Inductors

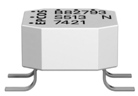
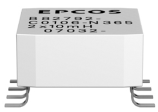
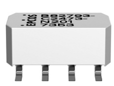
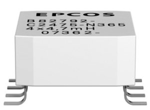
Data and signal line chokes
Selection guide, General

Date: October 2008

Data and signal line chokes

Selection guide

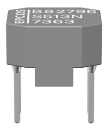
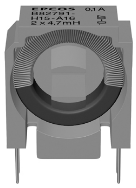
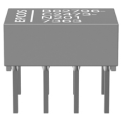
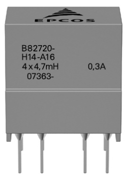
Surface-mount types

Design	Type	V_R V AC	L_R mH	I_R mA	Features
Double chokes					
	B82788C0/S0	42	0.011 … 0.1	150 … 300	I core, EIA size 1210, for automotive, industrial and telecom applications
	B82789C0/S0	42	0.011 … 0.1	150 … 300	I core, EIA size 1812, for automotive, industrial and telecom applications B82789*N: T_{op} up to 125 °C B82789*H: T_{op} up to 150 °C
	B82799C0/S0	42	0.011 … 0.47	200 … 300	Ring core, EIA size 1812, for automotive applications
	B82793C0/S0	42	0.005 … 47	100 … 2000	For automotive, industrial and telecom applications (L_R >4.7 mH only for tele- com applications), reduced height, high currents
	B82790C0/S0	42	0.005 … 4.7	200 … 1000	For automotive and industrial applications
	B82792C0	42	4.7 … 50	100 … 600	For telecom interfaces and ISDN systems
	B82794C0	42	4.7 … 68	200 … 700	For telecom applications and RF equipment
Quad chokes					
	B82793C2	42	0.011 … 2.2	100 … 200	For telecom applications and ISDN systems
	B82792C2	42	0.47 … 4.7	300 … 600	For telecom applications and RF equipment
	B82794C2	42	4.7 … 10	200 … 300	For telecom interfaces and ISDN systems

Data and signal line chokes

Selection guide

Leaded types

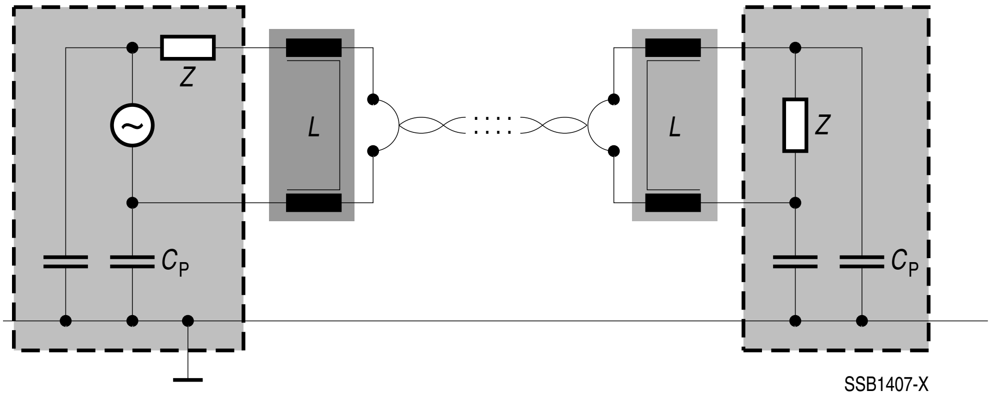
Design	Type	V_R V AC	L_R mH	I_R mA	Features
Double chokes					
	B82796C0/S0	42	0.005 … 4.7	400 … 1200	For automotive and telecom applications, high currents
	B82720H15	42	4.7 … 68	200 … 700	For telecom applications, small size
 	B82791G15/ H15	42	2.2 … 47	100	For telecom applications, horizontal and vertical versions, good RF characteristics, without potting
Quad chokes					
	B82796C2	42	0.011 … 2.2	100 … 200	For telecom applications, small size
	B82720H14	42	4.7 … 10	200 … 300	For telecom applications, compact design
	B82791G14	42	0.2 … 6	100	For telecom applications, good RF characteristics

1 Data line choke applications

In the data and signal transmission it is important to ensure electromagnetic compatibility.

