20%	COG	100	0.3	10,000	0.3	-55/+125°C
SF1806C221SDNB-*	1806	220	+50/-20%	COG	100	0.3	10,000	0.3	-55/+125°C
SF1806C471SDNB-*	1806	470	+50/-20%	COG	100	0.3	10,000	0.3	-55/+125°C
SF1806X102SDNB-*	1806	1,000	+50/-20%	X7R	100	0.3	10,000	0.3	-55/+125°C
SF1806X222SDNB-*	1806	2,200	+50/-20%	X7R	100	0.3	10,000	0.3	-55/+125°C
SF1806X103SDNB-*	1806	10,000	+50/-20%	X7R	100	0.3	10,000	0.3	-55/+125°C
SF1806X223SDNB-*	1806	22,000	+50/-20%	X7R	100	0.3	10,000	0.3	-55/+125°C
2 AMP FILTER SF1806Y224ZBNE-*	1806	220,000	+80/-20%	Y5V†	50	2.0	1,000	0.04	-25/+85°C

Bold Letter = High Current Applications
† = Temperature Characteristic is +30/-80%

* = Denotes Packaging Style. Replace with T for Tape and Reel or B for Bulk

Surface Mount EMI Filters Three Terminal Chips



Mechanical Dimensions

Dimensions in inches (mm)

Body Style/Size	Body Length (L)	Body Width (W)	Body Thickness (T)	End Terminal Length (LE)	Middle Terminal Length (LM)
SF0603	0.063 +/-0.006 (1.60 +/-0.15)	0.031 +/-0.006 (0.80+/-0.15)	0.023 +/-0.006 (0.6+/-0.15)	0.008 +/-0.006 (0.2 +/-0.15)	0.020 +/-0.006 (0.5 +/-0.15)
SF0805	0.079 +/-0.008 (2.0 +/-0.2)	0.049 +/-0.008 (1.25 +/-0.2)	0.032 +/-0.008 (0.8 +/-0.2)	0.012 +/-0.008 (0.3 +/-0.2)	0.024 +/-0.008 (0.6 +/-0.2)
SF1205	0.126 +/-0.008 (3.2 +/-0.2)	0.049 +/-0.008 (1.25 +/-0.2)	0.028 +/-0.008 (0.7 +/-0.2)	0.016 +/-0.012 (0.4 +/-0.3)	0.043 +/-0.012 (1.1 +/-0.3)
SF1806	0.177 +/-0.012 (4.5 +/-0.3)	0.063 +/-0.012 (1.6 +/-0.3)	0.039 +/-0.012 (1.0 +/-0.3)	0.020 +/-0.012 (0.5 +/-0.3)	0.055 +/-0.012 (1.4 +/-0.3)

Ordering Information

Example: **SF0805C221SBNCT**

This part number represents a three terminal chip with a body size of 0805 with a COG (NPO) dielectric. The capacitance is 220 pF with a capacitance tolerance of +50%/-20%. Voltage rating is 50 Volts DC. It has nickel barrier, solder plated terminations and a current rating of 0.4 Amp, (400 milliamps). The parts are taped and reeled.

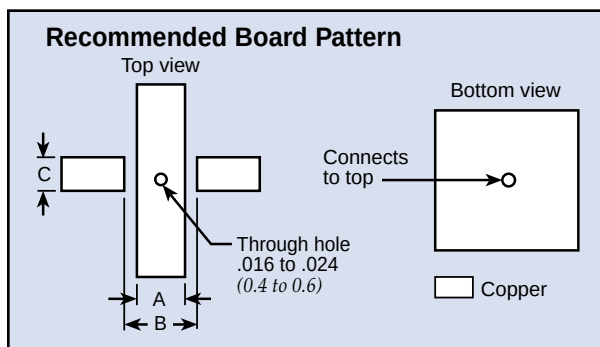
SF	0805	C	221	S	B	N	C	T
Style	Size	Ceramic	Capacitance Code	Capacitance Tolerance	Rated Voltage (Vdc)	Termination	Current Rating	Packaging
SF	0603 0805 1205 1806	C - COG X - X7R Y - Y5V	First Two Numbers are Significant, the Third Number Refers to Number of Zeroes	S - +50%/-20% Z - +80%/-20%	A - 25 B - 50 D - 100	N - Ni Barrier, Solder Plated	B - 0.3 A C - 0.4 A D - 1 A E - 2 A F - 3 A G - 4 A H - 5 A I - 6 A	T - Tape and Reel B - Bulk

Surface Mount EMI Filters

Three Terminal Chips Soldering Specifications

Soldering Instructions

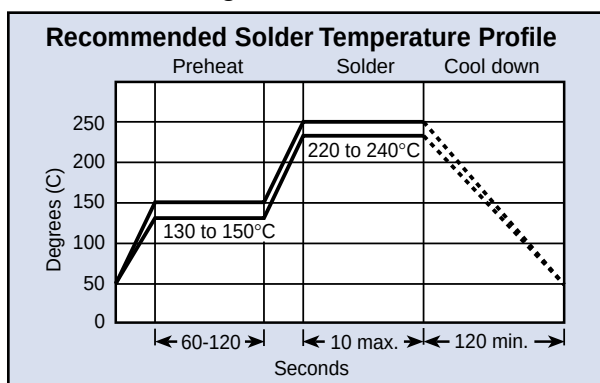
Reflow Soldering



Board Pattern Dimensions in inches (mm)

Body Style/Size	Dimension		
	A	B	C
SF0603	0.020 (0.5)	0.047 (1.2)	0.031 (0.8)
SF0805	0.024 (0.6)	0.059 (1.5)	0.039 (1.0)
SF1205	0.051 (1.3)	0.091 (2.3)	0.047 (1.2)
SF1806	0.079 (2.0)	0.138 (3.5)	0.051 (1.3)

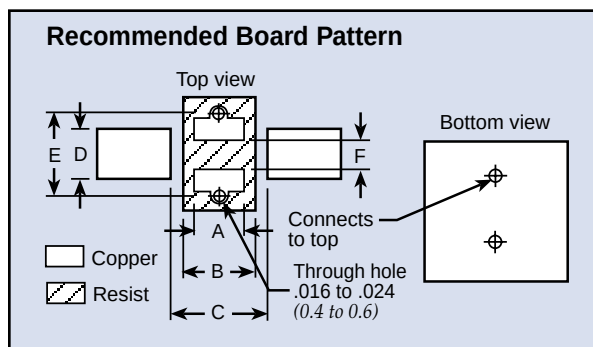
Reflow Soldering



General Soldering Notes

1. High soldering temperatures and long soldering times can cause leaching of the termination and adversely affect adhesion. These conditions can also decrease capacitance value. Use the above recommended solder temperature cycle.
2. Due to the mechanical characteristic of ceramic composition, aggressive thermal shock will degrade performance. Preheat the assembly before soldering using the above solder temperature profile as a guide.

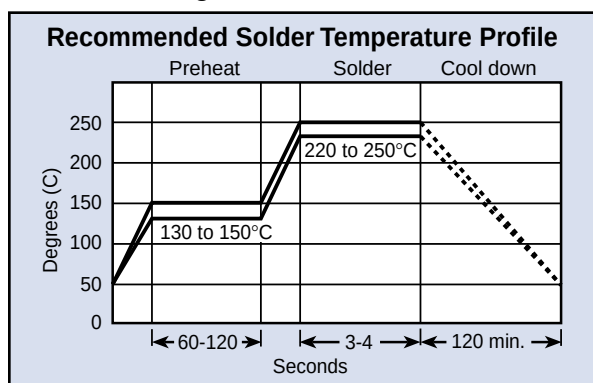
Flow Soldering



Board Pattern Dimensions in inches (mm)

Body Style/Size	Dimension					
	A	B	C	D	E	F
SF0603	0.020 (0.5)	0.031 (0.8)	0.047 (1.2)	0.031 (0.8)	0.071 (1.8)	0.016 (0.4)
SF0805	0.024 (0.6)	0.031 (0.8)	0.059 (1.5)	0.039 (1.0)	0.087 (2.2)	0.024 (0.6)
SF1205	0.051 (1.3)	0.059 (1.5)	0.091 (2.3)	0.047 (1.2)	0.118 (3.0)	0.024 (0.6)
SF1806	0.059 (1.5)	0.079 (1.5)	0.138 (3.5)	0.051 (1.3)	0.118 (3.0)	0.024 (0.6)

Flow Soldering



3. Use mild flux (less than 0.2% by weight of Chlorine), preferable rosin based. If water soluble, wash thoroughly to assure all residue is removed from the underside of components.
4. Ultrasonic Cleaning
When using an ultrasonic cleaning method, the following range is recommended:
Frequency: Not to exceed 28KHz
Output Power: Not to exceed 20W/liter
Cleaning Time: 5 minutes max

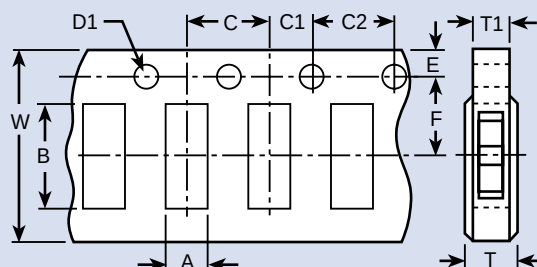
Three Terminal Chips Packaging Specifications

Package Quantities

Body Style/Size	Tape and Reel
SF0603	4,000 units/reel
SF0805	4,000 units/reel
SF1205	4,000 units/reel
SF1806	2,000 units/reel

Package Information

Paper Tape Dimensions SF0805 and SF1205 Bodies

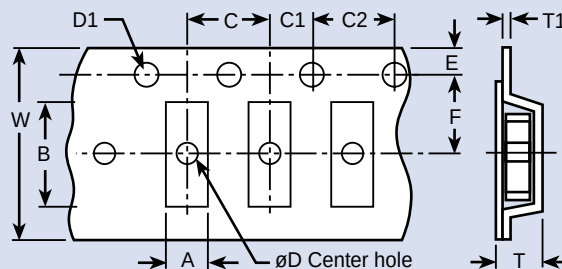


Dimensions in inches (mm)

