Air Core Current Limiting Reactors

Up to 36kV, 20MVAr*

Current Limiting Reactor (CLR) is one of the most effective short circuit current limiting devices. It reduces stresses on busses, insulators, circuit breakers and other high voltage devices. Use of CLR is the most practical and economical approach at current limiting.

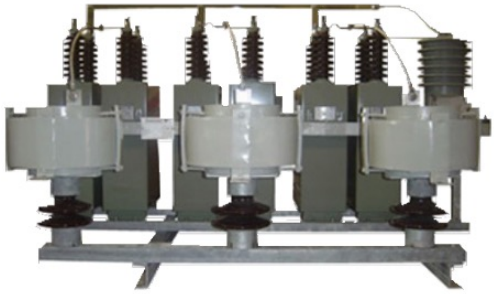
Current Limiting Reactors should be placed where the prospective short circuit current in a distribution or transmission system is calculated to exceed the interrupting rating of the associated switchgear. The inductive reactance is chosen to be low enough for an acceptable voltage drop during normal operation, but high enough to restrict a short circuit to the rating of the switchgear.

They are also used as load sharing reactors for balancing the current in parallel circuits. Current limiting reactors are manufactured up to 420 kV. These reactors are designed in a way to withstand the rated current continuously and fault currents for a certain period of time.

Inrush Current Limiting Reactors (Damping Reactors)

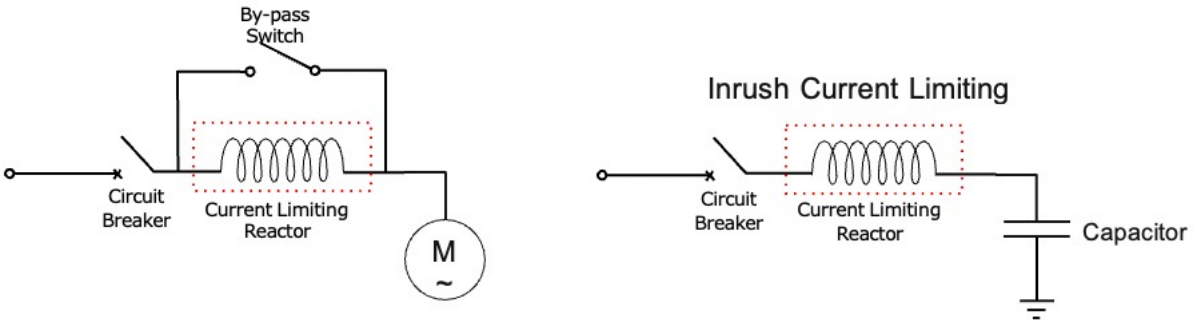
Inrush current limiting reactors are series connected with capacitors in order to limit the inrush currents that occur during their switching (turn-on) operations.

General Features



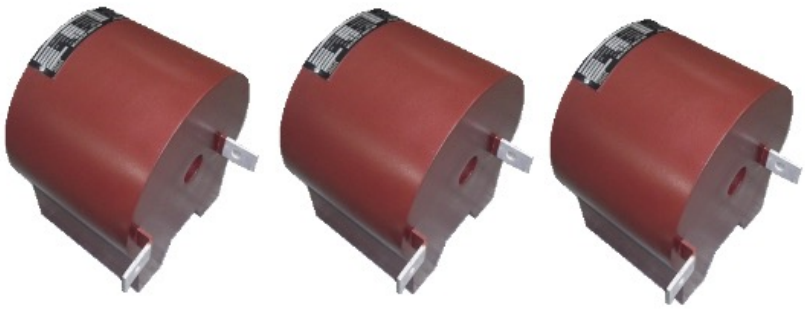
- Increases equipment and capacitor life
- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Special surface protection against UV, and for pollution Class IV areas
- Maintenance-free design.

Typical Connection Diagrams



Technical Specifications

- Voltage: Up to 36kV
- Power: Up to 20MVAr*
- Type: Aire core, dry type
- Frequency: 50Hz / 60Hz
- Installation: Enclosure available on demand, side-by-side, delta or vertical arrangement
- Winding: Aluminum or copper winding
- Painting: RAL7035 or other colors
- Temperature: -40°C to 55°C
- Insulation Class: F class or custom specific design
- Standards: IEEE, IEC and others
- Cooling: AN (air-neutral) cooling method
- Options:
    - Enclosure
    - Taps



Hilkar®

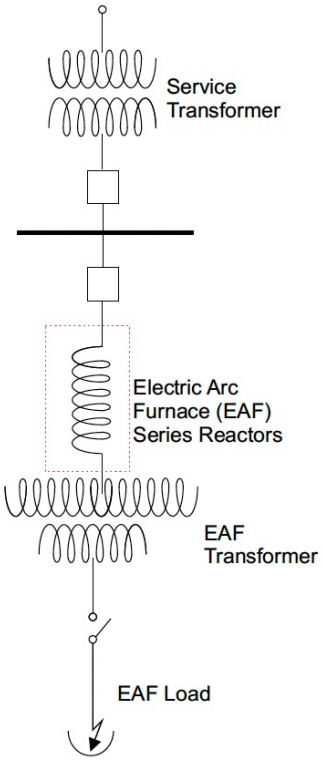
Air Core Electric Air Furnace Reactors

Up to 36kV, 20MVAr*

Arc Furnace Reactors are serially connected reactors that are installed in the supply systems of arc furnace transformers to stabilize arc and limit the unstable arc furnace current and voltage drop which optimize their melting process. These buffer reactors are connected in series to the primary side of the furnace transformer. Typically these reactors are tapped coils and manufactured as per customer's tap requirements.

Advantages

- Increases equipment and capacitor life
- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Special surface protection against UV, and for pollution Class IV areas
- Maintenance-free design.



Technical Specifications

- Voltage: Up to 36kV
- Power: Up to 20MVAr*
- Type: Air core, dry type
- Frequency: 50Hz / 60Hz
- Installation: Enclosure available on demand, side-by-side, delta or vertical arrangement
- Winding: Aluminum or copper winding.
- Painting: RAL7035 or other colors
- Temperature: -40°C to 55°C
- Insulation Class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Standards: IEC, IEEE and others
- Options: Enclosure. Taps.

Hilkar®

Air Core Harmonic Filter Reactors

Up to 36 kV*

Use of nonlinear loads such as power electronics based equipment and electric furnaces have been on the rise for the last decades. Such loads decrease the power quality of the network that they are connected to. One of the most important parameters for defining the power quality of harmonic distortion.

The harmonic distortion in a network causes:

- Equipment hearing
- Insulation failure due to overheating and higher voltage peaks than rated fundamental voltage (50Hz or 60Hz) sinusoidal signal
- Equipment malfunction (false zero cross detection on power electronics devices)
- Communication interference
- Increased noise in electrical machines
- Fuse and breaker mis-operation

Passive harmonic filters are the most commonly used devices for reducing the harmonic distortion in a network. These filters are built up from passive RLC components, i.e. resistors, inductors and capacitors.

