Technical Note

Philips Magnetic Products

Multilayer Suppressors

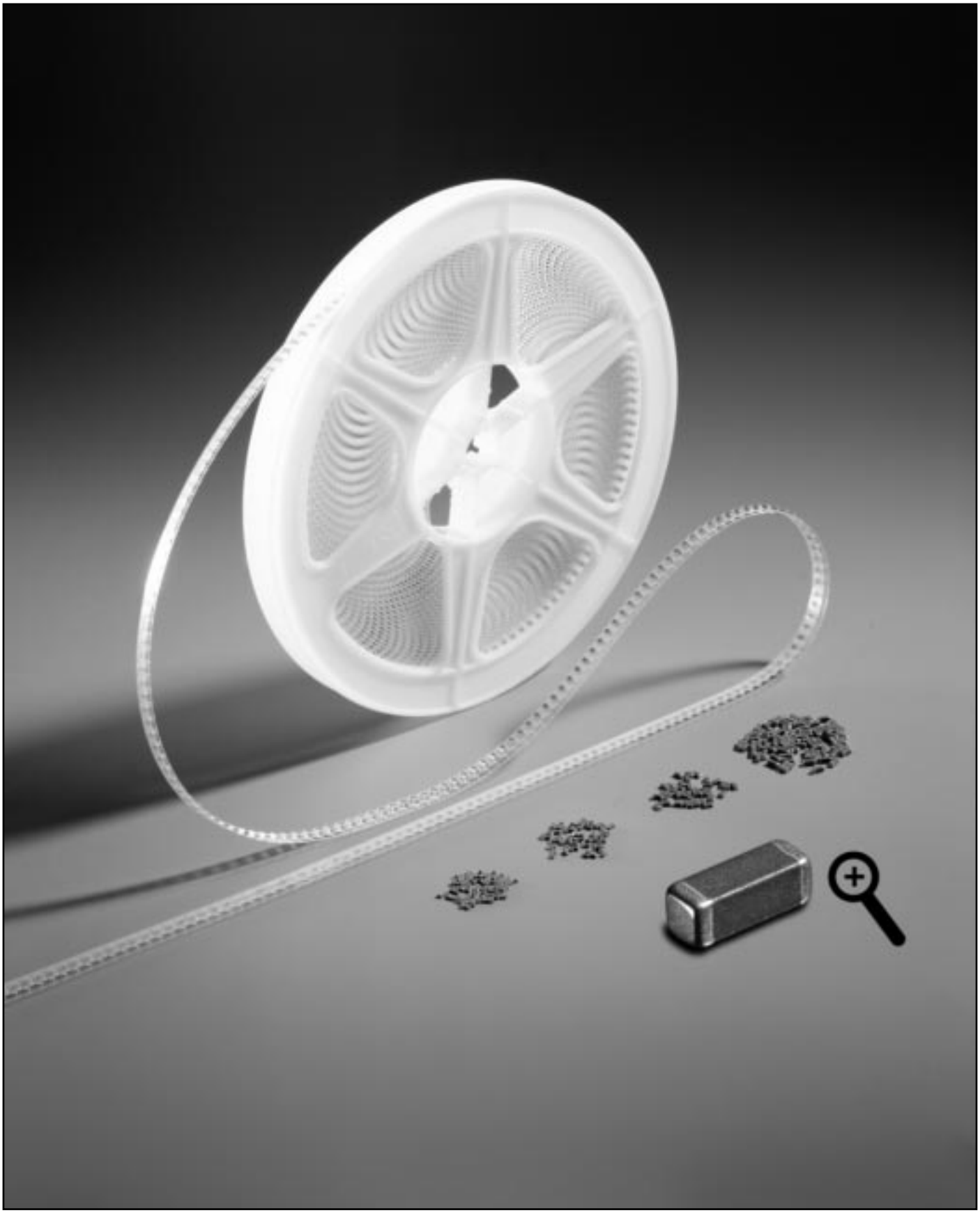
Let's make things better.

Philips Components

PHILIPS

MULTILAYER SUPPRESSORS

Contents



A view of Multilayer Suppressors

Introduction

PHILIPS COMPONENTS extends its range of SMD products (beads, chokes, common mode chokes) with multilayer suppressors.These ferrite chip beads combine magnetic materials with multilayer and thick film technology.

Multilayer suppressors are truly miniature components and have connecting surfaces that solder directly to the solder lands on a substrate. The multilayer electrode and terminations are made of silver to ensure high electrical conductivity. The electrode is embedded in a ferrite monolithic structure, which provides a good magnetic shielding and makes it very appropriate for high density mounting.

Multilayer suppressors are made in EIA standard sizes, which facilitates the use of existing automatic pick-and-place machines. They can be soldered with a wave or reflow soldering process on PC board assemblies. The products are supplied in standard tapes and reels.

These high quality components are manufactured with advanced production techniques, with a background knowledge of the product and a well-established and disciplined approach to quality control. All products are 100% controlled for impedance and DC resistance.

The size, performance and reliability of Multilayer Suppressors make them very attractive for a wide range of applications. Where the application demands a compact electronic circuit on a small board, these components offer the designer a powerful and reliable method of noise attenuation between electronic equipment with negligible effect on the actual signals.

With the new Multilayer Suppressor range PHILIPS COMPONENTS offers a wide range of components specially designed for surface mounting. We can also offer technological support on the use of components.

Features

- Monolithic structure for closed magnetic path and high reliability
- Standard EIA and EIAJ sizes: 0603, 0805, 1206 and 1806
- High impedance per volume which leads to effective high density circuits
- Suitable for wave and reflow soldering
- Wide range of impedance values
- Superior physical properties
- Available in standard EIA and EIAJ tape-and-reel
- Operating temperature -55°C to +125°C
- 100% sorting out on impedance

Materials

Materials 4S4 and 4S7 are specially designed for this technology. These nickel-zinc ferrites provide excellent characteristics for suppression applications.

4S4: $\mu \approx 250$
4S7: $\mu \approx 200$

Applications

Multilayer suppressors are a powerful solution for EMI/RFI attenuation for electronic equipment. Supplied in four standard sizes (0603, 0805, 1206 and 1806), they have impedances between 30 and 1000 Ω at 100MHz.

When installed in series with signal and/or power circuits, high frequency noise is suppressed. There is no need for ground termination, which makes these devices very suitable for circuits with difficult ground.
Typical suppression frequencies range from 10MHz to 1000MHz and rated currents are between 0.1 and 0.6 A.

Multilayer suppressors are specially designed to reduce noise in low impedance circuits while keeping the signal free from distortion. This is because at the interfering frequencies these components behave resistive. The high frequency noise is converted into heat rather than reflected to the source. This dissipation prevents ringing and parasitic oscillations.

These characteristics can be used for many different purposes:

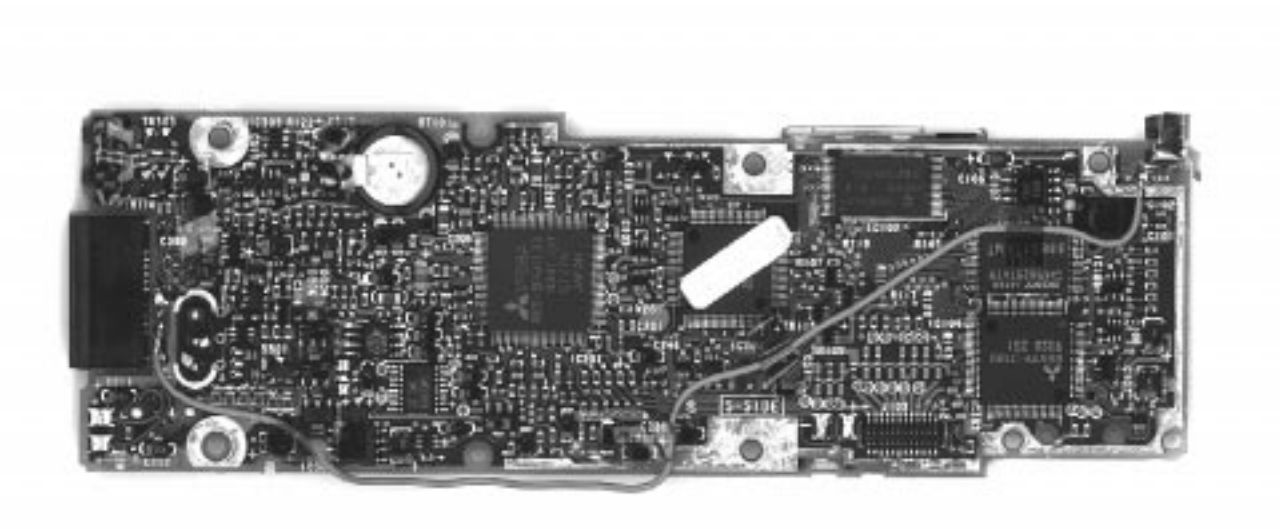
- Absorption of generated noise.
- In digital signals from high speed clock oscillators, for filtering and wave-shape correction.
- Prevention of high frequency interference entering circuit electronics.

Main applications areas for multilayer suppressors are:

- Computers and peripheral equipment
- Audio and video equipment
- VCR's
- Work stations
- Game machines
- Car electronics
- Television sets
- Digital communication equipment
- Telephone sets and cellular phones

To help designers in the trial and error process of finding the most suitable suppression component, we offer a sample box with a selection of our new range of multilayer suppressors.

Ordering code: SAMPLEBOX12

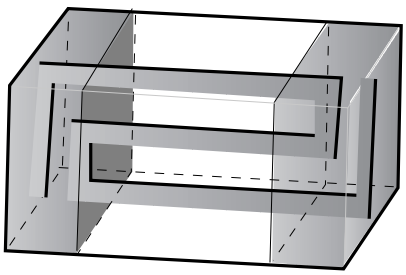


Inside view of a GSM phone where lots of Multilayer Suppressors are being used.

