Introduction to EMC

Schurter has over 75 years experience in the electronics and electrical industries, developing and manufacturing components that ensure a clean and safe supply of power. Schurter provides EMC Services to its customers in various industries, recommending solutions that guarantee electromagnetic compliance with international equipment standards. The full scope of Schurter's EMC products include Power entry Modules with Filter, Single and 3-Phase Filters, Chokes, Pulse Transformers and Driver Modules.

Introduction EMC

Definition of EMC / EMI	Filter parameters
Sources of EMI	X-Capacitor
Coupling mechanism	Y-Capacitor
Immunity and emission	Leakage current
Interference voltage measurement	Bleed resistor
EN55011/EN55022	Attenuation loss
Noise immunity	Attenuation diagram
Differences between surge,burst and ESD	Dielectric strength
Differential and common mode disturbances	Climatic category
Common mode disturbances	Rated voltage V_n and rated current I_n
Differential mode disturbances	Standards or approval marks

Definition of EMC / EMI

Electro Magnetic Compatibility = EMC

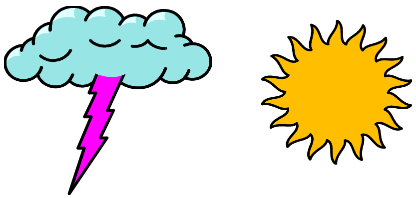
The electro magnetic compatibility is the ability of an electrical device, unit or system to function sufficiently well in its electromagnetic environment without generating unintentional interference to the other equipment in the system

Electro Magnetic Interference = EMI

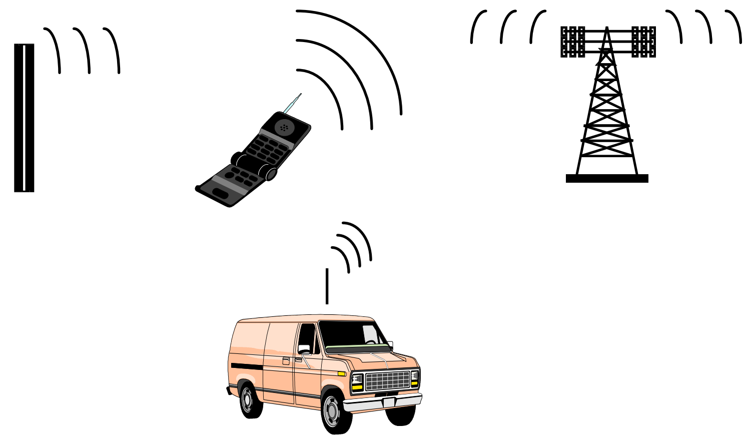
Electromagnetic energy emanating from one device which degrades or obstructs the effective performance of another device

