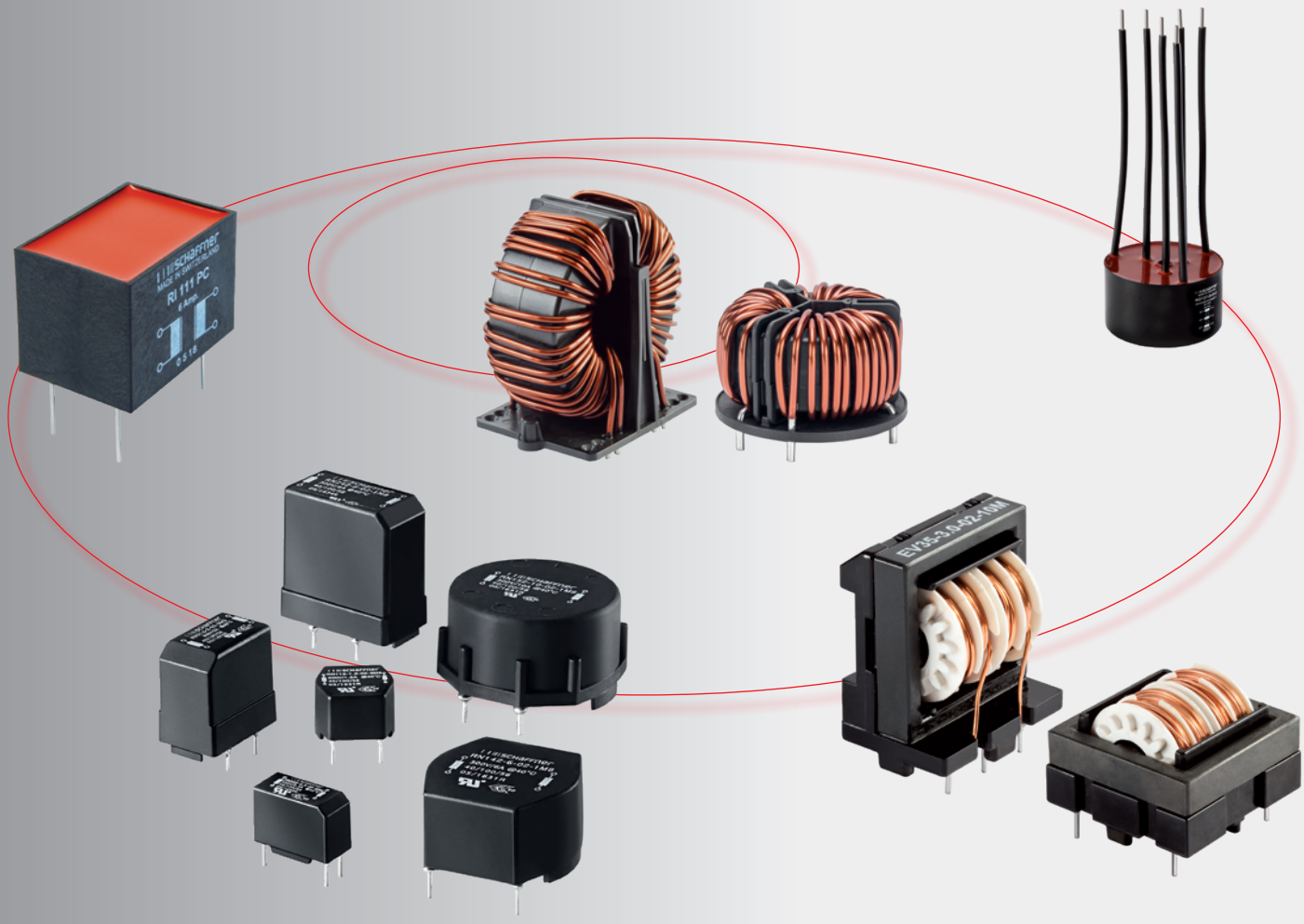
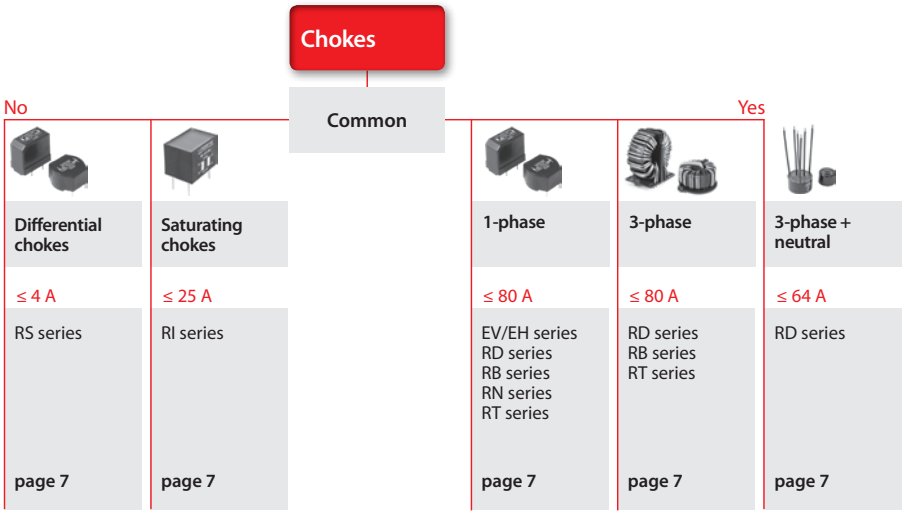
CHOKES CATALOG
MARCH 2018