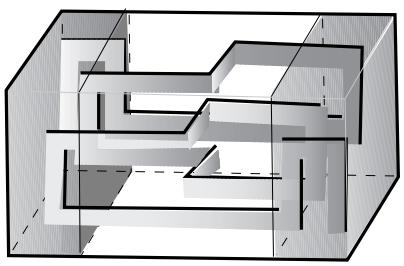
Product Construction

The use of silver for electrodes and terminations in multilayer suppressors ensures high electrical conductivity, which minimizes heat generation and cross talk.

The internal construction can be single layer or multilayer, depending on impedance requirements. Single layer products have a 'meander' design and are suitable for lower impedances, while multilayer types have alternating layers of ferrite and conductor piled up to achieve higher impedance levels.



Single layer



Multilayer

Fig.1 Internal structure of Multilayer Suppressors

The terminal electrode forms a conductive connection to the circuit. It is formed by three layers:

- Silver: for a good conductivity
- Nickel: protects silver termination against leaching
- Tin-lead: applied to insure good solderability

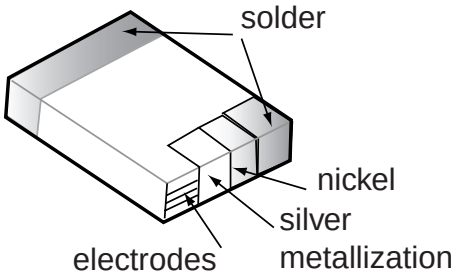


Fig.2 Structure of electrodes.

The products are suitable for both reflow and wave soldering.Their good solderability leads to:

- Lower soldering temperatures and shorter dwell times.
- The use of less active flux, thus reducing cleaning treatments of substrates.
- Better cost effectiveness and shorter production times due to less re-working and repairs.

Specifications for terminations are listed in the section on Quality Control Tests.

Type Number structure

Type Numbers for these products consists of four parts:

1. Product type
2. Size
3. Material
4. Impedance value

M L S 0 6 0 3 - 4 S 7 - 6 0 0

1 2 3 4

1. Product Type

MLS: Multilayer Suppressor

2. Size

0603: 1.6 x 0.80 (mm)
0805: 2.0 x 1.25 (mm)
1206: 3.2 x 1.60 (mm)
1806: 4.5 x 1.60 (mm)

3. Material

4S4
4S7

4. Impedance value

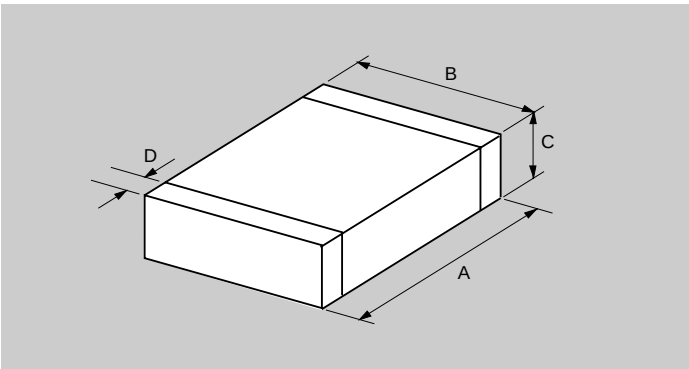
- Expressed in ohm (Ω)
- First two digits are significant figures
- Last digit is the number of zeros to follow
- Examples:

600	60 Ω
101	100 Ω
121	120 Ω
151	150 Ω
301	300 Ω
102	1000 Ω

Standard products are delivered taped and reeled and have a tolerance on impedance of ±25%. In case of different specifications a fifth group will be added to the Type Number.

Sizes

Standard sizes for multilayer suppressors are given in the table below.



Size	A (mm)	B (mm)	C (mm)	D (mm)	Weight (mg)
0603	1.60±0.15	0.80±0.15	0.74±0.15	0.36±0.15	5
0805	2.00±0.20	1.25±0.20	0.90±0.20	0.51±0.25	11
1206	3.20±0.20	1.60±0.20	1.10±0.20	0.51±0.25	28
1806	4.50±0.25	1.60±0.25	1.60±0.25	0.61±0.25	55

Product range

Type Number	SIZE	Z@100MHz	R_{DC} max(Ω)	I max (mA)
MLS0603-4S7-600	0603	60	0.4	300
MLS0603-4S7-101	0603	100	0.7	200
MLS0603-4S7-121	0603	120	0.8	200
MLS0603-4S7-151	0603	150	0.9	200
MLS0603-4S7-301	0603	300	1.2	150
MLS0603-4S7-601	0603	600	1.8	150
MLS0603-4S7-102	0603	1000	2.0	100
MLS0805-4S4-300	0805	30	0.1	600
MLS0805-4S4-600	0805	60	0.2	400
MLS0805-4S7-121	0805	120	0.3	300
MLS0805-4S7-301	0805	300	0.3	200
MLS0805-4S7-601	0805	600	0.6	200
MLS0805-4S7-102	0805	1000	0.8	150
MLS1206-4S4-300	1206	30	0.1	600
MLS1206-4S4-700	1206	70	0.2	400
MLS1206-4S4-900	1206	90	0.2	400
MLS1206-4S4-121	1206	120	0.2	300
MLS1206-4S4-601	1206	600	0.4	200
MLS1206-4S7-102	1206	1000	0.6	150
MLS1806-4S4-800	1806	80	0.1	600
MLS1806-4S4-151	1806	150	0.2	500

- R_{DC}: resistance of component for DC current.
- Maximum rated current: measure of current capacity of the component. When the maximum rated current is applied, temperature rise shall not exceed 20°C.
- Standard tolerance on impedance is ±25%.
- Other tolerances or electrical specifications can be provided upon request.
- Operating temperature: -55°C - +125°C.

Impedance characteristics

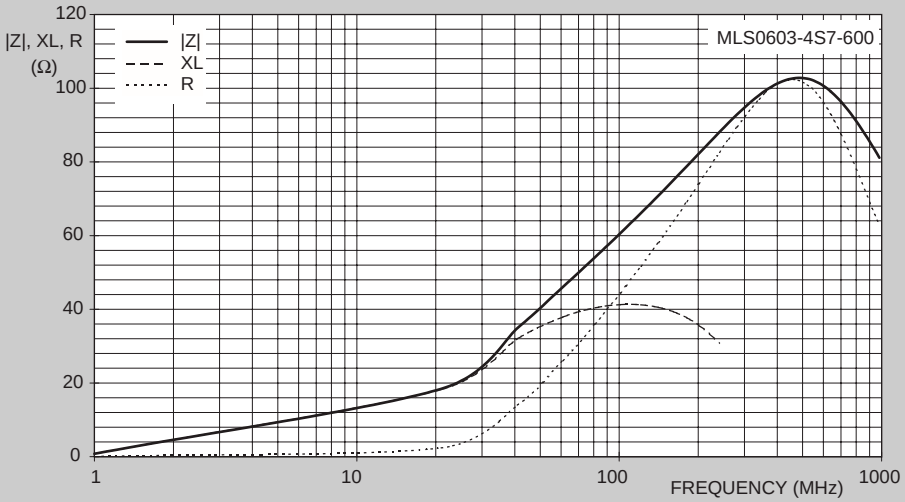


Fig.3 Impedance of MLS0603-4S7-600 as a function of frequency.

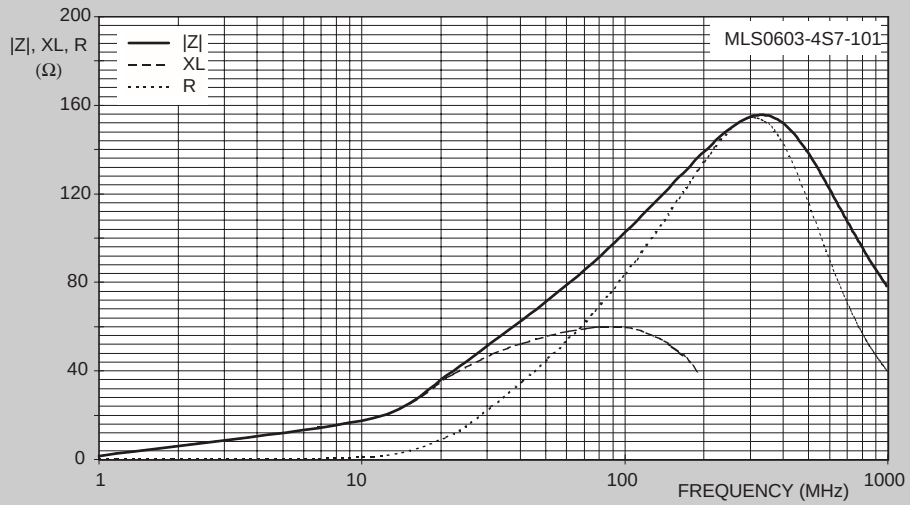


Fig.4 Impedance of MLS0603-4S7-101 as a function of frequency.

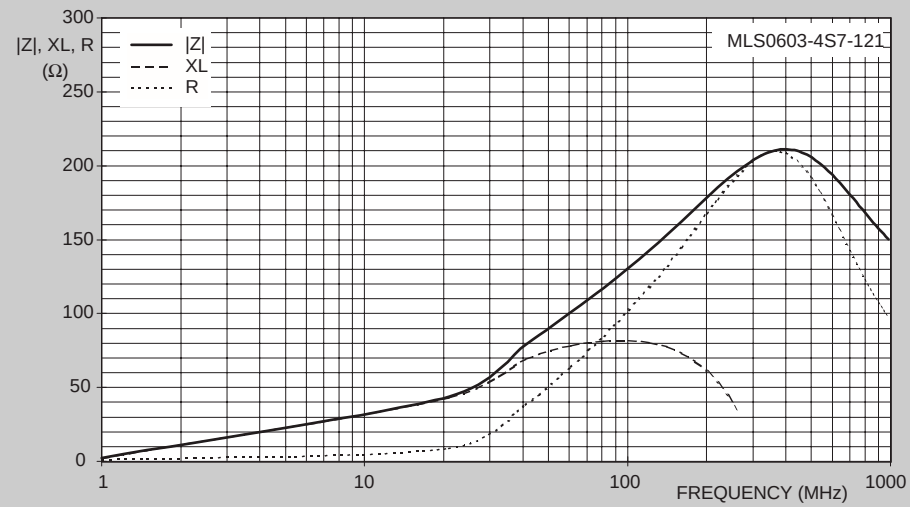


Fig.5 Impedance of MLS0603-4S7-121 as a function of frequency.

