

EMC FILTERS

Introduction

In the vicinity of electronics and control systems, there is often high powered equipment and cabling. In these situations it is possible that electronic circuits can be affected by these mains carrying components in such a way that signals become corrupted. Corrupted signals, especially in industrial surroundings, can lead to faulty operations or the disruption of a production line.

These interferences are caused by mains failure, harmonic distortion and transient switching voltages. The important frequency range lies mostly between 10 kHz and 100 MHz with the majority of this between 100 kHz and 10 MHz.

Electromagnetic compatibility discusses this topic in great detail.

Definition of EMC

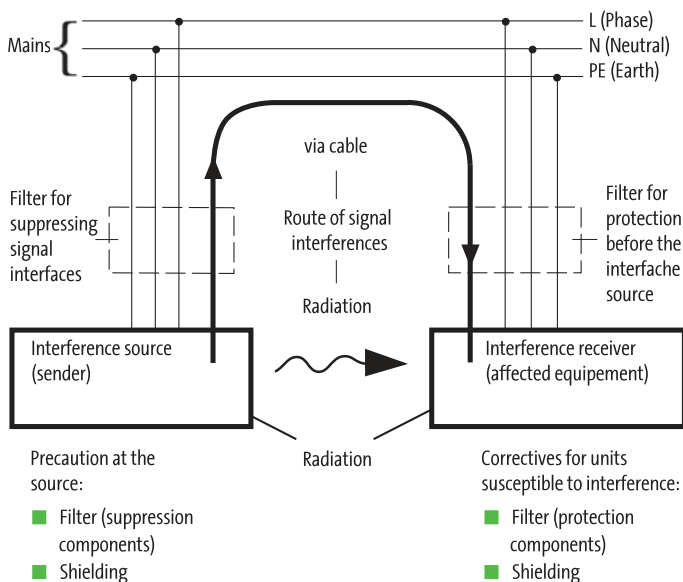
In DIN VDE 0870 part 1, the term electromagnetic compatibility (EMC) is defined as the ability of electronic equipment in an electromagnetic environment to function satisfactorily, without affecting the surrounding equipment or environment in a negative manner.

The law on EMC

On the 3rd May 1989, the E.E.C set up guidelines 89/336/EEC of the council of the European commission for harmonizing the laws on electromagnetic compatibility in each of the member states. In this guideline, EMC was defined as a goal.

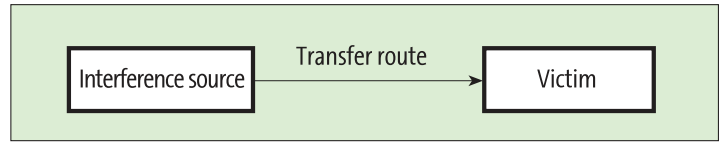
The EMC guidelines became mandatory law in Europe on the 01. January 1996. The law is upheld in that manufacturers and importers must provide EEC conformity declarations. An electrical product conforms, as soon as it fulfills all of the harmonized European laws.

The route of signal interferences



The Model

The electro-magnetic model is made up of three components i.e. the interference source, the transmission medium and the victim. The transmission medium can be described as the route taken by the interference. The transmission of interference can be by cable or by air.



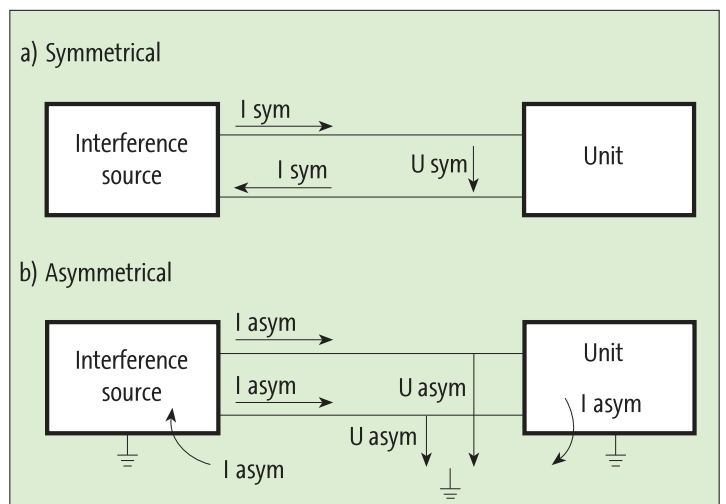
Interferences via cable

Cable carried interferences can be divided into two groups asymmetrical and symmetrical.

Symmetrical interference: The interference appears on the phase wire with reference to the neutral wire. The passage of interference to and from the victim, gives rise to a potential difference, which can be reduced by the connection of an X capacitor.

Asymmetrical interference: The interference is measured against earth. The interference appears on the phase wire and neutral wire together with reference to the earth wire. By placing a Y capacitor in front of the potential victim, the interference can be greatly reduced.

In reality a mix of both interference types will occur. By using mains filters and transient absorbers, both the susceptibility of the equipment is reduced as well as the degree at which interference emissions are released. Suppression equipment therefore plays a vital role in fulfilling EMC regulations



EMC FILTERS

How to chose the correct filters

The choice of filter to solve EMC problems should be made on both technical and economic grounds. To make an optimum choice a few important questions must be asked:

- Nominal voltage and frequency
- Nominal current: For the best performance the nominal current of the filter should be the same as that of the equipment.
- Max. value of the leakage current
- How demanding is the application
 - a) of the attenuation abilities as an interference protection unit?
 - b) in respect to the interference rating which are to be met?
- Placement
- Form, usage of space
- Mounting

Filter parameters

Nominal voltage: The nominal voltage of the filter should be equivalent to the max. supply voltage. This voltage should not be exceeded for more than 20 % of the time.