EMC/EMI Chokes
How to select the right choke family



schaffner
shaping electrical power

1. Introduction and general comments



This application note is written for circuit designers to better understand the benefits of the Schaffner choke portfolio. Technical details in this note assume familiarity with the basics of EMC/EMI. It intends to provide support in the selection of the right choke family.

With Schaffner chokes any DC, single-, three-phase or three-phase plus neutral EMC/EMI filter can be designed.

The available common mode, differential mode and saturating choke families are RN, RT, RB, RD, EV/EH, RS and RI. Each of them has unique features and they combine to create a comprehensive choke portfolio. Target applications are covered in each individual choke family section.

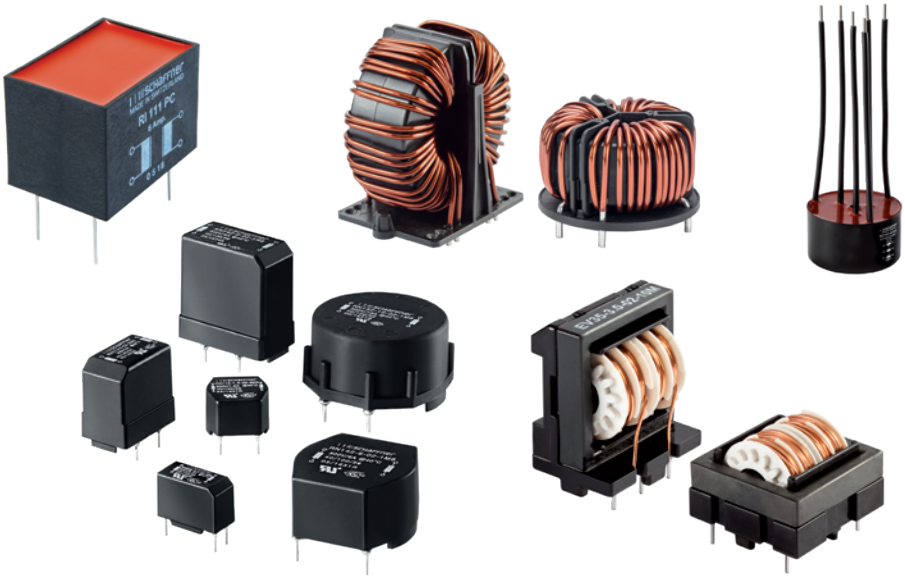
All of the discussed products are components to build up an EMC/EMI filter on PC board level, this is beneficial as it results in higher power density together with adjusted design and lowest cost.

Like most Schaffner EMC/EMI filters, the choke components can be used for worldwide applications. Housings, compound, bobbins and base plates consist of halogen free plastics. All materials are in accordance with the newest ROHS and REACH requirements.

