1. Industrial Mains Filters

Frequency range 0.01 MHz ... 1000 MHz

1.1 General Information

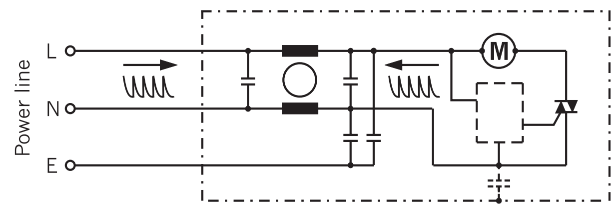
Electromagnetic Compatibility (EMC) is the capability of electrical equipment (installations, devices, assemblies) to operate effectively in its electromagnetic environment (Immunity), without in turn irresponsibly affecting this environment (Emission).

Mains filters of various types are used for the protection of electronic circuits, components and equipment against transients, or similar interference, on the mains power supply. A suitable filter can be selected from the existing product range for each equipment type in accordance with electromagnetic conditions of its environment.

Mains interference can be classified into four categories:

A) Fluctuations in the industrial mains supply (magnetic voltage stabilizer)
B) Harmonic wave interference in the frequency range 100 Hz ... 2 kHz (filter type→ selective harmonic)
C) Transient interference signals in the frequency range up to 300 MHz (filter type → low-pass)
D) Sinusoidal interference signals in the frequency range up to 1 GHz (filter type → broad band, low-pass)

In practice, however, interference is mainly found in the last two categories, C and D. Superimposed on the high-voltage mains supply, such interference can affect the performance of electronic circuits, or even cause them damage. An optimally-designed mains filter can perform a double function:



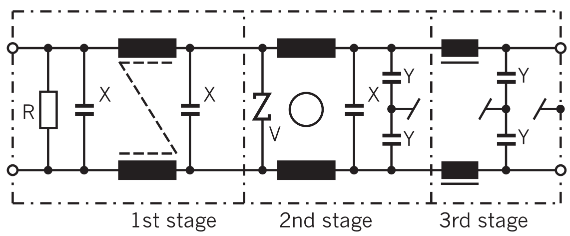
Double function of mains filter (⇄). Acts in both directions.

Function 1:
The filter protects an electronic control circuit from voltage spikes in the mains supply, which may be generated, for example, by electromechanical switches and relays.

Function 2:
The same filter also acts simultaneously in the opposite direction. The HF interference generated in the unit by thyristor control is attenuated such that the boundary values Class B, (EN 55011/55022) are maintained.

Filters are usually made up of capacitors and inductance coils. Components such as leakage resistors, surge dissipators and VHF chokes can also be integrated into the filter. Broad band filters which meet the highest requirements are often composed of 3 single stages put together to make one filter unit:

3-stage filter



1st stage
A symmetrically acting filter with high energy absorption. Leakage resistors would normally have capacitance value of > 0.1 mF. The capacitors are tested and approved as so-called Class X noise suppression capacitors. The 1st stage serves as dI/dt limitation.

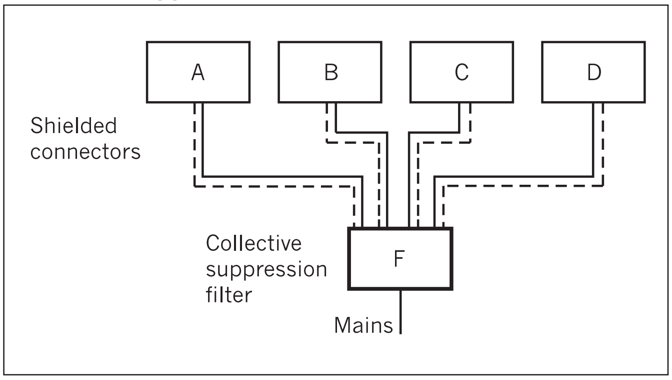
2nd stage
An asymmetrically acting filter with a high, broad band attenuation ratio. A ZNR varistor surge serves as the overvoltage suppression component. The earthed capacitors are tested and approved as so-called Class Y noise suppression capacitors.

3rd stage
Asymmetrically as well as symmetrically acting filter in the HF range up to 300 MHz. Feedthrough filters make high attenuation values possible up to the gigahertz range. These capacitors are also Class Y type. TIMONTA uses only approved noise suppression capacitors according to EN 132400.

1.2 Filter Assemblies

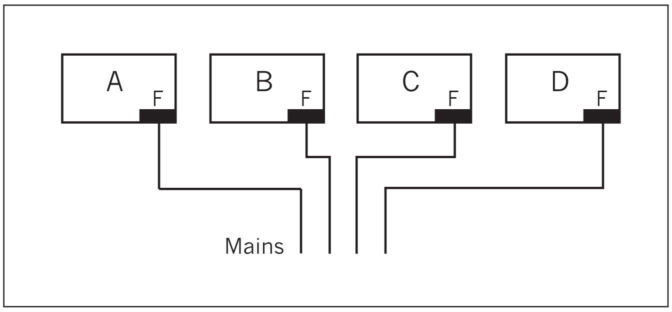
3 types of mains noise suppression filter assemblies are use in practice:

Collective Suppressor



The collective suppressor principle results in one filter per plant. This has to cope with the entire power input. In addition, all of the connecting cables have to be shielded. Furthermore interference generated by «A» device can reach other devices for instance «B» or «C» through the connecting cables. The following example promises to be a more economical solution.

Single Suppressors



In many cases, the single suppressor principle is the most economical solution.

Combined Single and Collective Suppressor

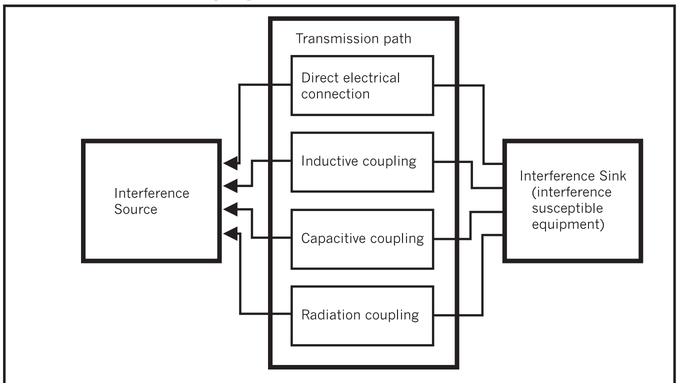
From the technical point of view, only the combined application of both suppression techniques can result in a significant improvement.

1.3 Interference Propagation

In the field of interference and RF suppression, the most significant means of transmission is the direct electrical connection, i.e. the connecting wiring.

The radiation coupling is also important from the electromagnetic compatibility (EMC) point of view; it cannot, however, be dealt with here.

Interference Propagation



Propagation and Coupling Paths

The capacitive and inductive coupling effects occur inside the case. These could be:

- Capacitive coupling through the coupling capacity of a mains transformer.
- Inductive coupling through control system wiring in parallel.

The introduction briefly mentioned the possibility of the mains filter operating with a double function. Depending on the main area of application, these filters are designated as either RF SUPPRESSION FILTERS or INTERFERENCE SUPPRESSION FILTERS.

The one filter may, therefore, appear under two references in the documentation. A filter is also classified by its mechanical design as well as its electrical data.

RF SUPPRESSION FILTERS impede the propagation of RF interference, generated by an electronic or electrical device into the mains. They also ensure an interference-free radio reception in the immediate vicinity.

