1. 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 compatibilty dicusses this topic in great detail.

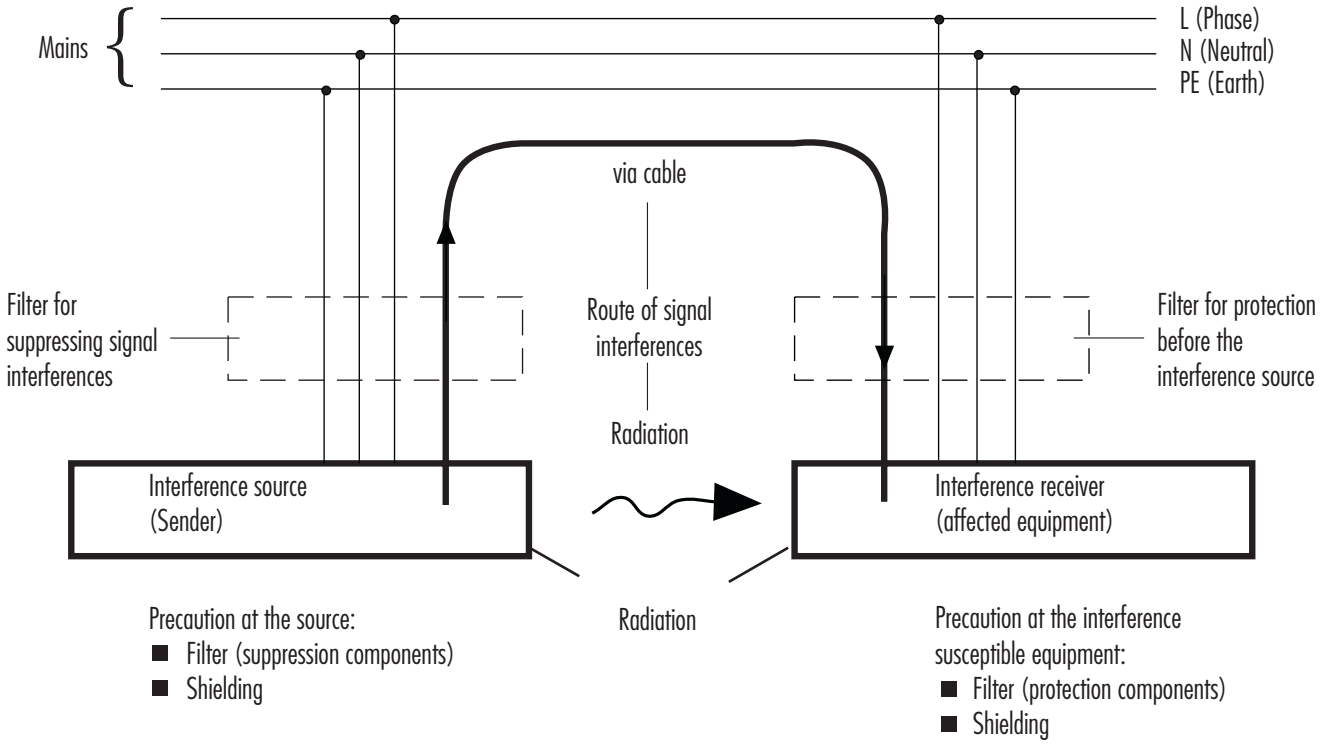
2. Definition of EMC

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

3. The law on EMC

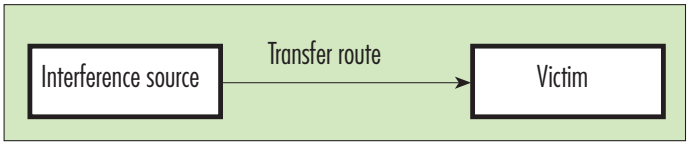
On the 3rd May 1989, the E.E.C set up guidelines 89/336/EEC of the council of the European commission for harmonizing the laws on electromagnetic compatibilty in each of the member states. In this guideline, EMC was defined as a goal.
The EMC guidelines became mandatory law in Europe on the 01. January 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



4. 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.



To combat cable carried interferences, mains filters or transient absorbers should be used.