Table 1 – Choke technical specifications/differences

Type	Family	Rated Voltage[1]	Lines	Current[2]	Inductance	Features	Housing
Saturating	RI	500 VAC	2	1.5 to 25 A	0.25 to 3 mH	Differential mode for high current app.	Plastic
Diff	RS	250 VAC	2	0.5 to 4 A	0.003 to 3.6 mH	Differential mode	Plastic
Common	RN	300 VAC	2	0.3 to 10 A	0.4 to 100 mH	Low-loss EMC/EMI filter design	Plastic
	EV/EH	250 VAC	2	0.3 to 5 A	2.5 to 90 mH	Broadband attenuation	Open construction[3]
	RT	600 VAC/ 425 VDC	2, 3	6 to 20 A	2.5 to 10 mH	High performance	Open construction[3]
	RB	600 VAC/ 100 VDC	2, 3	16 to 50 A	2.0 to 3 mH	High saturation	Open construction[3]
	RD	600 VAC/ 850 VDC	2, 3, 4	6 to 64 A	0.2 to 25 mH	4-line design (3P+N)	Plastic

All of the chokes feature a self-explanatory part number, which helps to find the right part for any application more easily. If the nominal current and the inductance (calculated according to switching frequency) is known, the selection is very fast, as the naming convention is based on inductance and current level (e.g. RN 212-1.5-02-3M3 – common mode choke of RN 212 series with 3.3 mH inductance at a current level of 1.5 A).



[1] Rated voltage denotes the approved voltage level with the certification bodies. The voltage level might differ with changed application circumstances. This needs to be adjusted in accordance to the specification of the application.
[2] Current can be adjusted according to derating and application specific circumstances.
[3] Open construction enables forced cooling with 1.6× rated current applicable.

1.1 RI chokes

The RI saturating type chokes change impedance at the moment of switching and can be used to attenuate differential-mode noise or symmetrical interference as generated in fast switching high current applications. These chokes are typically used in conjunction with suppression capacitors. For optimum attenuation chokes must be connected as close as possible to the semiconductor switching device.

Typical applications are:

- Suppressing high interference levels generated by fast switching circuits
- DC voltage smoothing
- EMC/EMI filters
- Phase angle control circuits
- Power supplies
- Chargers

1.2 RS chokes

RS chokes can be used in various applications. Applications include differential mode choke and storage mode choke designs. With the six different types of housing, inductances and current capabilities, the RS chokes are effective in cancelling out differential mode disturbances in switch mode power supplies. The combination of low DC resistance and low loss material makes them ideal for the use in low current power supplies operating at high switching frequencies.

1.3 RN chokes

The RN choke products are used in a high variety of applications, mainly focusing on low power levels and a very compact design. With the RN series, a lot of different small to medium size demands can be covered with perfect availability and fast and easy logistic services.

Main applications and fields of usage are:

- Information and communication technology
- Office and EDP equipment
- Medical devices
- Switch-mode power supplies

Due to the low ampere range, RN chokes are only available as two-line chokes. For AC and DC applications.

1.4 EV/EH chokes

EV/EH common-mode suppression chokes are mainly used to filter noise on AC power lines. EV/EH chokes are the broadband solution with high inductance values at high currents.

Typical applications are:

- Input filters for switch-mode power supplies
- Filters to reduce leaking noise
- TVs, VCRs, multimedia and audio equipment
- Office automation, communications and other electronic devices
- Electric ballast
- AC/AC converters

1.5 RT chokes

RT chokes cover the demand of high inductance and good saturation behavior. The product range is mainly focusing on small to medium current ranges for PCB assembly. The design is straight forward and easy to certify due to open construction.

Main target applications are:

- Drive applications
- Inverter applications in general
- HVAC
- Elevation
- High-power lighting
- And many others

The chokes are available in four different types covering a lot of different customer needs. Horizontal, vertical, 2-line and 3-line design is available to fit to any request and to accelerate the design process.

RT and RB chokes can be used with even higher ampere rating with applied active cooling.

1.6 RB chokes

These chokes are made for highly demanding applications in regard to voltage rating and environmental aspects. A few of the key benefits are the ruggedized construction and an ambient rating of 60 °C.

The chokes are available in two different performance levels, which allows maximum stable performance even with high inrush currents (no saturation) or highest performance even with reduced capacitor values (lower leakage current).

The rating of up to 1000 VDC gives the ability to design the chokes into DC links of motor drives or DC side of solar inverters.

