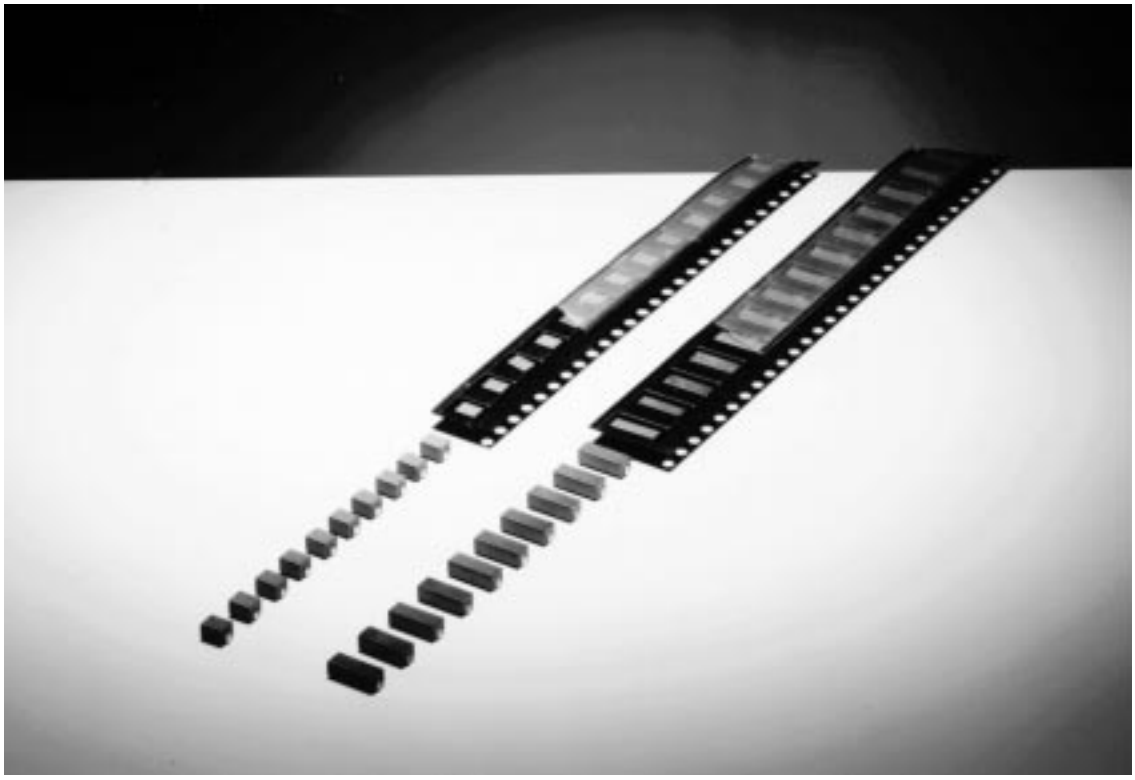
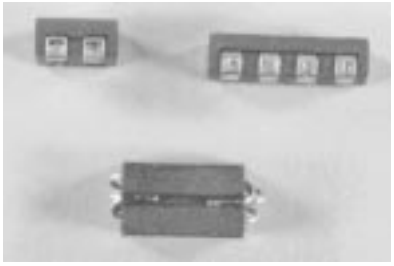
SMD Beads and Chokes



SMD beads in tape

Contents



INTRODUCTION

To support designers and manufacturers of electronic circuitry, PHILIPS COMPONENTS manufactures a comprehensive line of ferrite EMI-suppression products for use on circuit boards, through-hole as well as surface-mountable.

The demand for SMD-suppression components is still growing. Therefore PHILIPS COMPONENTS has focused its effort and expertise to develop new types and sizes through a continuously optimized design process to complete our SMD selection:

- ***Low profiled SMD-bead for flat designs***
- ***SMD-Current Compensated Chokes***
- ***SMD-Wide Band Chokes***

Our recognized know-how and staff of application engineers are the basis of the technical support, which is entirely at your disposal for your comments and inquiries.

Well controlled manufacturing processes, automated production lines and measuring equipment and a long experience in ferrites make PHILIPS COMPONENTS a flexible, capable and reliable partner, able to advise and provide also custom-designed products, either completely new or similar to existing types.

PHILIPS COMPONENTS offers smart solutions to comply with the more and more severe EMC norms and requirements: our new SMD-components are suitable to prevent generated interference and to suppress incoming noise signals and parasitic oscillations.

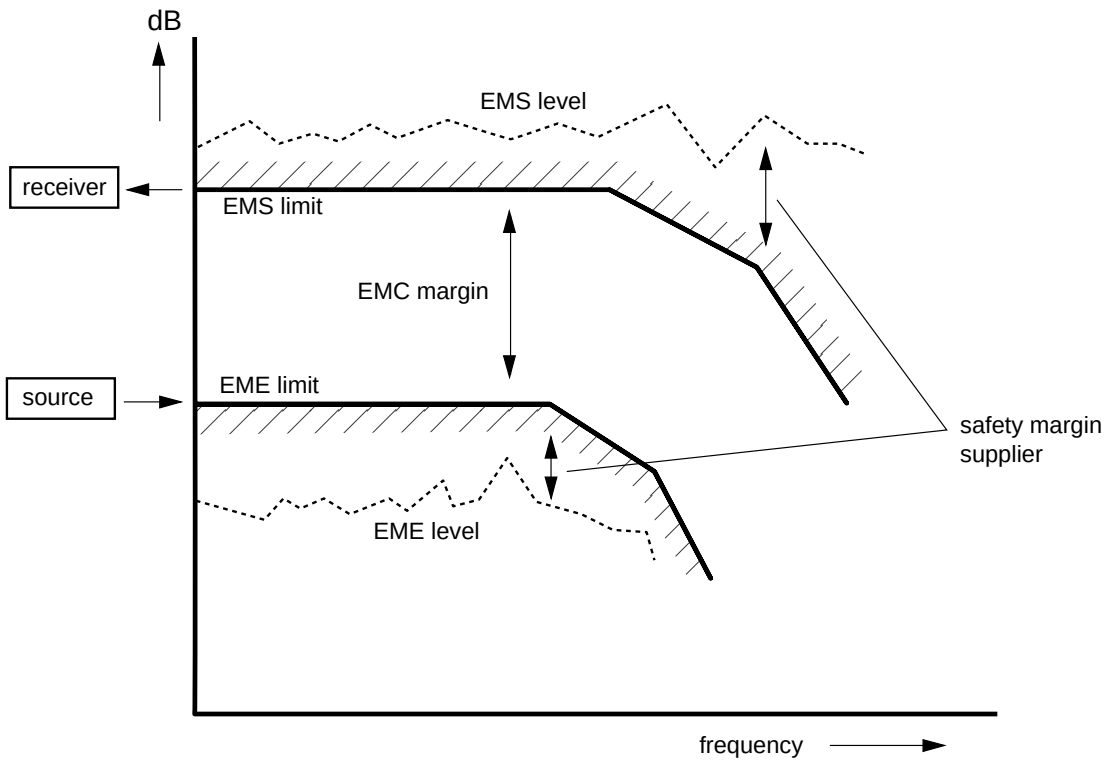
Interference suppression and EMC.