Nominal current: The nominal current shown is normally valid for temperatures up to 40 °C. The filter can be kept continually operating at any temperature up to this. At higher temperatures, the recommended supply current decreases. The max. temperature is 85 °C.

Leakage current: When choosing a filter, the leakage current is often an important factor. The maximum leakage current for machine and elec. equipment is listed in various guidelines.

Mounting

Single and 3-phase EMC filters are placed between mains and user, i.e. power supply unit. Herewith wire related interferences will be reduced. At the same time the system will be protected against extreme disturbance sources.

An additional mounting between interferences, such as frequency inverter and mains are necessary to make the machine EMC safe. Please be sure to use short wires.

Filters will be snapped on to DIN-rails or screw mounted. To achieve an optimal result a good grounding has to be considered. The PE will be connected onto the largest possible cross-section.

Following general guidelines for EMC installation should be considered:

- Sufficient distance between cables and data-/power wires.
- Grounding of shielded cables.
- Low resistive adjustment in between applications
- Inductive user with interferences, i.e. motors, solenoid valves and contactors are suppressed. Murrelektronik offers suitable suppression.

Correctly connected!

Ground wires at machines and system are among the simplest means to reduce effectively interferences at machines and systems. The flat cables made of highly flexible E-copper strand have excellent HF-characteristics, which effect a good leakage of the interferences.

At the same time the big wire diameter enables a safe connection to the protective ground wire. Ground connection should be as short as possible and of low resistance. Hole diameter, cross section and length are adapted to the applications with the relevant Murrelektronik products.

Ground wires with 16 mm² or 25 mm² are also very well suited for potential equalization between moving machine parts. The conventional time-consuming assembly with cable lugs is no longer necessary. The pressure-welded ends improve contact. The wires are electrolytically tin-plated, so that copper will not oxidize in a humid environment.

Ground wires as accessories for a correct connection to the earth conductor

The 3-phase EMC filters have a threaded pin as PE connector. This serves as earth conductor and as HF-diversion of the interferences filtered out. Murrelektronik now offers highly flexible Cu-ground wires as accessories, which are ideally matched to the filter elements.

Murrelektronik Testing Center

Since 1st January 1996 electronic products have to meet either the EMC guideline (European Union) or the EMC law (Germany).

The independent, accredited Murrelektronik testing center helps you with all the required tests and documentations for your products or applications in the field in order to get "CE" approval.

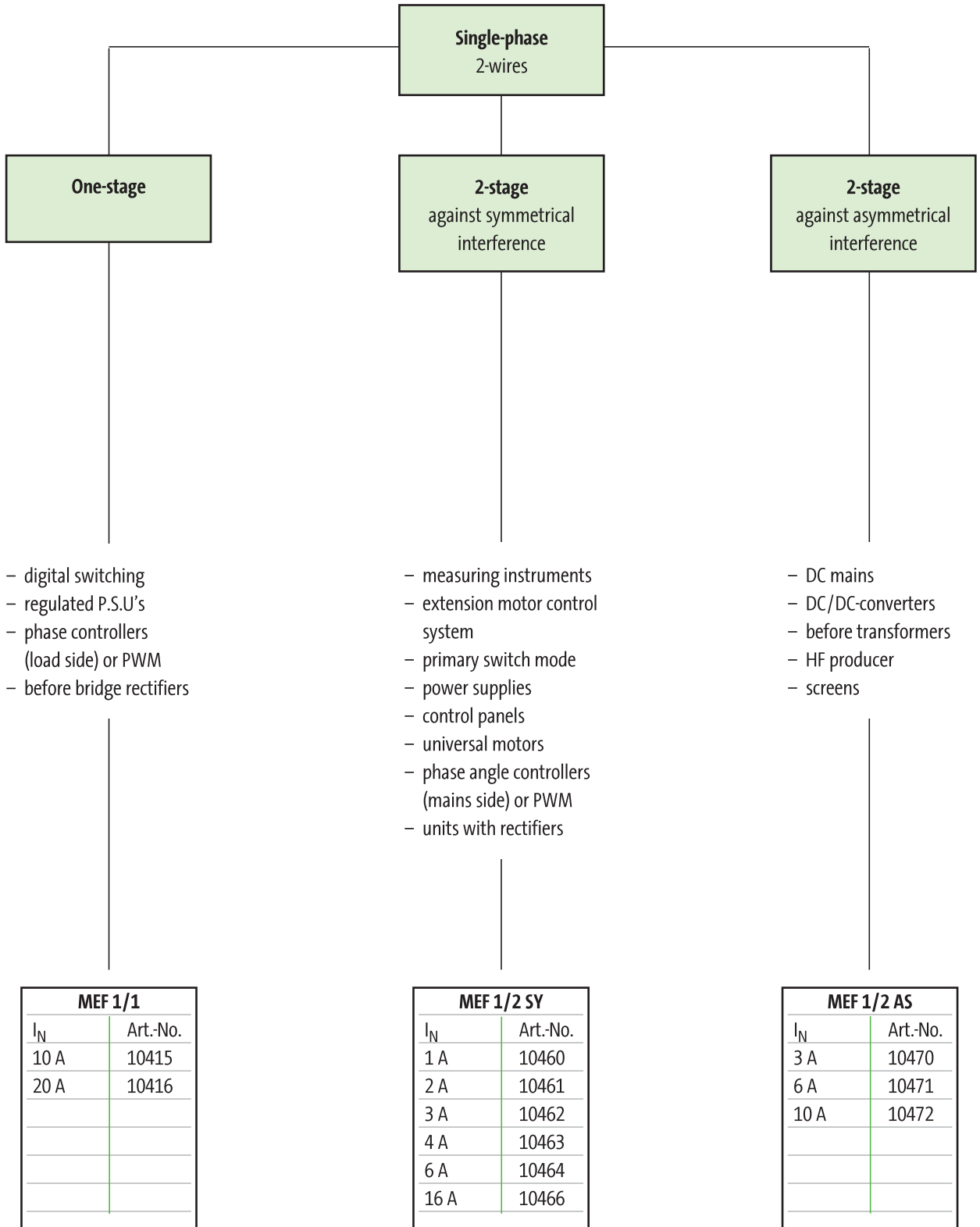
EMC services:

- EMC conformity tests to international norms
- Suppression device and modification suggestions
- Testing of the machines out in the field
- Tests during development
- Tests and optimization of circuit boards
- Advice for EMC guidelines and norms
- Advice for designing machines to EMC guidelines

EMC FILTERS

EMC filters for fixed units

- single-phase
- snap-on

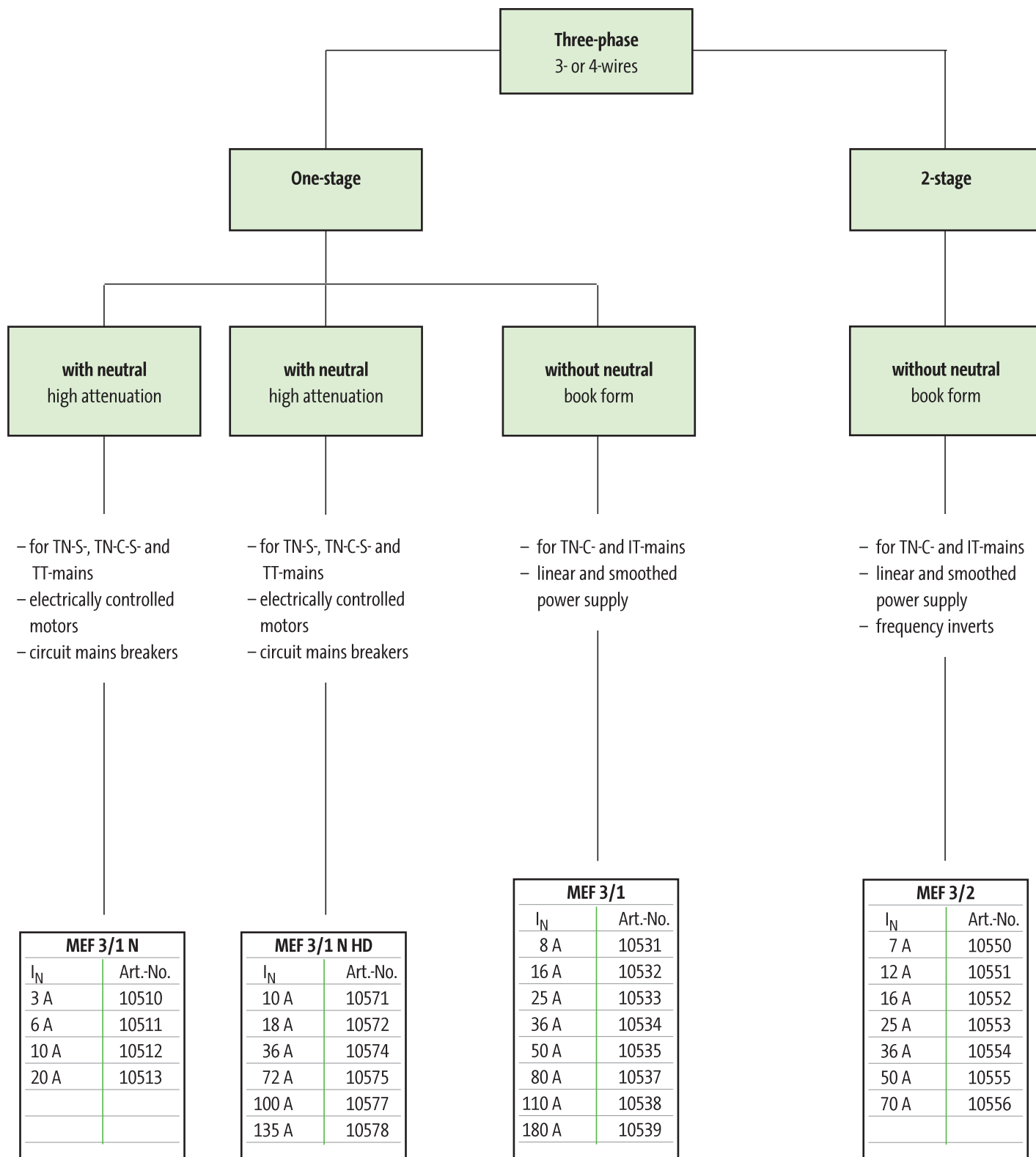


EMC Filters