Body Style/Size	Chip Cavity		Tape			Holes			Hole Diameter		Thickness	
	Length A	Width B	Width W	Center to End F	Indexing to End E	Center to Center C	Indexing to Center C1	Indexing to Indexing C2	Indexing D1		Overall T (Max.)	Carrier Tape T1 (Max.)
SF0603	0.039 +/-0.007 (1.0 +/-0.2)	0.075 +/-0.007 (1.9 +/-0.2)	0.315 +/-0.012 (8.0 +/-0.3)	0.138 +/-0.002 (3.5 +/-0.05)	0.069 +/-0.004 (1.75 +/-0.1)	0.157 +/-0.004 (4.0 +/-0.1)	0.079 +/-0.004 (2.0 +/-0.1)	0.157 +/-0.008 (4.0 +/-0.1)	0.059 +0.004/-0 (1.5 +/-0.1/-0)		0.043 (1.1)	0.039 (1.0)
SF0805	0.064 +/-0.008 (1.62 +/-0.2)	0.091 +/-0.008 (2.3 +/-0.2)	0.315 +/-0.012 (8.0 +/-0.3)	0.138 +/-0.002 (3.5 +/-0.05)	0.069 +/-0.004 (1.75 +/-0.1)	0.157 +/-0.004 (4.0 +/-0.1)	0.079 +/-0.004 (2.0 +/-0.1)	0.157 +/-0.008 (4.0 +/-0.1)	0.059 +0.004/-0 (1.5 +/-0.1/-0)		0.043 (1.1)	0.039 (1.0)
SF1205	0.067 +/-0.008 (1.70 +/-0.2)	0.138 +/-0.008 (3.5 +/-0.2)	0.315 +/-0.012 (8.0 +/-0.3)	0.138 +/-0.002 (3.5 +/-0.05)	0.069 +/-0.004 (1.75 +/-0.1)	0.157 +/-0.004 (4.0 +/-0.1)	0.079 +/-0.004 (2.0 +/-0.1)	0.157 +/-0.008 (4.0 +/-0.1)	0.059 +0.004/-0 (1.5 +/-0.1/-0)		0.043 (1.1)	0.039 (1.0)

Package Information

Tape and Reel Specification Plastic Carrier Tape Dimensions SF1806 Body



Dimensions in inches (mm)

Plastic Reel Dimensions

Dimensions in inches (mm)

Body Style/Size	Diameter (Max.)	Width (Max.)
SF0603	7.00 (180)	0.46 (11.5)
SF0805	7.00 (180)	0.46 (11.5)
SF1205	7.00 (180)	0.46 (11.5)
SF1806	7.00 (180)	0.61 (11.5)

Body Style/Size	Chip Cavity		Tape			Holes			Hole Diameter		Thickness	
	Length A	Width B	Width W	Center to End F	Indexing to End E	Center to Center C	Indexing to Center C1	Indexing to Indexing C2	Center D (Min.)	Indexing D1	Overall T (Max.)	Tape T1 (Max.)
SF1806	0.071 +/-0.008 (1.80 +/-0.2)	0.185 +/-0.008 (4.70 +/-0.2)	0.472 +/-0.008 (12.0 +/-0.2)	0.217 +/-0.002 (5.5 +/-0.05)	0.069 +/-0.004 (1.75 +/-0.1)	0.157 +/-0.004 (4.0 +/-0.1)	0.079 +/-0.004 (2.0 +/-0.1)	0.157 +/-0.008 (4.0 +/-0.1)	0.059 (1.5)	0.059 +0.004/-0 (1.5 +/-0.1/-0)	0.098 (2.5)	0.024 (0.6)

Surface Mount EMI Filters LC & LZ Type Chips

LC Features

- High efficiency EMI surface mount filter
- Ideally suited for high frequency signal lines
- Steep insertion loss (IL) characteristics
- Available in 0603, 0805 and 1206 body sizes

LC Typical Electrical Characteristics

Cut-off

Frequency Ranges 10 MHz to 220 MHz $\pm$ 20%

Rated Voltage 25 Volt

Rated Current 100 mA

IR 10 M Ω min.

Operating

Temperature Range -40°C to +85°C

LZ Features

- Monolithic construction of dielectric and ferrite materials
- Band stop filter with a choice of rejected frequency band
- Little delay and distortion from original signal wave
- Available in the 0402 and 0603 body sizes

LZ Typical Electrical Characteristics

Center

Frequency Ranges 10 MHz to 2,000 MHz $\pm$ 20%

Rated Current 50 mA and 100 mA

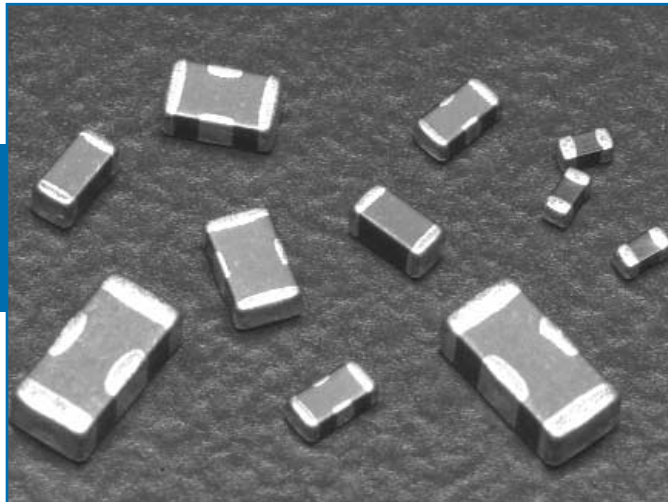
Rejected Bandwidth 0.5 dec. to 1.5 dec.

Operating

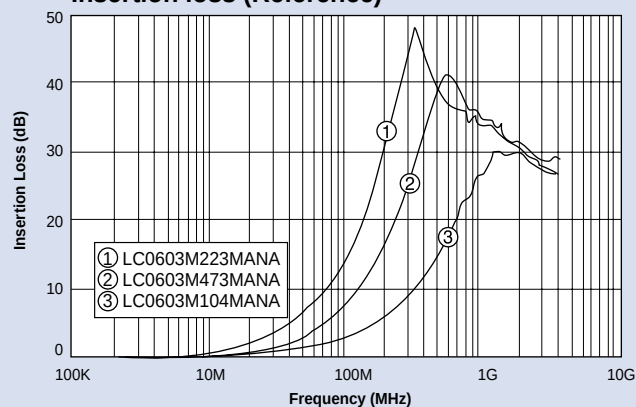
Temperature Range -25°C to +85°C

LC/LZ Applications

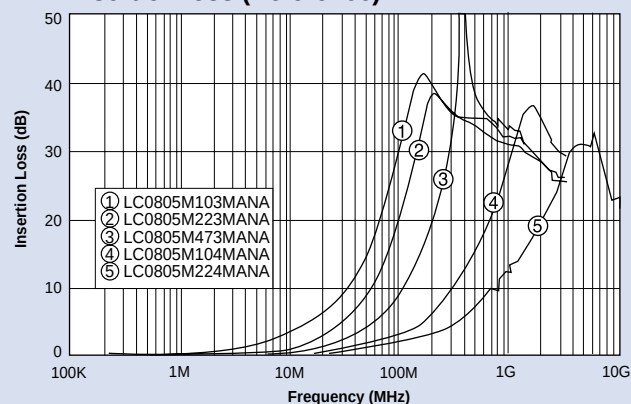
- Telecommunication equipment, fax, modem, and ADSL
- Computer and peripheral equipment
- Digital AV equipment, such as TV, VCR and DVD
- Digital circuit equipment noise countermeasure



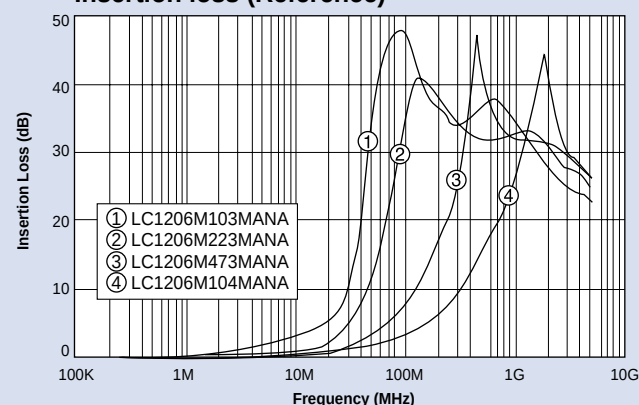
LC0603 Style Insertion loss (Reference)



LC0805 Style Insertion loss (Reference)



LC1206 Style Insertion loss (Reference)



Surface Mount EMI Filters

LC & LZ Type Chips

Specifications

Part Number	Body Size	Cut-off Frequency (MHz)	Cut-off Frequency Tolerance	Rated Voltage	Rated Current	I.R. (Min.)	Temperature Range
LC0603M223MANA-*	0603	22	± 20%	25 V	100 mA	10 MΩ	-40°C – +85°C
LC0603M473MANA-*		47					
LC0603M104MANA-*		100					
LC0805M103MANA-*	0805	10					
LC0805M223MANA-*		22					
LC0805M473MANA-*		47					
LC0805M104MANA-*		100					
LC0805M224MANA-*		220					
LC1206M103MANA-*	1206	10					
LC1206M223MANA-*		22					
LC1206M473MANA-*		47					
LC1206M104MANA-*		100					

* Denotes packaging style, replace with T for tape and reel or B for bulk

Ordering Information

Example: LC1206M223MANAT

This part number represents an LC EMI filter chip with a body size of 1206. The cut-off frequency is 22 MHz with a tolerance of ± 20%, voltage rating is 25 Volts DC. It has nickel barrier, solder plated termination and a current rating of 0.1 Amp (100 milliamps). The parts are taped and reeled.