Here a few potential applications:

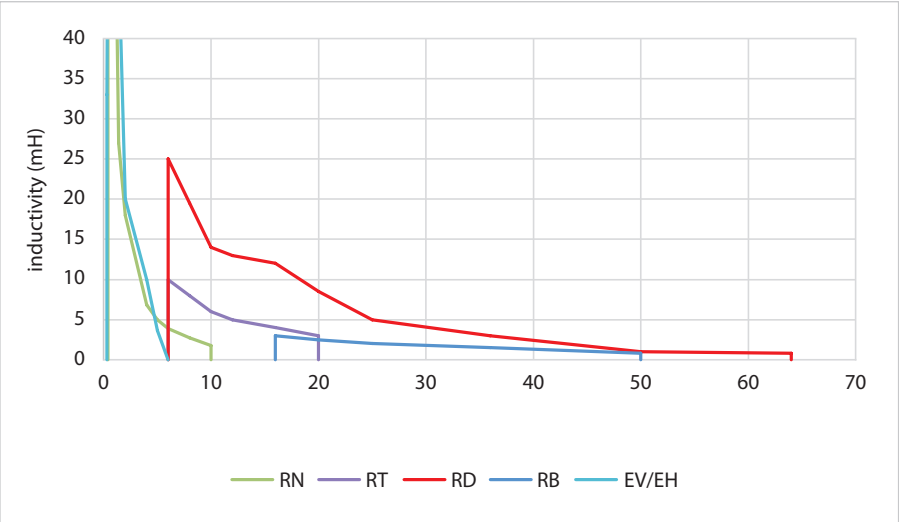
- PV (photovoltaic) inverter
- EV chargers
- Motor drives
- Welding robots

1.7 RD chokes

RD chokes are the most comprehensive choke family ranging from very few to highest ampere rating in the Schaffner portfolio. The chokes can be the base for filters in several different supplying grid topologies, the chokes are available in a 2-, 3- and 4-line configuration in a compact housing.

The lower amperage units can be PC board mounted and the higher amperage units are wired versions.

Due to this very wide portfolio, there is no proper selection of applications, as the RD chokes can built a base for a lot of different filter topologies in various different applications.



Common mode choke comparison

2. Electromagnetic compatibility (EMC) and electromagnetic interference (EMI)

The main task of the EMC/EMI filter design is to bring EMI noise down below the allowed limits of emission standards for the conducted RF (radiofrequency) range. The other major point is the robustness against EMI introduced by other devices in the same environment. For more details please refer to the application note basics in EMC and PQ.

To fulfill the generic standards for conducted emission, **EMI noise has to be reduced** starting from 150 kHz. In some product standards like for lighting the limits already start at 9 kHz.

The discussed chokes are so called common-mode (CM) or current-compensated chokes.

They are wound with at least two identical windings on the same core. Because of this design approach the choke **will not go into magnetic saturation under normal operating conditions. Designing filters with chokes is an economic way to combine low losses and minimal signal impact with efficient EMC/EMI filtering.**

Although all discussed chokes are common-mode chokes, EMC/EMI filters for both types of interferences –common-mode (CM) noise as well as for differential-mode (DM) noise – can be designed based on the chokes, because **L consists out of two parts.**

EMC/EMI chokes

An extensive selection of discrete EMC/EMI chokes with various inductance and current ratings allows optimized circuitry for EMC compliance to be designed easily and economically.

Approvals *		Inductance value [mH] / Rated current [A]	Features								Typical applications							
Choke family	Max. voltage	0 20 40 60 80 100 / 0 30 60 90 120 150	For common-mode noise	Saturating chokes	Single-choke	Dual-choke	Triple-choke	Quad-choke	PCB mounting	With flying leads	Frequency converters, UPS	Medical equipment	Traction systems	DC/DC or AC/DC converters	Switch-mode power supplies	Home electronics, TV, balasts	Battery chargers	Heaters, air conditioners
EV/EH series	250 VAC	0.5–90 / 0.3–5	■			■			■		■	■			■	■	■	■
RN series	300 VAC 300 VDC	0.4–100 / 0.3–10																
RD 5000 series	600 VAC 850 VDC	1–10 / 6–16	■			■	■		■		■		■					
RD 6000 series	600 VAC 850 VDC	1.5–15 / 6–16	■			■	■			■	■		■					
RD 7000 series	600 VAC 850 VDC	0.2–25 / 6–36	■			■	■	■		■	■		■					
RD 8000 series	600 VAC 850 VDC	0.2–12 / 16–64	■			■	■	■		■	■		■					
RT series	600 VAC 425 VDC	2.5–10 / 6–20 (32)																
RB series	600 VAC 1000 VDC	0.2–3 / 16–50 (80)**	■			■	■		■		■	■	■	■	■		■	■
RI series	500 VAC	1.5–25		■	■	■			■	■	■		■	■	■			
RS series	350 VAC	0.003–3.6 / 0.5–4			■	■			■		■	■		■	■	■	■	■

* Products evaluated by one or more of the above certification agencies. For details please consult the detailed data sheet.

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