EMC FILTERS

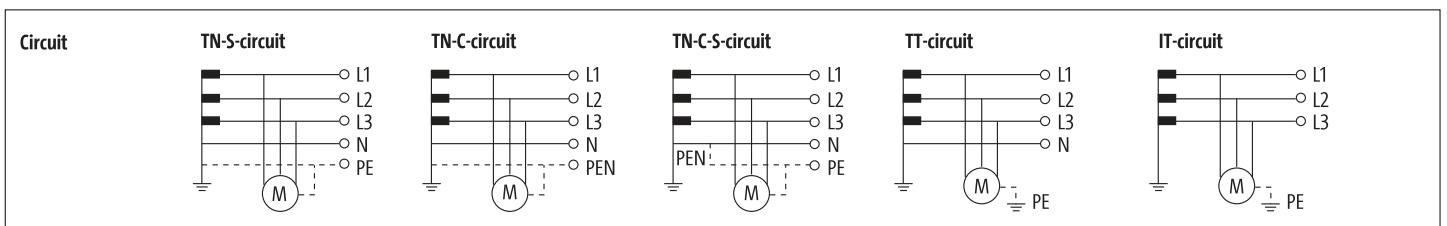
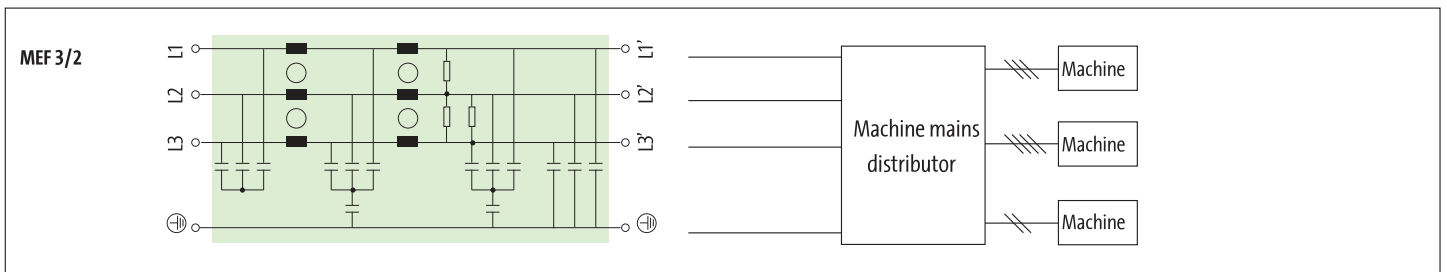
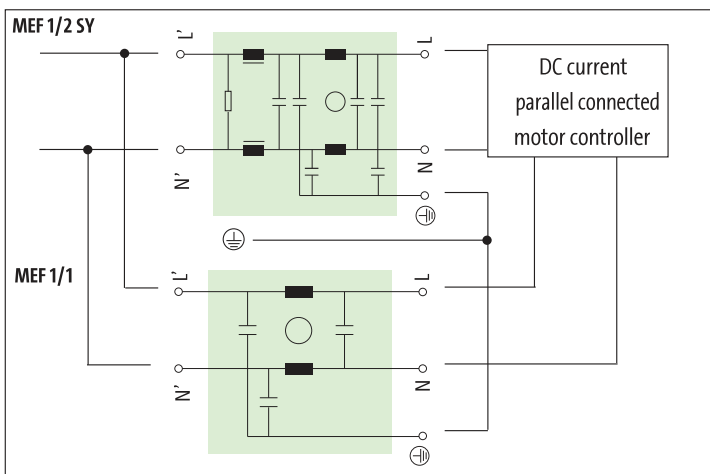
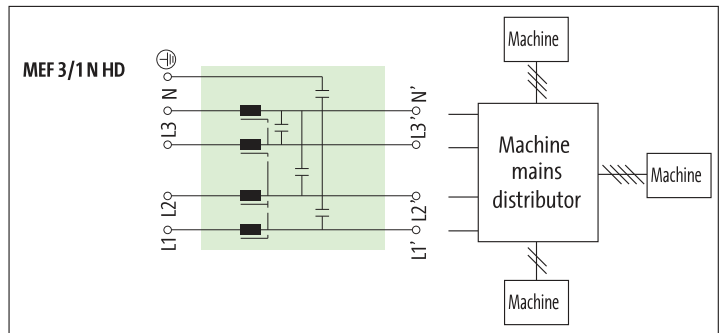
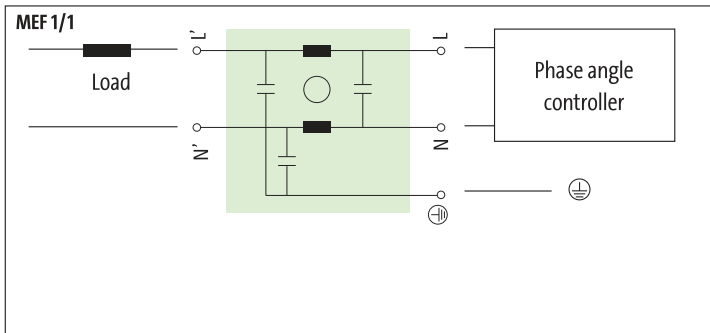
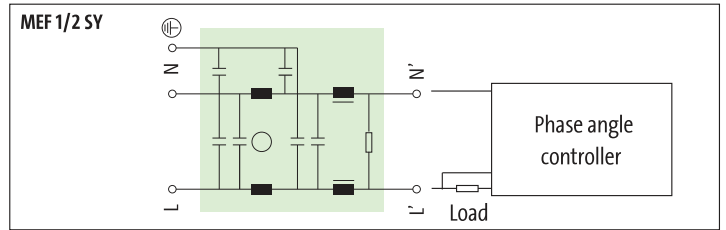
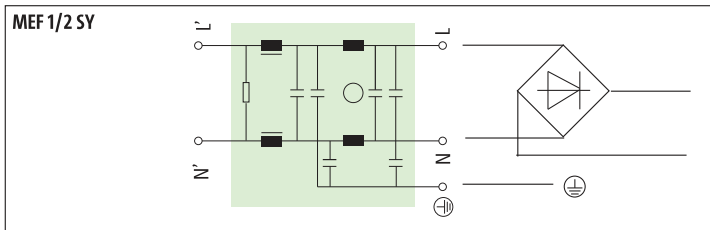
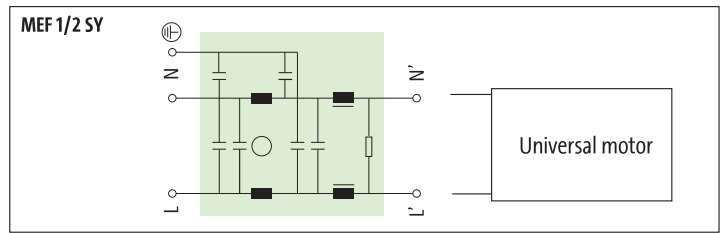
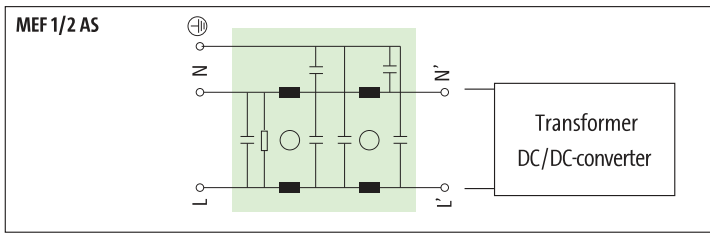
EMC filters for fixed units