Sources of EMI

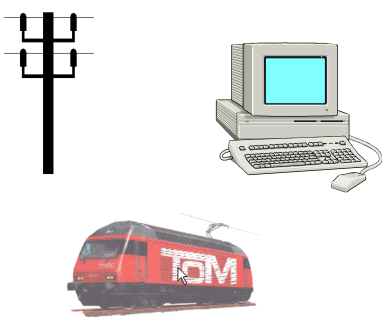
Natural



Man-Made Intentional



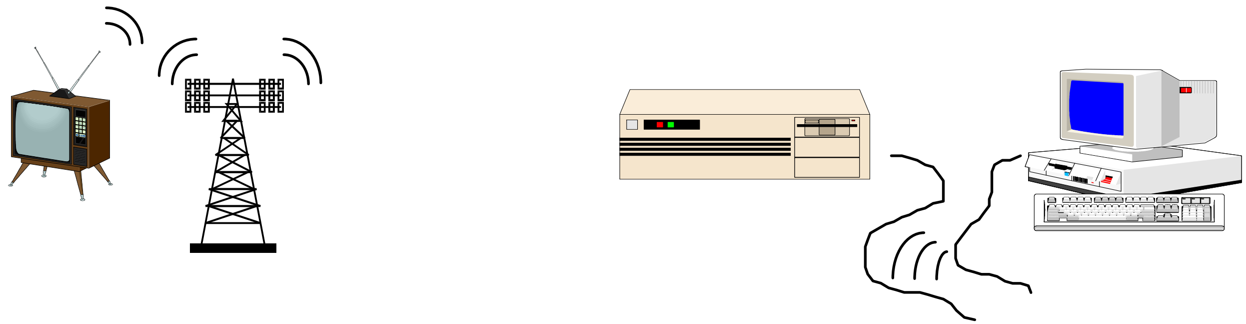
Man-Made Unintentional



Coupling mechanism

Radiated

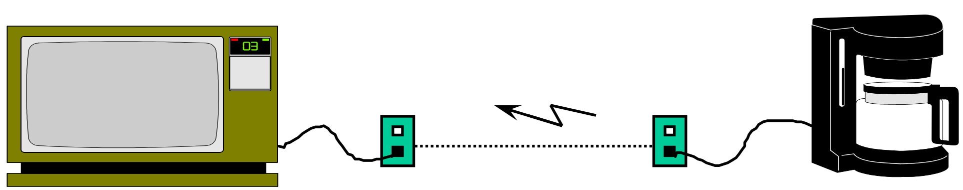
approx. 30MHZ-1GHz



Conducted

approx. 9kHz-30MHz

(SCHURTER Filter)



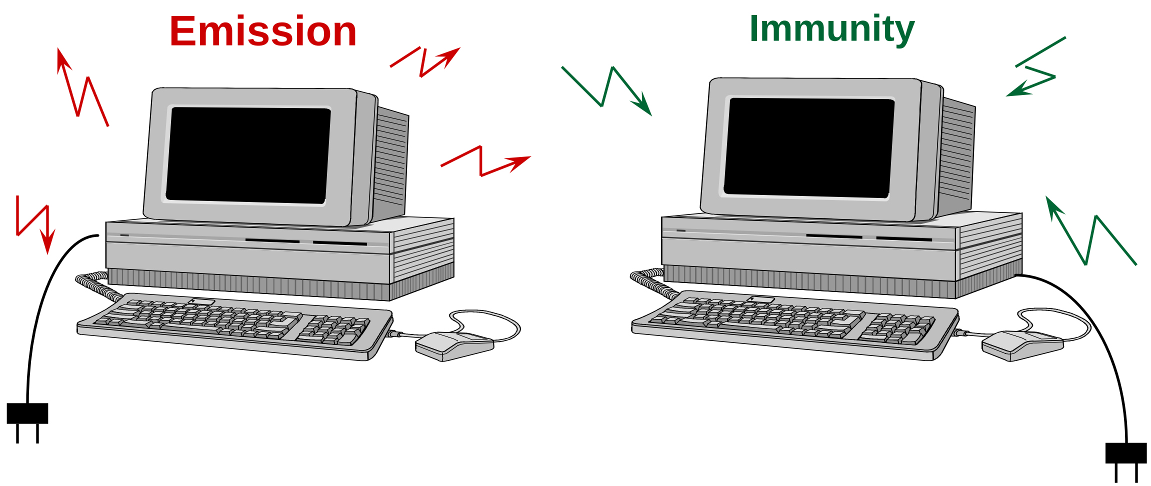
Immunity and Emission

According to standards, manufacturers of electrical devices are obliged to sufficiently protect their devices from electromagnetic disturbances

Immunity

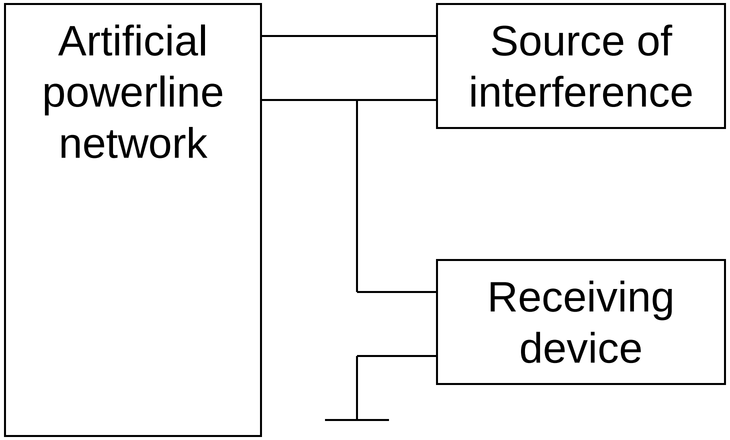
The manufacturers are obliged to ensure that these electrical devices produce very little electromagnetic disturbances to their surroundings

Emission



Interference voltage measurement

The emission of a device can be proven with interference voltage measurement. This measurement is accomplished in accordance with the standardised measuring method CISPR3.