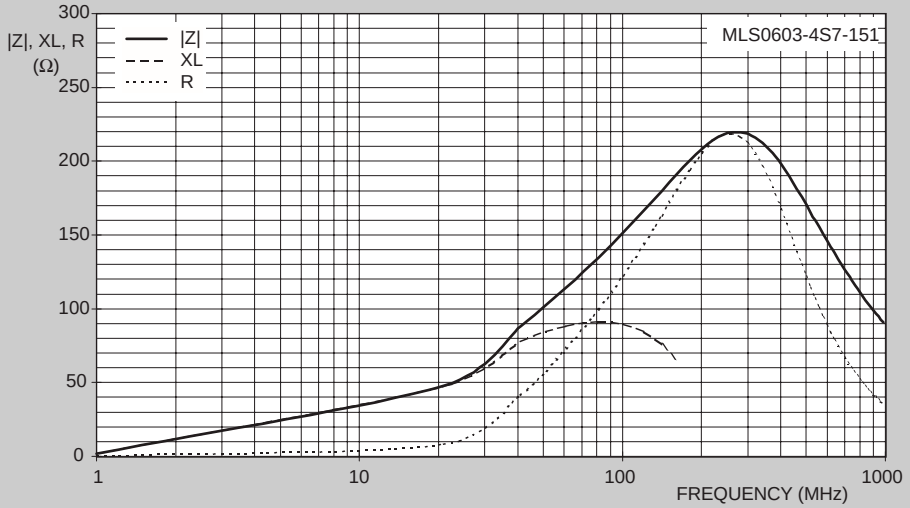


Fig.6 Impedance of MLS0603-4S7-151 as a function of frequency.

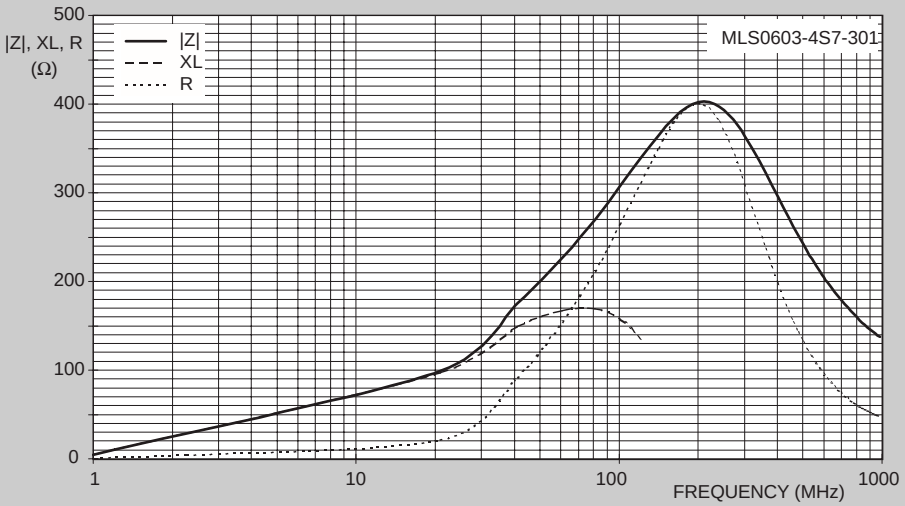


Fig.7 Impedance of MLS0603-4S7-301 as a function of frequency.

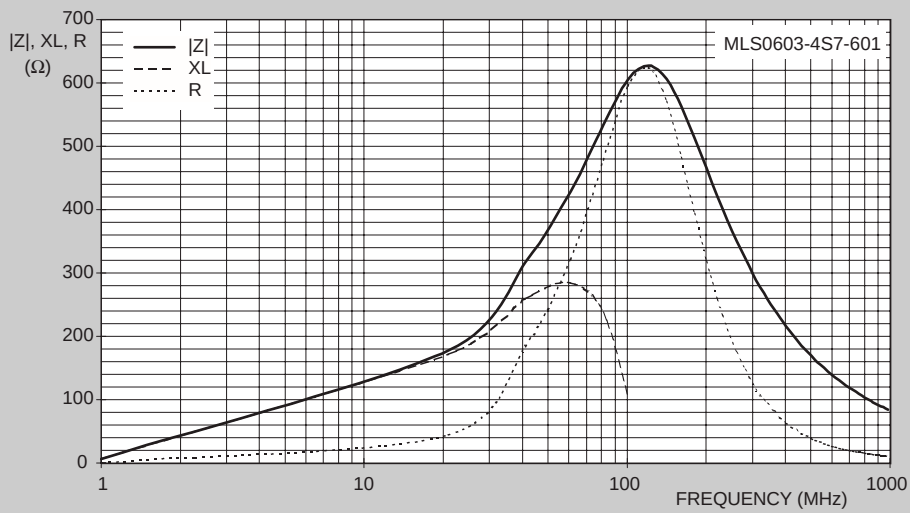


Fig.8 Impedance of MLS0603-4S7-601 as a function of frequency.

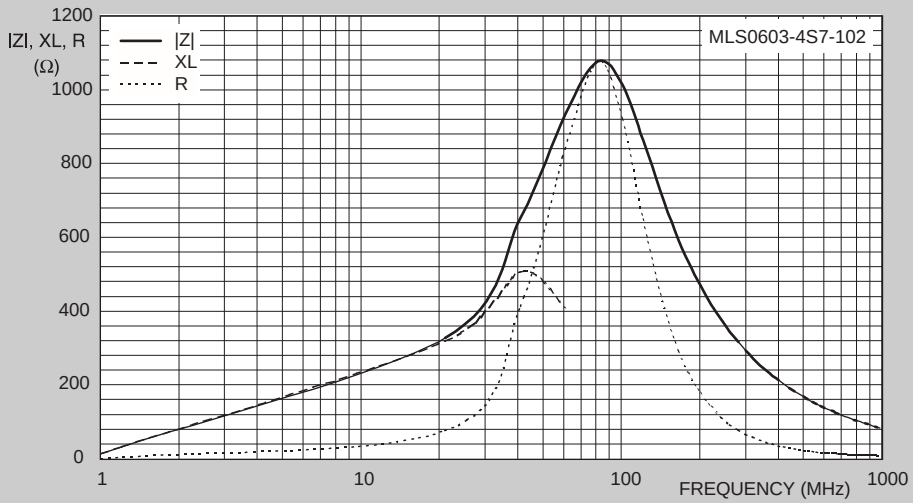


Fig.9 Impedance of MLS0603-4S7-102 as a function of frequency.

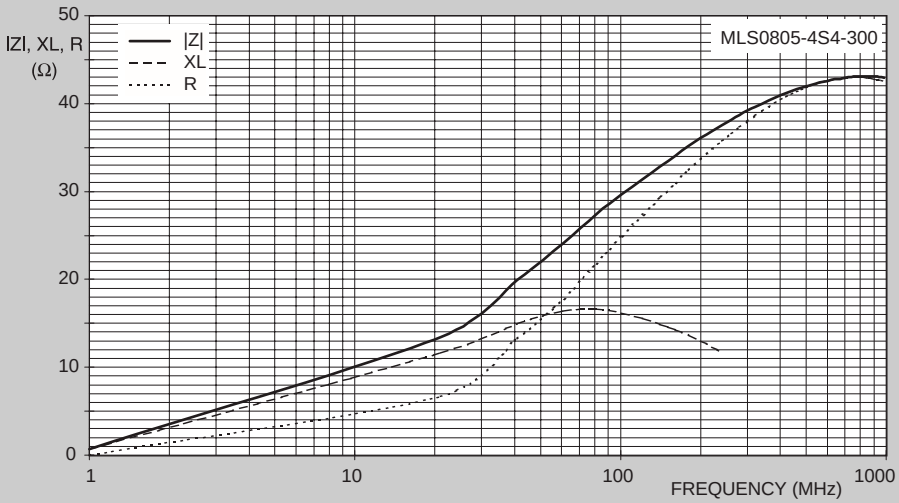


Fig.10 Impedance of MLS0805-4S4-300 as a function of frequency.

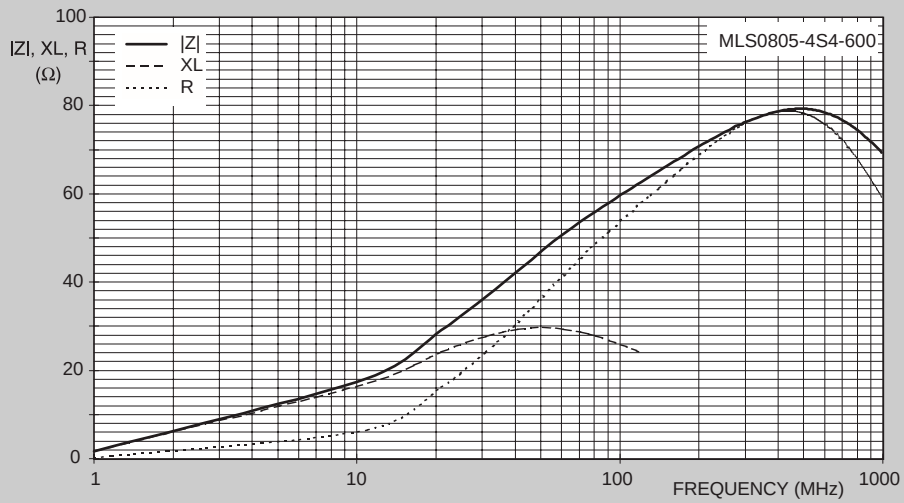


Fig.11 Impedance of MLS0805-4S4-600 as a function of frequency.