- The number of systems being used for the acquisition, processing and distribution of data is continuously growing.
- Microelectronics are spreading into new fields of application (e.g. automotive electronics).
- The growing popularity of xDSL with its high transmission rates and worldwide networks has led to new EMC problems.

Until recently the use of shielded cables was the main way of preventing data transmission from being disturbed by RF interference fields. A more economical solution is the use of symmetrical transmission line systems. In these, twisted pair lines are used in conjunction with data line chokes. The chokes used here have extremely good symmetry characteristics.



L = Data line choke

Z = Characteristic impedance

C_P = Parasitic capacitances

Diagram showing the principle of a symmetrical transmission line with data line chokes

2 Technical advantages

The main advantages are the low space requirements even for high inductance values used to suppress common-mode interference. This is achieved by using bifilar windings, which are more favorable for producing chokes with excellent symmetry characteristics than other winding designs. This results in very low stray inductance, a characteristic that is highly desirable for achieving the lowest possible attenuation of the differential-mode data signal.

Data line chokes suppress common-mode interference coupled into data lines from frequencies as low as 1 kHz up, whereby they have no effect on data signals with bandwidths of up to several megahertz.

⚠ *Note:*

To achieve the choke's function fully, care must be taken to ensure that the vector sum of all currents flowing through the choke is zero.

3 Applications

3.1 Interference suppression on data and communication lines

Increasingly high clock frequencies/transfer rates and the associated fast rise times mean that the signals used in modern data and telecommunications engineering are a serious potential source of RF interference that can influence other devices and systems. At the same time, electronic data and telecommunications equipment itself is becoming increasingly compact, which exposes it to the risk of external conducted and radiated interference. The wide-area networking of telecommunications equipment presents a special problem, because interference is then also able to propagate over wide areas. To judge this, it is important to look at the different propagation modes of conducted interference:

Differential-mode interference (symmetrical):

The effect of differential-mode interference can be kept to a minimum by suitable, balanced design of the transmission circuit.

One measure of this kind is the use of cables with twisted pairs. Because the conductors are routed so close together and twisted, coupling in of differential-mode interference through electromagnetic fields is practically impossible.

Common-mode interference (asymmetrical):

Common-mode interference is caused by electromagnetic fields that induce interference voltages in lines. It can only be reduced by filtering or shielding.

The most commonly used means of transmission are based on symmetrical data signals routed over twisted pairs. Examples of this are the analog plain old telephone system (POTS) and new digital systems like ISDN (integrated services digital network) or high-speed networks like ADSL (asymmetrical digital subscriber line).

In all such cases, the useful signal appears as a differential-mode signal. As mentioned, the interference coupled in by electromagnetic fields is in common mode. By appropriate protective circuitry it is possible to suppress the interference and at the same time let the transmitted symmetrical signal pass unaffected.

Chokes are a very effective means of protecting data lines. The different designs, optimized for telecommunications and data applications, exhibit very low stray inductance (approx. 1‰ of rated inductance) and excellent symmetry features. They can substantially enhance the characteristic symmetry of a transmission line and thus contribute further to increasing interference immunity and at the same time reducing emitted interference.

3.2 Automotive electronics

Automotive bus systems like CAN (Controller Area Network) and FlexRay®[1)] make it possible to simplify the wiring of a vehicle considerably, enabling the same cable harnesses to be used for vehicles fitted with different combinations of electrical equipment and appliances. In modern motor vehicles the CAN bus has evolved as a standard. However, car electronics is a growing field. In the past there were only a few controllers, e.g. ABS, powertrain, airbag. Nowadays, a lot of new features for driver assistance and safety applications are already available and this is by no means the end.