With the ever increasing intensive use of electronic equipment Electro Magnetic Compatibility (**EMC**) has become an important issue. Since 1928 laws specify limits of the level of interference caused by equipment (**EME**- Electro Magnetic Emission) and also the sensitivity of equipment for incoming interference (**EMS** - Electro Magnetic Susceptibility).

Limiting curves are defined by international organisations such as CISPR, and national committees e.g. FCC in the USA, VDE in Germany and VCCI in Japan.

During the design phase, problems with interference can be avoided to some extent. Often additional suppression components such as capacitors and inductors will be necessary to meet the required levels.
Inductive components are very effective in blocking interfering signals, especially at high frequencies.

EMC principles are explained in figure 1.



EMC = Electro Magnetic Compatability
EMS = Electro Magnetic Susceptability
EME = Electro Magnetic Emission

Fig.1 EMC principles

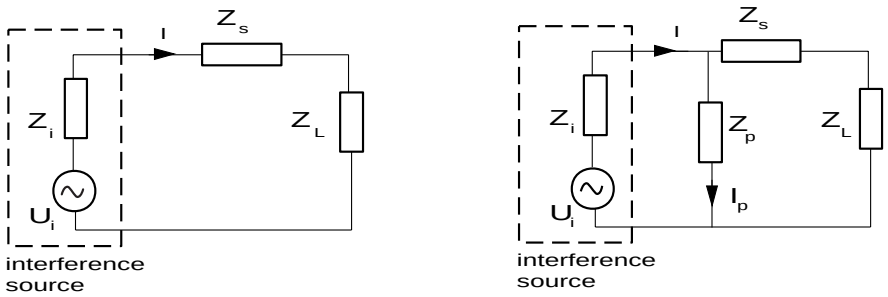


Fig.2 Basic suppression circuits

Capacitors are used as a shunt impedance **(Z_p)** for the unwanted signal. Unfortunately for high frequencies, most capacitors do not have the low impedance one might expect caused by parasitic inductance or resistance (Fig.2).

Inductors **(Z_S)** are used in series with the load impedance **(Z_L)**. Most inductive interference suppression components (choke, bead) are based upon a ferrite core.
Ferrite inductors provide a low impedance for the wanted signal, but a high impedance for the interfering, unwanted, noise signal.

The effectiveness of noise suppression is found by comparing the situation with and without inductor (Fig. 3).

A measure for its effectiveness is the insertion loss (attenuation), which is defined as the ratio of noise voltages **(U_{Ia},U_{Ib})** across the load impedance **Z_L** with and without inductor:

Insertion loss is given by:

$20 \log (U_{Ia}/U_{Ib})$ or

$20 \log(1+Z_S /(Z_i+Z_L))$ dB

The parameter to characterize the inductor performance, independent of a circuit, is its impedance as a function of frequency.

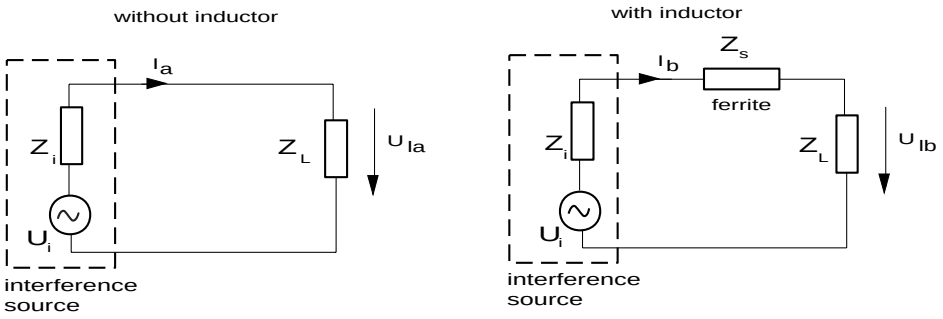


Fig.3 Interference suppression circuit with inductor

Material Characteristics

3S1 and 4S2

SYMBOL	VALUE/GRADE		UNIT	CONDITIONS		
	3S1	4S2		frequency	induction/field strength	temperature
μ_i	≈ 4000	≈ 700		≤ 10 kHz	0.1 mT	25 °C
$\hat{B}$	≈ 350	≈ 270	mT	10 kHz	250 A/m	25 °C
	≈ 180	≈ 180				100 °C
$\lvert Z \rvert$ *	ô 30	-	Ω	1 MHz		25 °C
	≥ 60	-		10 MHz		
	-	≥ 50		30 MHz		
	-	≥ 90		300 MHz		
ρ	≈ 1	≈ 10^5	Ωm	DC		25 °C
T_c	≥ 125	≥ 125	°C			
density	≈ 4900	≈ 5000	kg/m^3			

3B1 and 4B1

SYMBOL	VALUE/GRADE		UNIT	CONDITIONS		
	3B1	4B1		frequency	induction/field strength	temperature
μ_i	900 ± 20%	250 ± 20%		≤ 10 kHz	0.1 mT	25 °C
$\hat{B}$	≈ 330	≈310	mT	10 kHz	250 A/m	25 °C
	≈200	≈260				100 °C
$\frac{\tan\delta}{\mu_i}$	≤ 50.10^{-6}	-		450 kHz	0.1 mT	25 °C
	-	≤ 90.10^{-6}		1 MHz		
	-	≤ 300.10^{-6}		3 MHz		
ρ	≈ 0.2	≈ 10^5	Ωm	DC		25 °C
T_c	≥ 150	≥ 250	°C			
density	≈ 4800	≈ 4600	kg/m^3			

SMD Beads

SMD Beads

PHILIPS COMPONENTS ferrite beads are well known components to suppress unwanted interference. These are supplied as suppression beads to shift on a wire and as beads-on-wire for through-hole mounting on a PCB.
In response to market demands for smaller, lighter and more integrated electronic devices PHILIPS COMPONENTS added a series of **SMD beads**. They are small but powerful tools for EMI/RFI attenuation in electronic equipment.