- three-phase
- snap-on or screw mounting



EMC FILTERS

Examples of applications for EMC filters



EMC FILTERS

Mains filters are used to attenuate conducted interference without impairing the supply. These filters effectively attenuate both incoming interference which may affect sensitive equipment and also outgoing interference from the equipment to which they are connected and which may otherwise enter the mains supply.

Typical sources of continuous interference are switch mode power supplies, motors and phase controllers.

Comprising of inductive and capacitive components, they are most effective when their impedance is matched to the source of the interference. Good low impedance earthing is important.

Earth bonds should be kept as short as possible and mating surfaces should be free from paint and other impairments etc.

Ideally, the filter should be fitted as close as possible to the point at which the cable enters the cabinet. If this is not possible, shielded cable should be used between the filter and the point of entry with the shield firmly bonded to the cabinet.

Single-phase



MEF 1/1

Single-phase, one-stage, for large currents.

For general applications. DIN-rail mounting acc. to EN 60715.

Supply voltage: max. 250 V AC/DC, 0...60 Hz

Nominal current: 10...20 A

page 1.8.7



MEF 1/2 SY and MEF 1/2 AS

Single-phase, two-stage. Against symmetrical and asymmetrical interferences. The two step filter achieves high suppression values for more demanding applications. DIN-rail mounting acc. to EN 60715.

Supply voltage: max. 250 V AC/DC, 0...60 Hz

Nominal current: 1...16 A

page 1.8.8

Three-phase



MEF 3/1 N

Three-phase, one-stage. 4-wires with N, for general applications.

DIN-rail mounting acc. to EN 60715.

Supply voltage: max. 3 x 440 V AC

Nominal current: 3...20 A

page 1.8.9



MEF 3/1 N HD

Three-phase, one-stage. 4-wires with N, for applications where high attenuation is required.

Supply voltage: max. 3 x 500 V AC

Nominal current: 10...135 A

page 1.8.10



MEF 3/1 and MEF 3/2

Three-phase, 1- and 2-phase. Space saving book form. The two step filter achieves high suppression values for more demanding applications.

Supply voltage: max. 3 x 500 V AC or 3 x 600 V AC

Nominal current: 8...180 A

page 1.8.11

EMC FILTERS

Single-phase, one-stage
acc. to EN 133200

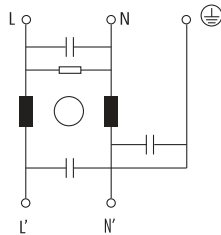
– snap-on

Approvals:  

MEF 1/1
For universal application



Circuit diagram



Ordering data

| | Art.-No. | Art.-No. |
|----------------------------------|--------------|--------------|
| Nominal current I_N (at 40 °C) | | |
| 10 A | 10415 | |
| 20 A | | 10416 |
| | | |
| | | |
| | | |

Technical data

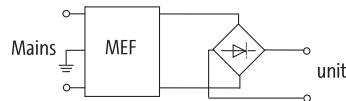
| | | |
|----------------------------------|--|--|
| Supply voltage | max. 250 V AC, 300 V DC | |
| Supply frequency | 0...60 Hz | |
| Max. leakage current at 250 V AC | ≤ 5 mA | |
| Test voltage (EN 60939-2) | L to N = 2.7 kV DC, 2 s; L to L = 2.1 kV DC, 2 s | |
| Overload current | 18 x I_N t ≤ 0.5 ms; 1.5 x I_N t ≤ 1 min. (1 x per hour) | |