INTERFERENCE SUPPRESSION FILTERS prevent mains interference from affecting electronic equipment. They enable an interference-free operation even in the case of a power supply badly affected by mains interference.

It is common to operate the mains filter in both directions in the one piece of equipment, allowing it to fulfil its double function as both interference and RF suppression filters as specified.

1.4 Asymmetric and Symmetric Interference

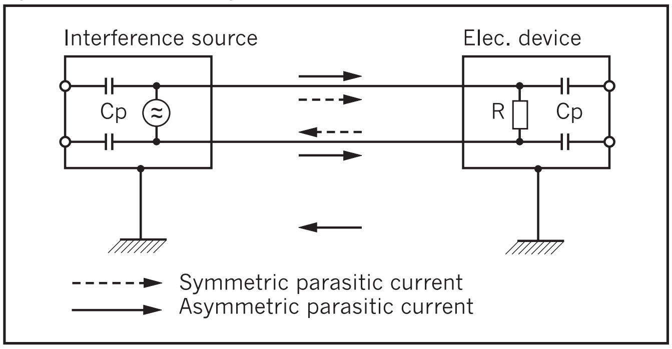
(Common and Differential Mode Interference)

Filter engineering differentiates between asymmetric and symmetric interference originating from supply lines.

In the case of a non-earthed interference source, interference at first only propagates along the connecting lines. Like the mains AC current, the parasitic current flows to the user on one lead, and returns to the interference source on the other. Both these currents are in differential mode. This type of interference is therefore referred to as differential mode or symmetric interference.

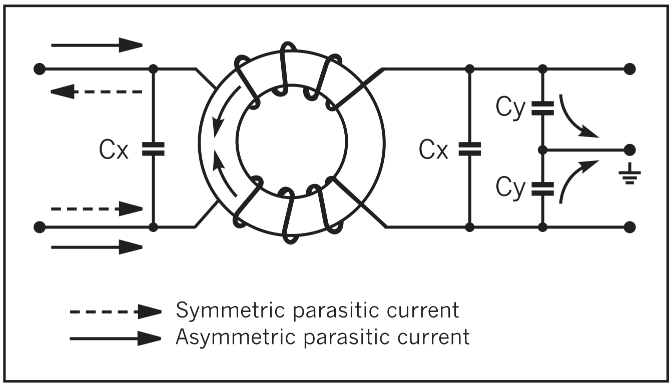
Due to the mechanical configuration and its parasitic capacitance, parasitic currents are also generated in the earthing circuit. This parasitic current flows on both connecting leads to the user and over an earthed lead back to the interference source. Both currents on the connecting lead are in common mode. This type of interference is therefore referred to as common mode or asymmetric interference.

Symmetric and asymmetric interference



1.5 RF Suppression Chokes

Current Compensated Chokes in Interference Suppression Filters



The main type of choke used in suppression filter engineering is the current compensated choke. This mainly damps the asymmetric interference. The symmetric parasitic current, or rather the magnetic flux they produce in the core, is compensated by means of a special type of winding. The relatively small attenuation of the symmetric parasitic currents can be balanced through the large, symmetrically connected capacitance C_x between the lines. Only the leakage inductance L_s of the choke is then of any importance.

$$L_{leakage} \approx \frac{L_{nominal}}{50} \text{ to } \frac{L_{nominal}}{100}$$

The high nominal inductance L_N active for asymmetric parasitic currents allows the insertion of small, earthed capacitances C_Y in a filter circuit. These capacitances are regulated by international standards for leakage currents.

1.6 RF Suppression Capacitors: General Information

All TIMONTA filters are fitted with Class X or Y RF suppression capacitors in accordance with international standards (IEC, EN). These are mainly self-healing metallized paper or polyester types, tested against the standards of major countries around the world and approved as noise suppression capacitors.

Class X capacitors are capacitors with unlimited capacity for those applications in which a failure caused by a short circuit cannot result in a dangerous electrical shock.

Class Y capacitors are capacitors intended for a operating voltage V_{eff} = 250 V with increased electrical and mechanical safety and limited capacitance.

Test Regulations

International:	IEC 60384-14 Ed.2
Europe:	EN 132400 (VDE 0565 T-1)

The choice of noise suppression capacitor C_Y is entirely dependent on the standard-approved leakage current. These currents are established according to the equipment class and application.

In accordance with the international standard IEC 60335-1, and the German standard VDE 0700 T-1, the major groups can be summarized as follows:

EN 60335-1 (IEC 60335-1)	Safety of household and similar electrical appliances
VDE 0700 T-1	Safety regulation for electrical equipment for domestic or similar purposes

Leakage Currents for Domestic Appliances

Portable appliances	of protection class I	0.75	mA
Stationary motorised equip.*	of protection class I	3.5	mA
Stationary heating appliances	of protection class II	5	mA
Appliances	of protection class II	0.25	mA
Covered appliances		5	mA
Other appliances		3.5	mA

* Stationary equipment = fix-mounted or weighing in excess of 18 kg (without carrying handle)

Leakage current for other applications

Ref.	Analytical	Medicine	EDP	Test equipment
UL*	0.5 mA (UL 1262)	0.1 mA (UL 544)	—	5.0 mA (UL 1244)
IEC	—	0.1 mA (IEC 60601-1)	3.5 mA (IEC 60950)	3.5 mA (IEC 61010-1)

UL * = Underwriter Laboratories, USA.

1.7 Filter classification

For easy reading of the catalogue data, TIMONTA uses the following simplified filter classification:

Symmetric and Asymmetric Attenuation

Attenuation value:			
Standard	Medium	High	Excellent
20-50 dB	40-70 dB	60-80 dB	70-95 dB

Leakage Current Classification

Operating leakage current:		
Medical	Standard	Industrial
< 0.1 mA	< 0.5mA	< 5mA

2. Standards

2.1 Technical Harmonization Directives with CE Mark of Conformity

The principal objective of a conformity evaluation procedure is to provide the authorities with the means of verifying that the product brought into the market meets the requirements of the directives, particularly in therms of health and safety for users and equipment.

The CE mark certifies conformance to the requirements of all harmonized EU directives relevant to the product.

2.2 The EMC Act

From 1st January, 1996, only those electrical and electronic devices, systems and installations may be sold or operated in the EU which conform to the EMC directive protection requirements.

The conformity of each device, system and installation labelled with the CE mark is to be certified by the manufacturer with an EU attestation of conformity.

It should be noted that, for the purposes of the EMC Act, single components and sub-assemblies which can have no independent function, count as components.

For EMC filters see chapter 4 in this introduction.