LC	1206	M223	M	A	N	A	T
Style	Size	Cut-off Frequency	Cut-off Tolerance	Rated Voltage	Termination	Rated Current	Packaging
LC	0603 0805 1206	M223 = 22 MHz	M = ± 20%	A = 25 VDC	N = Ni Barrier, Solder Plated	A = 0.1 A (100 mA)	T = Tape and Reel B = Bulk

Surface Mount EMI Filters LC & LZ Type Chips

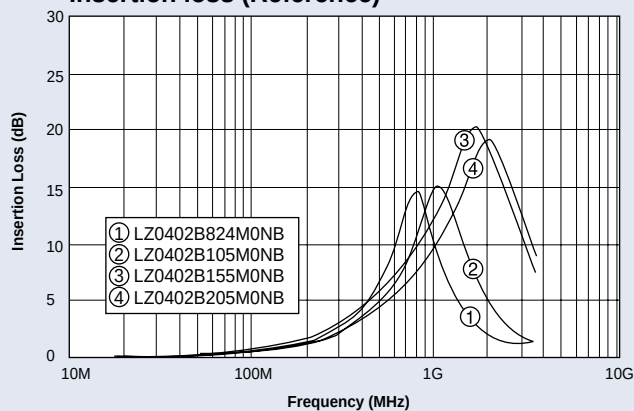
Specifications

Part Number	Body Size	Cut-off Frequency (MHz)	Cut-off Frequency Tolerance	Rejected Bandwidth (dec.)	Max. Insertion Loss	Rated Current	Operating Temperature Range
LZ0402Z824MBNB-* LZ0402B105MBNB-* LZ0402Y155MBNB-* LZ0402Y205MBNB-*	0402	820 1,000 1,500 2,000	± 20%	0.75 1.0 1.25 1.25	≥ 10 dB	50 mA	-25°C – +85°C
LZ0603A103MCNA-* LZ0603A223MCNA-* LZ0603A473MCNA-* LZ0603A104MCNA-* LZ0603B223MCNA-* LZ0603B104MCNA-* LZ0603B224MCNA-* LZ0603C474MDNA-*	0603	10 22 47 100 22 100 220 470		0.5 0.5 0.5 0.5 1.0 1.0 1.0 1.5	≥ 15 dB ≥ 20 dB	100 mA	

-* Denotes packaging style, replace with T for tape and reel or B for bulk

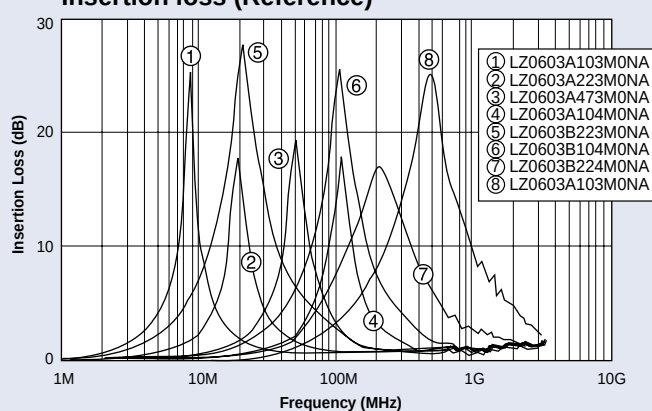
LZ0402 Style

Insertion loss (Reference)



LZ0603 Style

Insertion loss (Reference)



Ordering Information

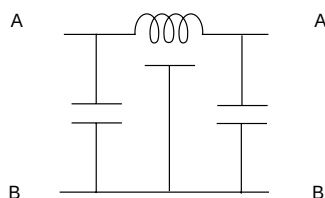
Example: **LZ0402B824MBNBT**

LZ	0402	B	824	M	B	N	A	T
Style	Size	Rejected Bandwidth	Center Frequency Tolerance	Center Frequency Loss	Max. Insertion	Termination	Rated Current	Packaging
LZ	0402 0603	A = 0.5 dec. Z = 0.75 dec. B = 1.0 dec. Y = 1.25 dec. C = 1.5 dec.	820 MHz	M = ±20%	B = ≥10 dB C = ≥15 dB D = ≥20 dB	N = Ni Barrier, Solder Plated	A=0.1A (100mA) B = 0.5A (50mA)	T = Tape and Reel B = Bulk

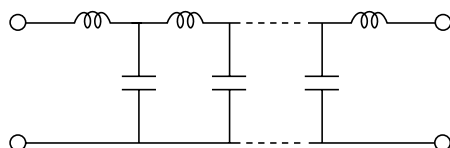
Surface Mount EMI Filters LC & LZ Type Chips

Circuit Schematic

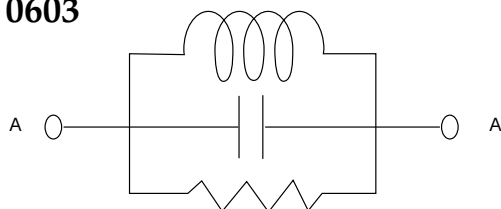
LC 0603



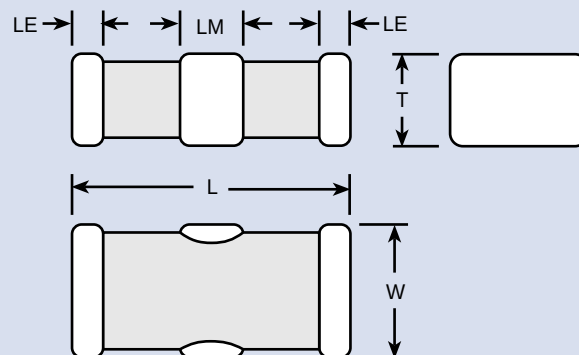
LC 0805 & 1206



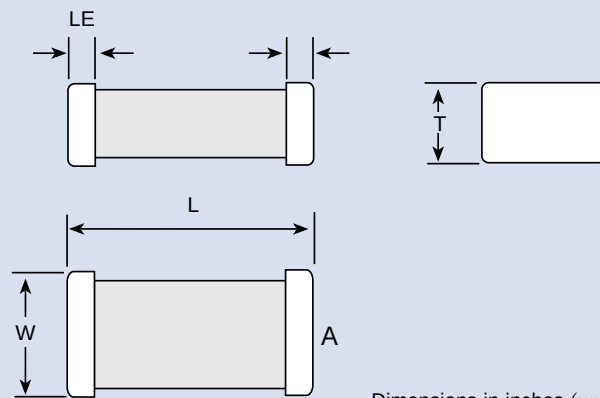
LZ 0402 & 0603



LC 0603, 0805 & 1206



LZ 0402 & 0603



Dimensions in inches (mm)

Mechanical Dimensions

Body Style/Size	Body Length (L)	Body Width (W)	Body Thickness (T)	End Terminal Length (LE)	Middle Terminal Length (LM)
LZ0402	0.039±0.002 (1.0±0.05)	0.020±0.002 (0.5±0.05)	0.020±0.002 (0.5±0.05)	0.010±0.004 (0.25±0.10)	
LZ0603	0.063±0.008 (1.60±0.20)	0.031±0.008 (0.80±0.20)	0.031±0.008 (0.80±0.20)	0.012±0.008 (0.30±0.20)	
LC0603	0.063±0.004 (1.60±0.10)	0.031±0.004 (0.80±0.10)	0.024±0.004 (0.60±0.10)	0.010±0.008 (0.25±0.20)	0.016±0.008 (0.40±0.20)
LC0805	0.079±0.007 (2.0±0.18)	0.049±0.004 (1.25±0.10)	0.031±0.008 (0.80±0.20)	0.012±0.010 (0.30±0.25)	0.024±0.012 (0.60±0.30)
LC1206	0.126±0.008 (3.20±0.20)	0.063±0.008 (1.60±0.20)	0.039±0.008 (1.0±0.20)	0.016±0.012 (0.40±0.30)	0.043±0.012 (1.10±0.30)

Dimensions in inches (mm)

Package Quantities

Body Style/Size	Tape and Reel
LZ0402	10,000 units/reel
LZ0603	4,000 units/reel
LC0603	4,000 units/reel
LC0805	4,000 units/reel
LC1206	2,000 units/reel

Surface Mount Filter Arrays SA Series

Features

- The filter's structure minimizes residual inductance with a high self resonant frequency, ensuring large insertion loss in a wide band.
- The common ground electrode built into the chip ensures complete grounding of all lines at the ground on both ends. The filter is designed to control cross talk.
- An optimum constant can be selected from the capacity range of 22-22,000 pF to best suit the frequency.
- Solder plated nickel barrier terminations offer good solderability and resistance to soldering heat.
- Available lead free/RoHs Compliant

Applications

- Noise reduction for DC lines on computers
- Computer peripheral equipment
- Digital TV & VTR
- Cellular telephones
- Automotive electronics

Typical Electrical Characteristics

Rated Voltage 25 VDC to 50 VDC

Rated Current 0.3 Amps

IR 10,000 MΩ Min.

DC Resistance 0.3 Ω Max.

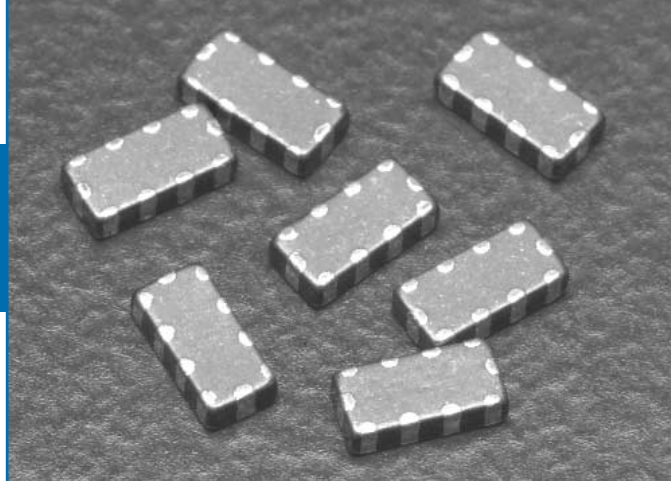
Temperature Range -55°C to +125°C

Capacitance Range 22 pF to 22,000 pF

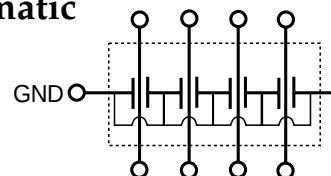
Capacitance Tolerance ±20%

Specifications

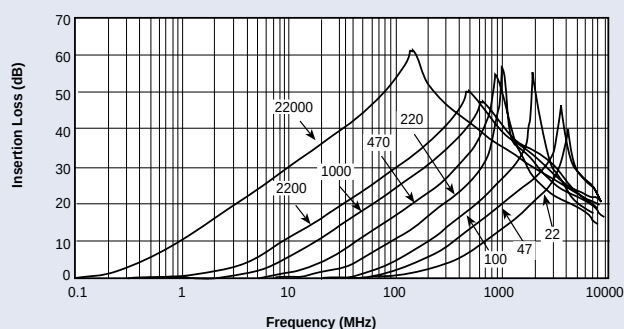
Part Number	Rated Voltage (@ 50/60Hz)	Rated Current	Temperature Characteristic	IR	DC Resistance	Operating Temp	Capacitance (pF)
SA1206C220	50 VDC	0.3A DC	C	10,000 MΩ min.	0.3Ω max.	-55/+125°C	22
SA1206C470			C				47
SA1206C101			C				100
SA1206C221			C				220
SA1206U471			U				470
SA1206R102			R				1,000
SA1206R222			R				2,200
SA1206R223	25 VDC		R				22,000