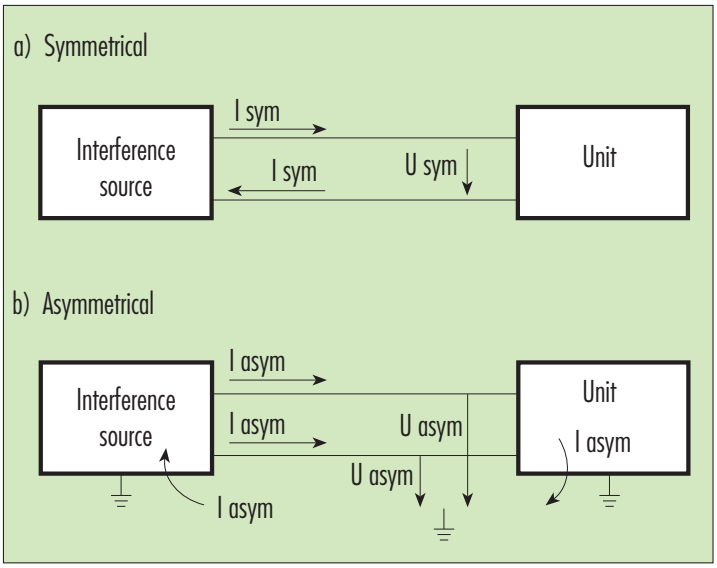
5. Interferences via cable

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 susceptibilty 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.



6. 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.
- 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
- Max. value of the leakage current

7. 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 45 °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.

8. 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 maschine 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.

9. Murrelektronik Testing Center

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

The independant, 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 for fixed units

1-phase

Snap-on

1-phase
2-lines

one-stage

- digital switching
- regulated P.S.U's
- phase controllers (load side) or PWM
- before bridge rectifiers

MEF 1/1	
I_N	Art.-No.
10 A	10415
20 A	10416

2-stage
against symmetrical interference

- measuring instruments
- extension motor control system
- primary switch mode
- power supplies
- control panels
- universal motors
- phase angle controllers (mains side) or PWM
- units with rectifiers

MEF 1/2 SY	
I_N	Art.-No.
1 A	10460
2 A	10461
3 A	10462
4 A	10463
6 A	10464
16 A	10466

2-stage
against asymmetrical interference

- DC mains
- DC/DC-converters
- before transformers
- HF producer
- screens

MEF 1/2 AS	
I_N	Art.-No.
3 A	10470
6 A	10471
10 A	10472

EMC filters for fixed units

3-phase

Snap-on or screw mounting

3-phase
3- or 4-lines

one-stage

2-stage

with neutral
snap-on

– for TN-S-, TN-C-S- and TT-mains
– electrically controlled motors
– circuit mains breakers

MEF 3/1 N	
I_N	Art.-No.
3 A	10510
6 A	10511
10 A	10512
20 A	10513

with neutral
high attenuation

– for TN-S-, TN-C-S- and TT-mains
– electrically controlled motors
– circuit mains breakers

MEF 3/1 N HD	
I_N	Art.-No.
16 A	10372
25 A	10373
36 A	10374
50 A	10375
80 A	10377
110 A	10378

without neutral
book form

– for TN-C- and IT-mains
– linear and smoothed power supply

MEF 3/1	
I_N	Art.-No.
8 A	10531
16 A	10532
25 A	10533
36 A	10534
50 A	10535
80 A	10537
110 A	10538
180 A	10539

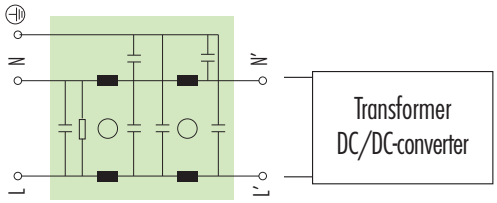
without neutral
book form

– for TN-C- and IT-mains
– linear and smoothed power supply
– frequency inverts

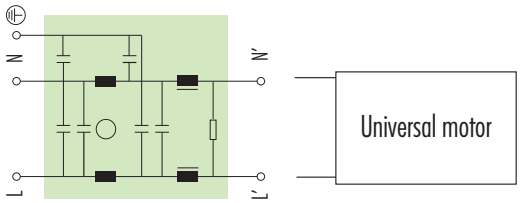
MEF 3/2	
I_N	Art.-No.
7 A	10550
12 A	10551
16 A	10552
25 A	10553
36 A	10554
50 A	10555
70 A	10556