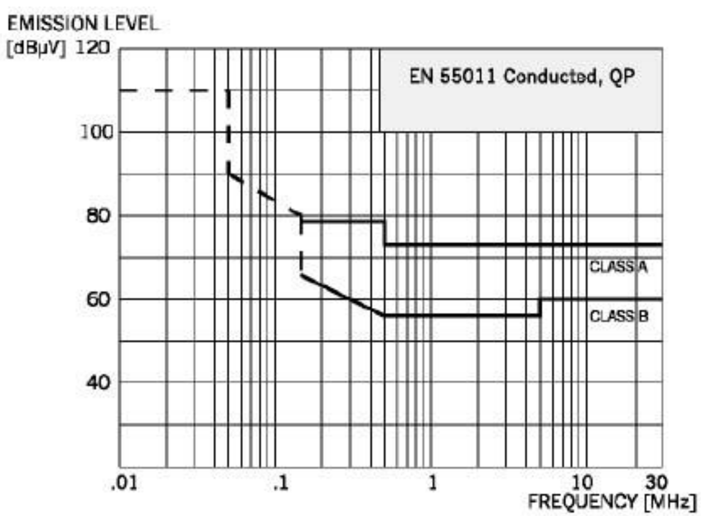
EN55011/EN55022

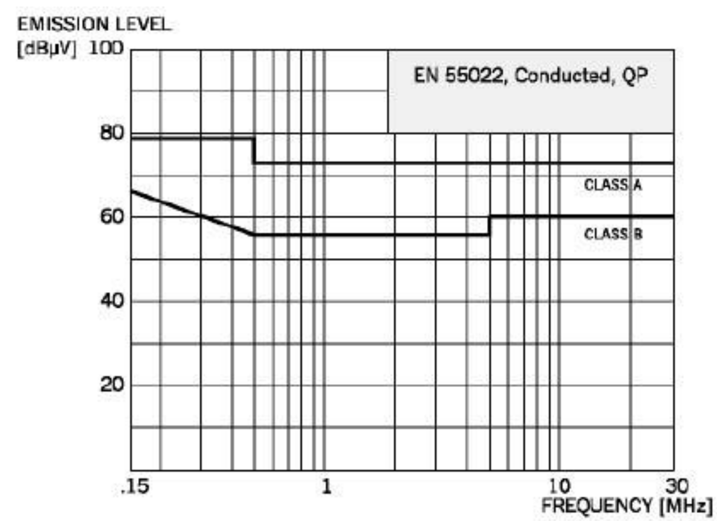
Each equipment manufacturer must adhere to the defined interference limits according to the standards to prevent disturbing the power network; for example, EN55011 covering ISM (Industrial, scientific and medical appliances) and EN55022 covering ITE (Information technology and telecommunications equipment). Boundary values are:

Class A: for application in an industrial field

Class B: for household and medical applications

The boundary values for class B equipments are stricter than those for the class A





Noise Immunity

The immunity of equipment can be examined in accordance with the following three test procedures:

- ESD (Electrostatic Discharge)
- Burst
- Surge

Equipment can be affected by two kinds of interferences:

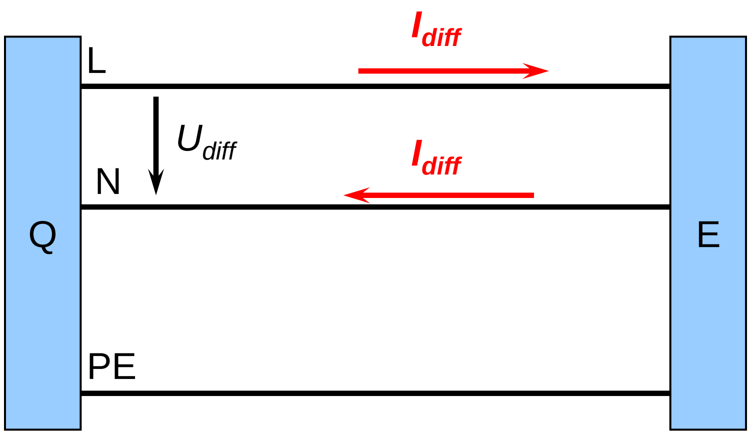
- Permanent interference (from HF transmissions)
- Transient interference (from the switching of electrical loads)

Difference between Surge, Burst and ESD

Characteristic	Electrostatic discharges	Transient interferences	Lightning
Description	**ESD**	**BURST**	**SURGE**
Voltage	Up to 15 kV	Up to 4 kV	Up to 6kV
Repeating frequency	Single Impulses	Multiple Impulses of 5 kHz	Max. 6 Impulses/Min
Application test object	contactable metal parts	network, signal, measuring and data line networks	network, signal, measuring and data line networks
Energy	> 10 mJ	300 mJ	300 J
Standard	EN 61000 4-2 IEC 61000 4-2	EN 61000 4-4 IEC 61000 4-4	EN 61000 4-2 IEC 61000 4-2