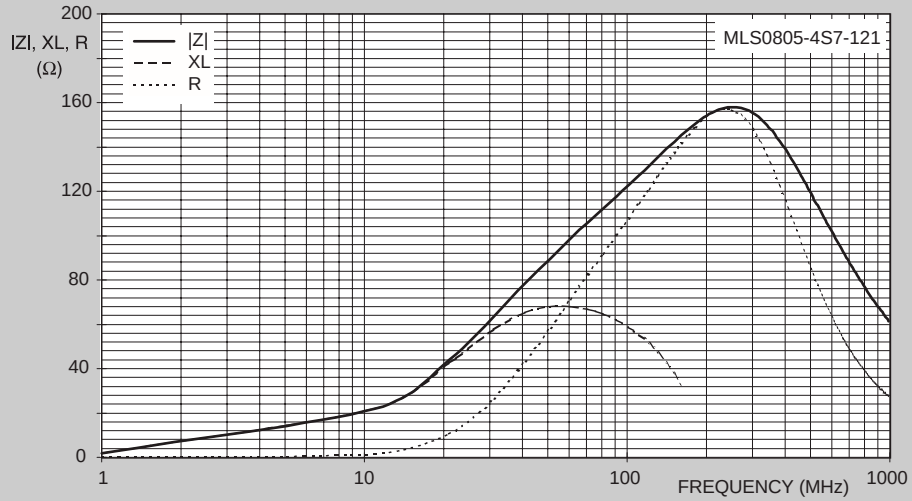


Fig.12 Impedance of MLS0805-4S7-121 as a function of frequency.

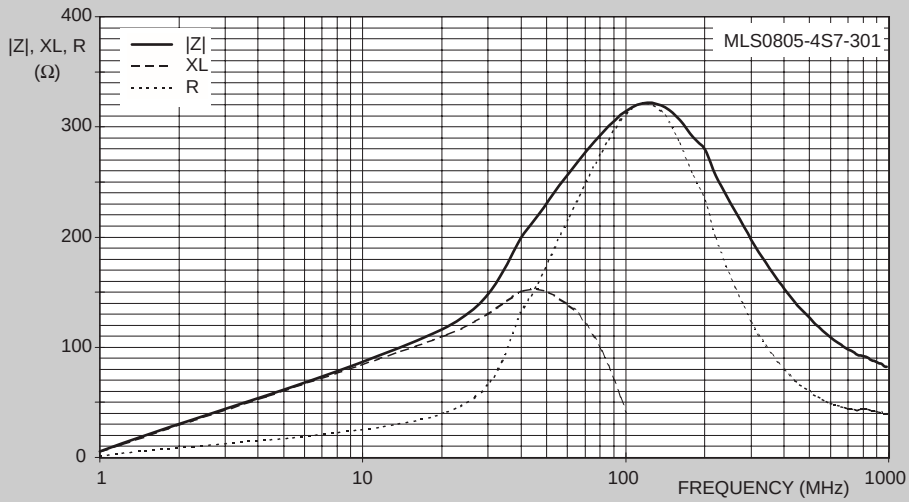


Fig.13 Impedance of MLS0805-4S7-301 as a function of frequency.

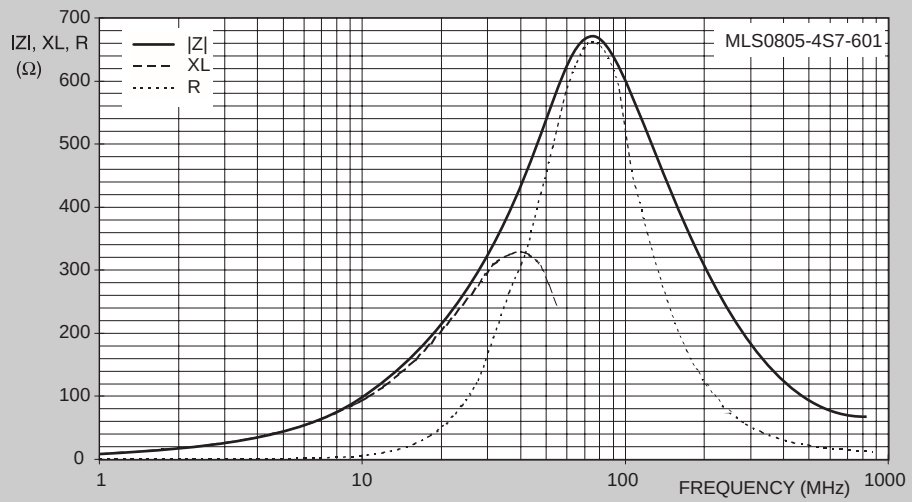


Fig.14 Impedance of MLS0805-4S7-601 as a function of frequency.

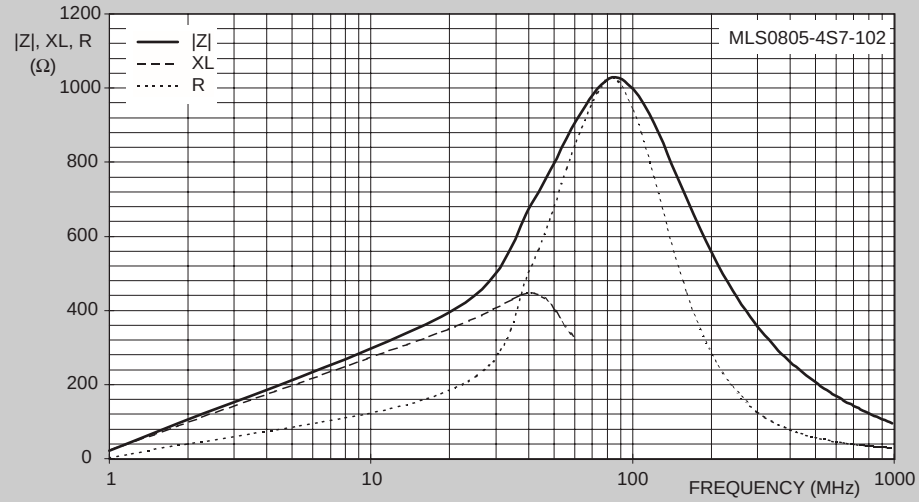


Fig.15 Impedance of MLS0805-4S7-102 as a function of frequency.

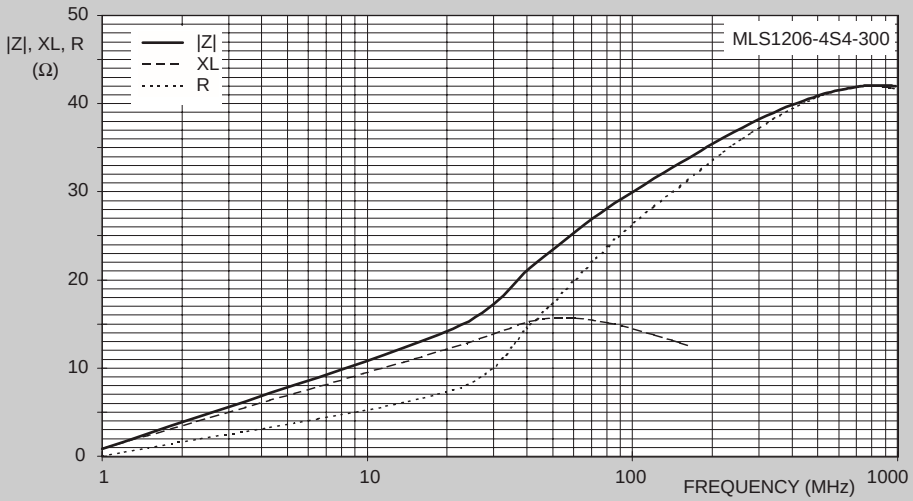


Fig.16 Impedance of MLS1206-4S4-300 as a function of frequency.

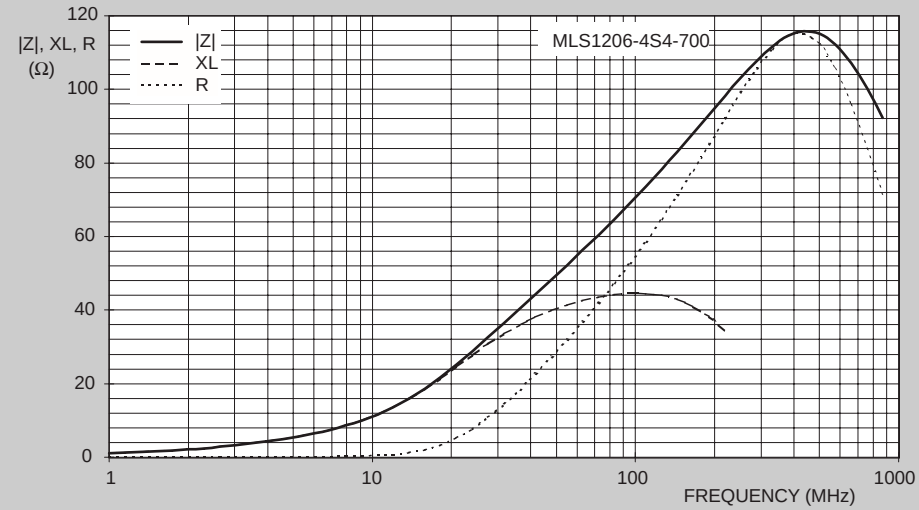


Fig.17 Impedance of MLS1206-4S4-700 as a function of frequency.