EU directives with CE designation

Mark Directives :	In force as of :	Period ending :
Simple Pressure Vessels Directive (87/404/EEC;90/488/EEC)	01.07.1990	
Toy Safety Directive (88/378/EEC)	01.01.1990	
Construction Products Directive (89/106/EEC)	27.06.1991	
Electromagnetic Compatibility Directive (89/336/EEC)/(93/31/EEC)	01.01.1992	31.12.1995
Machinery Safety Directive (89/392/EEC)/(91/368/EEC)/(93/44/EEC)	01.01.1993	31.12.1994
Personal Protective Equipment Directive (89/686/EEC;93/95/EEC)	01.07.1992	30.06.1995
Non-Automatic Weighing Instruments Directive (90/384/EEC)	01.01.1993	31.12.2002
Active Implantable Medical Devices Directive (90/385/EEC)	01.01.1993	31.12.1994
Gas Appliances Directive (90/396/EEC)	01.01.1992	31.12.1995
Telecommunications Terminal Equipment Directive (91/263/EEC)	06.11.1992	
Hot Water Boilers Directive (92/42/EEC)	01.01.1994	31.12.1997
Civil Uses Directive (93/15/EEC)	30.09.1993	31.12.2002
Medical Devices Directive (93/42/EEC)	01.01.1995	14.06.1998
Low Voltage Directive (73/23/EEC and 93/68/EEC)	01.01.1995	31.12.1996
Systems used in potentially explosive atmospheres (94/9/EECC)	01.03.1996	30.06.2003

EMC requirements in Europe as from 1996

Household, Luminaries and Telecommunication: Residential, commercial and light industrial	**Class Industrial:** (ISM) Industrial, Scientific and Medical
Emission • EN 50081-1	**Emission** • EN 50081-2
• EN 55022 ITE Information technology equipment • EN 55014 Household Applications and Tools • EN 60555-2 Harmonic (EN 61000-3-2)* • EN 60555-3 Voltage fluctuations (EN 61000-3-3)*	• EN 55011 • EN 60555-2 Harmonics (EN 61000-3-2)* • EN 60555-3 Voltage fluctuation (EN 61000-3-3)* (under consideration)
Immunity • EN 50082-1 • EN 61000-4-2 ESD • EN 61000-4-3 HF-Field • EN 61000-4-4 Burst • EN 61000-4-5 Surge	**Immunity** • EN 50082-2 • EN 61000-4-2 ESD • ENV 50140 Inducted HF-Field (enclosure) • ENV 50141 Inducted HF-Field (lines) • EN 61000-4-4 Burst • EN 61000-4-5 Surge • EN 61000-4-8 NF Magnetic Field (only for magnetic devices).
Remarks :* EN 61000-3-X replace EN 60555-X on 01.01.2001	

2.3 Electrical Safety Regulations

Since 31.12.96, the changeover has period for the low-voltage directives (73/23/EEC and 93/68/EEC) come to an end; i.e. the directives are in force. These directives involve, amongst others, the general safety requirements for users and equipment.

The most important safety standards for equipment/installations are listed in the following:

IEC 60950	Safety of Information Technology Equipment including Electrical Business Equipment
IEC 60335	Safety of Household an similar Electrical Appliances
IEC 61010-1	Safety requirements for Electronic Measuring Appartus
IEC 60601	Safety requirements for Electro-medical Equipment
UL 1950	Safety requirements for Information Technology Equipment
UL 544	Electric Medical and Dental Equipment

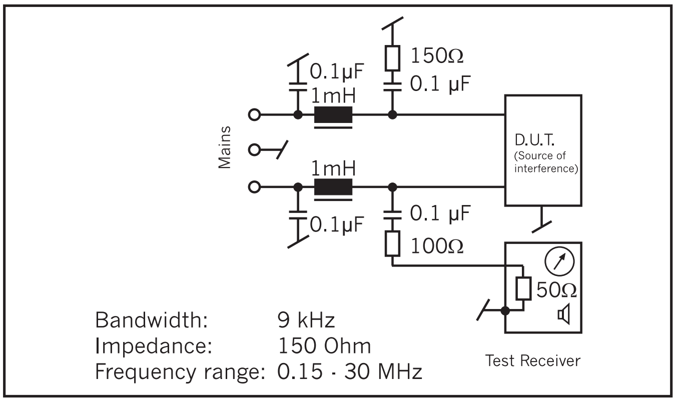
2.4 Interference Emissions

There are basically 2 types of emitted disturbances: conducted and radiated.

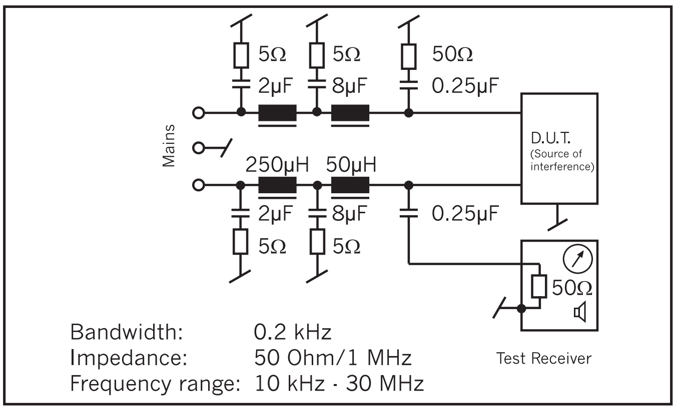
Line interferences are high frequency noise signals which are superimposed on the useful signals on input and output lines. Interference signals can be symmetrical or asymmetrical (see Chap. 1.4)

The significance of line interference is reduced dramatically above a frequency of 30 MHz.
From here radiated interference increases greatly. On the following pages we will nevertheless deal with conducted interference only.

Measuring Technique CISPR 1 VDE 0875



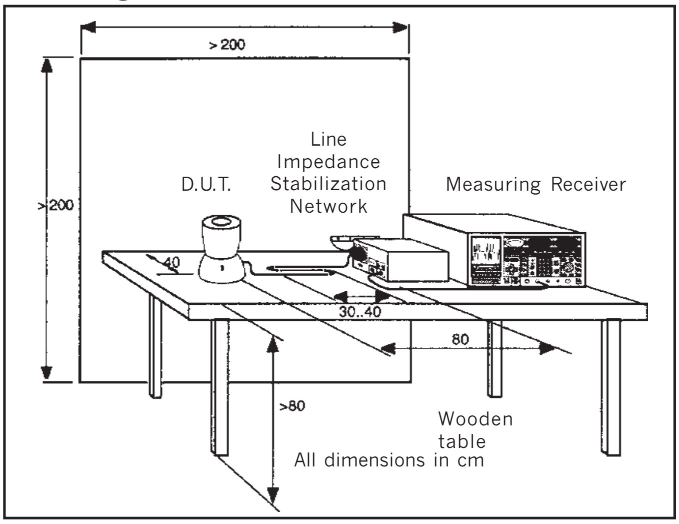
Measuring Technique CISPR 3 VDE 0871



The main differences between the two measuring techniques lie in the fixing of the line impedance (artificial mains) and the test bandwidth used for the test receiver. In the case of CISPR 3 (VDE 0871) specific interference levels are set for the frequency range down to the low frequency range (10 kHz to 150 kHz).
The trend in international organisations is towards replacing the CISPR 1 technique with the CISPR 3 technique, particularly with regards to the line impedance (150 to 50 OHM). These measurements can be made in the TIMONTA AG laboratories with the assistance of a EMC specialist in interference suppression.

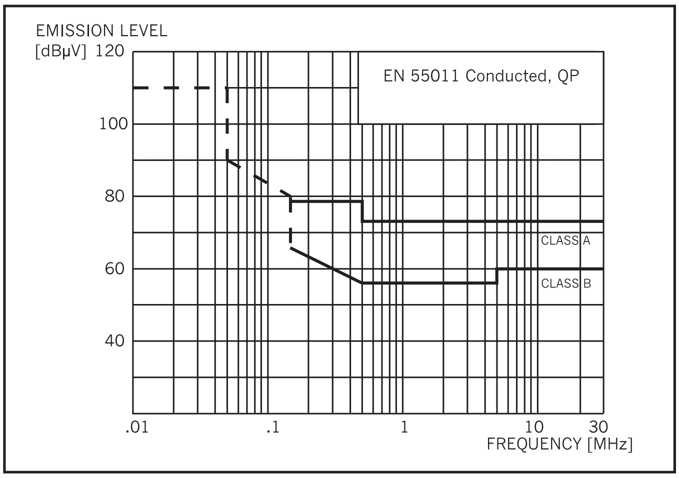
2.4.1 Radio Frequency Interference Boundary Values

RFI testing station



EN 55011: Boundary values and measuring systems for RF suppression for industrial, scientific and medical high frequency equipment (ISM), 1991 (see also CISPR 11 or VDE 0871)

Boundary values complying with EN 55011



Quasipeak (QP) and Average (AV) are two limits, neither of which must be exceeded and which are measured by two different test receivers. The test arrangement remains the same. These boundary values replace the boundary values given by the old standards for broadband and narrowband noise generators.