The inductors (reactors) in these filters serve to provide a resonance path together with the capacitors existing in the harmonic filter. By appropriately tuning the resonance frequency of a harmonic filter, the unwanted harmonic currents injected by the nonlinear loads can be prevented from going into the electrical grid. This is a very important measure that is taken for reducing the harmonic distortion in a network. Harmonic filter reactors may be used in single-tuned, second order, and C-type filters according to the type of load and purpose. Moreover, they may be used in series with Flexible AC Transmission Systems (FACTS) devices such as Static VAr Compensator (SVC), Static Synchronous Compensator (STATCOM) and High Voltage Direct Transmission (HVDC) in order to reduce the amount of harmonics that would be injected by these systems into the electrical grid.

At medium voltage level, usually air core dry type reactors are used as harmonic filter reactors. Having no magnetic core, air core reactors are free from saturation. They may be installed outdoor and indoor as long as magnetic flux path is considered during installation in order to stay away from ferromagnetic material while in operation.

In some industrial applications such as arc furnaces and ladle melt furnaces, it is vital to filter out some harmonics while not amplifying the existing interharmonics. Otherwise, excessive heating or overvoltages can occur which may damage or at least degrade the lifetime of equipment.

Moreover, industrial customers are forced to obey harmonic current and harmonic voltage limits defined with respect to voltage level and with respect to the ratio of short circuit power to load power, in standards such as IEEE 519.92. Therefore, careful design of the tuning frequency and rating of the reactors considering a wide frequency band including both the harmonics and interharmonics are important.

All Hilkar air core harmonic filter reactors are custom designed for different applications by considering the voltage, current, inductance, type of application (or filter type), harmonics, interharmonics, size, transient events such as switchings, and loss characteristics that are required to provide the most efficient design at the most economical prices. All the routine tests are performed in accordance with EN 60289 or other standards depending on customer request. Type test reports are available on request. All the test reports are submitted to customer. Basic testing program includes some or all of the following tests:

- Routine Tests (Inductance, Resistance, One Minute AC Insulation Voltage Withstand Test and Impulse Voltage Withstand Test)
- Short Circuit Withstand Test
- Temperature Rise Test
- Sound Level Test
- Seismic Test

Features

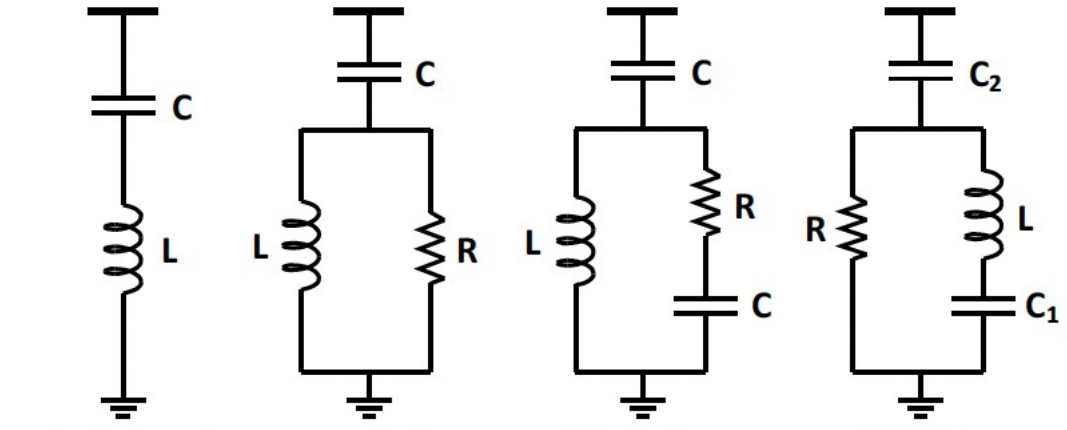
- Designed and tested to applicable IEC and IEEE standards
- Excellent high voltage strength
- High quality factor (Q)
- High thermal capacity
- High mechanical strength to withstand high short-circuit forces
- Fiberglass spacers are used in order to provide ease of cooling
- Compact design, dimensions can be adjusted according to customer's specific needs
- Side by side, delta or vertical arrangement depending on space availability
- Pulsed power compatibility for filter energization and transformer inrush scenarios
- Corrosion and heat resistant paint for indoor and outdoor applications

- Insulators with high creepage distance on demand for highly polluted areas and high altitudes
- Special surface protection against UV and pollution Class IV areas
- Maintenance-free design
- Aluminum, hot dip galvanized steel or concrete support stands are available
- Elevation stands are available

Technical Specifications

- Voltage: Up to 36kV*
- Fundamental Frequency: 50Hz / 60Hz
- Harmonic Current: $I_h = 0.3I_1$
- Maximum Current: $I_{max} = 2I_1$ for 60 seconds
- Type: Dry, air core
- Frequency (Harmonic Order): Up to 2.5 kHz (50^{th} harmonic for 50 Hz systems)
- Altitude: Up to 1000 m*
- Installation: Indoor / Outdoor
- Insulation Class: F (155°C)
- Winding Material: Aluminum or Copper
- Protection Degree: IP00 (Indoor), IP23 (Outdoor), others on demand
- Temperature Range: -40°C to 55°C
- Painting: RAL 7035, other colors on demand
- Cooling: Air Neutral (AN)
- Options: Taps with DIN or NEMA terminal configuration

Filter Types



single-tuned (or detuned) filter | second-order damped filter | third-order damped filter | C-type damped filter

Air Core Line & Load Reactors

Up to 36 kV

Line and load reactors are generally serial-connected to the input and/or output terminals of three phase equipment such as motor speed controllers, inverters and UPS systems. These equipment make use of semiconductor switches such as IGBTs, thyristors, and diodes and therefore create harmonic distortion and high switching over-voltages (dv/dt). Use of such equipment has been becoming more widespread as the technology advances. However, the negative effects of these equipment should not be overlooked.

By use of line and load reactors the adverse effects of using such equipment are decreased:

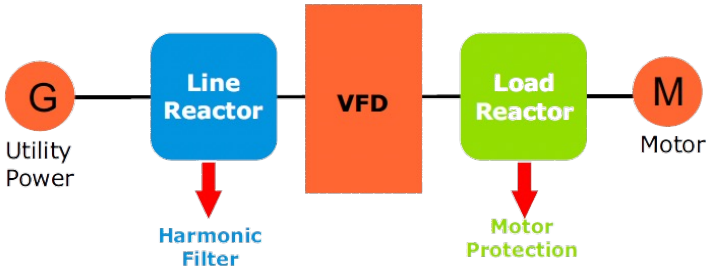
- Limited starting current
- Reduced motor noise
- Reduced motor temperature
- Reduced harmonic distortion
- Reduced motor heating
- Reduced switching over-voltages

These reactors are designed in order to provide 4% voltage drop. Different voltage drop values are provided on demand.