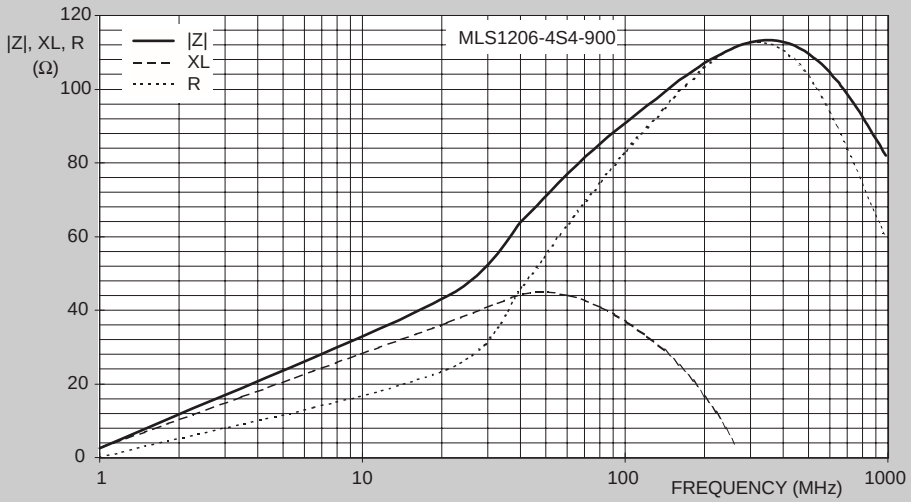


Fig.18 Impedance of MLS1206-4S4-900 as a function of frequency.

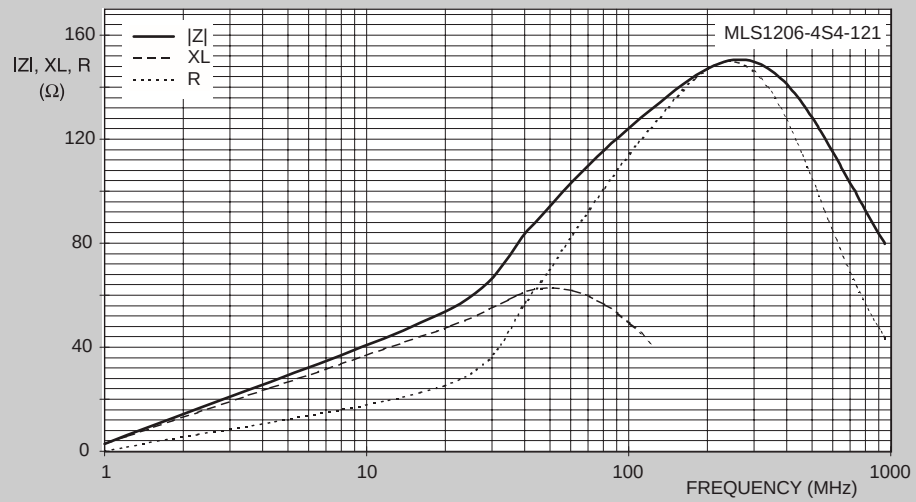


Fig.19 Impedance of MLS1206-4S4-121 as a function of frequency.

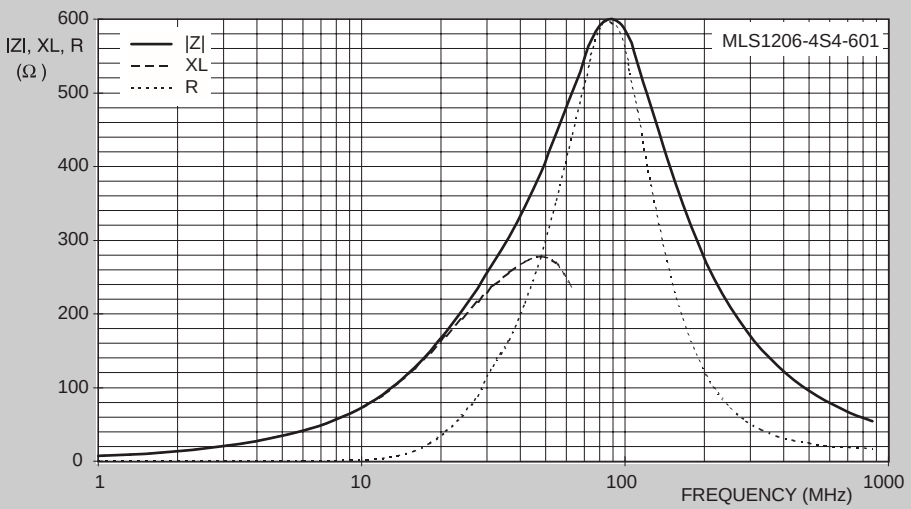


Fig.20 Impedance of MLS1206-4S4-601 as a function of frequency.

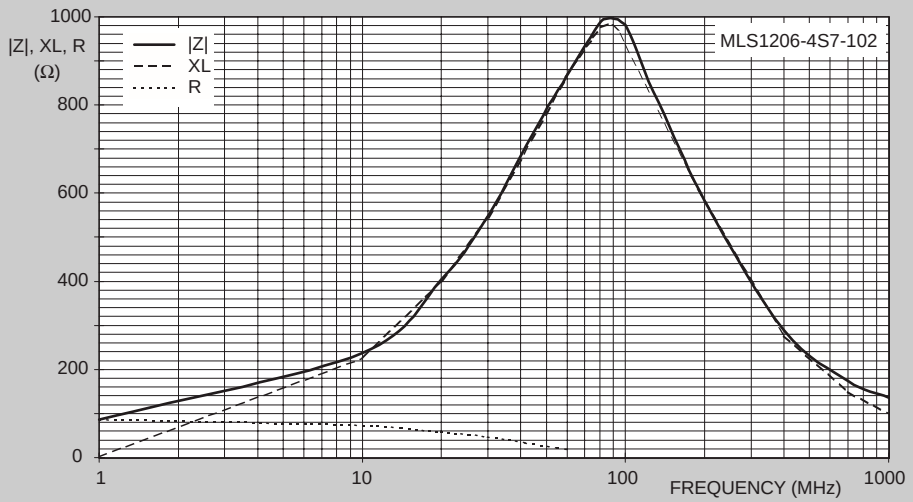


Fig.21 Impedance of MLS1206-4S7-102 as a function of frequency.

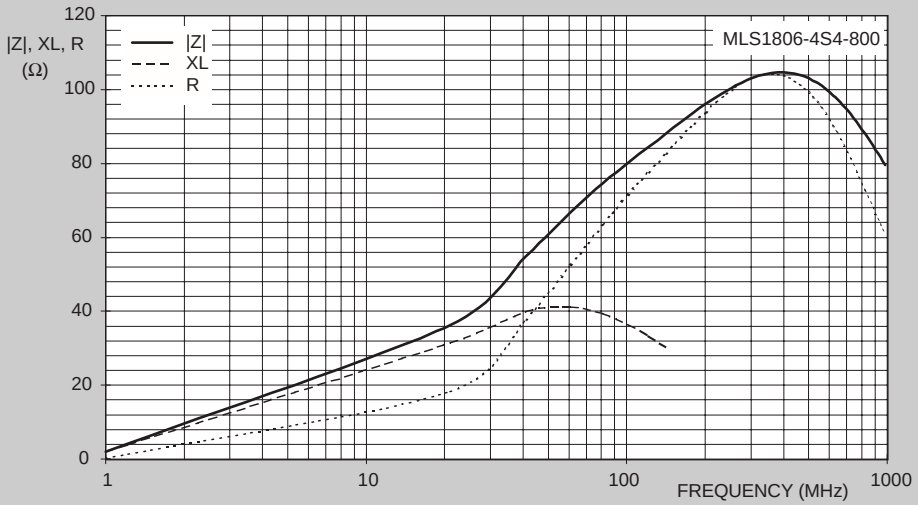


Fig.22 Impedance of MLS1806-4S4-800 as a function of frequency.

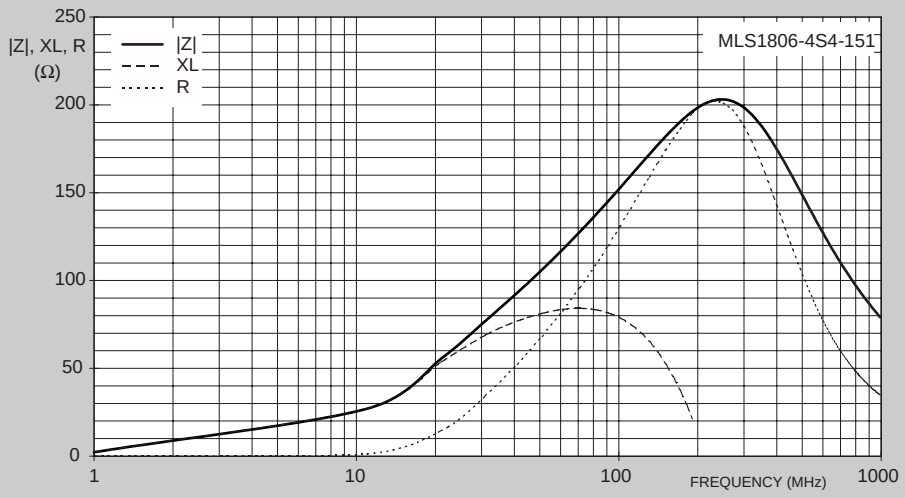
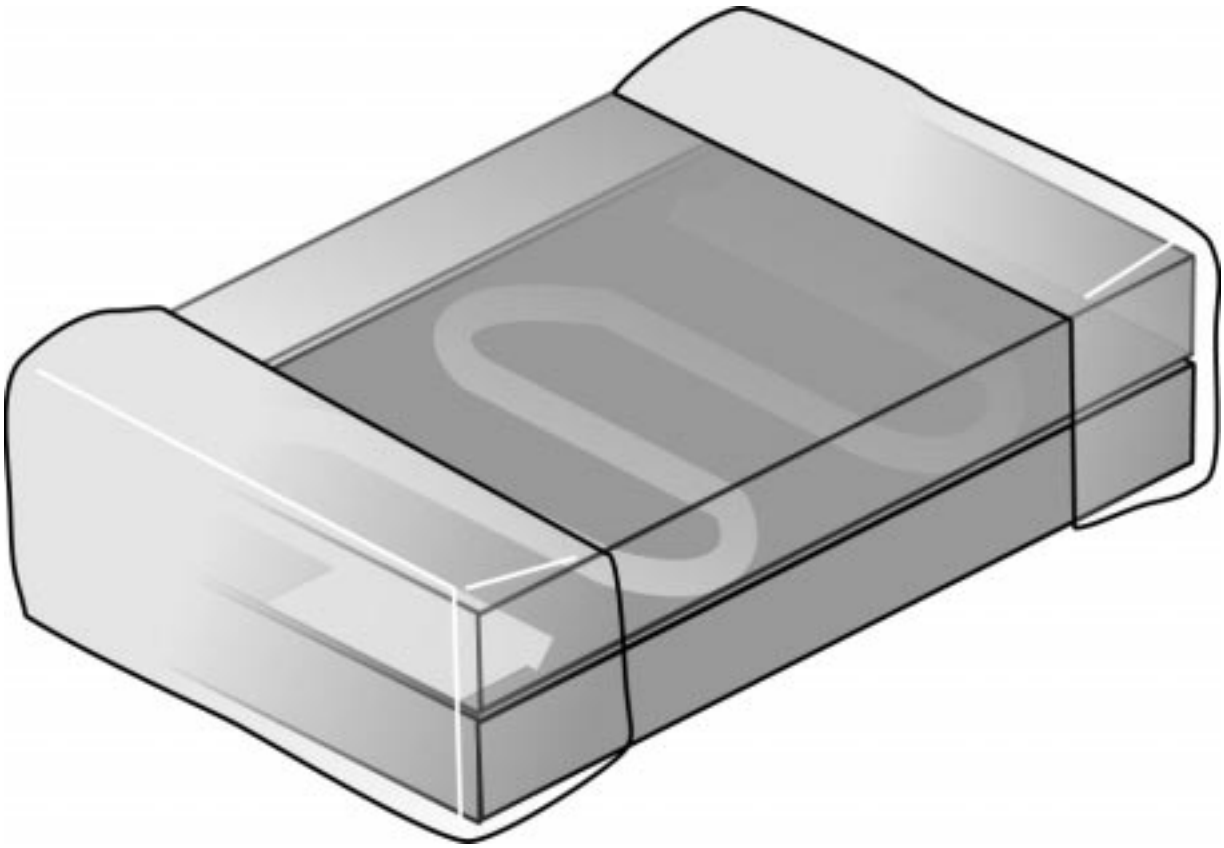