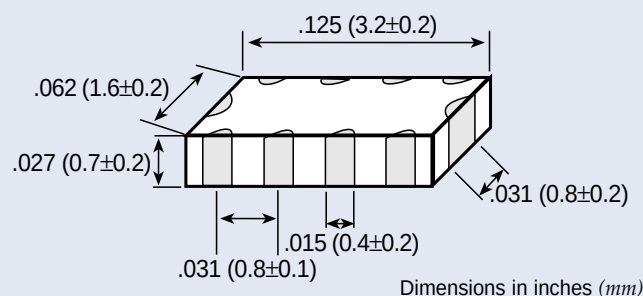
Circuit Schematic



Insertion Loss



Dimensions



Surface Mount Filter Arrays

SA Series

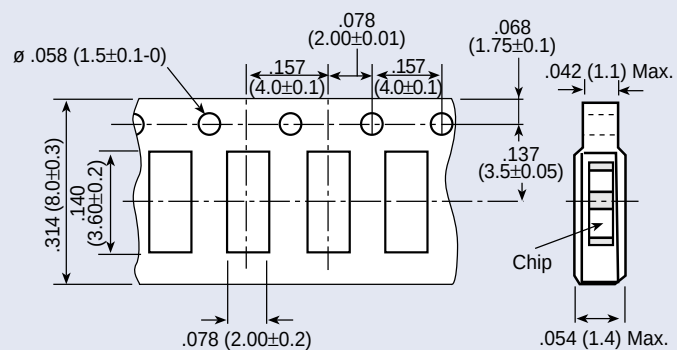
Ordering Information

SA	1206	C	220	M	B	N	B									
Style	Size	Temperature Characteristics	Capacitance	Capacitance tolerance	Rated Voltage (Vdc)	Termination	Packaging									
SA Series	1206	C +/- 30 ppm/°C R +/- 15% U -750 +/- 120 ppm/°C	<table><tr><th>Capacitance</th></tr><tr><td>22 pF</td></tr><tr><td>47 pF</td></tr><tr><td>100 pF</td></tr><tr><td>220 pF</td></tr><tr><td>470 pF</td></tr><tr><td>1,000 pF</td></tr><tr><td>2,200 pF</td></tr><tr><td>22,000 pF</td></tr></table>	Capacitance	22 pF	47 pF	100 pF	220 pF	470 pF	1,000 pF	2,200 pF	22,000 pF	M = ± 20%	A = 25 B = 50	N = Ni Barrier Solder Plated	T - Tape and reel 4,000 pc/reel B - Bulk pack 1,000 pcs/bag
Capacitance																
22 pF																
47 pF																
100 pF																
220 pF																
470 pF																
1,000 pF																
2,200 pF																
22,000 pF																

SA Tape and Reel Packaging

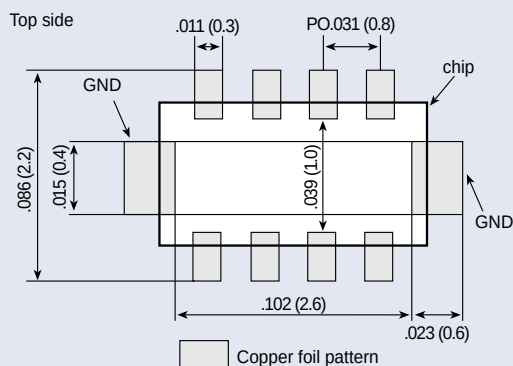
070

SA Tape and Reel Packaging

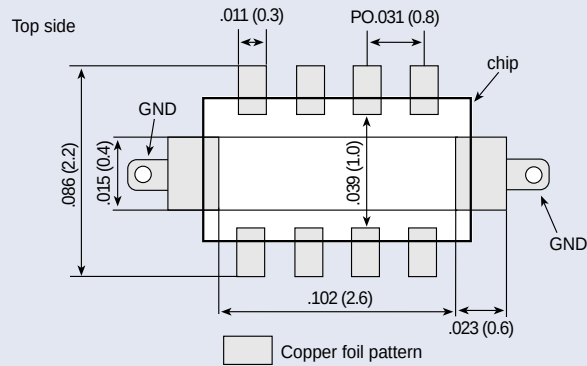
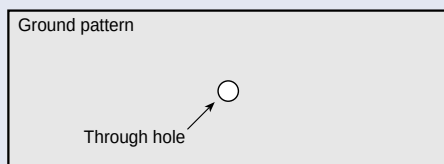


Dimensions in inches (mm)

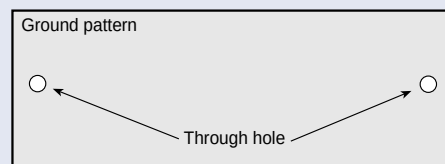
Recommended Board Pattern



Bottom side



Bottom side

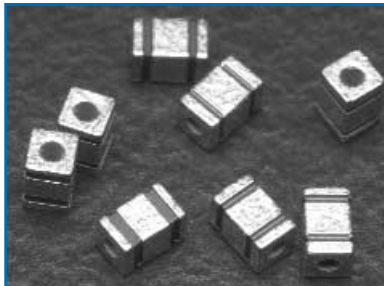


Dimensions in inches (mm)

Surface Mount Low Pass Filters

MSM, SSM, RSM & PSM Series

MSM - Miniature Surface Mount Chip Capacitors



The MSM series filters feature high temperature construction and have current ratings up to 10 Amps. The filter chips will hardly allow residual inductance and the self-resonant frequency extends to the microwave band. Applications include telecommunication equipment, computer and peripheral equipment and digital AV equipment, medical equipment, DC power supply lines.

- Miniature footprint help in dense circuit configuration
- Rated at 10 Amps
- Packaged in tape and reel or bulk form
- Operating temperature ranges of -25°C to +85°C and -55°C to +125°C
- Available lead free/RoHs Compliant

SSM - Square Surface Mount Filters



The SSM series filters feature high temperature construction and have current ratings up to 10 Amps. The filter chip series are non-polar and surface mountable with excellent performance characteristics and come in a Pi circuit configuration. Applications include telecommunication equipment, computer and peripheral equipment, digital AV equipment, power amplifiers, power supplies and high current bus lines.

- Square mechanical geometry enhances SMT soldering
- Rated to 10 Amps
- Packaged in tape and reel or bulk form
- Operating temperature range of -55°C to +125°C
- Available lead free/RoHs Compliant

RSM - Round Surface Mount Filters



The RSM series filters feature high temperature construction and have current ratings up to 10 Amps. The filter chip series are non-polar and surface mountable with excellent performance characteristics and come in a Pi circuit configuration. Applications include telecommunication equipment, computer and peripheral equipment, digital AV equipment, power amplifiers, power supplies and high current bus lines.

- Round mechanical geometry enhances SMT soldering
- Rated to 10 Amps
- Packaged in tape and reel or bulk form
- Operating temperature range of -55°C to +125°C
- Available lead free/RoHs Compliant

PSM - Power Surface Mount Filters

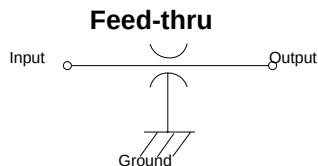


The PSM series filters feature high temperature construction and have current ratings up to 20 Amps. This filter series is non-polar and surface mountable with excellent performance characteristics and come in either a Feed-thru or Pi circuit configuration. Applications include telecommunication equipment, computer and peripheral equipment, digital AV equipment, power amplifiers, power supplies and high current bus lines.

- Provides time and costs saving compared to thru-hole filters
- Rated to 20 Amps
- Packaged in tape and reel or bulk form
- Operating temperature range of -55°C to +125°C
- Available lead free/RoHs Compliant



MSM



Working Voltage 50 VDC
Test Voltage 150 VDC
Current Rating 10 Amps max.
Insulation Resistance 1.0 MΩ
Terminations Ni-Barrier
Soldering Conditions Max. 250°C-5 sec.

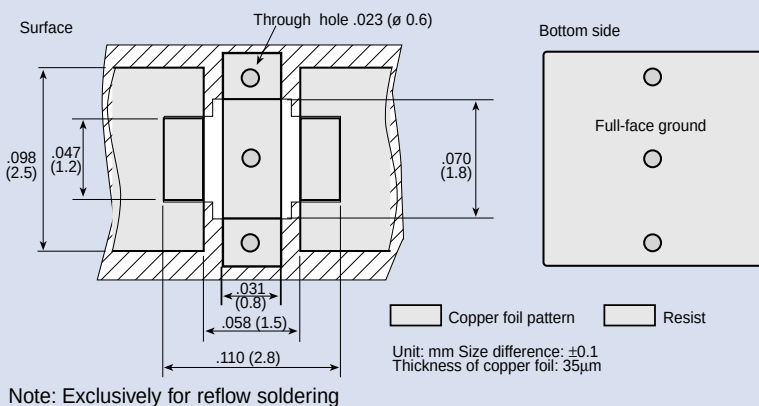
MSM Ordering Information

MSM	4	T	470M	10	T				
Style	Circuit Configuration	Temperature Characteristic	Capacitance	Current Rating	Packaging				
MSM (Miniature)	4 - Feed-thru	R - +/-15% T - +22/-33% V - +22/-82%	<table><tr><th>Value</th><th>Tolerance</th></tr><tr><td>47 pF</td><td>+50/- 20%</td></tr></table>	Value	Tolerance	47 pF	+50/- 20%	10 Amps	T - Tape and Reel 2,000 pcs/reel B - Bulk pack 1,000pcs/reel
Value	Tolerance								
47 pF	+50/- 20%								