To our existing standarized sizes we add a new type, the

- ***FLAT SMD BEAD ,***

a **very low profile** core that extends our range towards further miniaturization.

All types are available in suppression material grades **3S1** and **4S2**, according to your impedance and frequency requirements.

SMD beads offer the full advantages of SMD technology:

- ***Economical mounting***
- ***High packing density of components***
- ***Reliable soldering, ...***

Main applications for these modern components can be found in e.g.:

- ***Office automation equipment***
- ***Electronic data processing equipment***
- ***Telecommunication***
- ***Automotive***
- ***Consumer electronic products (audio/video)***
- ***Domestic appliances***

SMD Beads

SMD beads are available in different sizes and two suppression material grades. They are made of a ferrite tube with rectangular cross-section and a flat tinned copper wire which is bend around the edges and forms the terminals of the component. This design offers many superior mechanical and electrical features.

FEATURES:

- ***Low magnetic leakage due to closed magnetic circuit***
- ***Resistant to mechanical shocks and pressure***
- ***Excellent solderability (reflow and wave soldering)***
- ***Terminals are highly resistant to pull forces***
- ***Low tolerances of mechanical dimensions enable automatic mounting***

APPLICATIONS:

- ***EMI-suppression***
- ***Decoupling***
- ***Damping of parasitic oscillations***

FREQUENCY RANGE:

- ***3S1 for frequencies up to 100 MHz***
- ***4S2 for frequencies up to 1000 MHz***

TYPE NUMBER:

e.g. **BDS3/3/8.9-4S2**
(1)(2)(3)(4) (5)

(1)Product type (BDS=BeaD for Surface mounting)
(2)Width nominal (in mm)
(3)Height maximum including wire (in mm)
(4)Length nominal including wire (in mm)
(5)Material grade

ORDERING CODE (11 NC)

e.g. **4330 030 3630**

The first 11 digits of the 12 NC are sufficient to order the desired SMD bead.

SMD Beads

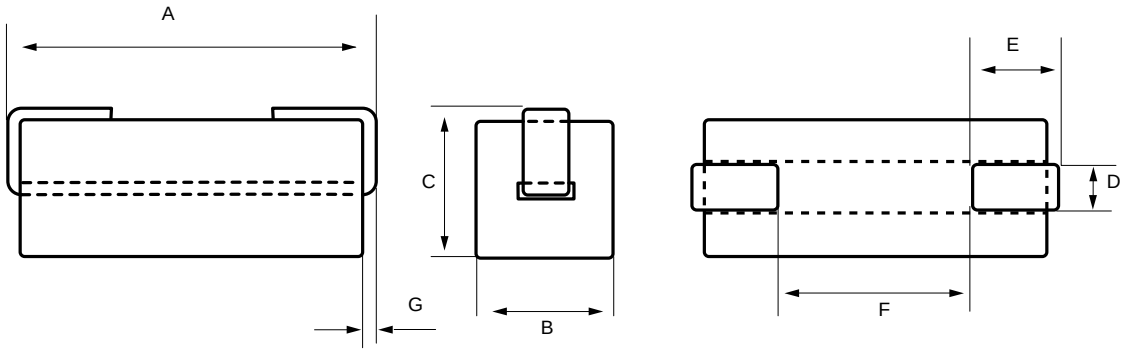


Fig.1 SMD bead

Dimensions

Shape	A		B		C	D	E	F	G
BDS3/3/8.9	8.9	± 0.35	3.05	± 0.15	< 3.0	≈ 1.27	> 1.2	> 5.0	0.2
BDS3/3/4.6	4.6	± 0.3	3.05	± 0.15	< 3.0	≈ 1.27	> 1.2	> 1.1	0.2
BDS4.6/3/8.9	8.9	± 0.35	4.60	± 0.30	< 3.0	≈ 1.27	> 1.2	> 5.0	0.2
BDS3/1.8/5.3	5.3	± 0.35	3.05	± 0.15	< 1.8	≈ 1.27	> 1.2	> 1.1	0.2

Electrical characteristics

Type number	Impedance (Ω) at frequency *					DC resistance	Mass
	3 MHz	10 MHz	25 MHz	100 MHz	300 MHz	(mΩ)	(g)
BDS3/3/8.9-4S2	-	-	65	100	110	< 1.0	≈ 0.3
BDS3/3/4.6-4S2	-	-	30	50	55	< 0.6	≈ 0.15
BDS3/3/8.9-3S1	55	80	65	-	-	< 1.0	≈ 0.3
BDS3/3/4.6-3S1	35	45	35	-	-	< 0.6	≈ 0.15
BDS4.6/3/8.9-4S2	-	-	65	100	110	< 1.0	≈ 0.5
BDS3/1.8/5.3-4S2	-	-	25	38	45	< 0.6	≈ 0.1
BDS3/1.8/5.3-3S1	-	28	33	25	-	< 0.6	≈ 0.1

* Nominal impedance values measured at 25 ^{o}C with a HP4191A impedance analyzer.
Minimum values may be up to 20% lower!

SMD Beads

Packaging And Ordering Codes

SMD beads are delivered taped and reeled, ready for use in automatic mounting machines. The packaging is according to IEC 286-A and EIA 481-A.

Type number	Packing quantity (pcs./reel)	ordering code
BDS3/3/8.9-4S2	2800	4330 030 3630
BDS3/3/4.6-4S2	3000	4330 030 3629
BDS3/3/8.9-3S1	2800	4330 030 3645
BDS3/3/4.6-3S1	3000	4330 030 3642
BDS4.6/3/8.9-4S2	2400	4330 030 3652
BDS3/1.8/5.3-4S2	3000	4330 030 3682
BDS3/1.8/5.3-3S1	3000	4330 030 3685