Fig.23 Impedance of MLS1806-4S4-151 as a function of frequency.



Impression of a Multilayer Suppressor

Reliability and Quality Controls

PHILIPS COMPONENTS multilayer suppressors are submitted to extensive tests to ensure high quality, high reliability and complete customer satisfaction. A brief description is given below.

1. Electrical Test

The inductive components are tested 100% for impedance and R_{DC} by automatic sorting machines. Samples from each lot of products are double-checked by QA personnel. All the components shall have electrical properties within the tolerances specified in the product specification.

· R_{DC} per MIL-STD-203 (Method 3)
· Rated Current per IEC-512-3 (Test 5a)

2. External Visual Inspection

Samples are inspected under 10 to 30 × magnification by microscope for any physical defects, such as chips, cracking, delamination, over-plating, etc. No damage shall be found in the products.

·EIA-595

3. Life Test

Samples are tested at 85ºC with maximum rated current for 1000 hours. After the test, no physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 10% from the initial value.

4. Loaded Humidity Test

The components are placed in a testing chamber at 85ºC and 85% relative humidity. Then 10% of the rated current is applied to the components for 1000 hrs. No physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 10% from the initial values.

5. Thermal Shock Test

The components are subjected to 500 temperature cycles between –45 ºC and +105 ºC. The transient time between these two temperatures shall not exceed 0.5 min.
No physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 20% from the initial values.

6. Vibration Test

The components are subjected to vibrations with a frequency range of 10 to 2000 Hz and up to 15 G of acceleration, in three directions for 12 hours. No physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 10% from the initial values.

7. Mechanical Shock Test

This test is performed on components that have been subjected to the vibration test. The shock acceleration is up to 50 G. The components are subjected to three shocks in each direction of three mutually perpendicular axes (total 18 shocks). No physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 10% from the initial values.

8. Bending Test

The chips are soldered on a PCB and subjected to one bend of 1 mm. The duration is 5 seconds. No physical and mechanical damage shall be observed, and the impedance shall not have changed by more than 10% from the initial values.

9. Insulation Resistance

A conductive wire is used to wrap the chip with one turn. The two terminations of the chip are shorted by the fixture. Each of the two inputs of a megohmmeter is connected to the shorted terminations and the conductive wire wrapped around the chip body respectively.
The resistance is measured at 100 volts and shall not be lower than 1000 MΩ.

10. Solderability Test

The chips are wetted with Type R rosin flux, then dipped into an Sn60Pb40 solder pot at 245°C for 5 seconds. As a result 95% of each termination surface shall be covered by new solder.

· MIL-STD-202 (Method 208G)

11. Resistance to Soldering Heat

The chips are dipped in flux first, then dipped into a solder pot at 260°C for 20 seconds. There shall not be any physical damage to the chips. More than 75% of each terminal surface shall be covered by new solder. The impedance shall not have changed by more than 20% after the test.

· MIL-STD-202 (Method 210C)

12. Leach Resistance

The chips are dipped in flux first, then dipped into a solder pot at 230°C for 5 seconds. The chips are withdrawn from the solder pot and allowed to cool down in air for 60 seconds. The dipping and cooling process is repeated for four more times. The chips are then inspected under a microscope with 10-30 × magnification. Every edge of termination must not be leached away by more than 5%.

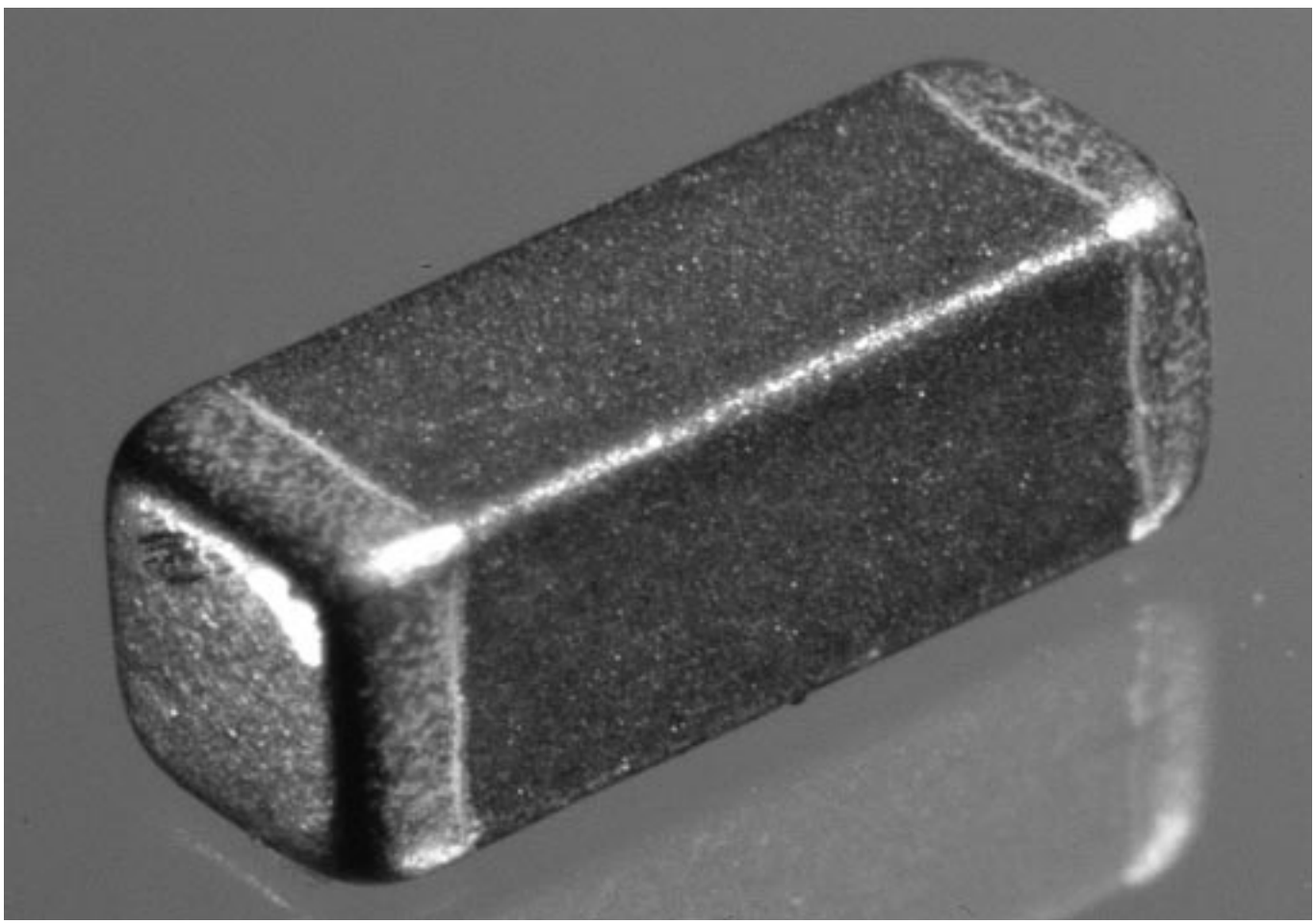
13. Solvent Resistance

The chips are submersed in isopropyl alcohol inside an ultrasonic bath for 3 minutes. The chips are then removed from the solvent and dried by a paper towel. The impedance of the chips shall not have changed by more than 10% after the solvent soaking.

14. Terminal Strength

The chips are lead attached to a wire with solder and suspended for 30 seconds with a weight according to the chip size (0.5 kg for 0603, 1.0 kg for 0805, and 1.5 kg for 1206 or larger). No damage shall be observed after the test.

· EIA-198D (Method 303)



Close-up of a Multilayer Suppressor

Soldering

The advantages of good solderability of both components and substrate can be summarized as follows:

1. Lower soldering temperatures and shorter dwell times prevent damage to devices or dissolution of metallization. The thickness of inter-metallic zones is minimized, thus increasing mechanical integrity and providing a stable electrical connection.