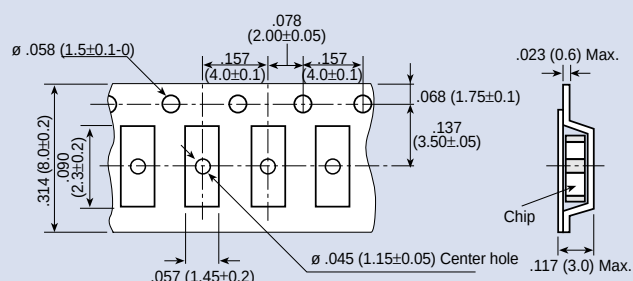
Specifications

Part Number	Temperature Characteristics	Capacitance	Capacitance Tolerance	Current Rating	Rated Rating	Temperature Range
MSM4T470M10	T	47pF	+50/-20%	10A	50VDC	-55/+125°C
MSM4R151M10	R	150pF				-55/+125°C
MSM4R271M10	R	270pF				-55/+125°C
MSM4V102M10	V	1000pF				-25/+85°C

MSM Recommended Board Pattern

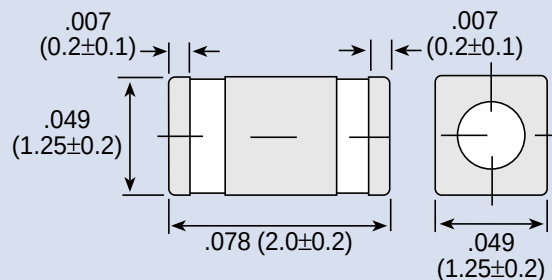
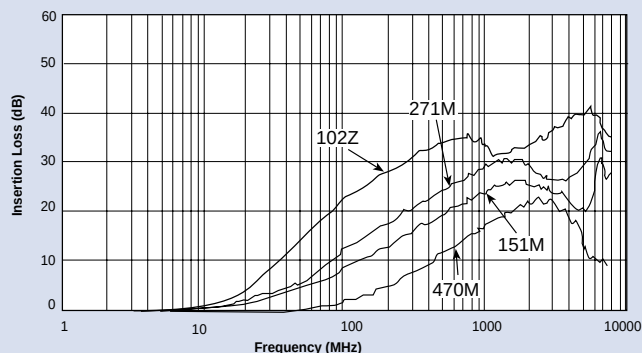


MSM Tape and Reel Packaging



Dimensions in inches (mm)

Insertion Loss

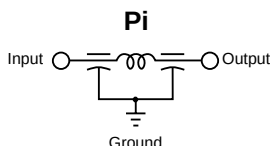


MSM

Dimensions in inches (mm)

Surface Mount Low Pass Filters SSM & RSM Series

SSM



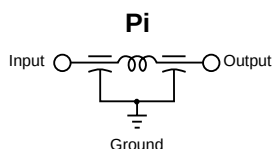
Working Voltage 100 VDC
 Test Voltage 250 VDC
 Current Max. 10 Amps
 Insulation
 Resistance Min. 10^4 M Ω
 Terminations Silver Plated
 Soldering
 Conditions Max. 250°C -5 sec.
 Marking None
 Packaging Bulk or Tape and Reel

Note: Insertion loss shown for the following SSM values* only:

101Z
 501P
 202P

*Additional IL charts available by request.

RSM



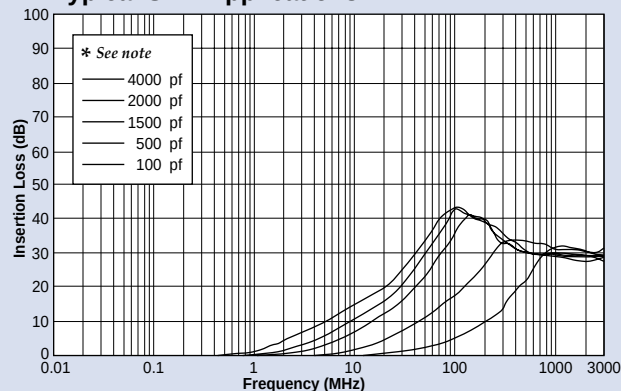
Working Voltage 100 VDC
 Test Voltage 250 VDC
 Current Max. 10 Amps
 Insulation
 Resistance Min. 10^4 M Ω
 Terminations Silver Ni-Tin plated
 Soldering
 Conditions Max. 250°C -5 sec.
 Marking None
 Packaging Bulk or Tape and Reel

Note: Insertion loss shown for the following RSM values only:

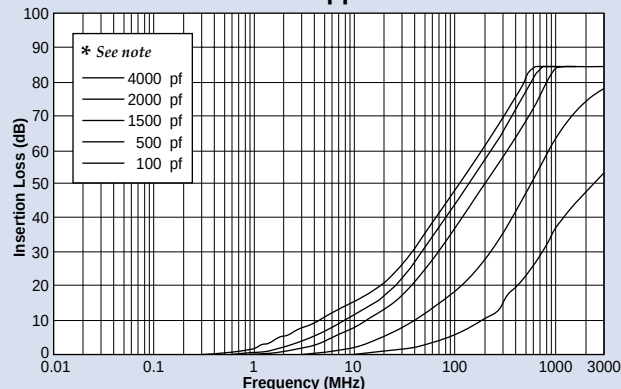
152P
 402Z

Pi Insertion Loss

Typical SMT Applications

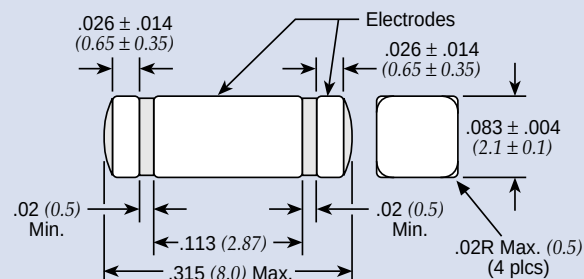


Shielded or Partition Applications

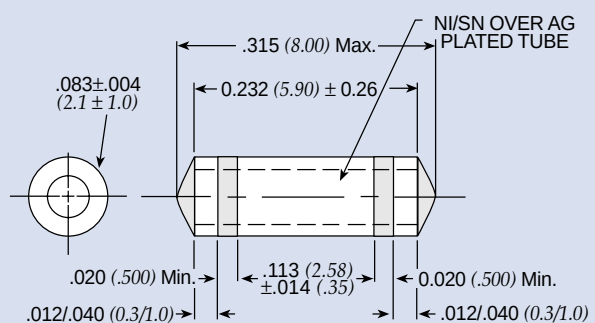


* Capacitance values for insertion loss curves are displayed left to right in the order shown.

SSM



RSM



Dimensions in inches (mm)

Surface Mount Low Pass Filters SSM & RSM Series

SSM & RSM Ordering Information

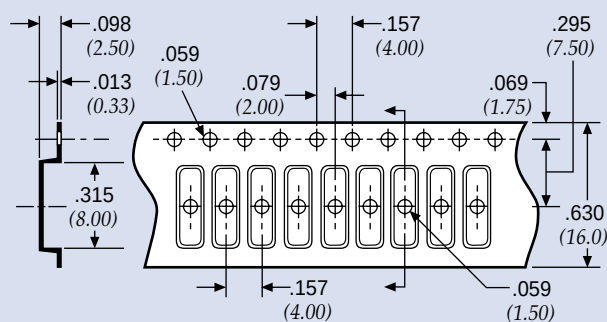
Example: **SSM1-101Z-05T 1**

SSM	1	-	101Z	-	05	T	1
Style	Circuit Configuration		Capacitance		Current Rating	Packaging	Tape and Reel
SSM (Square) RSM (Round)	1 - Pi				05 - 5 Amps 10 - 10 Amps	T - Tape and reel packaging B - Bulk packaging	1 - 1,000 pieces 6 - 6,000 pieces <i>Note: Tape and reel packaging - 1,000 pieces (7") and 6,000 pieces (13")</i>

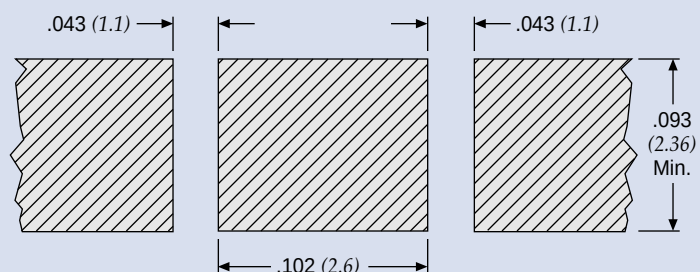
Code	Value	Tolerance
101Z	100 pF	+80/-20%
501P	500 pF	+100/-0%
152P	1500 pF	+100/-0%
202P	2000 pF	+100/-0%
402E	4000 pF	±25
402Z	4000 pF	+80/-20%

† Also available through Spectrum Control's authorized distributors.
 € Also available through Spectrum Control's authorized European distributors/agents.
 † SSM1-152P-05-T1 €

SSM/RSM Tape and Reel Packaging



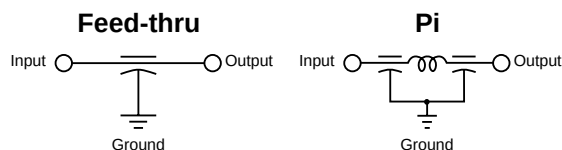
SSM Recommended Board Pattern



Dimensions in inches (mm)

Surface Mount Low Pass Filters PSM Series

PSM



Voltage Rating * 200 VDC @ -55°C to +125°C

DWV 700 VDC

Current

Rating 20 Amps (Feed-thru) max.
10 Amps (Pi) max.

Insulation

Resistance 1.0 GΩ @ 25°C

Dissipation

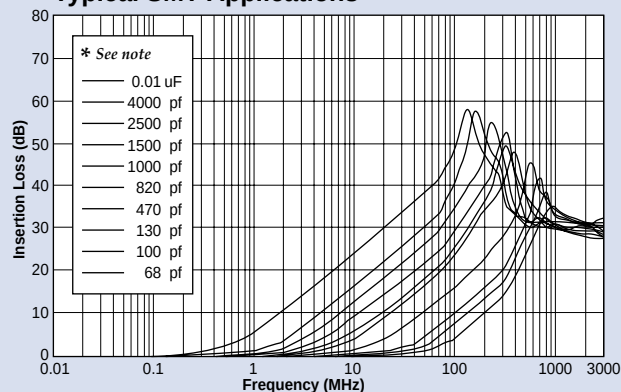
Factor 4.0% maximum

D.C.R. Max. .0005Ω, typ. .0002Ω

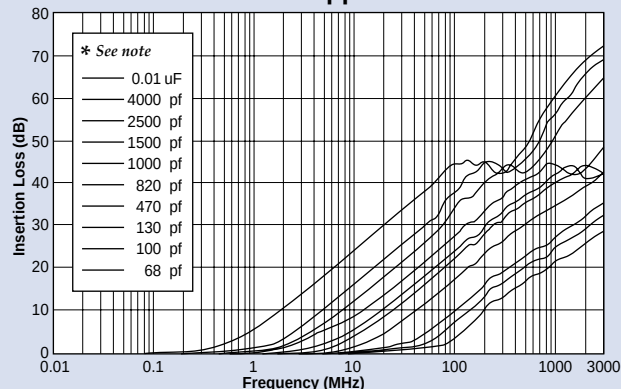
* AC rating available - consult factory.