All Hilkar line&load reactors are custom designed for different applications by considering the voltage, current, inductance, type of application, harmonics, interharmonics, size, transient events such as switchings, and loss characteristics that are required to provide the most efficient design at the most economical prices. All the routine tests are performed in accordance with IEC 60076-6 or other standards depending on customer request. Type test reports are available on request. All the test reports are submitted to customer.

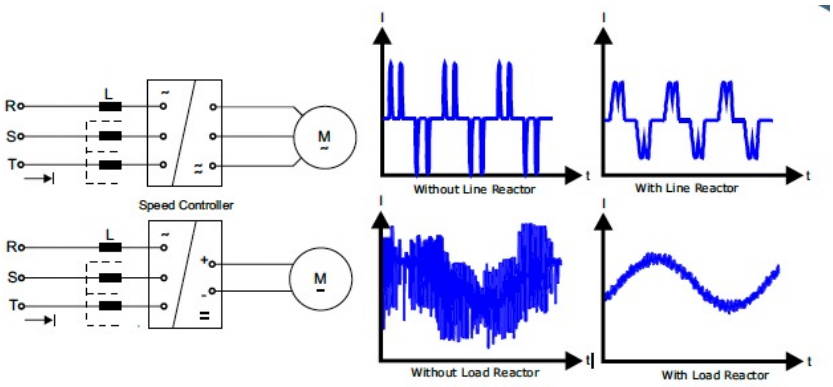
Basic testing program includes some some or all of the following tests:

- Routine Tests (Inductance, Resistance, One Minute AC Insulation Voltage Withstand Test and Impulse Voltage Withstand Test)
- Short Circuit Withstand Test
- Temperature Rise Test
- Sound Level Test
- Seismic Test



Features

- Designed and tested to applicable IEC and IEEE standards
- High quality factor (Q)
- High thermal capacity
- High mechanical strength to withstand high short-circuit forces
- Fiberglass resin spacers are used in order to provide ease of cooling
- Compact design, dimensions can be adjusted according to customer's specific needs
- Maintenance-free design
- Side-by-side, delta or vertical arrangement
- Insulation varnish & corrosion resistant paint
- Aluminum, hot dip galvanized steel or concrete support stands on demand
- Elevation stands on demand
- Enclosures on demand



Technical Specifications

- Voltage: Up to 36kV
- Type: Air Core
- Altitude: Up to 1000m*
- Installation: Indoor / Outdoor
- Insulation Class: F (155°C)
- Winding Material: Aluminum or Copper
- Insulation Material: F class film or epoxy resin reinforced fiberglass
- Temperature Range: -40°C to 55°C
- Cooling: Air Natural (AN)
- Options: Taps with DIN or NEMA terminal configuration.

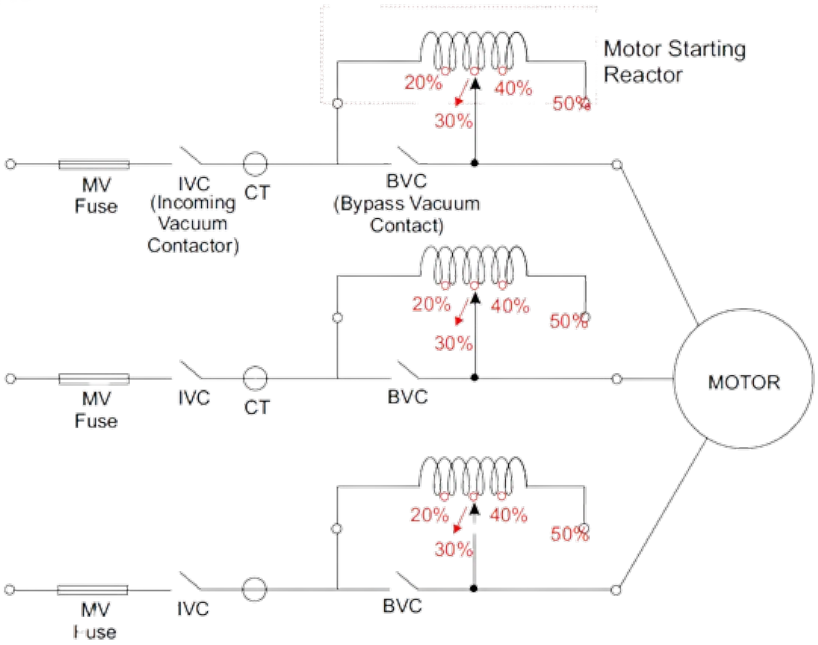
Air Core Motor Starting Reactors

Up to 15 kV

Motor starting reactors are used to reduce voltage during starting of large 3 phase motors while limiting inrush currents. Large motors generally draw 6-8 times more current than their nominal current. Normally, they are started with 70% of voltage and the rest of the voltage, that is normally about 30%, is dropped across the motor starting reactor. After 15 - 20 seconds, the reactor is switched off by contactors in the system.

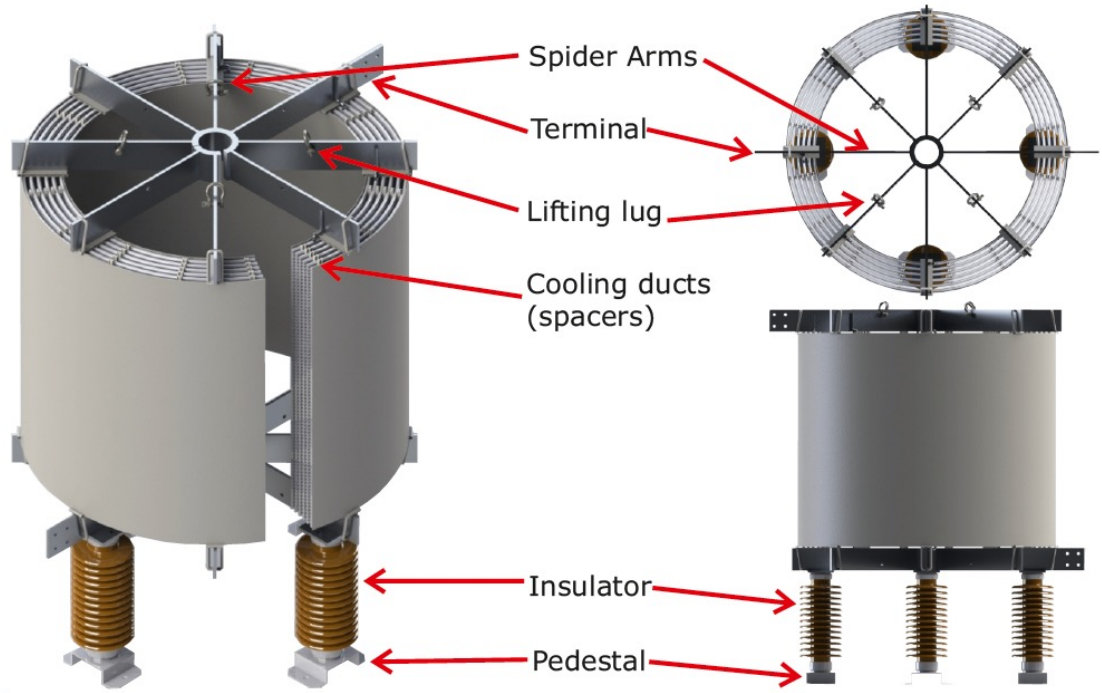
Advantages

- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Special surface protection against UV and pollution Class IV areas
- Maintenance-free design