2. It permits the use of a less active flux. Therefore the flux residue activity is low and cleaning the substrate may be unnecessary.

3. Better cost effectiveness by shorter production times owing to less re-working and repairs.

PHILIPS COMPONENTS multilayer chip beads have a nickel barrier and solder coated termination, which offers excellent solderability and solder leach resistance per EIA 198D, methods 301 and 302.

These products are suitable for reflow and wave soldering. Recommended temperature profiles for both methods are given below.

For hand soldering, recommended settings are 17W at 350°C, within 2 seconds. Diameter of solder tip: 1.2mm max. The tip should not be applied to the electrode terminations.

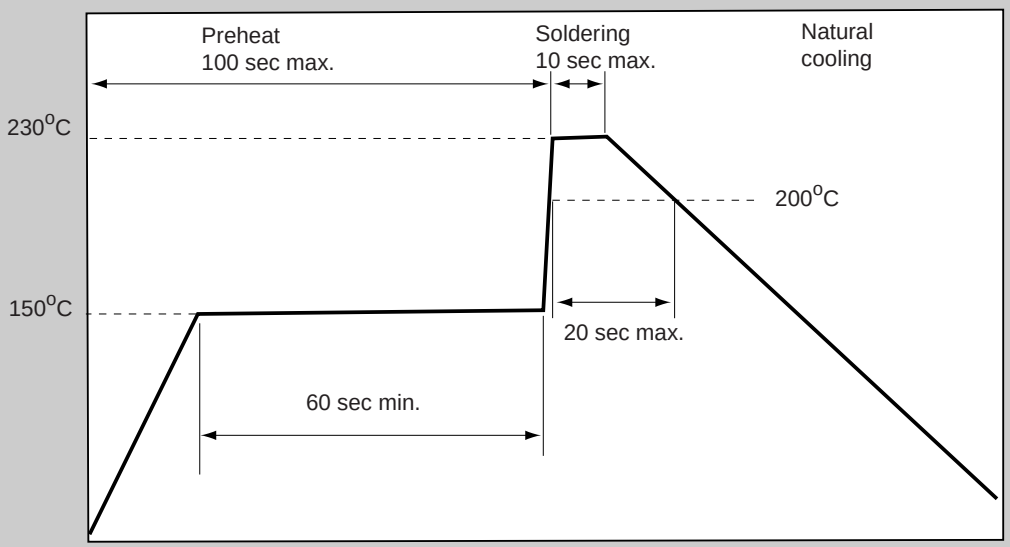


Fig.24 Recommended temperature profile for reflow soldering.

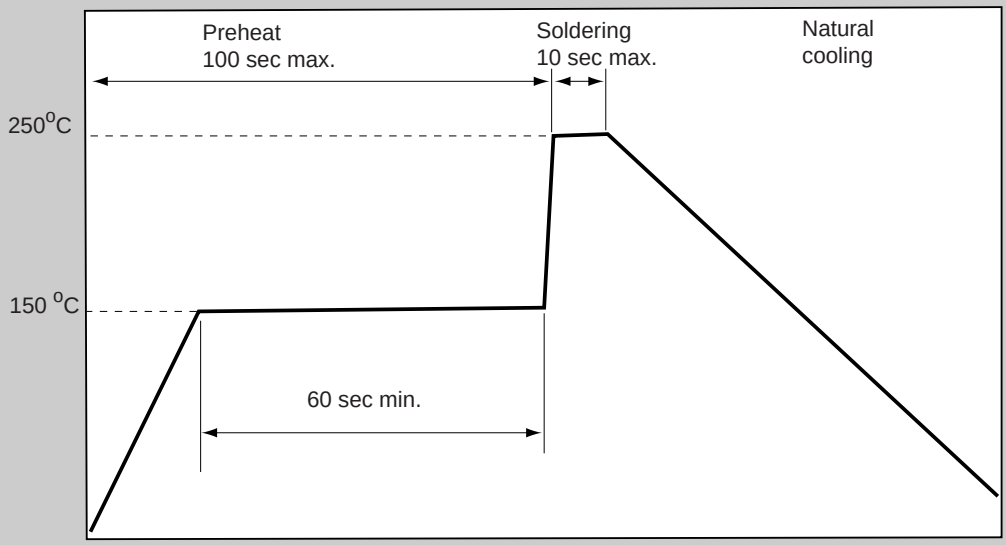


Fig.25 Recommended temperature profile for wave soldering.

Recommended solder lands

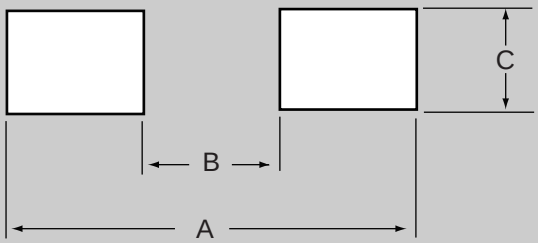


Fig.26 Recommended solder lands

Land Pattern Dimensions

Chip Size	A	B	C
0603	2.1	0.7	0.7
0805	2.6	1.0	1.0
1206	4.4	2.2	1.35
1806	6.0	3.0	1.35

Packing

PHILIPS COMPONENTS multilayer suppressors are delivered taped and reeled, ready for use in automatic pick-and-place machines, according to IEC 286-A and EIA 481-A.
Reels are sealed in plastic bags with desiccant.

Bulk products are available upon request.

Reel

Reel size is 180mm (7 inch).
Reels of size 330mm (13 inch), with approximately 10000 products, are available upon request.