RECOMMENDED SOLDER LANDS

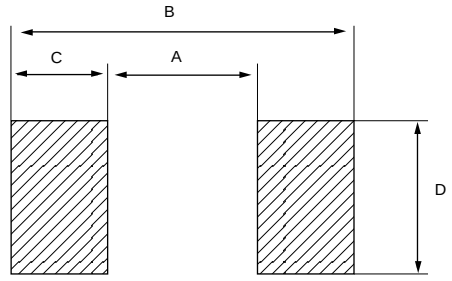


Fig.2a Solder lands for reflow soldering

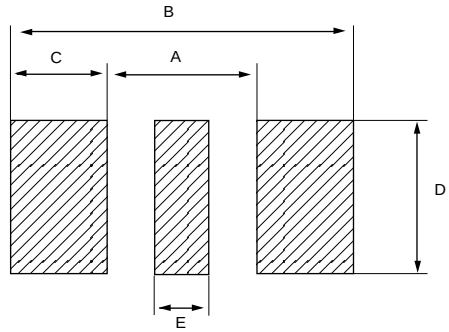


Fig.2b Solder lands for wave soldering

Dimensions (mm) of solder lands

Shape	Reflow soldering				Wave soldering				
	A	B	C	D	A	B	C	D	E
BDS3/3/8.9	7.0	10.8	1.9	3.3	6.0	12.2	3.1	3.0	2.5
BDS3/3/4.6	2.8	6.4	1.8	3.3	2.0	6.4	2.2	3.0	0.8
BDS4.6/3/8.9	7.0	10.8	1.9	3.3	6.0	12.2	3.1	3.0	2.5
BDS3/1.8/5.3	2.8	7.2	2.2	3.3	2.0	7.2	2.6	3.0	0.8

SMD Beads

Typical Impedance Curves

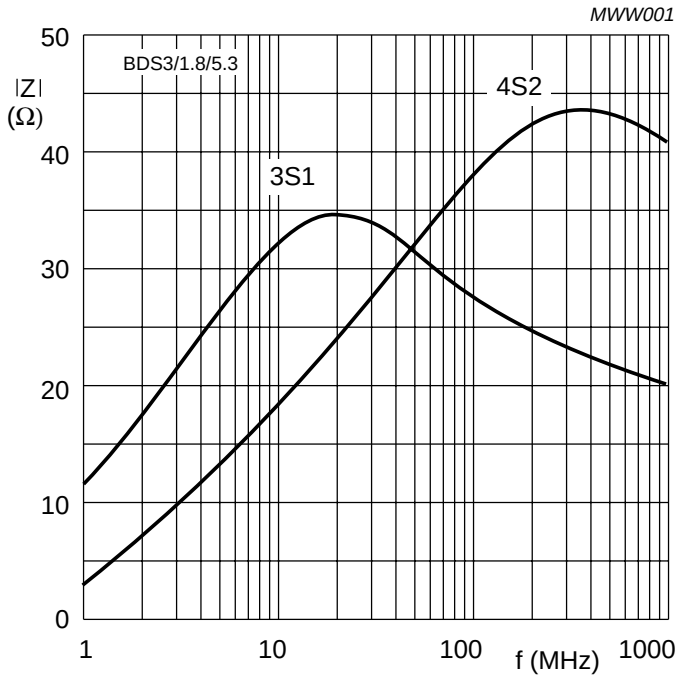


Fig.3 Impedance as a function of frequency for BDS3/1.8/5.3

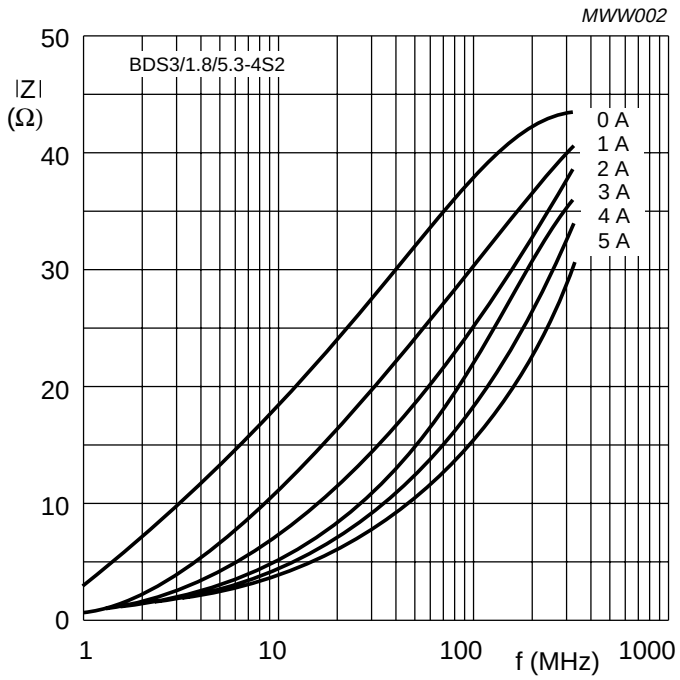


Fig.4 Impedance as a function of frequency with DC or AC bias current for BDS3/1.8/5.3-4S2

SMD Beads

Typical Impedance Curves

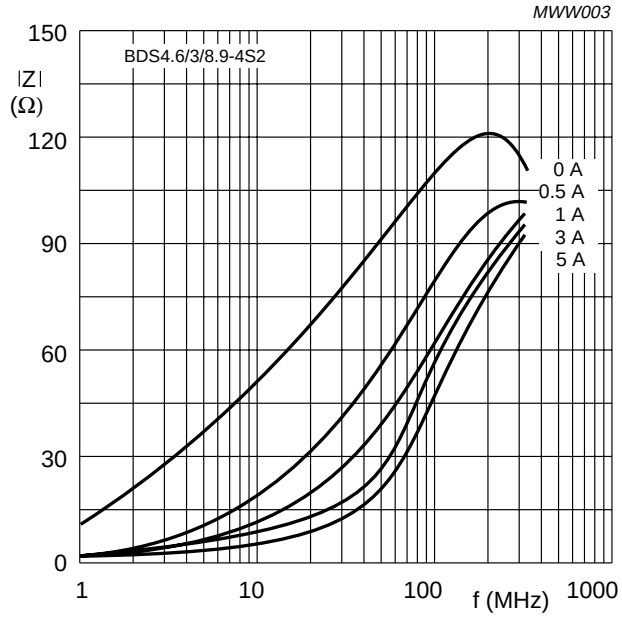


Fig.5 Impedance as a function of frequency with DC or AC bias current for BDS4.6/3/8.9-4S2

SMD Common Mode Chokes

SMD Common Mode Chokes

OPERATING PRINCIPLE

Interferences propagating via supply or signal lines can be suppressed by placing a high impedance in series. This can be provided by a ferrite inductor. However, saturation by the supply current can be a problem. Remedies are a low permeability material or a gapped / open magnetic circuit. The disadvantage is the large number of turns required to achieve the required inductance, leading to high copper losses. With standard suppression methods in a signal path, the wanted signal is often suppressed along with the interference, and in many modern applications (EDP for instance) this leads to unacceptable loss of signal. This can be overcome with **current compensation**, based on the fact that supply or signal currents in both lines are opposite and have equal magnitude.