Technical Specifications

- Voltage: Up to 15kV
- Power: Up to 1 MW motors
- Type: Air Core, dry type
- Frequency: 50Hz / 60Hz
- Installation: Enclosure available on demand, side-by-side, delta or vertical arrangement
- Standards: IEC 60076-7, IEEE Std. C57.21
- Winding: Aluminum or copper winding
- Temperature: -40°C to 55°C
- Painting: RAL7035 or other colors
- Insulation class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Options:
    - Enclosure
    - Elevated support stands
    - Skid mounted
    - Taps
    - DIN or NEMA terminal configuration



Hilkar®

Air Core Shunt Reactors

Up to 36kV, 20MVAr*

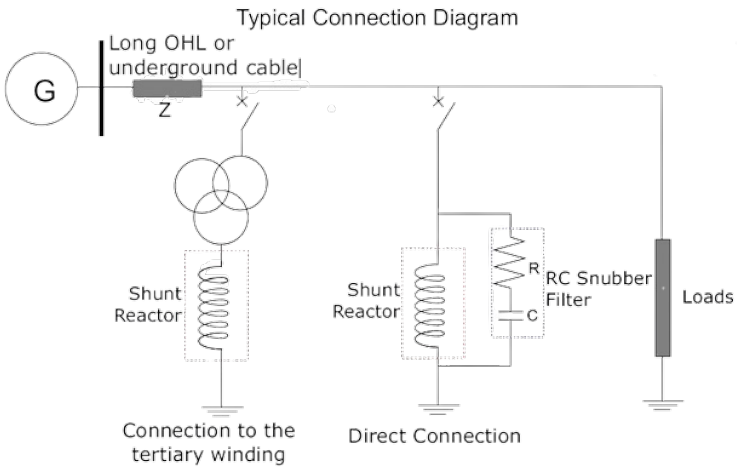
Shunt Reactors act as absorbers of reactive power to increase energy efficiency of the power system.

Shunt Reactors are inductors that are used in order to compensate capacitive reactive power generated by long and lightly loaded transmission lines as well as underground cables, thus allowing the flow of more active power through the system and avoiding over voltages. The shunt reactors provide inductive compensation.

Shunt reactors are connected to the tertiary winding of the main transformer or they are directly connected to the line. In high power and high voltage systems, shunt reactors should be used with because in such systems switching transient voltages are extremely high and the switching devices can be damaged.

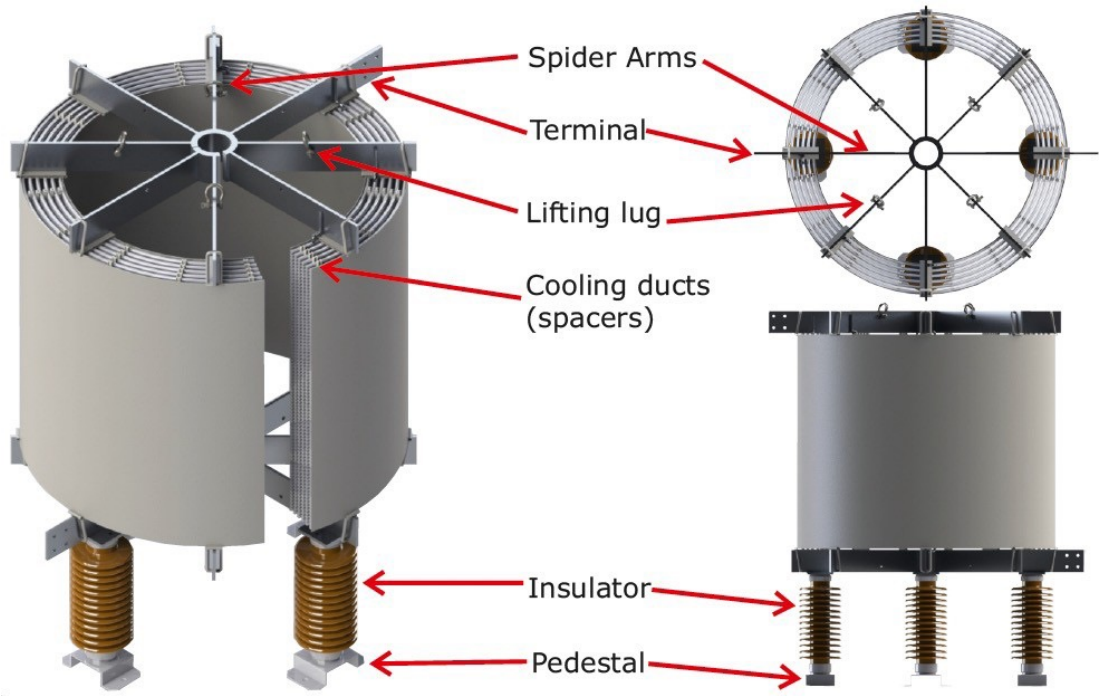
Advantages

- Manufactured for any power rating and duty cycle
- Air core, dry type construction
- Limited temperature rise enables longer lifetime
- Special surface protection against UV and pollution Class IV areas
- Maintenance-free design
- Epoxy impregnated, fiberglass encapsulated winding
- Low losses
- Low noise level



Technical Specifications

- Manufactured for any power rating and duty cycle
- Voltage: Up to 36kV
- Power: Up to 20MVAr*
- Type: Air core, dry type
- Frequency: 50Hz / 60Hz
- Installation: Enclosure available on demand, side-by side, delta or vertical arrangement
- Standards: IEC 60076-6, IEEE Std. C57.21
- Winding: Aluminum or copper winding
- Temperature: -40°C to 55°C
- Painting: RAL7035 or other colors
- Insulation Class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Options:
    - Enclosure
    - Elevated support stands
    - Skid mounted
    - Taps
    - DIN or NEMA terminal configuration
    - Complete solution with CBs, snubber circuit and protection relay



Air Core Smoothing Reactors

Up to 36 kV

Smoothing Reactors are serially connected reactors inserted in DC systems to reduce harmonic currents and transient over currents and/or current ripples in DC systems.

They are necessary in order to smooth the direct current wave shape to reduce losses and improve system performance. Smoothing Reactors are used in HVDC links and industrial applications including traction systems, variable speed drives, UPS systems, etc.