Feed-thru Insertion Loss

Typical SMT Applications

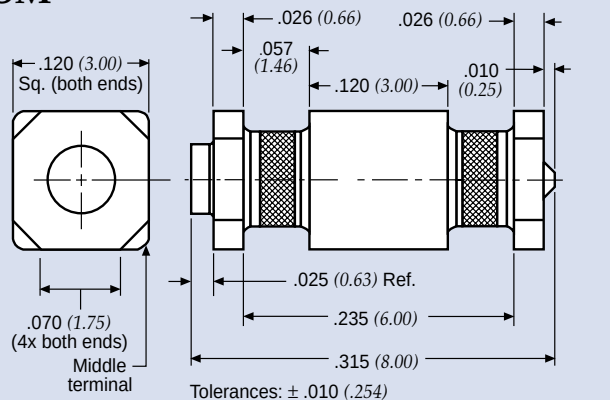


Shielded or Partition Applications



* Capacitance values for insertion loss curves are displayed left to right in the order shown.

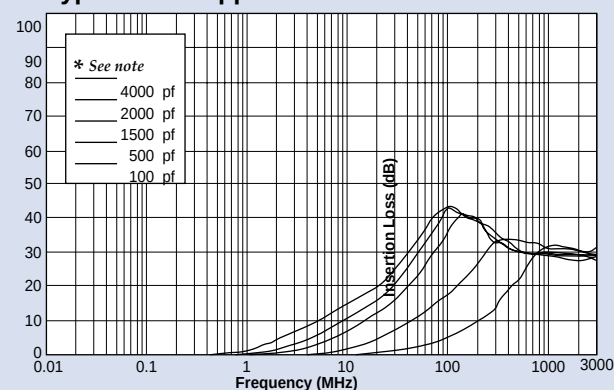
PSM



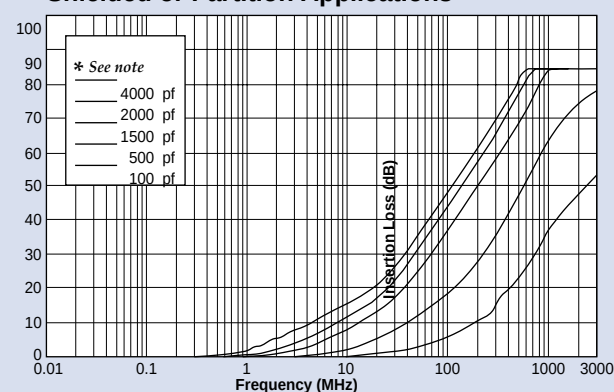
Dimensions in inches (mm)

Pi Insertion Loss

Typical SMT Applications



Shielded or Partition Applications



Surface Mount Low Pass Filters PSM Series

PSM Ordering Information

Example: **PSM4-402Z-20T0**

PSM	4	-	402Z	-	20	T	0
Style	Circuit Configuration		Capacitance		Current Rating	Packaging	Tape and Reel
PSM (Power)	1 - Pi 4 - Feed-thru				10 - 10 Amps (Pi) 20 - 20 Amps (Feed Thru)	T - Tape and reel packaging B - Bulk packaging	0 - 500 pieces 2 - 2,000 pieces <i>Note: Tape and reel packaging - 500 pieces (7") and 2,000 pieces (13")</i>
† Also available through Spectrum Control's authorized distributors.							
€ Also available through Spectrum Control's authorized European distributors/agents.							
† PSM1-402Z-10T0 €							
† PSM4-103Z-20T0 €							
† PSM4-152M-20T0 €							
† PSM4-402Z-20T0 €							
			Code	Value*	Tolerance		
			680M	68 pF	±20%		
			101M	100 pF	±20%		
			131P	130 pF	+100/-0%		
			471P	470 pF	+100/-0%		
			821M	820 pF	±20%		
			102M	1000 pF	±20%		
			152M	1500 pF	±20%		
			252P	2500 pF	+100/-0%		
			402Z	4000 pF	+80/20%		
			103Z**	.01 µF	+80/-20%		

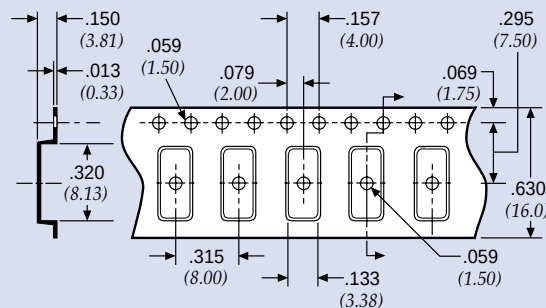
* Other capacitance values available as special order.

** Available in Feed-thru circuit only.

Technical Notes

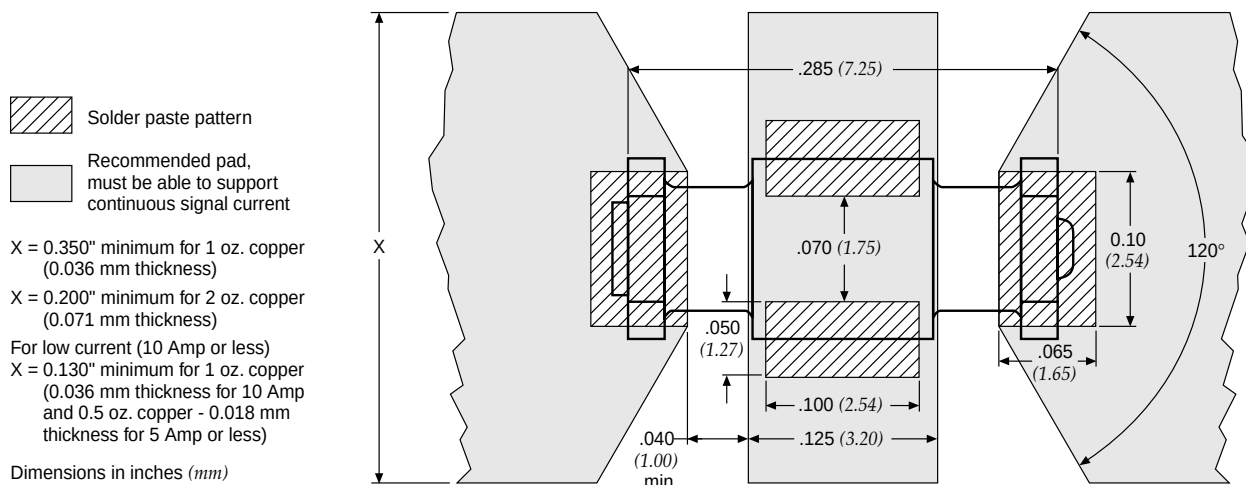
- Soldering recommendations supplied upon request
- Reflow temperature limit is 250°C
- Unit weight is approximately 0.4 grams
- Tape and reel packaging available for automated assembly

PSM Tape and Reel Packaging



Dimensions in inches (mm)

PSM Recommended Board Pattern



Thru-hole Filters

High Frequency PCB Filters

The economical High Frequency PCB Filter offers electrical characteristics which allow many devices to meet most government and industry specifications for EMI control, while providing good electrostatic discharge protection.

A lossy ferrite filter with a center ground lead is terminated within the filter's thermoset epoxy body.

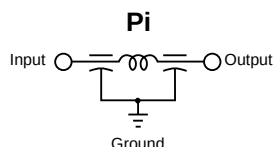
The High Frequency PCB Filter offers savings three ways. First is the low cost of the filter assembly. Second is the economy of installation. Three silver plated leads are inserted into holes in a printed circuit board which has a ground path circuit, for conventional flows-soldering with other components. No special mounting plate or brackets are needed and when the holes are placed as recommended in a .062 (1.57mm) thick board, no lead trimming is required. Elimination of hand soldering provides opportunities for improved quality in addition to applied-cost benefits.

A third savings results from placing a filter at the source of an EMI problem, potentially eliminating the need for additional filtering at other points in the circuit.

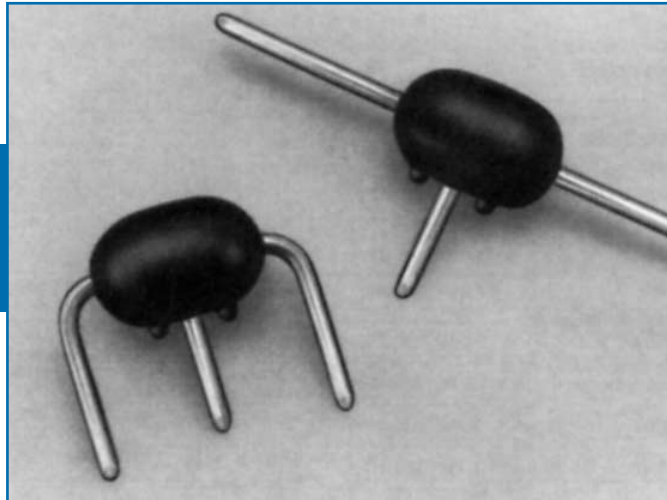
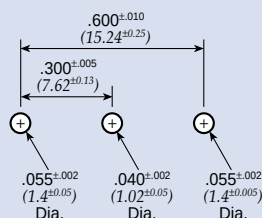
Features

- Provides EMI filtering to protect low power digital circuits - helps equipment meet FCC and VDE specifications
- Mounts directly to printed circuit board with no bracket or plate for lower applied costs - can be flow soldered with other components
- Encapsulated for environmental protection
- Mounts on PCB to begin filtering at the source of the problem
- Built-in standoffs permit cleaning or coating under the filter

Schematic



Recommended PCB Hole Layout



Typical Electrical Characteristics

Current Max. 10A DC; 0.3A RF
 Operating Voltage Max. 50 VDC, -25°C +85°C
 Capacitance 800 pF min.
 Dissipation Factor 0.1 Max.
 Dielectric
 Withstanding Voltage 125 VDC for 5 seconds
 Insulation Resistance Min. 100 MΩ at 100 VDC
 for 2 minutes and 25°C

Direct Current

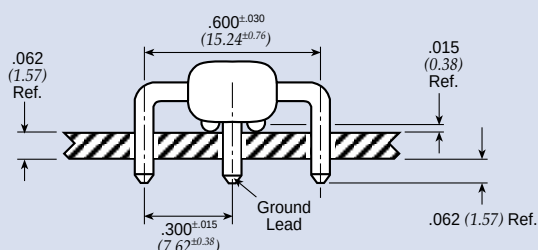
Resistance 0.002 Ohms Max.