General data

| | | |
|----------------------|---|---------------|
| Wiring method | screw connection, touch protected | |
| Wire cross-section | 0.2...6 mm ² single core (AWG 24...9); 0.2...4 mm ² multiple core (AWG 24...11) | |
| Climatical category | 25/85/21 (EN 600068-1) | |
| Mounting method | DIN-rail mounting TH 35 (EN 60715) | |
| Weight | approx. 316 g | approx. 450 g |
| Dimensions H x W x D | 107 x 65 x 39 mm | |

Description/Application

The single-phase, one-stage EMC filters MEF 1/1 are used in the range 0.1...30 MHz to suppress cable carried interference in power and control cabling. The best results are obtained with short connection cables (example: earth connection < 10 cm) of the largest possible cross-section. The EMC filters are bi-directional. Voltage interferences irrespective of where they originate, either **voltage input** or **modules**, are suppressed. The filter with over voltage protection has an additional transient function. Typical usage: – good filter performance is achieved when applied to the bridge rectifier i.e.:



Notes

Attenuation curves on request. Suitable ground straps see page 1.8.12

EMC Filters

EMC FILTERS

Single-phase, two-stage
acc. to EN 133200

– snap-on

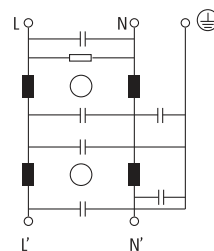
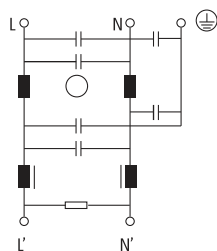
Approvals:  

MEF 1/2 SV
Against symmetrical interference



MEF 1/2 AS
Against asymmetrical interference

Circuit diagram



| Ordering data | Art.-No. | Art.-No. |
|----------------------------------|--------------|--------------|
| Nominal current I_N (at 40 °C) | | |
| 1 A | 10460 | |
| 2 A | 10461 | |
| 3 A | 10462 | 10470 |
| 4 A | 10463 | |
| 6 A | 10464 | 10471 |
| 10 A | | 10472 |
| 16 A | 10466 | |

| Technical data | |
|----------------------------------|---|
| Supply voltage | max. 250 V AC, 300 V DC |
| Supply frequency | 0...60 Hz |
| Max. leakage current at 250 V AC | ≤ 5 mA |
| Test voltage (EN 60939-2) | L to N = 2.7 kV DC, 2 s; L to L = 2.1 kV DC, 2 s |
| Overload current | 18 x I_N t ≤ 0.5 ms; 1.5 x I_N t ≤ 1 min (1 x per hour) |

| General data | |
|----------------------|---|
| Wiring method | screw connection, touch protected |
| Wire cross-section | 0.2...6 mm ² single core (AWG 24...9); 0.2...4 mm ² multiple core (AWG 24...11) |
| Climatical category | 25/85/21 (EN 600068-1) |
| Mounting method | DIN-rail mounting TH 35 (EN 60715) |
| Weight | approx. 450 g |
| Dimensions H x W x D | 107 x 65 x 39 mm |

| Description/Application | | | |
|--|---|--|---|
| | The single-phase 2-stage EMC filters MEF 1/2 are used in the range 0.1...30 MHz to suppress cable carried interference on mains and control cables. The best filter performance is achieved by using short connection wires (suggestion: earth connection < 10 cm) and the largest possible diameter. The EMC filters work bi-directionally (in both directions). The filters are for demanding applications. The filters are designed for use with fixed modules. One step of the filter is always for the suppression of asymmetrical interferences (magnetically compensated suppression). The second step is, dependant on application for symmetrical or asymmetrical interferences. | | |
| Application: | <table border="0"> <tr> <td style="vertical-align: top;"> symmetrical interferences: – units with high repetitions of the switching process – switch mode P.S.U.'s – phase controllers – supply of universal motors – to transformers </td> <td style="vertical-align: top; padding-left: 20px;"> asymmetrical interferences: – units with high switching frequency and rapid repetitions – switch mode P.S.U.'s – in DC-mains – for transformers – frequency inverter </td> </tr> </table> | symmetrical interferences: – units with high repetitions of the switching process – switch mode P.S.U.'s – phase controllers – supply of universal motors – to transformers | asymmetrical interferences: – units with high switching frequency and rapid repetitions – switch mode P.S.U.'s – in DC-mains – for transformers – frequency inverter |
| symmetrical interferences: – units with high repetitions of the switching process – switch mode P.S.U.'s – phase controllers – supply of universal motors – to transformers | asymmetrical interferences: – units with high switching frequency and rapid repetitions – switch mode P.S.U.'s – in DC-mains – for transformers – frequency inverter | | |

| Notes |
|---|
| Attenuation curves on request. Suitable ground straps see page 1.8.12 |

EMC FILTERS

Three-phase, one-stage
acc. to EN 133200

– with neutral

Approvals:

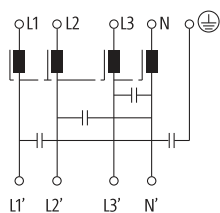


MEF 3/1 N

Snap-on



Circuit diagram



Ordering data

| | | Art.-No. |
|----------------------------------|-----------------------------------|----------|
| Nominal current I_N (at 40 °C) | screw connection, touch protected | |
| 3 A | | 10510 |
| 6 A | | 10511 |
| 10 A | | 10512 |
| 20 A | | 10513 |