Examples of applications for EMC filters

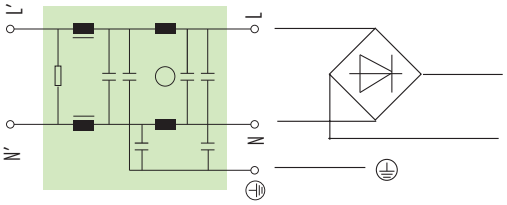
MEF 1/2 AS



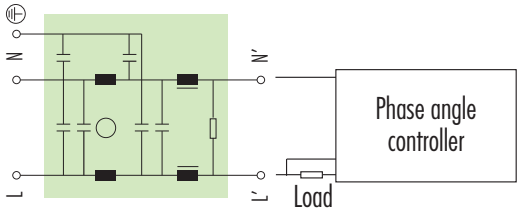
MEF 1/2 SY



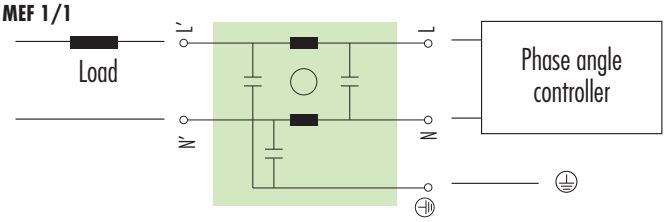
MEF 1/2 SY



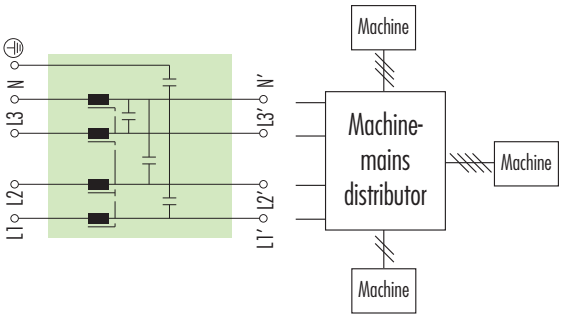
MEF 1/2 SY



MEF 1/1

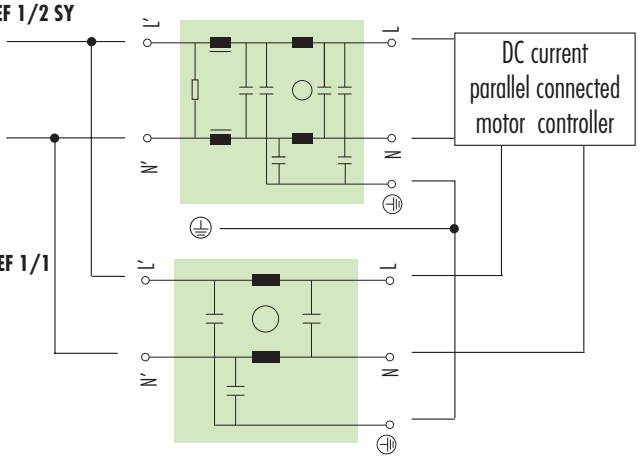


MEF 3/1 N HD

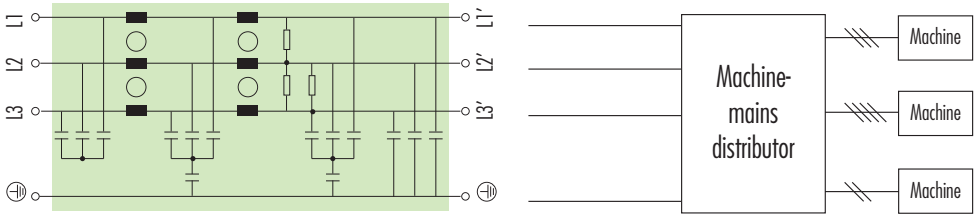


MEF 1/2 SY

MEF 1/1

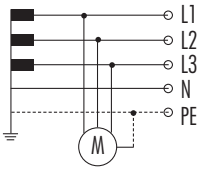


MEF 3/2

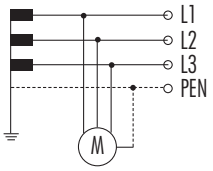


Circuit

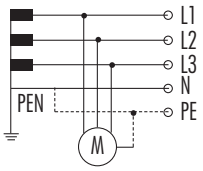
TN-S-circut



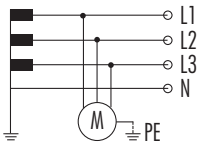
TN-C-circuit



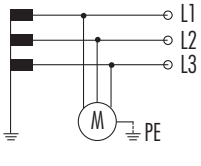
TN-C-S-circuit



TT-circuit



IT-circuit



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 to EN 60715.
Supply voltage: max. 250 V AC/DC, 0 . . . 60 Hz
Nominal current : 10…20 A