In Philips' new interference-suppression beads, a pair of conductors within a single soft-ferrite block are connected along their lengths by an air gap. Common-mode signals - interference signals passing in the same direction along the input and output channels of a device (a IC for instance) - serve to reinforce the magnetic flux around both conductor, and are therefore attenuated. In contrast, the wanted signal passing along the input and output channels serves to cancel the flux around the conductors and therefore passes unattenuated.

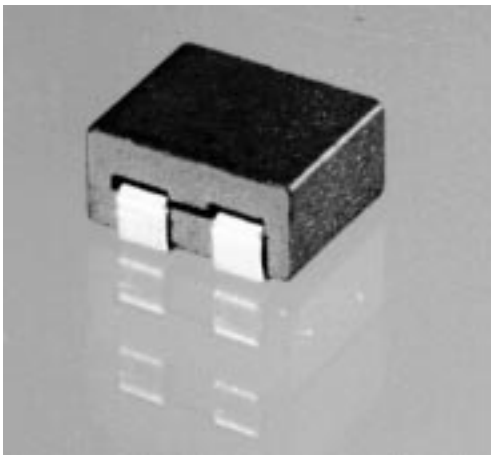
These common mode chokes are available in 2 sizes in **4S2** material with 2 different winding configurations.

In combination with appropriate tracks on the PCB the products can also serve as

- ***MULTI-TURN CHOKE***
- ***TRANSFORMER***

The main application areas for the SMD common mode choke can be found in e.g.

- ***Electronic data processing***
- ***Telecommunication***
- ***Consumer electronics***
- ***Domestic appliances***



SMD Common Mode Chokes

FEATURES

- ***Resistant to mechanical shocks and pressure***
- ***High resistivity material***
- ***Low tolerances of mechanical dimensions enable automatic mounting***
- ***Flat sides to improve handling by automatic placement machines***
- ***Low leakage inductance***
- ***Suitable for different functions, depending on PCB connections***

APPLICATIONS

- ***EMI suppression***
- ***Supply line filtering***
- ***Data line filtering***

TYPE DESCRIPTION

e.g. **CMS2-5.6/3/4.8-4S2**
(1) (2) (3)(4)(5) (6)

(1)Product type (CMS=Common Mode Surface mountable choke)
(2)Number of strips
(3)Width nominal (in mm)
(4)Height maximum including wire (in mm)
(5)Length nominal including wire (in mm)
(6)Material grade

PACKAGING AND ORDERING CODES (11 NC)

4330 030 36881 (Type number CMS2-5.6/3/4.8-4S2)
4330 030 36911 (Type number CMS4-11/3/4.8-4S2)

The first 11 digits of the 12 NC are sufficient to order the desired SMD bead.

SMD common mode chokes are delivered taped and reeled, ready for use on automatic mounting machines. Packaging is according to IEC 286-A and EIA 481-A.

Packing quantity: 2400 Pcs./Reel

SMD Common Mode Chokes

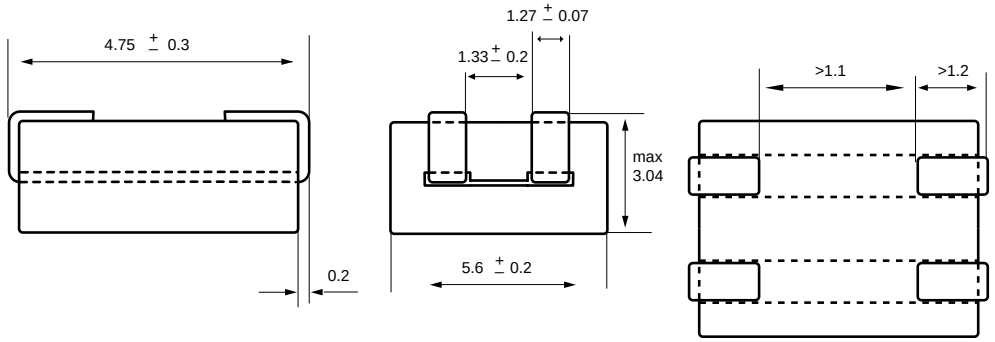


Fig.1 SMD common mode choke with two conductors (CMS2-5.6/3/4.8)

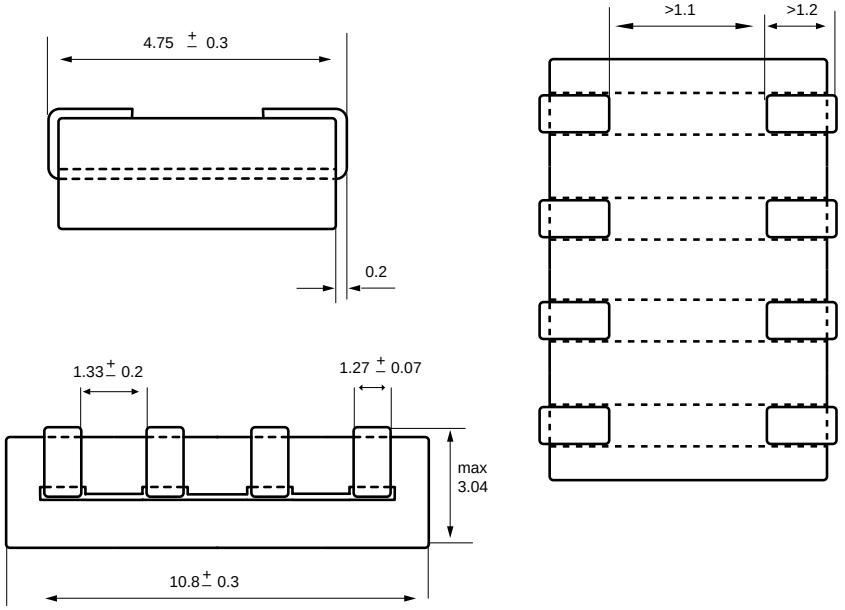


Fig.2 SMD common mode choke with four conductors (CMS4-11/3/4.8)

Electrical characteristics

type number	remark	Impedance (Ω) at frequency			Mass
		30 MHz	100 MHz	300 MHz	(g)
CMS2-5.6/3/4.8-4S2		23	35	50	≈ 0.3
CMS4-11/3/4.8-4S2	inner channel	13	23	42	≈ 0.6
	outer channel	16	30	50	

*Nominal impedance values measured at 25 ^{o}C with HP4191A impedance analyzer.
Minimum values may be up to 20% lower!