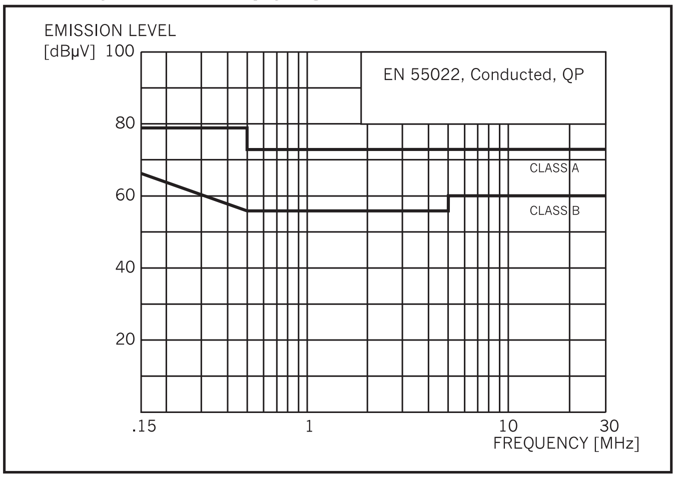
Boundary values are divided into Class A and B.

Into Class A fall those devices which should not be operated in residential buildings and should not be connected to power supplies which also supply these areas. Class A boundary values hall not be exceeded.

Into Class B fall devices for which above restrictions do not apply. Class B boundary values shall not be exceeded.

EN 55022: Boundary values and measuring systems for RF suppression for information technology installations (Telecommunications) 1987 (see also CISPR 22 or VDE 0878).

Boundary values complying with EN 55022



Into Class A fall all units which should be used in a commercial environment and should be used with a safety distance of 30 m to other units.

Into Class B fall all units which have no restrictions on their use.

EN 55013: Boundary value and measuring techniques for RF suppression characteristics of radio receivers and connected equipment, 1990 (see also CISPR 13 or VDE 0872 Part 13)

EN 55014: Boundary values and measuring systems for RF suppression for electrical household appliances, handheld electrical tools and similar electrical products, 1993 (see also CISPR 14 or VDE 0875, Part 14)

EN 55015: Boundary values and measuring systems for RF suppression for fluorescent lamps and lighting, 1993 (see also CISPR 15 or VDE 0875, Part 15)

2.4.2 Harmonics
(EN 61000-3-2, IEC 61000-3-2)

Current harmonics represent a distortion of the normal sine wave provided by the utility. When a product such as an SCR switched load or a switching power supply distorts the current, harmonics at multiples of the power line frequency are generated. Two significant consequences arise as a result of harmonic generation. First, because of finite impedances of power lines, voltage variations are generated that other equipment on the line must tolerate. Second, when generated in a three-phase system, harmonics may cause overheating of neutral lines.

Power line harmonics are generated when a load draws a non linear current from a sinusoidal voltage. The harmonic component is an element of a Fourier series which can be used to define any periodic waveshape. The harmonic order or number is the integral number defined by the ratio of the frequency of the harmonic to the fundamental frequency (e.g., 150 Hz is the third harmonic of 50 Hz; n = 150/50).

After multiple postponement finishes at 1.1. 2001 the transition-period for the EN 61000-3-2, frequently called “PFC-Norm”. It applies to all electrical and electronic devices with input current up to max. 16 A per phase, which are designed to connect to the general low-voltage mains.

Limits are set only for 220/380 V, 230/400 V and 240/415 V at 50 Hz.

Class	Equipment
A	Simmetric three phase equipment and all other equipment not in other classes
B	Portable tools
C	Lighting equipment
D	Equipment having special Waweshape π/3x3 0.35/1/0.35 with power ≤ 600 W not motor driver

This standard distinguishes four classes of equipment.

A harmonics test to conform to the standards must include an analysis of the incoming current up to the 40th harmonic (for f_N = 50 Hz, f_H = 2 kHz).

The IEC 61642 "Industrial a.c. networks affected by harmonics-Application of filters and shunt capacitors" give guidance for the use of passive a.c. harmonic filters and shunt capacitors for the limitation of harmonics and power factor correction intended to be used in industrial applications, at low and high voltages.

2.4.3 Voltage Fluctuations (Flicker)
(EN61000-3-3 IEC 61000-3-3 IEC 61000-3-5)

The appearance of flicker effects and voltage fluctuations on the mains supply is caused by varying loads connected to the mains.

The most critical are the effects of voltage fluctuations on equipment such as lights and illumination. Here the light output and thereby the intensity is an exponential function of the supplied voltage. This fluctuation in light intensity is called flicker. Many people experience dizziness and headaches as a result.

There are various limit values depending on the type of voltage fluctuation (square, sinusoidal and mixed or erratic voltage fluctuation).

Flickers are measured by so-called flicker meters (arranged in compliance with EN 60808).

2.5 Immunity

2.5.1 ESD (Electrostatic Discharge)
(EN 61000-4-2, IEC 61000-4-2)

One of the main interference sources, along with switching through radio interference , is electrostatic discharge from people and equipment.

2.5.2 Burst
(EN 61000-4-4, IEC 61000-4-4)

One of the most common and most dangerous sources of interference are transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc.).

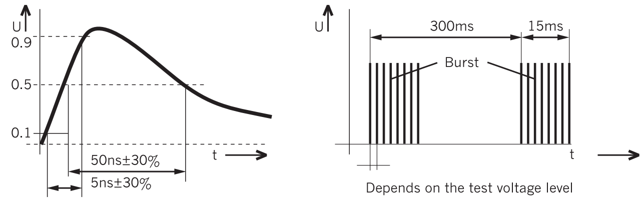
The burst test measures the resistance of the device to repetitive fast transients.

2.5.3 Surge
(EN 61000-4-5, IEC 61000-4-5)

This test procedure measures the behaviour of a device when subjected to high-energy pulses. Sources of such pulses are switching events due to lightning strikes, short-circuits, or switching cycles which vary in time and place.

Surge test on Timonta filters are according to EN 133200.