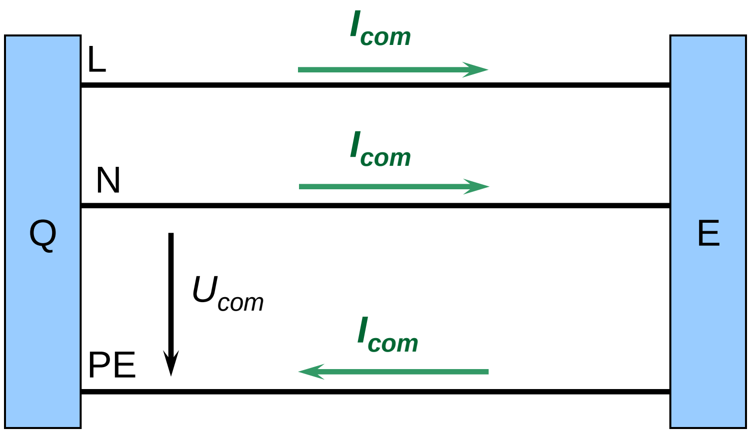
Differential and common mode disturbances

Differential Mode



Disturbance flows via the phase line to the interference receiver and via the neutral line back to the interference source.
Voltage between the phase and neutral conductors can be measured.

Common Mode



Disturbance flows via the phase/neutral line to the interference receiver and via ground back to the source of interference.
Voltage between the phase/neutral pole and earth can be measured.

Q: Interference source
E: Interference receiver
L: Phase
N: Neutral pol
PE: Earth

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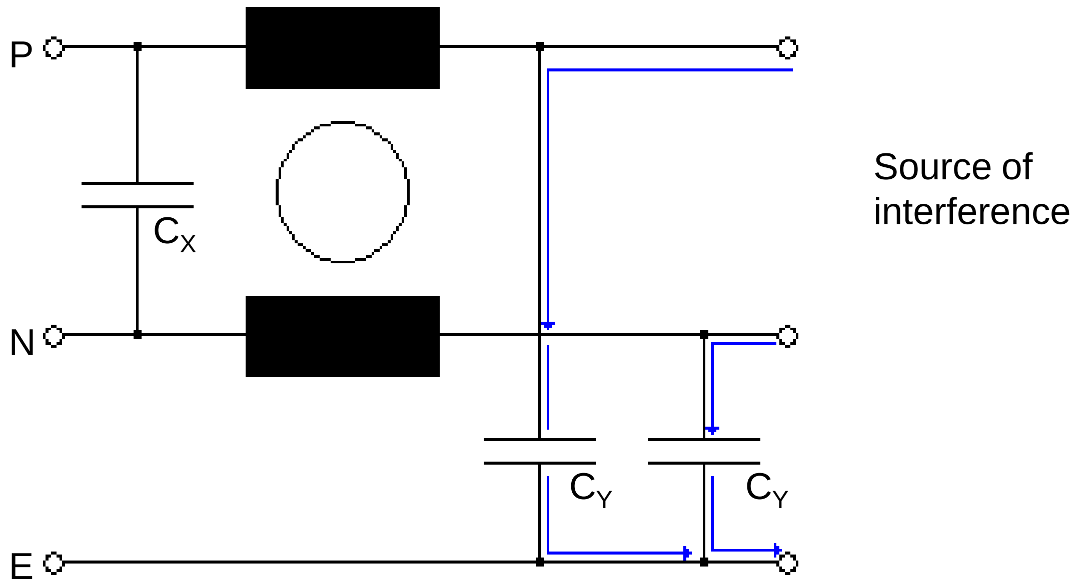
Common Mode disturbances



The attenuation is achieved by the effect of the choke L and the two Y-capacitors. The interference current flows back through C_Y via protective ground to the interference source.