SMD Common Mode Chokes

Recommended Solder Lands

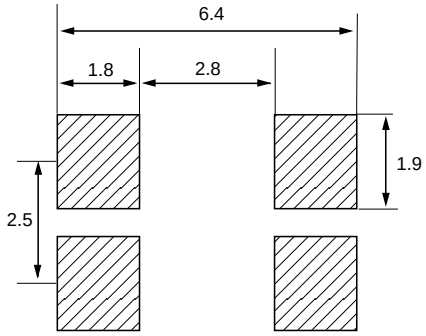


Fig.3a Solder lands for reflow soldering of CMS2-5.6/3/4.8

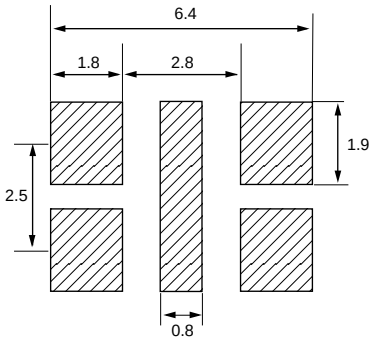


Fig.3b Solder lands for wave soldering of CMS2-5.6/3/4.8

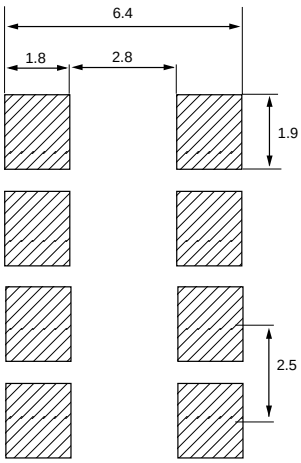


Fig.4a Solder lands for reflow soldering of CMS4-11/3/4.8

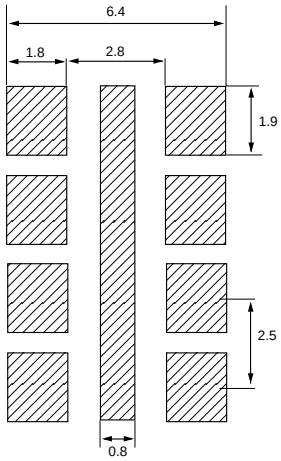


Fig.4b Solder lands for wave soldering of CMS4-11/3/4.8

SMD Common Mode Chokes

Typical Impedance Curves

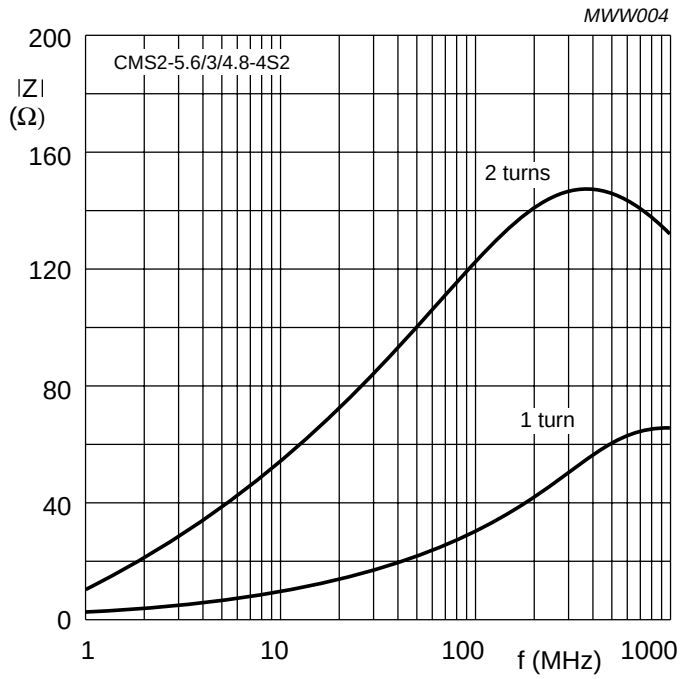


Fig.5 Impedance as a function of frequency for CMS2-5.6/3/4.8 (1 and 2 turns).

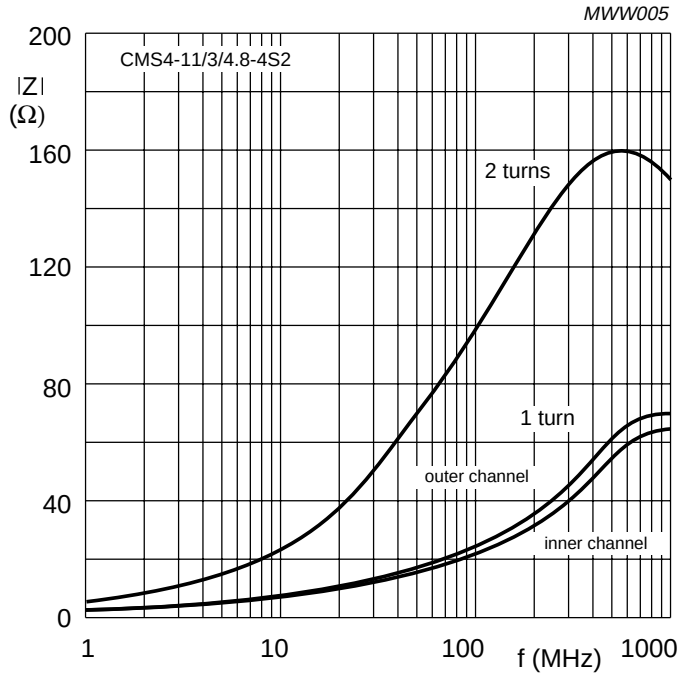
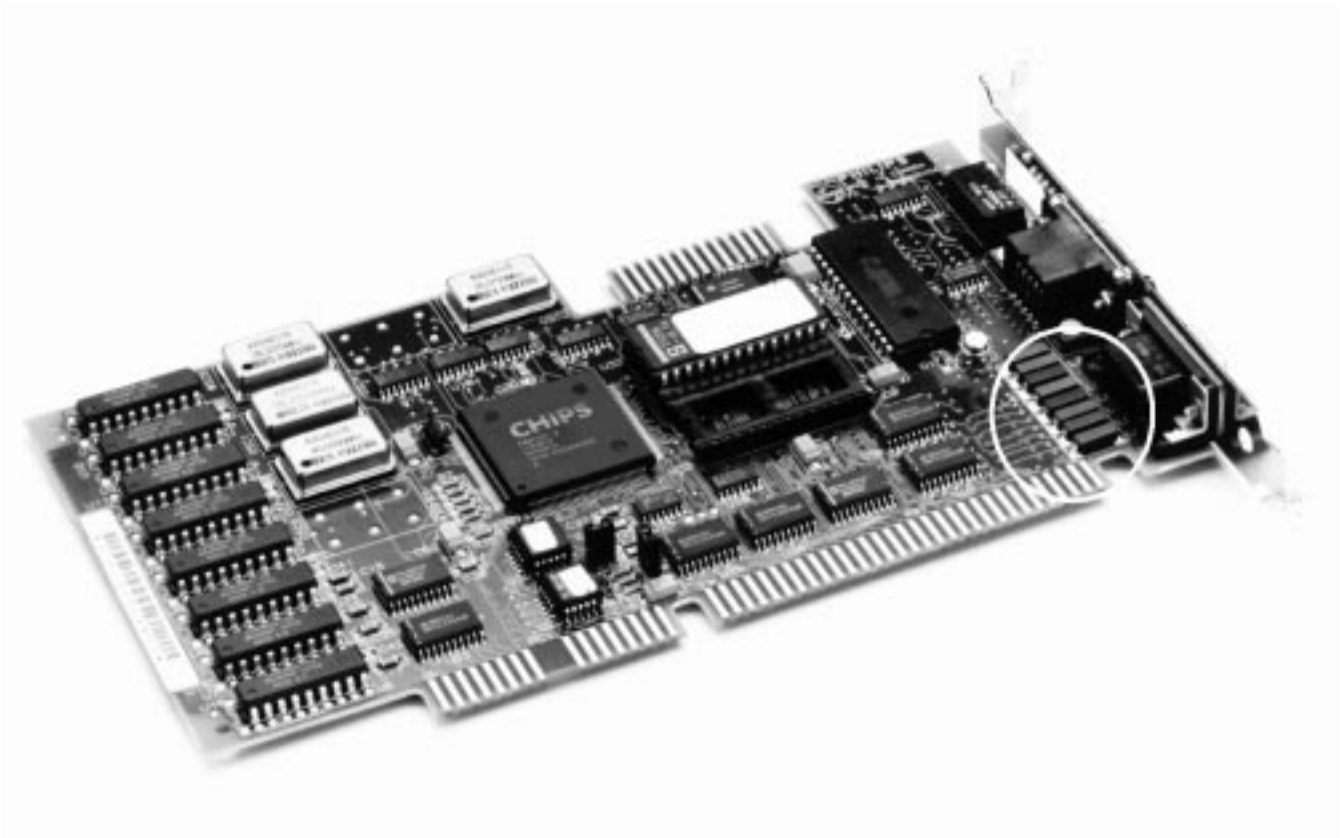