Packing quantities

SIZE	PACKING QUANTITY
0603	4000
0805	3000
1206	3000
1806	2000

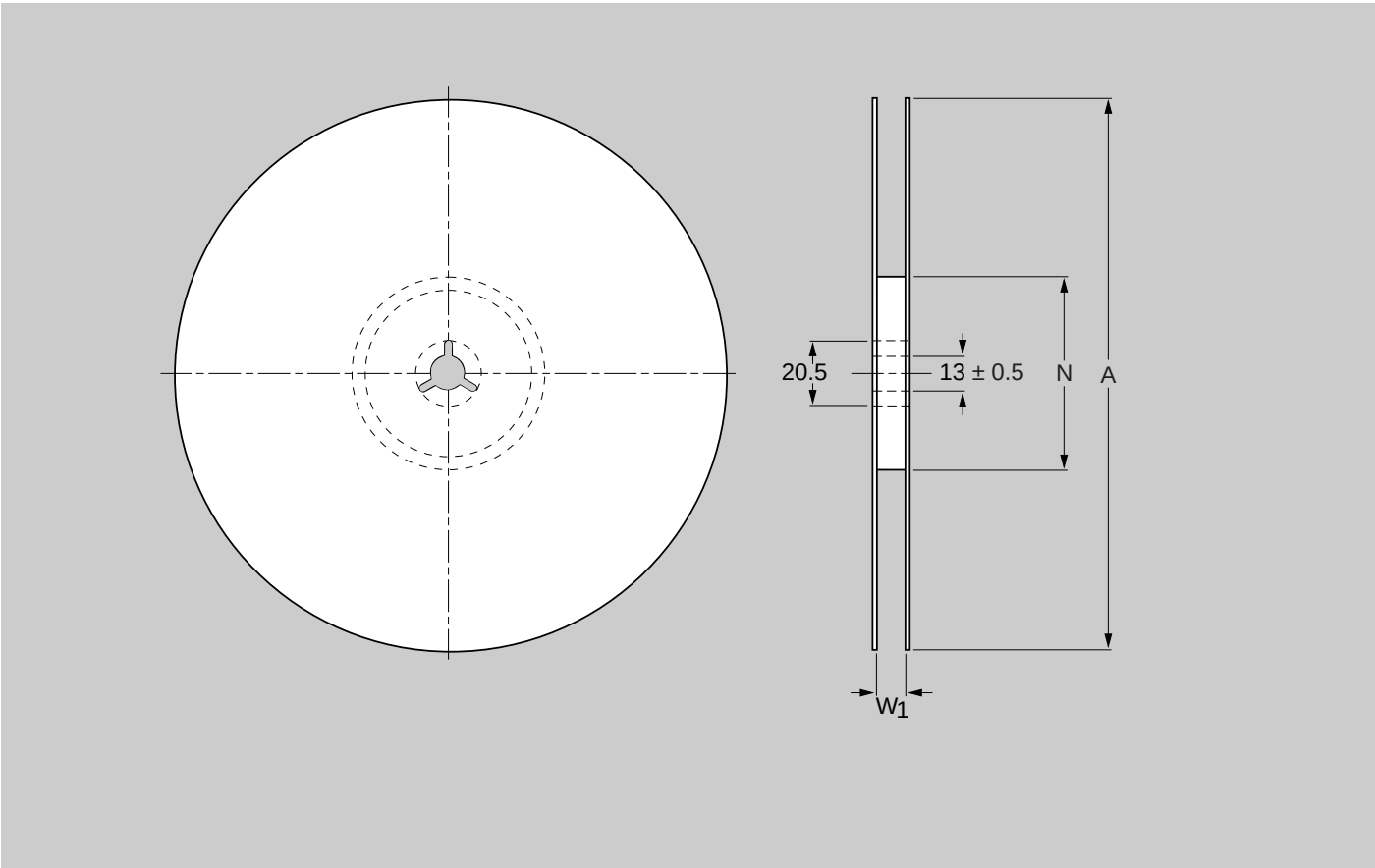


Fig.27 Dimensions of reel

TAPE WIDTH	A	N	W1
8	178±2	50 min	10±1.5
12	178±2	50 min	14±1.5

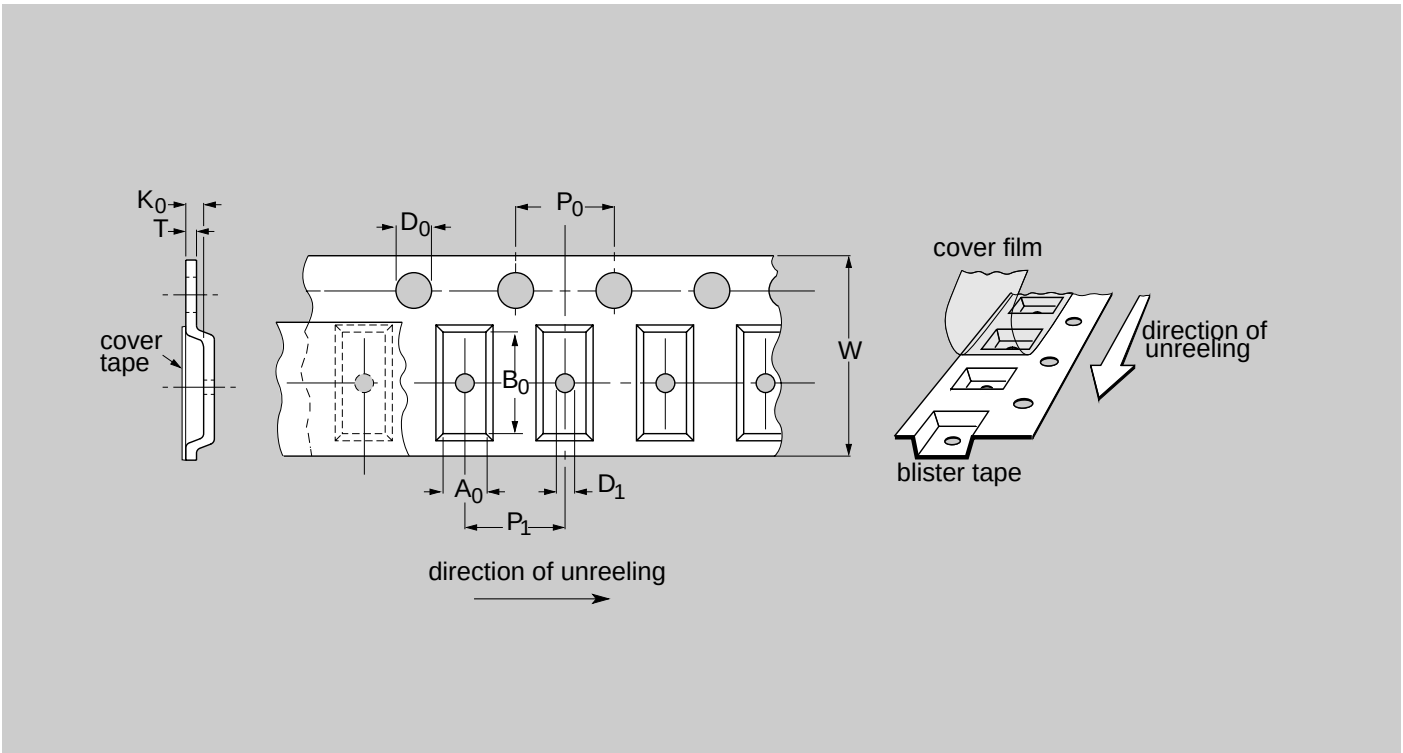


Fig28. Dimensions of blister tape

SIZE	A_0	B_0	W	T	D_0	D_1	P_0	P_1	K_0
				max	min	min			
0603	1.1±0.1	1.9±0.1	8.0±0.2	0.3	0.5	0.5	4.0±0.1	4.0±0.1	1.1
0805	1.6±0.1	2.4±0.1	8.0±0.2	0.3	0.5	0.5	4.0±0.1	4.0±0.1	1.2
1206	2.0±0.1	3.6±0.1	8.0±0.2	0.3	0.5	0.5	4.0±0.1	4.0±0.1	1.2
1806	2.0±0.1	5.0±0.2	12±0.3	0.3	0.5	0.5	8.0±0.1	4.0±0.1	2.0

Storage requirements

Storage requirements advised here should be observed in order to ensure the soldering of the exposed electrode:

- Maximum ambient temperature shall not exceed 40°C. Storage temperature higher than 40°C could result in deformation of packaging materials.
- Maximum relative humidity recommended for storage is 70%. High humidity with high temperature can accelerate the oxidation of the tin-lead plating on the termination and reduce the solderability of the components.
- Sealed plastic bags with desiccant shall be used to reduce the oxidation of the electrodes and shall only be opened prior to use. After unpacking, reseal or store with a desiccant.
- Products shall not be stored in environments with the presence of harmful gases containing sulfur or chlorine.

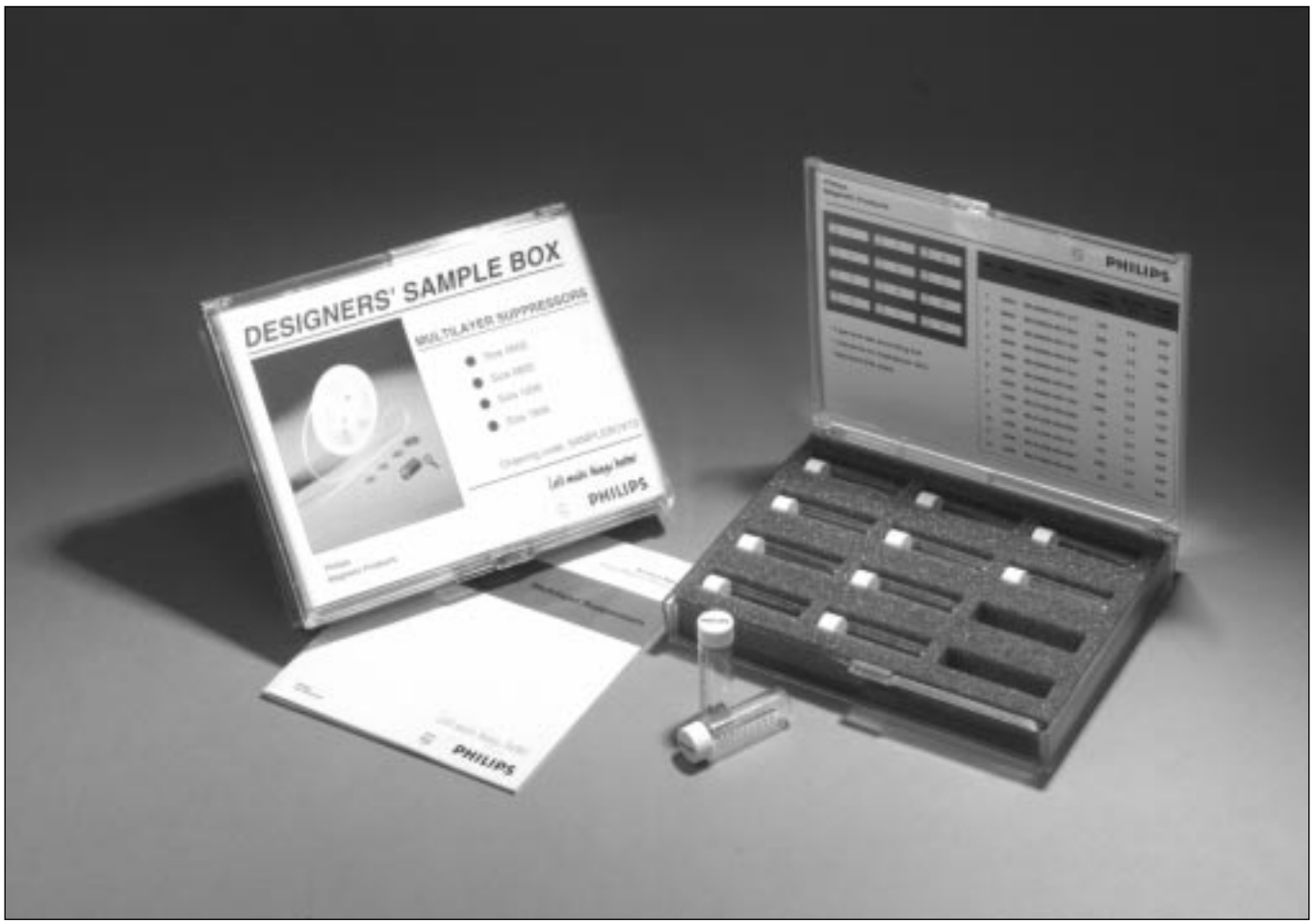
Trouble shooting

Problem	Cause	Action
Chips pop out of carrier tape before assembly	Electrostatic force.	Use of metal brush connected to ground on the feeding track to remove electrostatic charges prior to peeling off cover tape.
Chips pop off PCB during reflow soldering	Electrostatic or electromagnetic force. Excess amount of flux.	Remove the charges and electromagnetic force. Reduce amount of flux.
Tombstoning during reflow soldering	Uneven printing of solder paste on connection patterns. Uneven fluxing.	Apply even and adequate amount of solder paste on PCB patterns. Even fluxing.
Cracking of chips during assembly process	In-adequate preheating. Excess amounts of solder paste. Excess PCB bending. Excess force applied by chip placement head.	Preheat PCB before soldering. Apply adequate amounts of solder. Avoid excessive bending. Avoid excessive mounting force or apply supporting pin to reduce PCB bending.
Cracking of chips or damage of solder connections during ultrasonic cleaning	Excessively high ultrasonic energy.	Recommended ultrasonic setting: · Frequency: 20kHz · Power: 20 W/liter · Washing time: 5.min. max.
Cracking of chips or damage of terminations during hand soldering	Excessively high temperature. Long soldering time. High wattage solder iron.	Recommended hand soldering settings: · Wattage of solder iron: 17W · Temperature: 350^{o}C · Time: 2 sec · Diameter of solder iron tip: 1.2mm max.

Sample box

PHILIPS COMPONENTS has now available a new sample box to help designers develop effective solutions. This new sample box contains a selection of our new range of multilayer suppressors, in 4 different sizes: 0603, 0805, 1206 and 1806.

Ordering code: SAMPLEBOX12.



Sample box with Multilayer Suppressors.

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