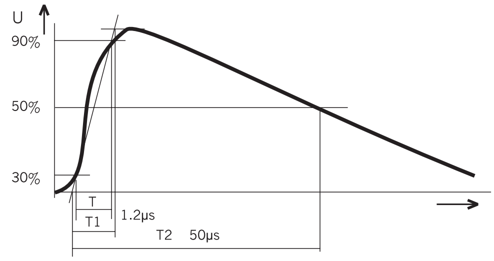
Specification of the Burst test impulse



a) Waveshape of a single pulse into a 50 Ohm load

b) General graph of a fast transient/burst

Surge voltage form in open circuit



Guideline for the selection of ESD test levels

Class	Relative ambient humidity as low as [%]	Antistatic material (floor)	Synthetic material (floor)	Level air discharge (kV)	Level contact discharge (kV)
Class 1	35	x		2.00	2.00
Class 2	10	x		4.00	4.00
Class 3	50		x	8.00	6.00
Class 4	10		x	15.00	8.00

Recommended test levels for Fast Transient/Burst

Test levels	The installation is characterized by following attributes	Voltage peak: [kV]		Repetition rate [kHz]
		Power supply	Signal ports	
Level 1 Well-protected environment	• Suppression of all EFT/B* in the switched power supply circuits • Separation between power supply lines and control and measurement circuits • Shielded power supply cables with the screens earthed at both ends	0.50	0.25	5.0
Level 2 Protected environment	• Partial suppression of EFT/B* in the power supply and control circuits • Separation of all the circuits from other circuits associated with environments of higher severity levels • Physical separation of unshielded power supply and control cable from signal and communication cables	1.00	0.50	5.0
Level 3 Typical industrial environment	• No suppression of EFT/B* in the power supply and control circuits • Poor separation of the industrial circuits from other circuits • Dedicated cables for power supply, control, signal and communication lines • Poor separation between power supply, control, signal and communication cables	2.00	1.00	5.0
Level 4 Severe industrial environment	• No Suppression of EFT/B* in the power supply and control and power circuits • No separation between power supply, control, signal and communication cables • Use of multicore cables in common for control and signal lines	4.00	2.00	2.5

*EFT/B: Electrical Fast Transient/Burst

Installation classification for Surge Immunity test

Class	Environment definition	Voltage peak [kV] L → N [2Ω]	Voltage peak [kV] L/N → PE [12Ω]
Class 0 well-protected environment	• All cables with overvoltage protection • Well-designed earthing system • Surge voltage may not exceed 25 V	—	—
Class 1 Partly protected environment	• All cables with overvoltage protection, well interconnected earth line network • Power supply completely separated from the other equipment • Surge voltage may not exceed 500 V	0.50	—
Class 2	• Separate earth line to earthing system • The power supply is separated from other circuits • Non-protected circuits are in the installation, but well separated and in restricted numbers • Surge voltage may not exceed 1000 V	1.00	0.50
Class 3	• The installation is earthed to the common earthing system • Protected electronic equipment and less sensitive electric equipment on the same power supply network • Unsuppressed inductive loads are in the installation	2.00	1.00
Class 4	• The installation is connected to the earthing system for the power installation • Current in the kA range due to earth faults • The power supply network can be the same for both the electronic and the electrical equipment • Surge voltages may not exceed 2000 V	4.00	2.00
Class 5	• Electrical environment for electronic equipment connected to telecommunication cables •The interference voltages can be extremely high • All cables and lines are provided with overvoltage protection	depending on the local power supply network	depending on the local power supply network

3. General Technical Data - Filter parameters

3.1 Rated voltage U_R (U_{max})

The rated voltage U_R is the maximum RMS alternating line to line voltage (U_{max}) which may be applied continuosly to the terminals of the filter. The rated voltage is the nominal voltage including 10% tolerances.

Example:

filter with U_R = 440 VAC is made for a power system with nominal voltage 400 VAC +10%.

For standard three phase filters the voltage between phase and earth is intended $U_R / \sqrt{3}$ (example 440/250 VAC).

Filters made for IT power systems withstand a voltage between phase and earth equal to U_R. Timonta filters for IT systems have code ending with "I": ex. FMAC-0932-2512I.

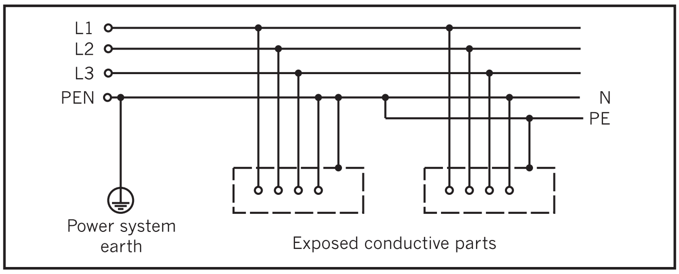
The line frequency f_N (50/60 Hz) may be exceeded under certain conditions. We recommend the users to consult in any case our technical department. DC power operation is possible in most cases.

3.1.1 Power distribution system

There are three main types of power distribution systems according to IEC 60950 (1.2.12): TN, TT, IT.

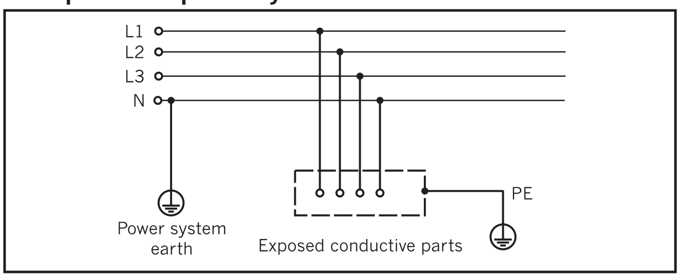
The TN POWER SISTEM is a power distribution system having one point directly earthed, the exposed conductive parts of the installation being connected to that point by protective earth conductors. Three types of TN POWER SISTEMS are recognized according to the arrangement of neutral and protective earth conductors: TN-S, TN-C-S, TN-C.

Example of TN-C-S power system



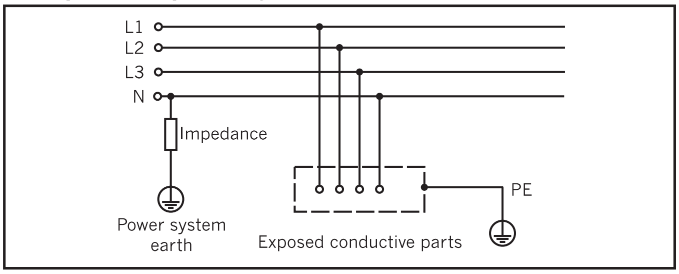
TN-C-S is in a system which neutral and protective functions are combined in a single conductors in a part of the system.

Example of TT power system



A TT POWER SYSTEM is a power distribution system having one point directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically indipendent of the earth electrodes of the power system.

Example of IT power system



The IT POWER SYSTEM is a power distribution system having no direct connection to earth, the exposed conductive parts of the electrical installation being earthed.
In this case the voltage between phase and earth can reach the line to line voltage.

3.2 Nominal Current I_N

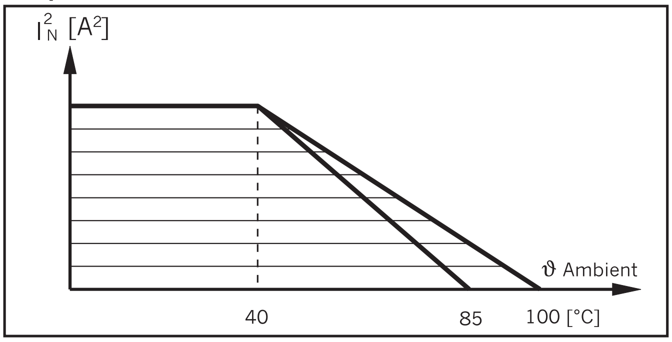
The technical data gives the max continuous supply current in function of the ambient temperature $I_N/\vartheta a$.

The TIMONTA range generally differentiates between two types of filters:

- High-current filter: ϑa at I_N = 40°C, ϑa_{max} = 100°C
- All other filters: ϑa at I_N = 40°C, ϑa_{max} = 85°C

The permissible working current at higher ambient temperatures can be read from the following graph.