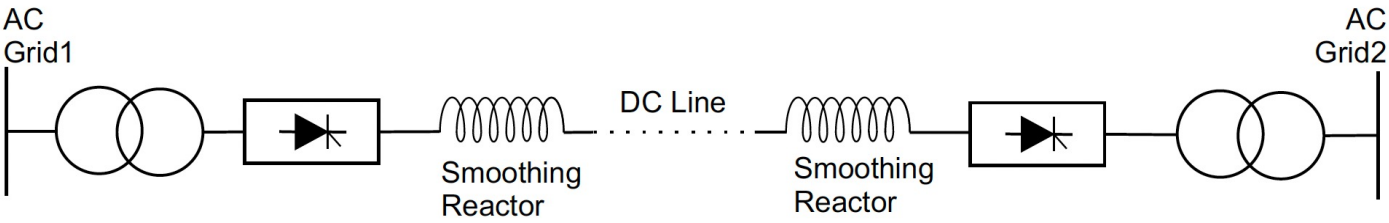
Smoothing Reactors reduce the occurrence of alternation failure in inverters caused by the dips in AC voltage at the converter bus. They prevent consequent communication failures in inverters by reducing the rate of rise of direct current in the bridge when the direct voltage of another series connected bridge collapse.

Smoothing Reactors smooth the ripple in the direct current in order to prevent the current becoming discontinuous for light loads. They decrease harmonic voltages and currents in DC lines. They limit the crest current in the rectifier due to a short circuit on the DC line.

Smoothing reactors limit the current in the valves during the converter bypass pair operation due to the discharge of shunt capacitances of the DC line.

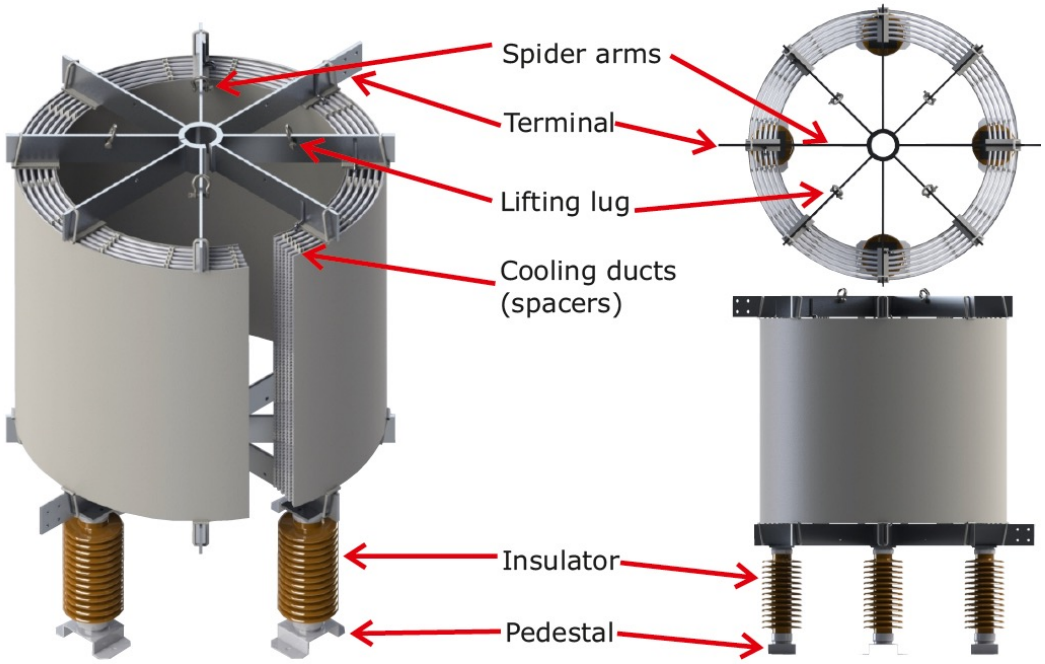
Advantages

- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Special surface protection against UV and pollution Class IV areas
- Maintenance-free design



Technical Specifications

- Voltage: Up to 36kV
- Type: Air core, dry type
- Frequency: 50Hz / 60Hz
- Installation: Indoor / Outdoor
- Winding: Aluminum or copper winding
- Painting: RAL 7035 or other colors on demand
- Construction: Epoxy impregnated, fiberglass encapsulated construction
- Temperature: -40°C to 55°C
- Insulation Class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Options:
    - Taps
    - Enclosure available on demand
    - Available designs as per IEEE, IEC and others
    - DIN or NEMA terminal configuration



Hilkar®

Air Core Test Lab Reactors

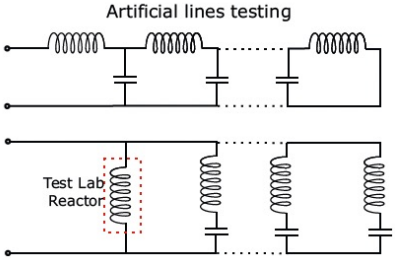
Up to 36 kV

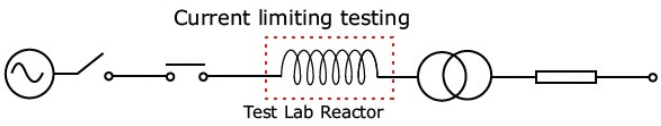
Test Laboratory Reactors are designed for high voltage and high-power test laboratories.

They are designed to withstand the most extreme electrical service conditions during test periods. Design techniques are implemented in accordance with the most demanding service conditions. These reactors are used for various purposes in test laboratories such as current limiting and synthetic testing of circuit breakers, capacitor testing, artificial line simulation etc.

Advantages

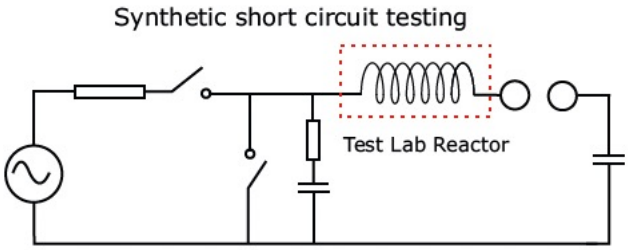
- Air core, dry type construction
- Limited temperature rise enables longer lifetime
- Maintenance-free design
- High short-circuit withstand capability
- Epoxy impregnated, fiberglass encapsulated winding