1) FlexRay® is a registered trademark of Daimler AG

Data and signal line chokes

General

The need to reduce CO_2 emissions will lead to sophisticated engine management with many sensors, actuators and control units. Driver assistant systems will continue to grow in the future.

This development was foreseen by major automotive tier 1 suppliers. So, in 2000 a consortium was founded. The target was to develop an automotive bus system that would fulfill the additional requirements for future in-car control applications including the combination of higher data rates, deterministic behavior and the support of fault tolerance. These efforts led to the FlexRay bus. This is able to handle a data rate of 10 Mbit/s on two channels, meaning a gross data rate of up to 20 Mbit/s.

Both CAN and FlexRay are serial two-wire bus systems that network the various control systems in an automobile and thus enable these to communicate with each other. Transmission of data is by a symmetrical signal. Due to asymmetries (see table below) in reality there is no 100% symmetrical signal possible.

Topic	Reason for asymmetry	Reason for parasitics
Layout of bus signal lines	Routing of signal CAN H (FlexRay BP) Routing of signal CAN L (FlexRay BM)	Capacitance and inductance of vias
Termination filters	Matching of split termination	Capacitance of resistors to ground
Connectors	Geometry pad CAN H/CAN L (FlexRay BP/BM)	Capacitance and inductance of contacts
Printed circuit board	Width path CAN H (BP) Width path CAN L (BM) Etching of lines and pads Soldering of pins	Dielectricity of PCB

These asymmetries can cause EMC problems. On one hand external electromagnetic fields may couple onto the bus and interfere with the useful signal. On the other hand the bus may radiate voltages that can interfere with other electronic equipment in the automobile. Neither is desirable and for safety-relevant applications absolutely forbidden. The solution is specially designed data line chokes. In general these chokes are quite similar for both: CAN and FlexRay. But due to the different clock rates the focus is on different parameters.

For both applications it is necessary to achieve high common-mode interference suppression (asymmetrical attenuation) in a broad bandwidth.

A CAN bus choke may have higher symmetrical attenuation in the megahertz frequency range. In the CAN bus this is necessary to adequately suppress the differential-mode that is induced due to this system's inherent lack of symmetry.

For FlexRay, because of the clock rate up to 10 MHz, this is forbidden. A symmetrical inductance (stray inductance of common-mode choke) in the megahertz range would influence the useful signal and lead to a lack in signal integrity. For this the stray inductance must be a minimum.

As a consequence to excellent electrical ratings and especially the very low stray inductance, the 100 µH SIMDAD data line choke (B82789C1104N003, EIA size 1812) was chosen as the reference type for FlexRay by the EMC working group of the FlexRay consortium. Also the 51 µH was tested and found suitable for FlexRay.

Meanwhile the high-temperature series B82789C*H (51 µH, 100 µH) has also been tested by the Institute of Applied Science in Zwickau, which is responsible for EMC measurements for the FlexRay consortium. It was demonstrated that the results are nearly the same. These test results are obtainable.

Subsequent development work on data line chokes finalized in a new SIMDAD 1210 series (B82788, EIA size 1210). For this series the EMC test reports for CAN and FlexRay are already available. It can be demonstrated that although size is significantly reduced, performance is quite similar to the 1812 series.

4 Markings

The markings stamped on the data line chokes are described in the respective data sheets. The following coding methods are used to mark inductance values and the date of manufacture on components:

Inductance values (coded in nH):
Example: 104 = 10×10^4 nH = 100 000 nH = 100 µH

Date of manufacture:
On small styles the date of manufacture is coded by four digits, e.g. 8293:

8 = calendar year 2008
29 = calendar week 29
3 = 3rd day of week (Wednesday)

On larger components the month and year are marked, e.g. 06/08 or 06-08 or the date of manufacture is coded using five digits, e.g. 08293:

08 = calendar year 2008
29 = calendar week 29
3 = 3rd day of week (Wednesday)