Technical data

| | |
|---------------------------|--|
| Supply voltage | max. 3 x 440 V AC |
| Supply frequency | 50...60 Hz |
| Max. leakage current | ≤ 3 mA |
| Test voltage (EN 60939-2) | L to N = 2.7 kV DC, 2 s; L to L = 2.1 kV DC, 2 s |
| Overload current | $18 \times I_N$ $t \leq 0.5$ ms; $1.5 \times I_N$ $t \leq 1$ min. (1 x per hour) |

General data

| | |
|----------------------|--|
| Wiring method | screw connection, touch protected |
| Wire cross-section | 0.2...6 mm ² single core (AWG24...9); 0.2...4 mm ² multiple core (AWG 24...11) |
| Climatical category | 25/85/21 (EN 60068-1) |
| Mounting method | DIN-rail mounting TH 35 (EN 60715) |
| Weight | approx. 450 g |
| Dimensions H x W x D | 107 x 65 x 39 mm |

Description/Application

The 3-phase and one-stage EMC filters MEF 3/1 are used in the range 0.1...30 MHz and dampen interferences found in cables from the mains, supply units and control systems. The best results are obtained with short connection cables (example: earth connection < 10 cm) of the largest possible cross-section. The EMC filters are bi-directional. They reduce symmetrical and asymmetrical interferences, that regularly appear with electronically controlled three phase units through mains influences.

Notes

Attenuation curves on request. Suitable ground straps see page 1.8.12

EMC FILTERS

Three-phase, one-stage
acc. to EN 133200

– with neutral

Approvals:

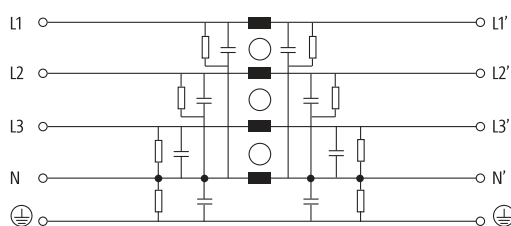


MEF 3/1 N HD

With increased damping



Circuit diagram



Ordering data

| | | Art.-No. |
|----------------------------------|-----------------------------------|----------|
| Nominal current I_N (at 40 °C) | screw connection, touch protected | |
| 10 A | | 10571 |
| 18 A | | 10572 |
| 36 A | | 10574 |
| 72 A | | 10575 |
| 100A | | 10577 |
| 135A | | 10578 |

Technical data

| | |
|---------------------------|--|
| Supply voltage | max. 3 x 500 V AC |
| Supply frequency | 50..60 Hz |
| Max. leakage current | ≤ 15 mA |
| Test voltage (EN 60939-2) | L to N = 3.3 kV DC, 2 s; L to L = 3.1 kV DC, 2 s |
| Overload current | 18 x I_N t ≤ 0.5 ms; 1.5 x I_N t ≤ 1 min. (1 x per hour) |

General data

| | | |
|---------------------|-----------------------------------|--|
| Wire cross-section | Art.-No. 10571, 72, 74 | 0.2...10 mm ² (AWG 24...7) single core; 0.2...6 mm ² (AWG 24...9) multiple core |
| | Art.-No. 10575 | 0.5...25 mm ² (AWG 20...3) single core; 0.5...25 mm ² (AWG 20...3) multiple core |
| | Art.-No. 10577 | 6...35 mm ² (AWG 9...2) single core; 10...35 mm ² (AWG 7...2) multiple core |
| | Art.-No. 10578 | 16...50 mm ² (AWG 5...0) single core; 16...50 mm ² (AWG 5...0) multiple core |
| Climatical category | 25/85/21 (EN 60068-1) | |
| Mounting method | screw fixing, M6; from 100 A, M10 | |

Description

Application

The 3-phase and one-stage EMC filters MEF 3/1 are used in the range 0.1...30 MHz and dampen interferences found in cables from the mains, supply units and control systems. The best results are obtained with short connection cables (example: earth connection < 10 cm) of the largest possible cross-section. The EMC filters are bi-directional. They reduce symmetrical and asymmetrical interferences, that regularly appear with electronically controlled three phase units through mains influences

Dimensions

| Art.-No. | H x W x D (mm) | Weight (kg) |
|--------------|-----------------|-------------|
| 10571, 10572 | 153 x 130 x 100 | 1.0 |
| 10574 | 153 x 130 x 100 | 1.1 |
| 10575 | 153 x 118 x 125 | 1.6 |
| 10577 | 170 x 180 x 140 | 3.4 |
| 10578 | 170 x 180 x 140 | 4.5 |

Notes

Attenuation curves on request. Suitable ground straps see page 1.8.12

EMC FILTERS

Three-phase
acc. to EN 133200

– book form

Approvals:  

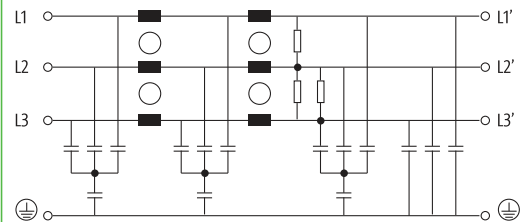
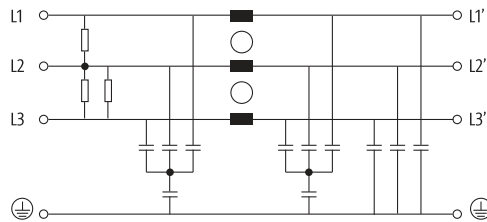
MEF 3/1
One-stage