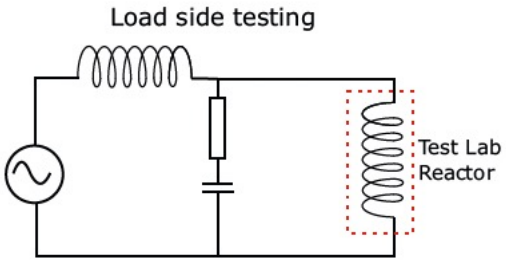




MV Technology Solutions

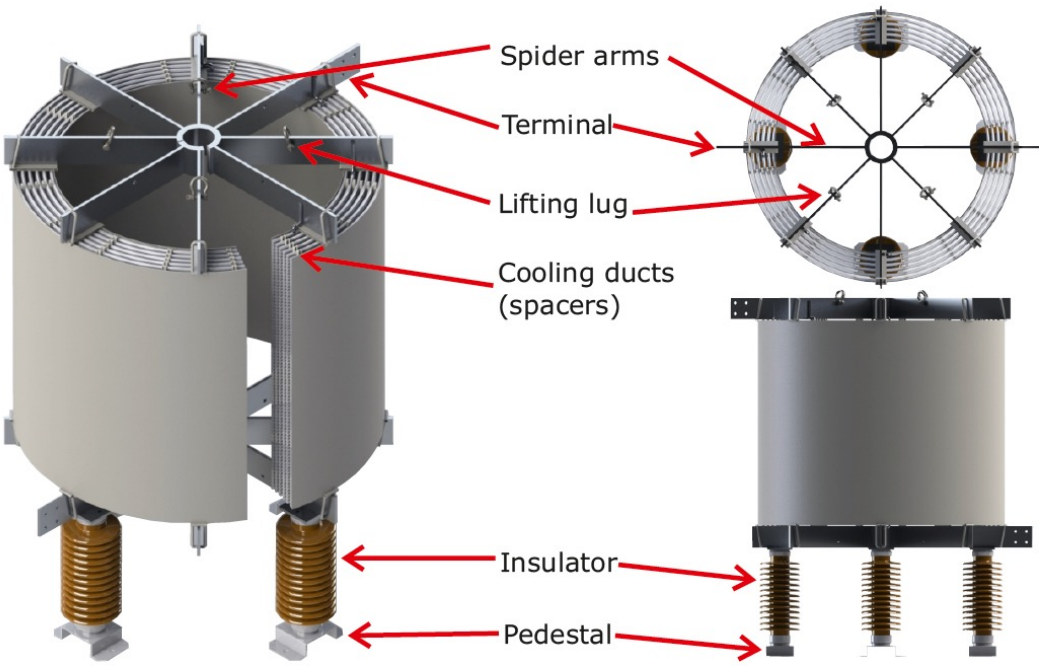
www.mvtech.com.au





Technical Specifications

- Voltage: Up to 36kV
- Type: Air core, dry type
- Installation: Indoor / Outdoor side-by-side, delta or vertical arrangement depending on space availability
- Winding: Aluminum or copper winding
- Painting: RAL 7035 or other colors on demand
- Construction: Epoxy impregnated, fiberglass encapsulated construction
- Temperature: -40°C to 55°C
- Insulation Class: F Class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Options:
    - Taps
    - Enclosure available on demand
    - Available designs as per IEEE, IEC and others
    - DIN or NEMA terminal configuration



LV Iron Core Harmonic Filter Reactors

Up to 1000 V

Nonlinear loads such as power electronics based equipment and electric furnaces are sources of harmonic currents leading to harmonic distortion, which is one of the most important parameters for defining the power quality. Most of the commercial loads such as personal computers, photocopy machines, power supplies, and compact fluorescent lamps; and industrial loads such as AC and DC motor drives inject harmonic currents into the network that they are connected to.

The harmonic distortion in a network causes:

- Equipment heating
- Insulation failure due to overheating and higher voltage peaks than rated fundamental voltage (50Hz or 60Hz) sinusoidal signal
- Equipment malfunction (false zero cross detection on power electronics devices)
- Communication interference
- Fuse and breaker mis-operation

Passive harmonic filters are the most commonly used devices for reducing the harmonic distortion in a network. These filters are built up from passive RLC components, i.e. resistors, inductors and capacitors.

At low voltage level, usually iron core reactors are used as harmonic filter inductors. They may be also used at medium voltage level in some applications.

The reactors in these filters serve to provide a resonance path together with the capacitors existing in the harmonic filter. By appropriately tuning the resonance frequency of a harmonic filter, the unwanted harmonic currents injected by the nonlinear loads can be prevented from going into the electrical grid.

In the design stage, the calculations of both the series resonance (the frequency at which the filter impedance becomes minimum) and the parallel resonance (the frequency at which the equivalent network and filter impedance becomes maximum) are important. In practice, the most commonly used filter type is single-tuned filter which consists of the series connection of a capacitor and a reactor. For this configuration, series resonance frequency is calculated as follows:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

where L is the inductance of reactor in Henries, and C is the per phase equivalent capacitance of the capacitor bank in Farads. On the other hand, the ratio of reactor's reactance to capacitor's reactance at the fundamental frequency is called p factor.

f_r= 134 Hz for p = 14%
f_r = 189 Hz for p = 7%
f_r = 210 Hz for p = 5.64%

are the industrial standard values in 50Hz networks for single-tuned filters, where the series resonance frequency is not tuned to an integer multiple of the fundamental frequency, i.e. any harmonic component, but it is tuned to a non-integer multiple of the fundamental frequency, i.e. an interharmonic. Then, this configuration is called a de-tuned filter. De-tuning is done in order to avoid any harmonic filtering, but to provide reactor power compensation only, while eliminating the risk of parallel resonance with any harmonic or interharmonic component existing in the grid, and also reducing the inrush currents of the harmonic filter. However, in order to provide a series resonance frequency tuned to 5th harmonic for a 50Hz network,

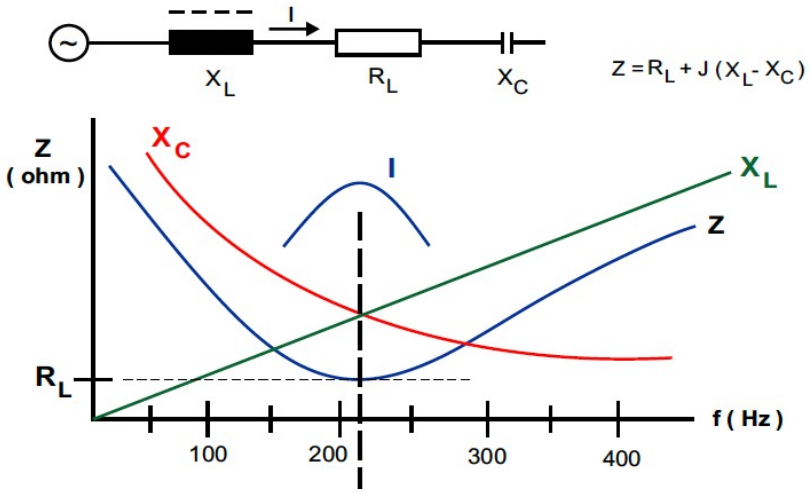
$$f_r = 250 \text{ Hz} \quad \text{gives} \quad p = \left(\frac{f_1}{f_r}\right)^2 x100 = 4\%$$

It is evident here that the series connection of the reactor and capacitor increases the amount of voltage on the capacitor above network voltage. This increase is in relation with the value of p as follows:

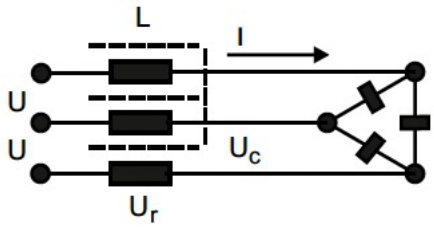
$$U_c = \frac{U_{rt}}{(1-p)}$$

where Urt is the network voltage and Uc is the capacitor voltage. It is important to consider this rise of voltage while choosing the voltage ratings of the capacitor bank.