Fig.6 Impedance as a function of frequency for CMS4-11/3/4.8 (1 and 2 turns).



SMD beads in action

SMD Wide Band Chokes

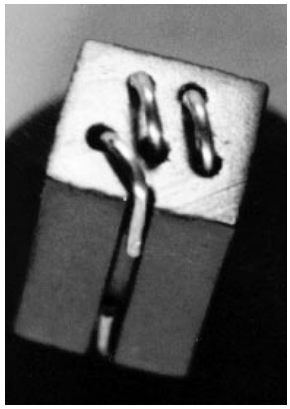
SMD Wide Band Chokes

SMD wide-band chokes are an alternative to a SMD bead when more impedance or damping is required. The design of this product is based on our well known range of through-hole wide-band chokes. In these products the conductor wire is wound through holes in a multi-hole ferrite core, thus separating them physically and reducing coil capacitance. The result is a high impedance over a wide frequency range, a welcome feature for many interference problems. The present SMD design preserves the excellent properties and reliability of the original wide-band chokes by keeping the number of electrical interfaces to an absolute minimum.

FEATURES:

- ***Low leakage inductance due to closed magnetic circuit***
- ***Small mechanical tolerances enable automatic mounting***
- ***Flat sides to improve handling by automatic placement machines***
- ***Reliability of simple design***
- ***Single wire construction without extra electrical interfaces***
- ***Resistant to mechanical shocks and pressure***
- ***Resistant to thermal mismatch because of flexible wire connections***

APPLICATIONS:



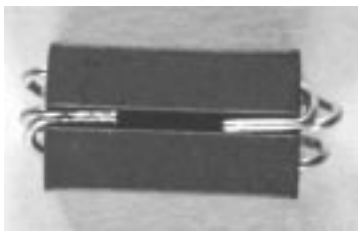
- ***EMI suppression***
- ***Damping of parasitic oscillations***

FREQUENCY RANGES:

- ***3B1 covers medium frequencies < 30 MHz***
- ***4B1 covers high frequencies up to 300 MHz***

TYPE DESCRIPTION:

e.g. **WBS2.5-5/4.8/10-4B1**
(1) (2)(3)(4) (5) (6)
(1)Product type (WBS=Wide Band choke for Surface mounting)
(2)Number of turns
(3)Width nominal (in mm)
(4)Height maximum including wire (in mm)
(5)Length nominal including wire (in mm)
(6)Material grade



ORDERING CODES (12 NC)

4330 030 41661 (Type number WBS2.5-5/4.8/10-3B1)
4330 030 41681 (Type number WBS2.5-5/4.8/10-4B1)

The first 11 digits of the 12 NC are sufficient to order the desired SMD wide-band choke.

Deliveries in bulk. Blister tape in accordance with IEC 286-A and EIA 481-A will follow soon.

SMD Wide Band Chokes

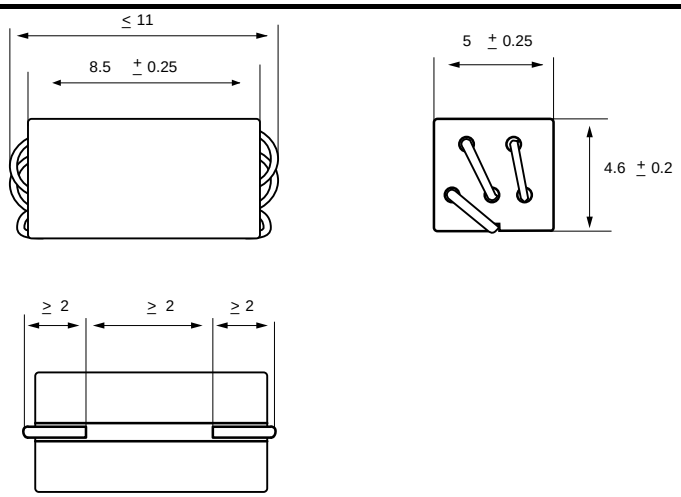


Fig.1 SMD wide-band choke

Electrical characteristics

Type number	Impedance (Ω) at frequency*					R_{DC}	Mass
	10 MHz	25 MHz	50 MHz	100 MHz	300 MHz	(mΩ)	(g)
WBS2.5-5/4.8/10-3B1	300	-	625	600	-	< 7.5	≈ 0.9
WBS2.5-5/4.8/10-4B1	-	485	-	850	350	< 7.5	≈ 0.9

*Nominal impedance values measured at 25 ^{o}C with HP4191A impedance analyzer.
Minimum values may be up to 20% lower!