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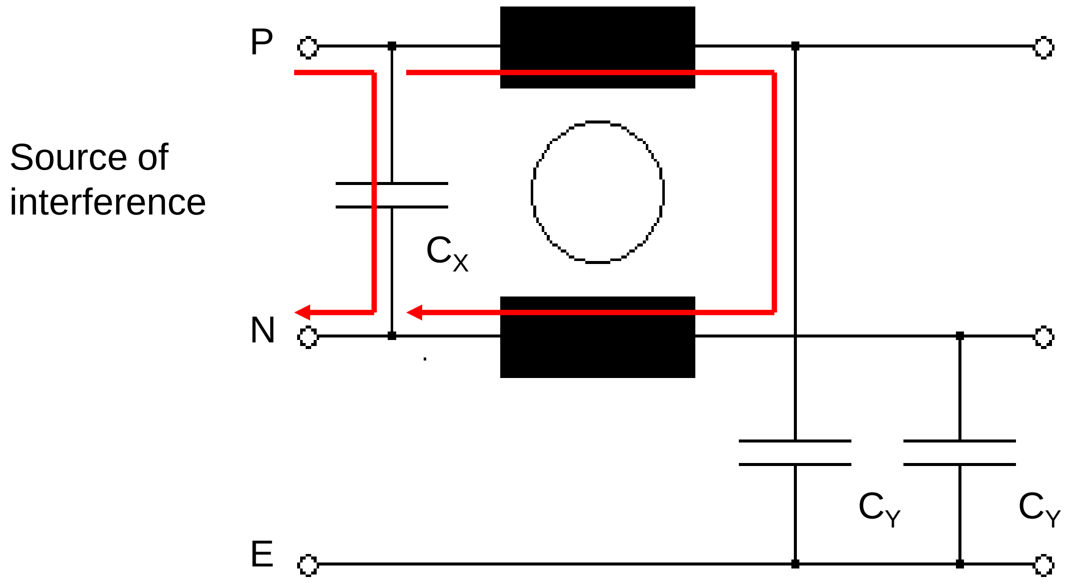
Differential Mode disturbances



The attenuation is carried out by the Capacitor C_X and the dispersion inductance (difference between the two coils).

Filter-Parameters

Rated voltage:

The rated voltage is considered as the maximum operating voltage having a frequency of 50/60Hz

Rated current:

For an optimum filtering effect, the filter’s rated current is to be matched as closely as possible to the rated current value of the equipment

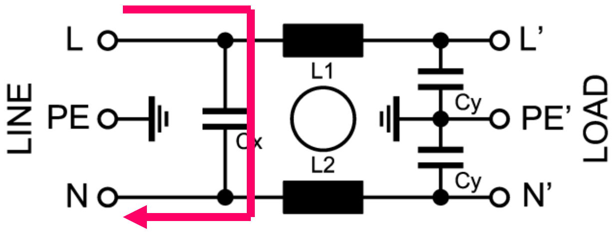
Placement of the filter:

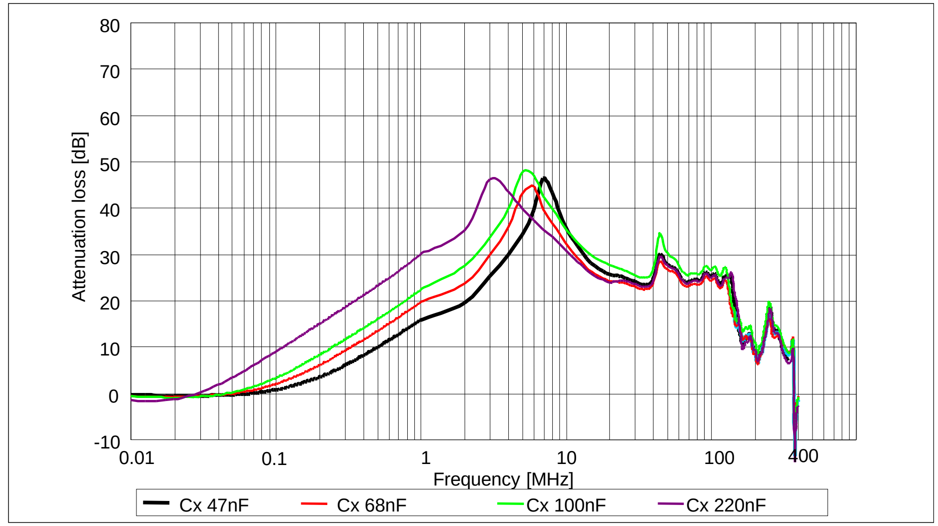
Always as close as possible to the source of interference

- Interference protection (immunity): filter directly at the network noise source
- Interference suppression (emission): Filter close to the disturbance source