Apart from single-tuned filters, harmonic filter reactors may also be used in second order and C-type filters according to the type of load and purpose (Different types of filters are given in figure below). Moreover, when they are used in medium voltage level, they may be used in series with Flexible AC Transmission Systems (FACTS) devices such as Static VAr Compensator (SVC) and Static Synchronous Compensator (STATCOM) in order to reduce the amount of harmonics that would be injected by these systems into the electrical grid.



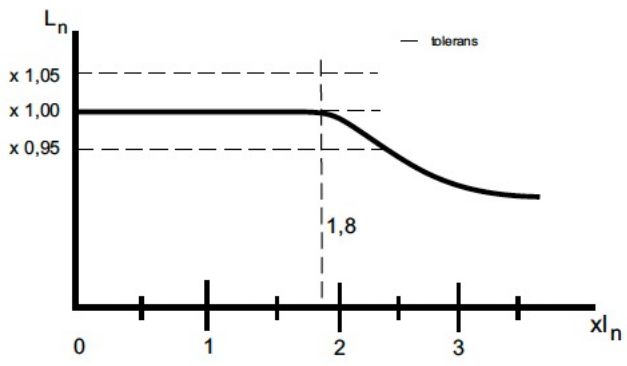
Industrial customers are forced to obey harmonic current and harmonic voltage limits defined with respect to voltage level and with respect to the ratio of short circuit power to load power, in standards such as IEEE 519.92. Therefore, careful design of the tuning frequency and rating of the reactors considering a wide frequency band including both the harmonics and interharmonics are important.



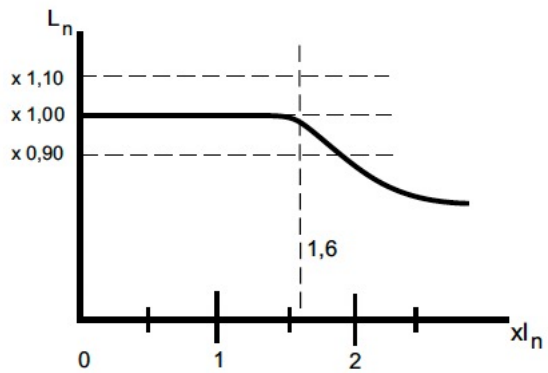
Note : DC resistance of the reactor is ignored in the figure

All Hilkar iron core harmonic filter reactors are custom designed for different applications by considering the voltage, current, inductance, type of application (or filter type), harmonics, interharmonics, size, transient events such as switchings, and loss characteristics that are required to provide the most efficient design at the most economical prices. All the routine tests are performed in accordance with EN 60289 or other standards depending on customer request. Type test reports are available on request. All the test reports are submitted to customer. Basic testing program includes some or all of the following tests:

- Routine Tests (Inductance, Resistance, One Minute AC Insulation Voltage Withstand Test and Impulse Voltage Withstand Test)
- Short Circuit Withstand Test
- Temperature Rise Test
- Sound Level Test
- Seismic Test



For harmonic and current limiting reactors.



For general purpose inductances

Technical Specifications

- Voltage: Up to 1000 V
- Fundamental Current: I_1 (50-60 Hz)
- Harmonic Current: I_h = 0.3I1
- Overload Current: I_{th} = 1.2I1
- Magnetic Saturation Current: I_m = 1.8In
- Maximum Current: I_{max} = $2I_1$ for 60 seconds
- Type: Dry, iron core
- Frequency (harmonic order): Up to 2.5kHz (50^{th} harmonic for 50Hz systems)
- Altitude: Up to 1000m*
- Installation: Indoor
- Insulation: Class F (155°C)
- Winding Material: Aluminum or Copper
- Protection degree: IP00 (indoor)
- Temperature range: -40°C to 55°C
- Cooling: Air Natural (AN)
- Options: Taps with DIN or NEMA terminal configuration

Features

- Designed and tested to applicable IEC and IEEE standards
- Excellent voltage withstand
- High quality factor (Q)
- High thermal capacity
- High mechanical strength to withstand high short-circuit forces
- Laminated core, low core losses
- Low tolerance of inductance value
- Off-load tapping on demand
- Compact design, dimensions can be adjusted according to customer's specific needs
- Single phase or three phase design
- Pulsed power compatibility for filter energization and transformer inrush scenarios
- Corrosion and heat resistant electrostatic paint
- Insulators with high creepage distance on demand for polluted areas and high altitudes
- Maintenance-free design
- Aluminum, hot dip galvanized steel or concrete support stands are available

LV Iron Core Line & Load Reactors

Up to 690 V

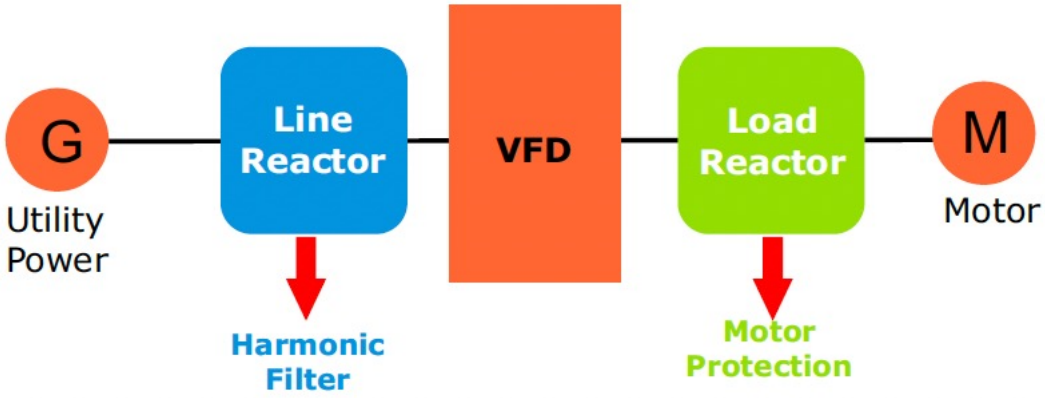
Line and load reactors are generally serial-connected to the input and/or output terminals of three phase equipment such as motor speed controllers, inverters and UPS systems. These equipment make use of semiconductor switches such as IGBTs, thyristors, and diodes and therefore create harmonic distortion and high switching over-voltages (dv/dt). Use of such equipment has been becoming more widespread as the technology advances. However, the negative effects of these equipment should not be overlooked.

By use of line and load reactors, the adverse effects of using such equipment are decreased:

- Limited starting current
- Reduced motor noise
- Reduced harmonic distortion
- Reduced motor heating
- Reduced switching over-voltages
- Easier selection of fuses as per nominal motor current

These reactors are designed in order to provide 4% voltage drop. Different voltage drop values are provided on demand.

All Hilkar line&load reactors are custom designed for different applications by considering the voltage, current, inductance, type of application, harmonics, interharmonics, size, transient events such as switchings, and loss characteristics that are required to provide the most efficient design at the most economical prices. All the routine tests are performed in accordance with IEC 60076-6 or other standards depending on customer request. Type test reports are available on request.