Minimum No-Load

Insertion Loss Per MIL-STD-220 at 25°C; PCB
 mounted, 50 Ohm strip line
 3dB @ 8 MHz
 10dB @ 25 MHz
 15dB @ 50 MHz
 20dB @ 100 MHz-1GHz

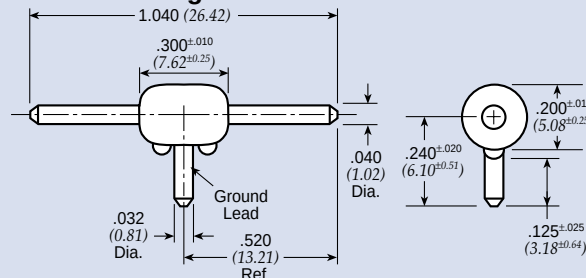
Preformed to Recommended Mounting Configuration Part Number 842448-2

Recommended Mounting Configuration



Dimensions in inches (mm)

Standard Configuration Part Number 842448-1



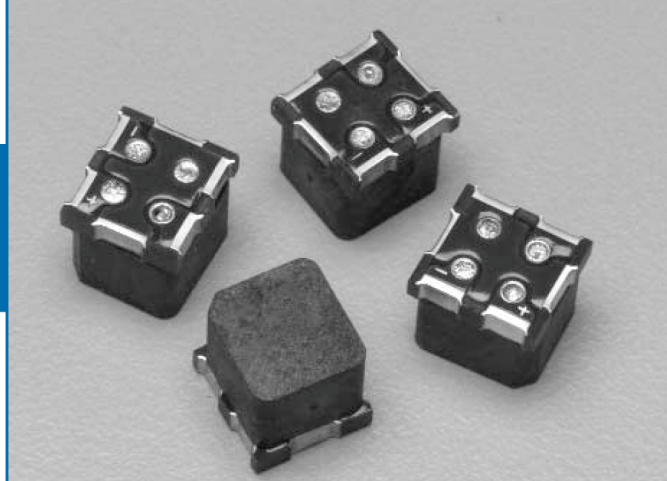
Mini Surface Mount Power Filters MSP Series

Features

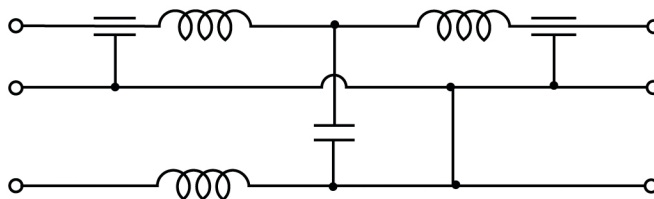
- Designed for 10A DC power lines
- Offers high insertion loss in a wide frequency band by combining feed through capacitors, multilayer ceramic capacitors and ferrite bead inductors with high self resonance frequency.
- Compact EMI package with plus and minus lines

Applications

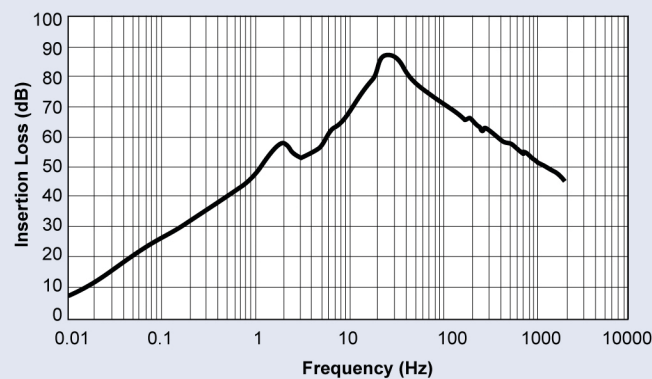
- Electronic measuring instruments
- Industrial equipment
- Automotive electronics
- Switching power supplies
- DC-DC converters



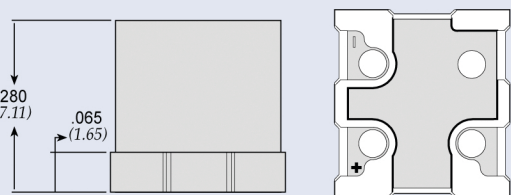
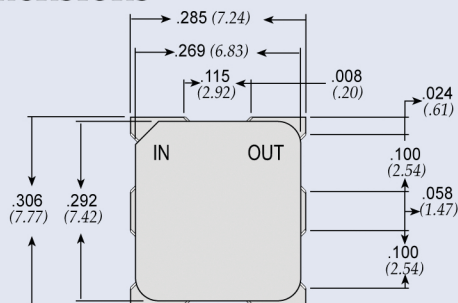
Circuit Schematic



Insertion Loss



Dimensions



Dimensions in inches (mm)

Specifications

Model	Rated Voltage	Rated Current	Max. DCR	Temperature Range
MSP	50VDC	10A	5 MΩ	-25°C ~ +105°C

Miniature PCB Power Filters MPC Series



Tested and found to be
IAW VDE 0565 Part 3

61-MPC Series

Rugged construction design enables parts to perform in industrial environments. The 61-MPC series is ideally suited for products that must conform to FCC part 15 regulations. Agency approvals: UL recognized, CSA certified, TUV approved (tested and found to be in accordance with VDE 0565 Part 30. Applications include;

- Personal computers and peripherals
- Measuring instruments
- Home appliances and vacuum cleaners
- Monitor and display units
- Switching power supplies
- Available lead free/RoHS Compliant

11-MPC Series

Power filters are available in PCB mount, bolt-in, fast-on tab or solder lug. The 11-MPC series is ideally suited for products that have been limited board space and require a low cost alternative. Available in both metal and plastic cases. Applications include;

- Personal computers and peripherals
- Digital equipment
- Measuring instruments and medical equipment
- TV & VCR monitors and display units
- Available lead free/RoHS Compliant

MPC-010/-015 Series

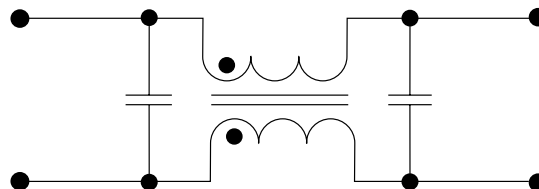
The compact design of the MPC-010 and -015 series power filters integrates a feed thru capacitor, multilayer ceramic capacitor and ferrite bead inductors. This series is ideally suited for dense PCBs and where both positive and negative lines have reduce EMI in one housing. Applications include;

- DC power lines on industrial equipment
- Measuring instruments
- Home appliances and vacuum cleaners
- Monitor and display units
- Switching power supplies
- Available lead free/RoHS Compliant

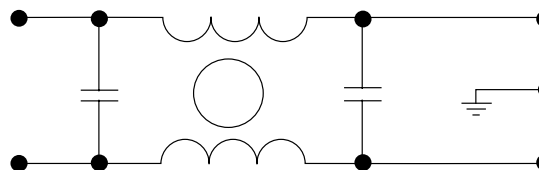


Circuit Diagrams

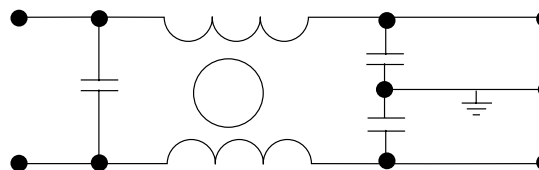
Circuit 1



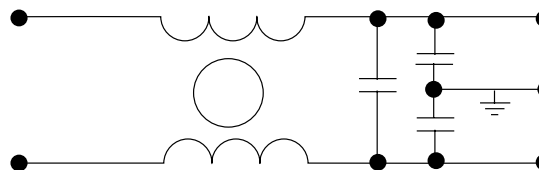
Circuit 2



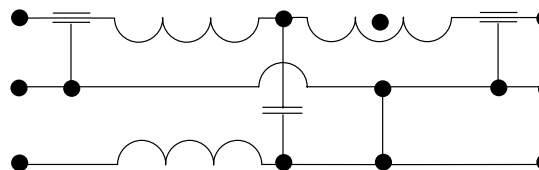
Circuit 3



Circuit 4



Circuit 5



Miniature PCB Power Filters

MPC Series

Specifications

Model	Rated Voltage (@ 50/60Hz)	Rated Current	Leakage Current (Max.)	Inductance (L ₁)	Temperature Rise (Max.)	Circuit Diagram	Figure
61-MPC-010-1-11	250VAC	1A	0.1mA	11mH	40°C	1	A
61-MPC-016-1-11		1.6A		6.0mH			
61-MPC-025-1-11		2.5A		2.4mH			
61-MPC-036-1-11		3.6A		1.2mH			
11-MPC-001-2-B	120/250VAC	1A	5uA	————	30°C	2	C
11-MPC-001-5-A			0.50mA			3	B
11-MPC-001-5-B							C
11-MPC-002-5-B		2A				4	E
11-MPC-002-5-D							F
11-MPC-003-5-E		3A				3	C
11-MPC-006-5-B		6A					D
11-MPC-006-5-C							C
11-MPC-016-5-B		16A	0.2mA			4	C
MPC-010-050	50 VDC	10A	————	————	————	5	G
MPC-010-250	250 VDC						
MPC-015-050	50VDC						

Note: Test voltage: 1500VAC one minute, line to ground. Insulation resistance: 300 MΩ min. at 500VDC. Voltage drop: 1V max. at rated current. Weight: 17.5g