X- Capacitor

Differential mode noise

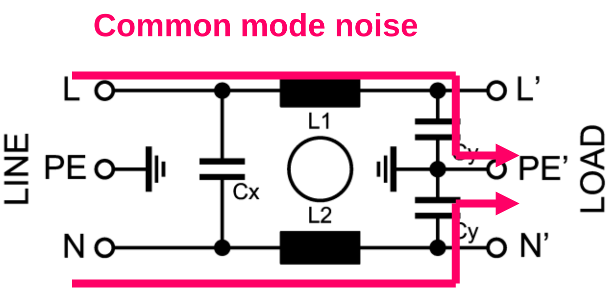


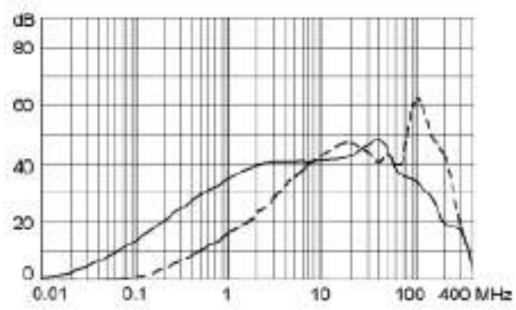


The **X capacitor** dampens **differential mode** noise between L and N. For high frequency energy, the capacitor acts as a short circuit.
X capacitors are **self-healing** (SH) metallized paper or polyester types. As a result, these self-healing capacitors can withstand a high pot surge pulse. The capacitor can loose some of its capacitance, but the insulation remains the same.
A larger capacitance results in a higher attenuation loss.

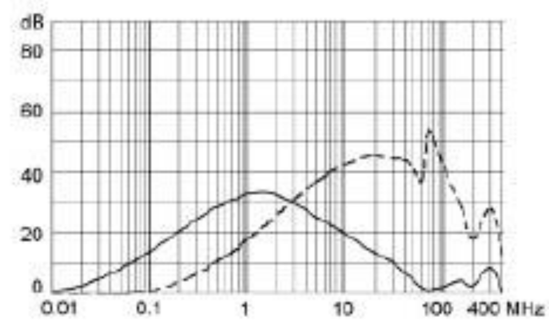
Typical values:	47, 68, 100nF		
Safety class:	X1	4kV pulse	1.2/50µs
	X2	2.5kV pulse	1.2/50µs

Y- Capacitor





Standard (with Y-capacitor)



Medical M5 (without Y-capacitor)

The Y-**capacitor** dampens **Common mode** noise between L / N and PE. For high frequency energy that comes simultaneously on both lines, the capacitor acts as a short circuit to ground.
Y-capacitors are mainly made with ceramic material; some are metallized paper.
The capacitance value is limited because of the **leakage current**.

Typical values:	2.2nF, 470pF		
Safety classes:	Y1	8kV pulse	1.2/50µs
	Y2	5kV pulse	1.2/50µs

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Leakage Current

The leakage current is mainly determined by the capacitance between line and ground. International equipment standards limit this current.

Filter Type	**Leakage Current**	**Voltage**	**Y-Capacitor**
Standard	< 0.5mA	250V 60Hz	2x 2.2nF
Medical	< 80µA	250V 60Hz	2x 470pF
Medical	< 5µA	250V 60Hz	none

Leakage current for household appliances:

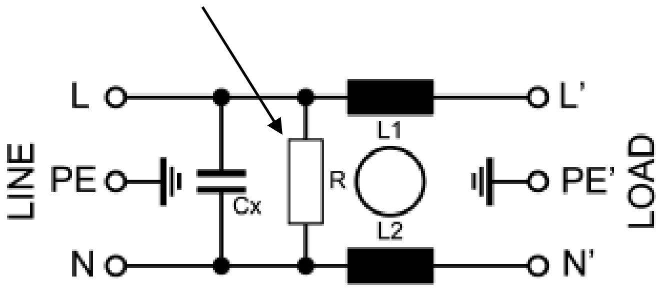
Type of appliance	**Protection class**	**I_L max. (mA)**	**U (V)**	**f (Hz)**
Portable appliances	I	0.75	250	50
Stationary motor appliances	I	3.5	250	50
Stationary heating appliances	I	0.75/kW (max.5.0)	250	50
Appliances	II	0.25	250	50
Appliances	I, 0I, III	0.5	250	50

Leakage current for other applications:

Ref.	Laboratory	Medical	IT	Measuring devices
UL	0.5mA (UL 1262)	0.1mA (UL 544)	3.5mA (UL 1950)	5.0mA (UL 1244)
IEC		0.1mA (IEC 60601-1)	3.5mA (IEC 60950)	3.5mA (IEC 61010-1)

Bleed Resistor (Discharge Resistor)

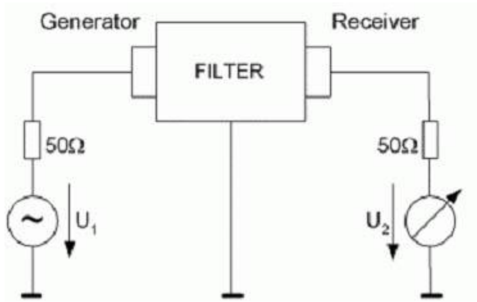
Medical filters and filters with an X-capacitor >100nF have a bleed resistor so that no inadmissible residual voltage occurs at the open inlet pins.