MEF 3/2
Two-stage



Circuit diagram



Ordering data

Nominal current I_N (at 40 °C)

| | Art.-No. | Art.-No. |
|-------|--------------|--------------|
| 8 A | 10531 | 10550 |
| 12 A | | 10551 |
| 16 A | 10532 | 10552 |
| 25 A | 10533 | 10553 |
| 36 A | 10534 | 10554 |
| 50 A | 10535 | 10555 |
| 80 A | 10537 | 10556 |
| 110 A | 10538 | |
| 180 A | 10539 | |

Technical data

| | | |
|----------------------------------|--|-------------------|
| Supply voltage | max. 3 x 600 V AC | max. 3 x 500 V AC |
| Supply frequency | 50...60 Hz | 50...60 Hz |
| Max. leakage current at 250 V AC | ≤ 10 mA | ≤ 15 mA |
| Test voltage (EN 60939-2) | L to N = 3.3 kV DC, 2 s; L to L = 3.1 kV DC, 2 s | |
| Overload current | 18 x I_N t ≤ 0.5 ms; 1.5 x I_N t ≤ 1 min. (1 x per hour) | |

General data

| | | | | | | |
|--------------------|-----------------------------------|-----------------------------|--------------------------------|---------------|-----------------------------|--------------------------------|
| Wiring method | screw connection, touch protected | | | | | |
| Wire cross-section | Art.-No. | single core/mm ² | multiple core/ mm ² | Art.-No. | single core/mm ² | multiple core/ mm ² |
| | 10531...10533 | 0.2...10 /AWG24...7 | 0.2...6 /AWG24...9 | 10550...10554 | 0.2...10/AWG24...7 | 0.2...6 /AWG24...9 |
| | 10534...10535 | 0.5...16 /AWG20...5 | 0.5...10 /AWG20...7 | 10555 | 0.5...16/AWG20...5 | 0.5...10 /AWG20...7 |
| | 10537 | 6.0...35 /AWG9...2 | 10...25 /AWG7...2 | 10556 | 0.5...25/AWG20...3 | 0.5...16 /AWG20...5 |
| | 10538 | 16...50 /AWG5...0 | 16...50 /AWG5...0 | | | |
| | 10539 | 25...95 /AWG3...0000 | 35...95 /AWG2...0000 | | | |

Climatical category 25/85/21 (EN 600068-1)

Mounting method screw fixing, M5 to 50 A, further M6 screw fixing, M6

Description

Application

The 3-phase and one-stage EMC filters MEF 3/1 resp. 3/2 0.1...30 MHz and dampen interferences found in cables from the mains, supply units and control systems. They are suitable for TN-C- and IT mains. The best results are obtained with short connection cables (example: earth connection < 10 cm) of the largest possible cross-section. The EMC filters are bi-directional.

They reduce symmetrical and asymmetrical interferences, that regularly appear with electronically controlled three phase units through mains influences.

Dimensions

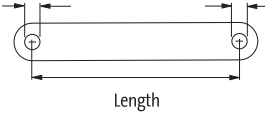
| Art.-No. | H x W x D (mm) | Weight (kg) |
|---------------|-----------------|-------------|
| 10531...10533 | 250 x 90 x 100 | 1.3 |
| 10534 | 250 x 90 x 100 | 1.5 |
| 10535 | 250 x 90 x 100 | 1.7 |
| 10537 | 270 x 85 x 135 | 2.2 |
| 10538 | 270 x 90 x 150 | 3.2 |
| 10539 | 380 x 120 x 170 | 5.1 |
| 10550...10554 | 226 x 50 x 140 | 1.7 |
| 10555, 10556 | 295 x 70 x 177 | 5.1 |

Notes

Attenuation curves on request. Suitable ground straps see page 1.8.12

EMC Filters

ACCESSORIES

| Ground straps | Profile | i.e. | | | Art.-No. | |
|--|--------------------|--------------------------------|----------|----------------------------------|----------------------------|----------------------------|
| Hole for metric screw or centric screw thread bolt  | 16 mm ² | 200 mm for hole | M6 | MEF 3/1 NHD, MEF 3/1 and MEF 3/2 | to 80 A | 4000-71001-162 0006 |
| | 35 mm ² | 200 mm for hole | M6 | MEF 3/1 NHD, MEF 3/1 and MEF 3/2 | to 80 A | 4000-71001-352 0006 |
| | 50 mm ² | 300 mm for hole | M10 | MEF 3/1 NHD und MEF 3/1 | from 100 A | 4000-71001-503 0010 |
| | 95 mm ² | 300 mm for hole | M10 | MEF 3/1 NHD und MEF 3/1 | from 100 A | 4000-71002-953 0010 |
| Mounting set | Thread/Length | | Art.-No. | | | |
| 1 x 6-point screw | M6 x 25 | for ground strap with M6 hole | | | 4000-71003-010 2506 | |
| 1 x nut | M10 x 35 | for ground strap with M10 hole | | | 4000-71003-010 3510 | |
| 2 x shims | M10 x 40 | for ground strap with M10 hole | | | 4000-71003-010 4010 | |
| 2 x lock washer | | | | | | |
| 2 x label | | | | | | |

Notes