Figure A

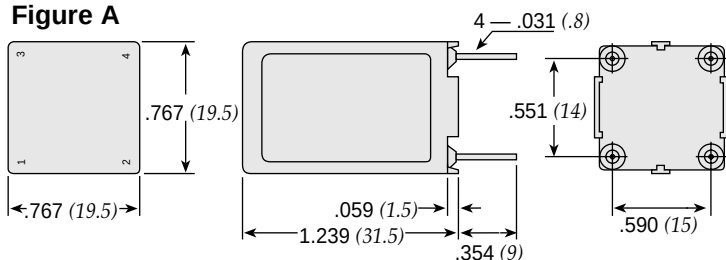


Figure B

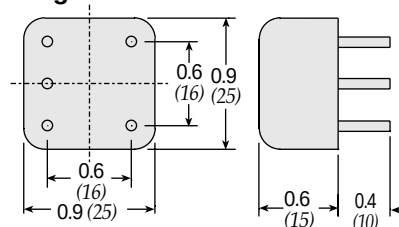


Figure C

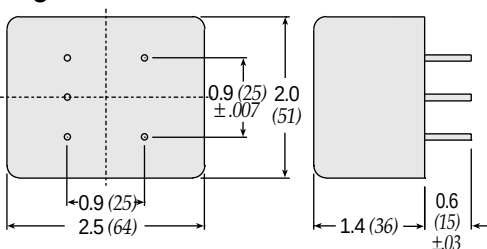


Figure D

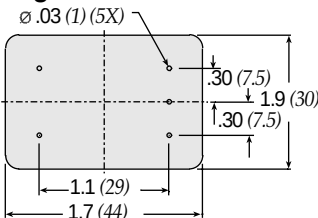


Figure E

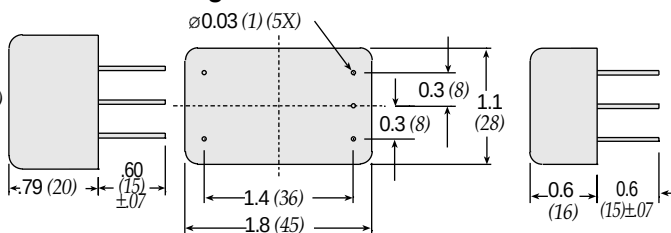


Figure F

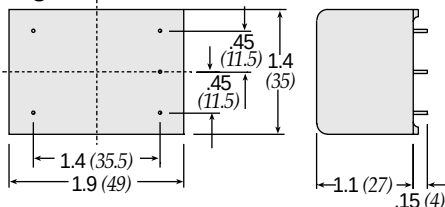
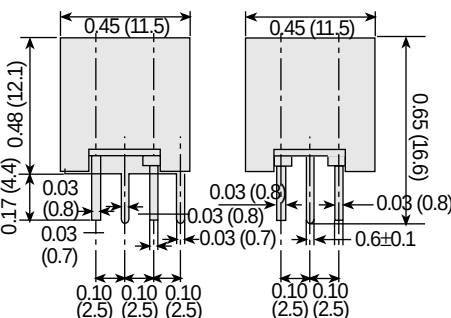


Figure G

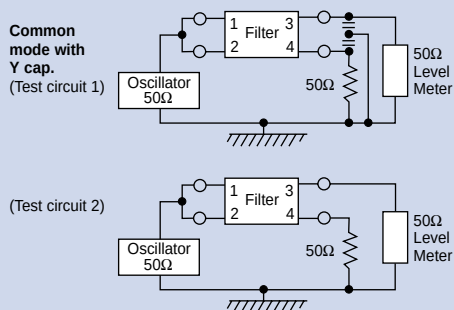


Dimensions in inches (mm)

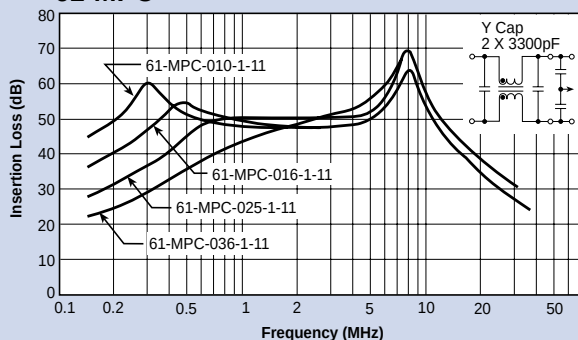
Miniature PCB Power Filters MPC Series

61-MPC Series

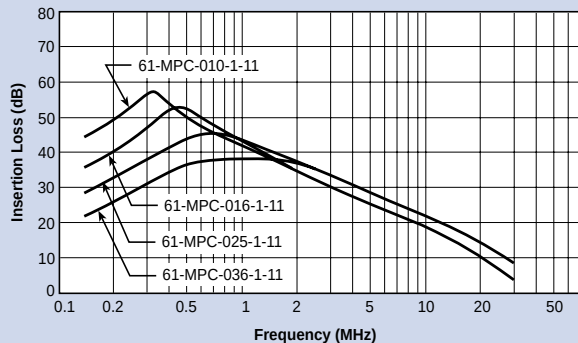
Common Mode



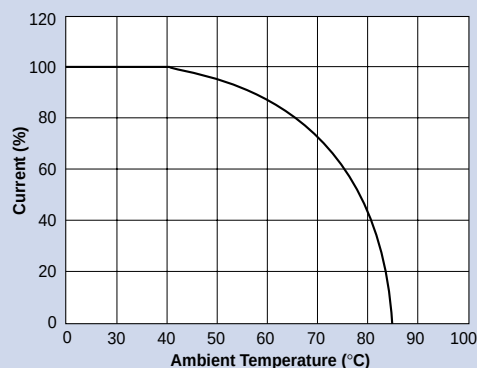
61-MPC



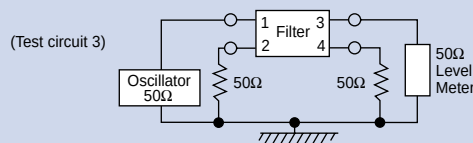
61-MPC



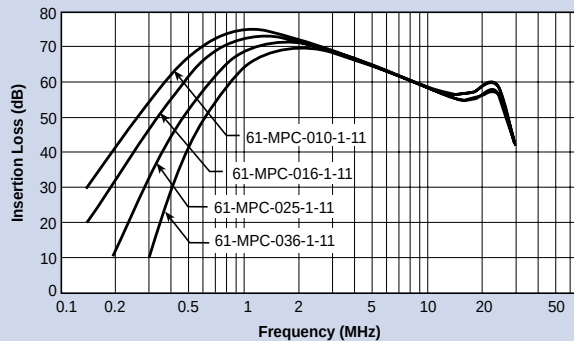
Temperature Characteristics



Normal Mode



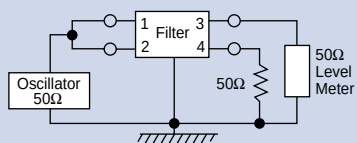
61-MPC



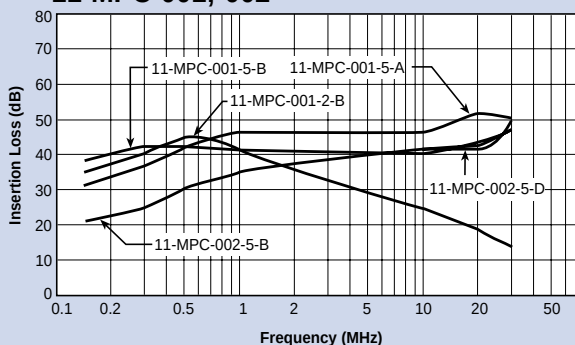
Miniature PCB Power Filters MPC Series

11-MPC Series

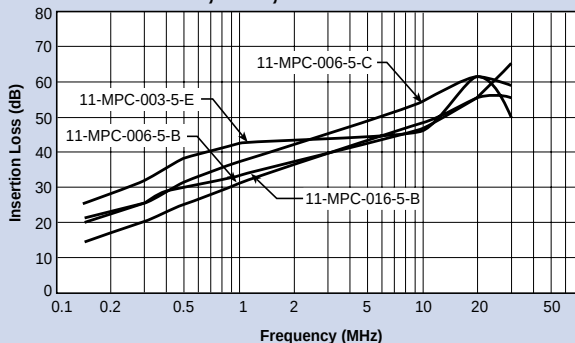
Common Mode



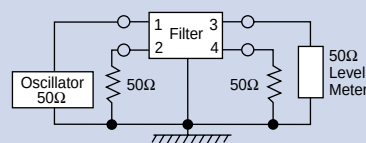
11-MPC-001;-002



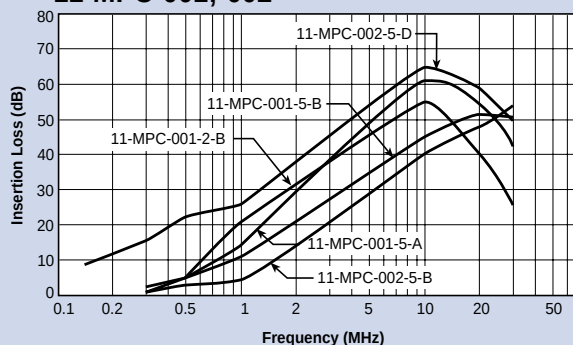
11-MPC-003;-006;-016



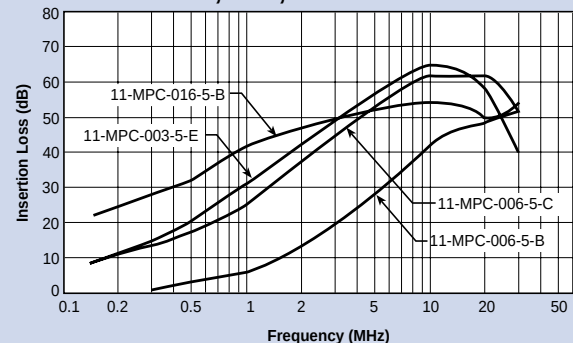
Normal Mode



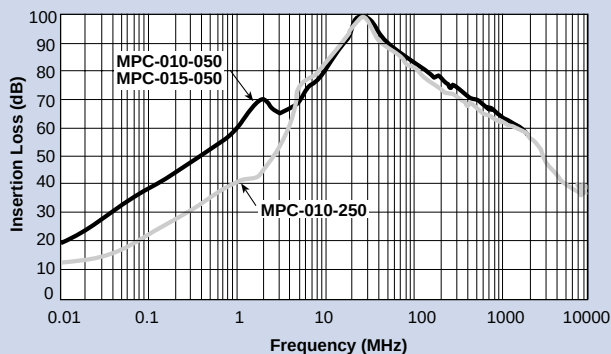
11-MPC-001;-002



11-MPC-003;-006;-016



MPC-010 & 015 Series



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