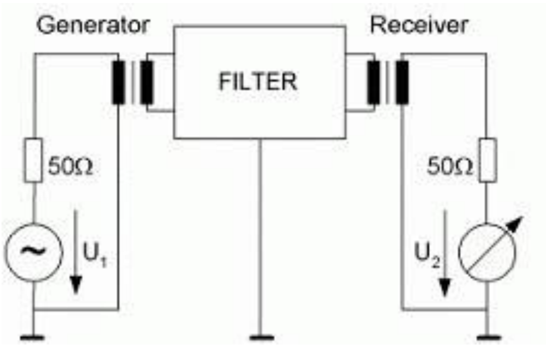
medical filter

Technical data bleed resistor: 1 MOhm, 0.5W

Attenuation Loss



Common Mode Measurement

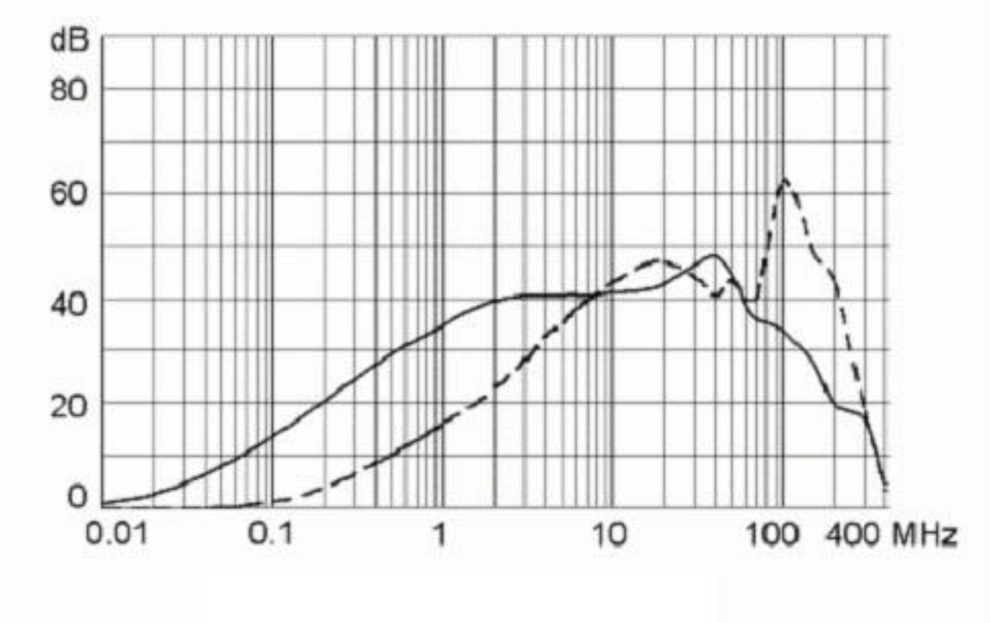


Differential Mode Measurement

In common mode measurements, the line and neutral conductor are measured with respect to ground.

In differential mode measurement, the attenuation loss is measured between line and neutral conductor through a balancing transformer. The ground terminal is not used.
The measurement impedance is 50 Ohm according to standard CISPR17.

Attenuation Diagram



The diagram shows the loss (Y-axis) with respect to the frequency (X-axis). The frequency is a logarithmic scale and the loss is in decibels, which is also logarithmic.
E.g. 6dB = double of the loss

Formula: $$A_{db} = 20\log\frac{U_1}{2U_2}$$

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Dielectric strength

All our filters fulfil the high voltage requirements of the IEC- and UL-standards.
The type test requires applying a voltage of 2121VDC for 60 seconds.
The test voltages listed in our catalogue are reduced values for the 100%-production test for two seconds.

High pot test:	**L – N:**	**L+N – PE:**
Engineering test	2121VDC; 60s	3000VDC; 60s
Production test	1075VDC; 2s	2121VDC; 2s
Catalogue	1700VDC; 2s	2700VDC; 2s

Standards:		
IEC60939-1, EN133200	1075VDC; 60s / 2s	2250VDC; 60s / 2s
IEC60950	2121VDC; 60s / 1s	2121VDC; 60s / 1s
UL1283	1768VDC; 60s / 1s	2121VDC; 60s / 1s

Note: High pot test with “On filters with a bleed resistor” => the high pot test should be done without bleed resistor.