Permissible Working Current as a Function of Ambient Temperature



Up to the approved nominal ambient temperature ϑa the filter can be operated continuously at its nominal current. Above this temperature the square of the nominal current drops off linearly and reaches its zero point at ϑa_{max} (85 or 100 °C).

Examples:

High-current filter for example FMAC-0934-5010 @ ϑa = 70°C is valid

$I_{70°C} = I_N \times \sqrt{(100 - \vartheta a)/60} = 50 \times \sqrt{(100 - 70)/60} = 35.4$ A

All other filter for example FMLB-0109-1040 @ ϑa = 70°C is valid

$I_{70°C} = I_N \times \sqrt{(85 - \vartheta a)/45} = 10 \times \sqrt{(85 - 70)/45} = 5.8$ A

The current can exceed the given nominal value during short period. Specific information and current values / duration are given on request.

3.3 RF Suppression Capacitor Complying with EN 132400

(VDE 0565.T1)

All TIMONTA filters are equipped with components which have been tested and approved as RF suppression capacitors.

The most important test data for RF suppression capacitors are:

Capacitance C_x, C_y ± 20% for f_M = 1 kHz

Insulation resistance R_{is} between the capacitor terminals:

for C > 0.33 µF: $R_{is} \times C$ > 2000 s (time constant τ)

for C ≤ 0.33 µF: R_{is} > 6000 MOhm

Major voltage test and standards for C_X and C_Y capacitors

Country	Standard	C	Rigidity	Pulse Test 1.2/50 µs
Europe	EN 132400 IEC 60384-14.2	X1 X2 Y1 Y2	4.3 U_R VAC 4.3 U_R VAC 4.0 kVAC 2.5 kVAC	4.0 kV 2.5 kV 8.0 kV 5.0 kV
	IEC 60950 (Equipment Standard)	X1 X2	2700 VDC, 60s 2121 VDC, 60s	4.0 kV 2.5 kV
USA	UL 1414		2121 VDC, 60s	50 Pulse, 10 kV, 1000 Ω
	UL 1283		2121 VDC, 60s 2545 VDC, 1s	—
Switzerland	SEV 1055	X Y	4.3 U_R VAC 2(100 + 2 U_R) min. 2250 VAC	3.0 kV 5.0 kV

3.4 RF Suppression Chokes Conforming to EN 138100

(IEC 60938, VDE 0565.T2)

All TIMONTA filters are fitted with chokes which satisfy the guidelines set down by international and national standards organisations.

The most important test data for RF suppression chokes are:

Maximum variation of inductance:	– 30% / + 50% for compensated – 15% / + 15% for linear and storage
Test frequency	1MHz ± 20% at L ≤ 10 µH 100kHz ± 20% at 10 µH < L ≤ 1 mH 10kHz ± 20% at 1 mH < L ≤ 50 mH 50 to 120 Hz ± 20% at L > 50 mH
Test current:	0.1 mA
Test temperature:	25°C ± 3°C
Insulation resistance R_{is}:	6000 MOhm

Test voltages

Chokes for	Between connections	Inner and outer insulation
AC	4.3 U_R VDC	2 U_R + 1500 VAC, but at least 2000 VAC
DC	3 U_R VDC	2 U_R + 1500 VDC

Temperature rise at nominal current: ΔT = 60°C

Short-circuit strenght:

EN and VDE: not applicable

SEV→ : 25 x I_N (2 half-waves)

3.5 Leakage Current

(see also Chapter 1.6 RF Suppression Capacitors: General information)

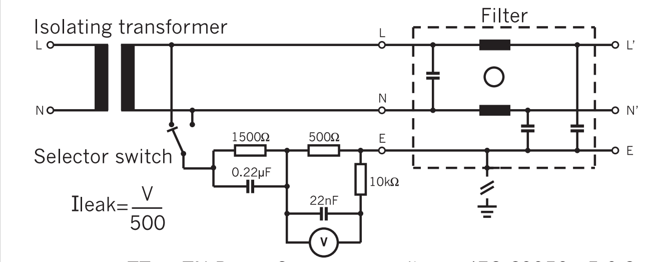
3.5.1 1-Phase measuring Techniques

Measurement of the leakage current (simplified).

The leakage current is measured from every pole of the network:

- to all accessible metal parts
- to metal parts of protection class II equipment which is separated only by the base material from parts under voltage.

The test is made with AC at 250 V / 50 Hz.
Measurements are made in both switch positions (see diagram).



TT or TN Power System according to IEC 60950 - 5.2.3 - Annex D

Protection Class I:
devices are fitted with a special grounding conductor to provide protection against electrical shocks (L,N,PE wire cable). TIMONTA filters correspond to Protection Class I.

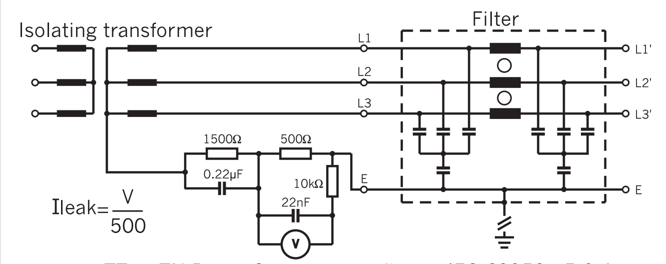
3.5.2 3-Phase Test Method

The standard IEC 60950 defines two measuring methods for leakage current.

TT, TN mains	IEC 60950 5.2.4	"Operating Leakage Current"
IT mains	IEC 60950 Annex G.4	"Worst Case Leakage Current"

3.5.2.1 Operating Leakage Current

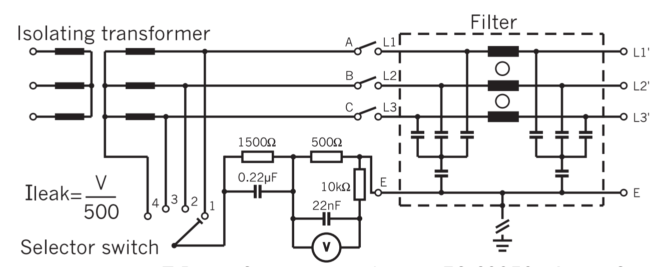
Under normal operating conditions of TT and TN systems (Europe) the leakage current flows from the measured object towards earth.



TT or TN Power System according to IEC 60950 - 5.2.4 - Annex D

3.5.2.2 "Worst Case Leakage Current"

This value indicates the leakage current which could flow through a person in the event of accidental breakage of the equipment safety earth conductor in a IT system (with UL-E = UL-L = 440VAC). The measuring circuit is shown in the drawing below. All possible combinations of the switches A, B, C and the selector switch are utilised for the measurement. The maximum value among the indicated leakage currents is the worst case value (two phases switched off) at nominal voltage.



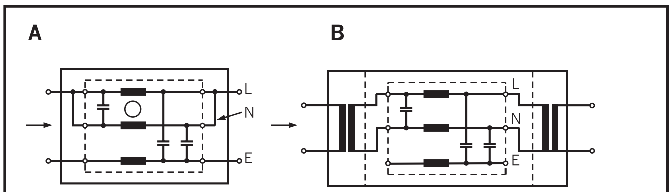
IT Power System according to IEC 60950 - Annex G - Annex D

This value roughly corresponds to the maximum leakage current at power on (transients), at power fail (with UL-E = UL-L/1.73 = 250VAC) and under operating conditions in power systems with one phase directly connected to ground (with UL-L = 440VAC) (Japan).

3.6 Insertion Transmission Loss (asymmetric and symmetric)

A) In asymmetric measurements, the line and neutral conductors are measured with respect to earth.