Recommended Solder Lands

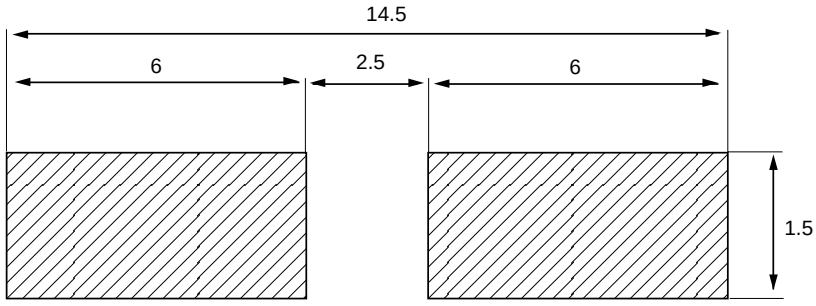


Fig.2 Solder lands for SMD wide-band choke

Dimensions of solder lands are based on a solder paste layer thickness of approx. 200µm.
(≈ 0.7 mg solder paste per mm^2)

SMD Wide Band Chokes

Typical Impedance and Damping Curves

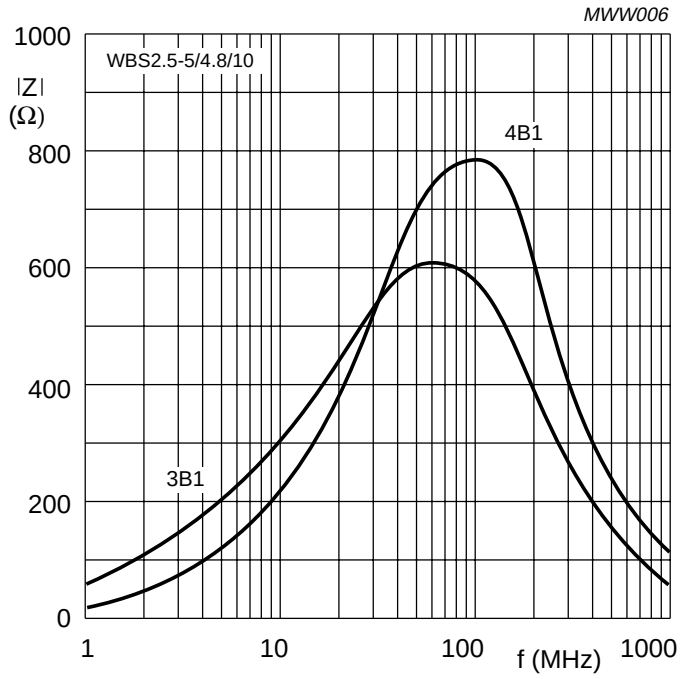


Fig.3 Impedance as a function of frequency for WBS2.5-5/4.8/10.

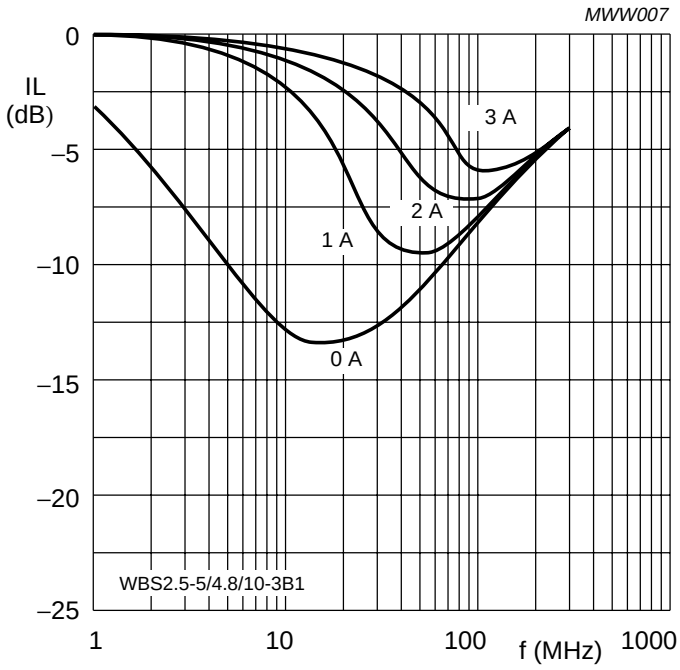


Fig.4 Attenuation as a function of frequency with bias current as a parameter (measured in a 50Ω/50Ω system)

SMD Wide Band Chokes

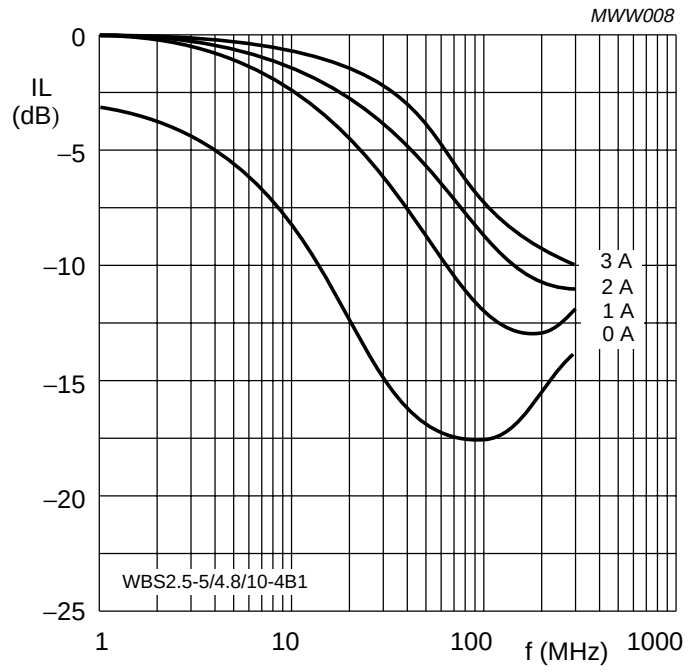


Fig.5 Attenuation as a function of frequency with bias current as a parameter (measured in a 50Ω/50Ω system)