Climatic category

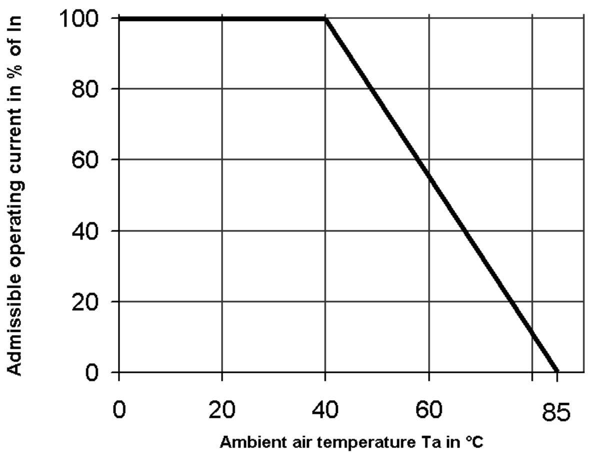
The indication of the climatic category shows the maximum upper and lower ambient air temperatures according to IEC/EN 60068-1.

25/085/21

21	air humidity 95% relative at 40 C	21 days
085	upper limiting temperature	+85 C
25	lower limiting temperature	-25 C

Rated Voltage V_n and Rated Current I_n

For each filter type, the rated voltage and the rated current are specified in the technical data sheet. The rated currents given refer to the full load (In) at an ambient temperature of 40 C (45 C).
Current at other temperatures is shown in the derating curve, or can be ascertained by the formula:



$$I = I_n \sqrt{\frac{T_{\max} - T_a}{T_{\max} - T_n}}$$

I = admissible operating current at elevated ambient air temperature
In = rated current
Tmax = max. allowable ambient air temperature (85 C)
Ta = ambient air temperature
Tn = allowable ambient air temperature at rated current (40 C)

Note: For power entry modules with fuse holders, the derating curve of the fuse holder has to be taken into consideration.

Standards or Approval marks

SCHURTER mains filters comply with international standards.

Filter standards:	IEC 60939, EN 133200, UL 1283, CSA 22.2 No.8
Appliance standard:	IEC 60950

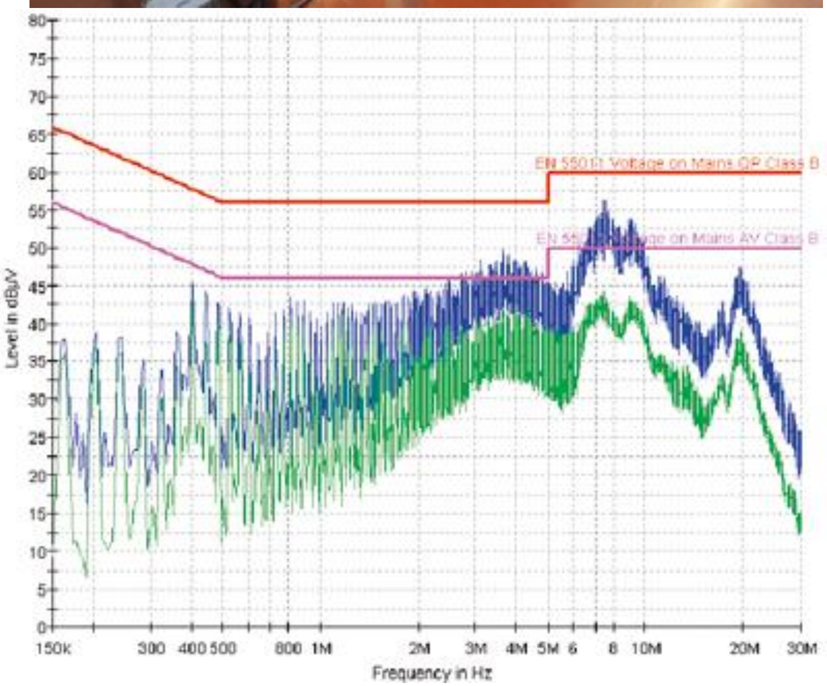
Typical approval mark on our mains filters are:

VDE(D) Semko (S) UL (USA) CSA (CAN)

New approvals:

Europe (VDE) North America UL, CSA

EMC Services



Schurter invites you to test our EMC competence. Schurter EMC Services will conduct the necessary preliminary immunity and interference tests of your electrical systems or equipment. The EMC competence center is equipped with all the necessary measurement tools and an EMC chamber for measuring line-bound interference. An appropriate standard or customer-specific EMC solution is recommended based on the results. The product is overseen from the R&D stage all the way to production, guaranteeing optimal product quality and EMC results.

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More Information

- For more information on new EMC filters from Schurter – Click here
- For an overview of EMC products from Schurter –

  Click here
- Schurter offers custom EMC solutions. To request a custom filter specific to your unique requirements –

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