B) In symmetric measurements, the insertion transmission loss is measured between line and neutral through a balancing transformer; the earth wire is not used.



A: Line (L) and neutral (N) are measured to earth (E).

B: 4-pole network with integrated balancing transformer for the measurement of insertion transmission loss in the symmetric case.

3.6.1 Measurement Method

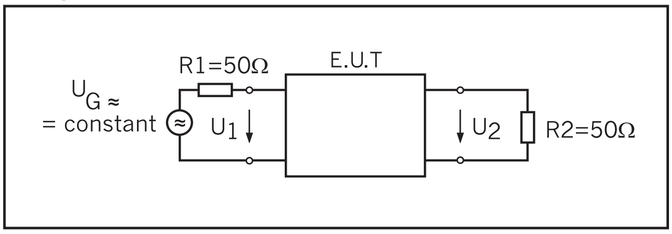
The insertion loss D is defined as that loss which results when a four-pole network is inserted into an existing layout, having a surge impedance Z, assuming that the LHS and the RHS terminal impedances of the four-pole network are equal in magnitude and real, the insertion transmission loss and the overall loss are the same.

The insertion transmission loss, in decibels, can be obtained as follows:

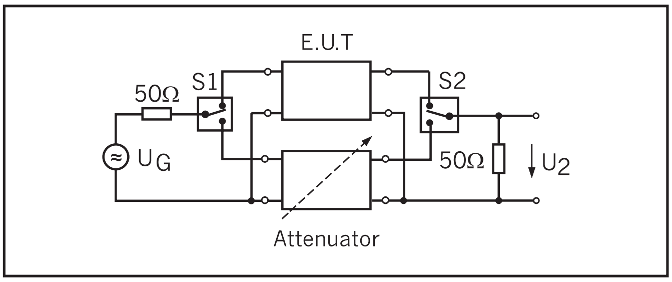
$$D_{dB} = 20 \log \left(\frac{U_G}{2\,U_2} \right)$$

In practice, the substitution method is still used because its main advantage is that the absolute value of the voltage does not need to be known.

Four-pole network with real termination



Substitution method for measurement of insertion trasmission loss



This conventional measurement method is being replaced more and more by the rational frequency domain method or by measurements using the spectrum analyser. The principal method remains nevertheless the same. Though the measurement of insertion transmission loss under load (nominal current) is prescribed, in practice it presents some difficulties.

3.7 Voltage tests on noise suppression filters complying to EN 133200 (VDE 0565.T3)

In compliance to the known standards of the IEC, EN, VDE and UL, the filters are tested as follows. In principle, these tests correspond to those of the RF suppression capacitors.

EN 133200

Nominal voltage	Between connections	Inner and outer insulation C*≤ 1 µF	C*> 1 µF
150 ≤ U_R ≤ 250 VAC	4.3 U_R VDC	1500 VAC or 2250 VDC	4.3 U_R VDC
250 < U_R ≤ 500 VAC	4.3 U_R VDC	2 kVAC or 3 kVDC	4.3 U_R VDC
500 < U_R ≤ 760 VAC	4.3 U_R VDC	3 kVAC or 4 kVDC	4.3 U_R VDC

*) C is the capacity measured between the connection block to which the high voltage is connected for test.

UL 1283 (Appliance filters)

Nominal voltage	Between connection	Between connection and case
U_R ≤ 250 VAC	1250 VAC or 1768 VDC	1500 VAC or 2121 VDC
250 < U_R ≤ 600 VAC	950 VAC + 1.2 U_R or 1343 VDC + 1.697 U_R	UL table 28.3 440 VAC: 1919 VAC or 2756 VDC 600 VAC: 2225 VAC or 3146 VDC

UL 1283 prescribe production-line test with lower voltages (UL tab. 41.2)

3.7.1 Test duration

- 2 sec. for production test
- 60 sec. for types test

The Timonta final production test has a duration of 2 sec. This test may not be repeated more than one time (i.e. incoming inspection at the customer). Any filters that has been under test for 60 sec. can not be commercially used (reduced life cycle).

3.8 Test Marks for Filters

The test mark of conformity is a guarantee for high-quality components conforming to standards!
TIMONTA mains filters have been tested by all major testing organisations and carry the corresponding test mark. The insulation voltages are summarised in Section 3.7.

Test mark of conformity of national testing organisations

Country	Authority	Symbol	Standard
Switzerland	SEV	SEV	EN 133200
Germany	VDE	DVE	EN 133200
Sweden	SEMKO	S	EN 133200
USA	UL		UL 1283
Canada	CSA		CSA C 22.2 Nr. 8-M 1982
USA / Canada	UL / CSA	c us	both UL/CSA

3.8.1 The CCA Mark (CENELEC Certification Agreement)

The filter standard applicable for the EU is the EN 133200. All European testing organisations carry out their tests according to the same standard. When a filter is tested by a testing body, the recognition (i.e. the test mark) of other testing bodies can be requested via the CCA mark with no further testing required.

3.9 Application Classes (IEC 60068-1)

The aim of this standard is to create a basis for classification of telecommunication engineering electrical components according to application classes which correspond to their climatic and mechanical suitability.

Example:

2. Upper temperature limit + 100°C

↑

1. Lower temperature limit – 25°C ← **25/100/21** → 3. Equipment ambient conditions 95% RHA*/21 days per year

*relative humidity of air

3.10 Degree of protection: IP grade (IEC 60529)

This norm and the correspondig European EN 60529 gives standard grade of protection by enclosure for electrical equipment with rated voltage not exceeding 72.5 kV.

Example:

Protection against solid parts
2 → Ø 12mm
4 → Ø 1mm

↑

International protection ← **IP 20** → Protection against liquids 0 → no protection

Timonta filters have IP related to their connection art.

Connections	IP grade
Faston	IP 00
Cables	IP 00 (1)
Bolts	IP 00
Connection blocks (2)	IP 20

(1) Higher IP can be reached through correct installation of cables.
(2) With all the cable correctly connected.

The standard IEC 60439 distinguishes between operating face and main portion of enclosure. For combi filters we give in part 3 the operating face protection grade plug and fuse holder plugged in.

3.11 Mounting of Combi-Filters

With all combi-filters the maximum torque of the M3 mounting screws must not exceed 0.5 Nm.

3.12 Switch technical data for Combi-Filters

Timonta combi-filters are equipped with single or double pole switches.
Their main technical data are given in the following table.

Switch power and electrical life endurance

Countries	**Operations**	**Double pole switch** resistive load	inductive load (2)	**Single pole switch** resistive load	inductive load (2)
Europa	50.000 operations (5E4)	6A, 250 Vac	4A, 250 Vac	–	–
(VDE, SEV, ...)	10.000 operations	12A, 250 Vac	4A, 250 Vac	16A, 250 Vac	3A, 250 Vac
	5.000 operations (1)	–	10A, 250 Vac	–	–
UL, CSA	–	15A, 125 Vac	1/3 HP	16A	–
	–	7.5A, 250 Vac	1/2 HP	16A	–
Inrush current:		50A, 5ms		20A, 5ms	
Contact gap (3):		>=3mm		>=3mm	

(1) Indicative value.
(2) The inductive load test is done according to EN61058-1 with cos φ=0.6 at switch on and cos φ=0.95 at switch off.
(3) Switch with contact gap equal or over 3mm are suited for full disconnecting the appliance from the power supply.

3.13 Technical modifications

Technical data are subject to change without notice.