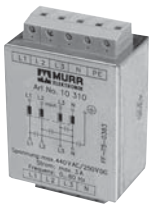
page 3.1.7

MEF 1/2 SY and MEF 1/2 AS

Single-phase, 2-stage. Against symmetrical and asymmetrical interferences. The two step filter achieves high suppression values for more demanding applications. DIN-rail mounting to EN 60715.
Supply voltage: max. 250 V AC/DC, 0 . . . 60 Hz
Nominal current: 1…16 A

page 3.1.8

Three-phase



MEF 3/1 N

Three-phase, one-stage. 4-lines with N, for general applications.
DIN-rail mounting to EN 60715.

Supply voltage: max. 3 x 440 V DC
Nominal current: 3…20 A

page 3.1.9

MEF 3/1 N HD

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

Supply voltage: max. 3 x 440 V DC
Nominal current: 3…110 A

page 3.1.9

MEF 3/1 and MEF 3/2

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

Supply voltage: max. 3 x 500 V AC/DC est. 3 x 600 V AC
Nominal current: 8…180 A

page 3.1.10

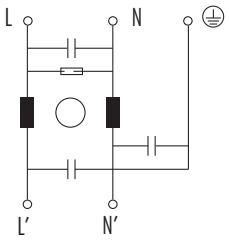
Single-phase, one-stage to EN 133200

Snap-on 2-lines, also for DC

MEF 1/1

for universal application

Circuit diagram



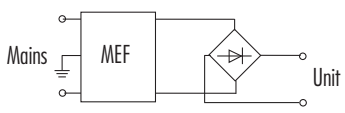
Ordering data	Art.-No.
Nominal current I_N (at 40 °C)	
10 A	**10415**
20 A	**10416**

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 (to EN 133000)	L –> N 2.7 kV DC, 2 s / L –> 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	rising-clamp screw terminals
Wire cross-section	0.2…6 mm² single core AG24…9, 0.2…4 mm² multiple core AWG24…11
Climatical category	25/85/21 (EN 60068-1)
Mounting method	DIN-rail mounting to EN 60715 (TH 35)
Weight	0.45 kg
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.

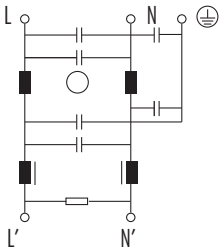
Single-phase, 2-stage to EN 133200

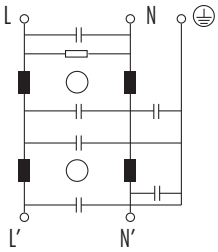
Snap-on 2-lines, also for DC

MEF 1/2 SY
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 (to EN 133000)	L –> N 2.7 kV DC, 2 s / L –> 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	rising-clamp screw terminals
Wire cross-section	0.2…6 mm² single core AWG24…9, 0.2…4 mm² multiple core AWG24…11
Climatical category	25/85/21 (EN 60068-1)
Mounting method	DIN-rail mounting to EN 60715 (TH 35)
Weight	0.45 kg
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:

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 freq. and rapid repetitions
- switch mode P.S.U's
- in DC-mains
- for transformers
- frequency inverter

Notes

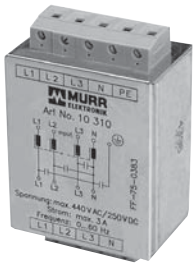
Attenuation curves on request.

3-phase, one-stage to EN 133200

with neutral

MEF 3/1 N

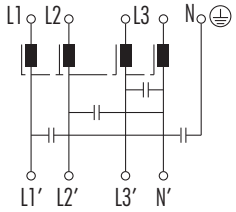
snap-on

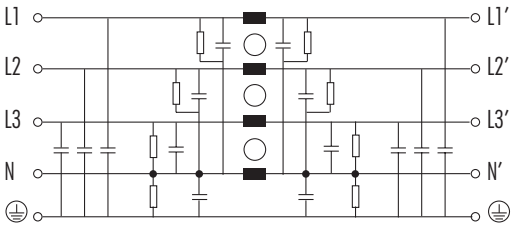


MEF 3/1 N HD

with increased attenuation

Circuit diagram





Ordering data	**Art.-No.**	**Art.-No.**
Nominal current I_N (at 40 °C)		
3 A	**10510**	
6 A	**10511**	
10 A	**10512**	
16 A		**10372**
20 A	**10513**	
25 A		**10373**
36 A		**10374**
50 A		**10375**
80 A		**10377**
110A		**10378**

Technical data		
Supply voltage	max. 3 x 440 V AC	max. 3 x 440 V AC
Supply frequency	50…60 Hz	50…60 Hz
Max. leakage current at 440 V AC	< 3 mA	< 5 mA
Test voltage (to EN 133000)	L –> N = 2.7 kV DC, 2 s / L –> L = 2.1 kV DC, 2 s	L –> N = 2.8 kV DC, 2 s; L –> L = 1.7 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)	1.5 x I_N t < 1 min. (1 x per hour)

General data		
Wiring method	rising-clamp screw terminals	rising-clamp screw terminals
Wire cross-section	0.2…6 mm² single core AWG24…9, 0.2…4 mm² multiple core	Art.-No. 10372 ≤ 4 mm²/AWG11; Art.-No. 10373 ≤ 6 mm²/AWG9
	AWG 24…11	Art.-No. 10374, 10375 ≤ 10 mm2/AWG7
		Art.-No. 10377 ≤ 25 mm²/AWG3; Art.-No. 10378 ≤ 50 mm²/AWG0
Climatical category	25/85/21 (EN 60068-1)	
Mounting method	DIN-rail mounting to EN 60715 (TH 35)	screw fixing, M6

Description

Dimensions vertical mounting

Art.-No.	H x W x D (mm)	Weight (kg)
10510…10513	107 x 65 x 39	0.45
10372, 10373	151 x 241 x 66	3.0
10374, 10375	151 x 251 x 66	3.5
10377	151 x 378 x 81	7.6
10378	387 x 150 x 81	7.8

Application

The 3-phase and one-stage EMC filters MEF 3/1 are used in the range 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.

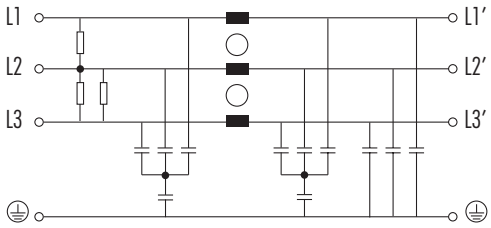
3-phase to EN 133200

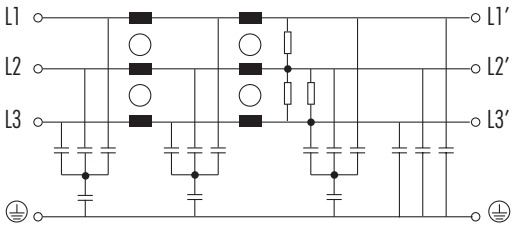
Book form

MEF 3/1
one-stage

MEF 3/2
2-stage

Circuit diagram





Ordering data	**Art.-No.**	**Art.-No.**
Nominal current I_N (at 40 °C)		
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 (to EN 133000)	L –> N = 3.3 kV DC, 2 s / L –> 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: rising-clamp screw terminals

Wire cross-section

Art.-No.	single core/mm²	multi core/ mm²
10531…10533	0.2…10 /AWG24…7	0.2…6 /AWG24…11
10534…10535	0.5…16 /AWG20…5	0.5…10 /AWG20…7
10537	6.0…35 /AWG9…2	10…25 /AWG7…2
10538	16…50 /AWG5…0	16…50 /AWG5…0
10539	25…35 /AWG3…0000	35…95 /AWG2…0000

Art.-No.	single core/mm²	multi core/ mm²
10550…10554	0.2…10/AWG24…7	0.2…6 /AWG24…9
10555	0.5…16/AWG20…5	0.5…10 /AWG20…7
10556	0.5…25/AWG20…3	0.5…16 /AWG20…5

Climatical category	25/85/21 (EN 60068-1)
Mounting method	screw fixing, M5 to 50 A, M6 / screw fixing, M6

Description

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

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.

Notes

Attenuation curves on request.