4. Quality Assurance

To produce market focused products according to customers needs, Timonta use since 1995 a quality management system certified ISO 9001. Timonta products comply with most international safety standards.

Delivery quality

The product properties that can endanger the safety of users and / or can impair the faultless functions of product are proved 100%.
Random sampling inspections are made according to DIN ISO 2859 Part1
The AQLs (AQLs = acceptable quality levels) are based on single sampling plan for normal inspection, inspection level II.

Classification of defects

Inoperatives: (total unusuable components)
short circuit or open circuit, breakage of case, terminals, wrong or missing identification parameters, mixing with other component / product.

Other defectives: defects in electrical characteristics (electrical characteristics outside of specified limits), defects in mechanical properties, e.g. wrong dimensions, damaged case, terminals, bad legible marking.

AQL figures:

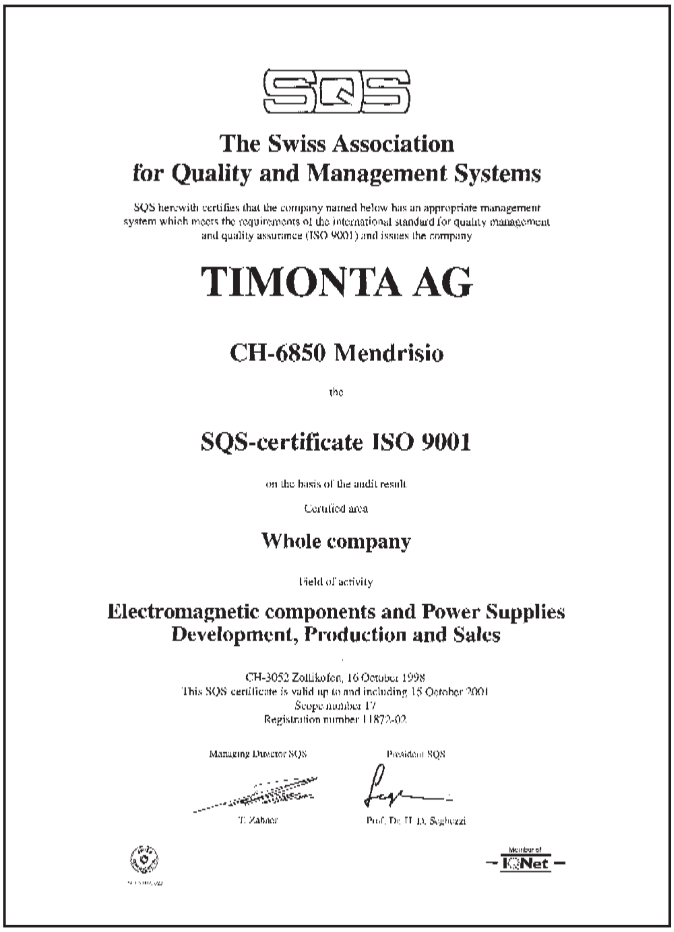
	chokes	filters
inoperatives (electrical and mechanical)	0.065	0.1
sum of electrical defects	0.25	0.25
sum of mechanical defects	0.25	0.4

Declaration of conformity (EN 45014)

Till this day, chokes, EMC-Filter according to EN 138100 and EN 133200 do not fall under the directive EEC/73/23, EEC/93/68 and EEC/89/336 therefore they do not need the declaration of conformity and the CE marking. EMC filters with additional functions as: connector for power inlet, fuses, switch, voltage selector require the CE mark. This apply to Timonta combi-filter family.

Export control (EEC 3381/94)

Chokes and EMC-Filter according to EN 138100 and EN 133200 are made for specific civil application therefore do not need Export control declaration according to EEC/3381/94.



SQS

The Swiss Association
for Quality and Management Systems

SQS herewith certifies that the company named below has an appropriate management system which meets the requirements of the international standard for quality management and quality assurance (ISO 9001) and issues the company

TIMONTA AG

CH-6850 Mendrisio

the

SQS-certificate ISO 9001

on the basis of the audit result

Certified area

Whole company

Field of activity

Electromagnetic components and Power Supplies
Development, Production and Sales

CH-3052 Zollikofen, 16 October 1998
This SQS certificate is valid up to and including 15 October 2001
Scope number 17
Registration number 11872-02

Managing Director SQS — T. Zahner
President SQS — Prof. Dr. H. D. Seghezzi

Member of IQNet

1. Introduction

TIMONTA AG not only manufactures professional EMC noise suppression components and power supplies, but provides a matching EMC service for its customers as well.
In a fully-equipped Faraday room our EMC experts conduct noise suppression and interference susceptibility tests on customers' equipment. There is also the possibility of on-site consultation and testing for non-transportable equipment.
Our subsidiary in Germany has similar facilities available as well, and likewise offers an EMC service. Detailed information may be received directly from our subsidiary in Freiburg i. Br.
TIMONTA AG can also provide testing services in other countries by mutual agreement.

2. The EMC Testing Facilities in Mendrisio

The testing facilities consist of the following (the facilities are continually kept up to date with the latest standards):

2.1 Shielded Room

External sources of electromagnetic fields, generated by industry, high-voltage and others, can cause large errors in RF interference measurements. This problem is solved by a room (4 x 6 x 3 metres) double-shielded on all sides. The electric power supply (3-phase) is screened by high-quality filters, with an active attenuation in the range of 10 kHz to 1000 MHz. Supply 3 x 400 V + N, 50 Hz, max. 25 A. Other voltages, currents and frequencies are available upon request

2.2 Test Instruments for RF Interference Measurements

The test rigs comply to the requirements as laid down in CISPR, VDE, EN, FCC, MIL and SEV.

- Line Impendance Stabilization Network 4 X 25A (50Ω/50µH + 5Ω, 0,01 - 30 MHz), complying to CISPR 16
- Test receiver (9 kHz-1 GHz) complying to CISPR 16 and 22
- Measurement across the entire frequency range is fully automatic
- Peak-, Quasipeak and Average value display
- Detector probe 1500 Ohm, complying to CISPR 1 and 16
- VHF Antenna (30 - 300 MHz)
- MDS noise power clamps
- Noise test receiver complying to CISPR 1 (30 MHz-300 MHz and 10 kHz - 30 MHz)
- Noise test receiver complying to CISPR 3 (10 MHz-150 MHz and 85 kHz - 30 MHz).

2.3 Test Instruments for LF Interference Measurements

- Harmonics (EN 61000-3-2)
- Flickers (EN 61000-3-3)

2.4 Simulation Transient Noise Voltages

According to international and national regulations:

- Electrostatic discharge up to 25 kV (EN 61000-4-2)
- Rapid transient burst, up to 4 kV, 2.5/5 kHz (EN 61000-4-4)
- High-energy noise pulse, surge 6 kV, 1.2/50 µs, 3kA 8/20 µs (EN 61000-4-5)
- Terminal network for power supply, board networks, and signal conductors
- Test rig in accordance with IEC 60255-5
- Surge voltage in accordance with VDE 0160 and IEC 61000-4-5

Futher test options:

- AC and DC insulation test
  AC to 6 kV / 100 mA
  DC to 12 kV / 10 mA
- Attenuation measurements in 50/50 Ohm system
- Saturation measurements up to 120 A
- Isulation resistance test to 20 GOhm (500 and 1000 VDC)

3. Testing Session Reservations

We recommend that you discuss your test series with us in advance with respect to the applicable standards, the desired interference suppression and type of device to test. For enquiries and reservations for testing sessions, please contact:

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