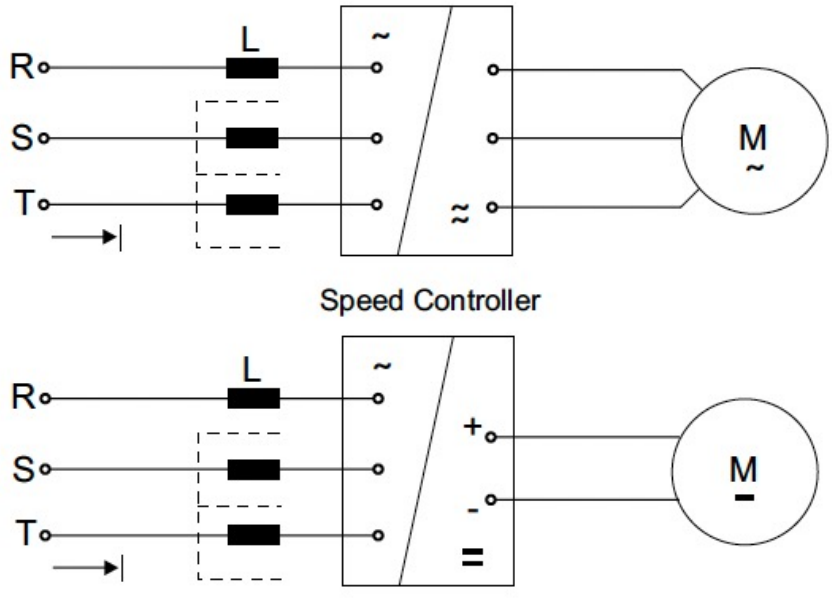


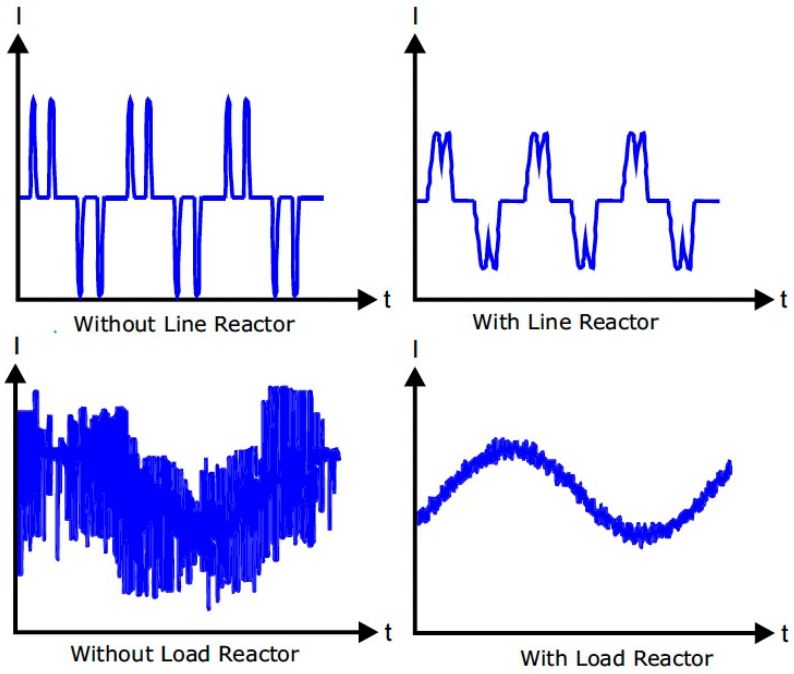
All the test reports are submitted to customer. Basic testing program includes some or all of the following tests:

- Routine Tests (Inductance, Resistance, One Minute AC Insulation Voltage Withstand Test and Impulse Voltage Withstand Test)
- Short Circuit Withstand Test
- Temperature Rise Test
- Sound Level Test
- Seismic Test

Features

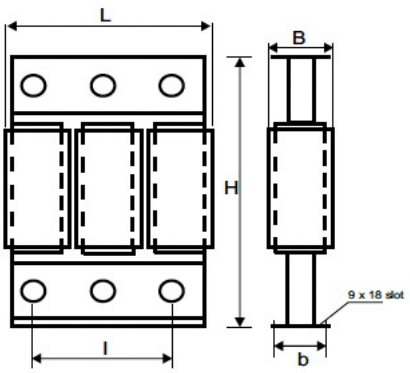
- Designed and tested to applicable IEC and IEEE standards
- High quality factor (Q)
- High thermal capacity
- High mechanical strength to withstand high short-circuit forces
- Compact design, dimensions can be adjusted according to customer's specific needs
- Maintenance-free design
- Aluminum, hot dip galvanized steel or concrete support stands on demand
- Elevation stands on demand
- Enclosures on demand





Technical Specifications

- Voltage: 208 – 690 V
- Rated Current: I_n, 50-60 Hz
- Overload Ratings: $I_{max} = 2I_1$ for 12s, $1.5I_1$ for 60s, $1.1I_n$ continuous
- Linear Current: $I_{lin} = 1.6I_1$
- Impedance Levels (Z): 1.5%, 2%, 3%, 4%, and 5%
- Type: Iron Core
- Altitude: Up to 1000m*
- Installation: Indoor
- Insulation: Class F (155°C)
- Winding Material: Aluminum or Copper
- Insulation Material: F class film or epoxy resin reinforced fiberglass
- Protection degree: IP00 (indoor)
- Temperature range: -40°C to 55°C
- Thermostat: 125°C
- Insulation Level: 3kV AC for 1 min
- Cooling: Air Natural (AN)
- Options: Taps with DIN or NEMA terminal configuration



Type	I_n (A)	L ±5% @ I_{lin} (mH)	Motor (kW)	Loss (W)	Weight (kg)	Dimensions (mm)				
						L	I	B	H	b
MR5	10	2.93	4	31	2.1	180	120	72	170	72
MR5	16	1.83	7.5	43	3.8	180	120	72	170	72
MR10	20	1.47	10	45	3.8	180	120	78	170	78
MR10	25	1.17	11	52	3.8	180	120	78	170	78
MR10	35	0.84	15	54	6.5	180	120	78	170	78
MR15	40	0.73	18.5	60	6.5	240	160	105	207	94
MR15	50	0.59	22	65	13.5	240	160	105	207	94
MR20	63	0.47	30	75	13.5	250	160	105	207	105
MR25	80	0.37	37	86	18	250	160	105	207	105
MR30	100	0.29	45	86	18	250	160	122	207	114
MR40	125	0.23	55	90	23	300	200	130	260	120
MR50	160	0.18	75	100	23	300	200	130	260	125
MR50	200	0.15	90	107	26	300	200	140	260	135
MR60	250	0.15	112	131	52	300	200	156	260	150
MSR10	320	0.125	150	166	52	300	200	156	260	150
MSR10	320	0.0175	187	160	68	300	200	156	260	150
MSR10	400	0.060	225	145	50	300	200	156	260	150
MSR10	500	0.050	262	145	69	430	290	156	260	150

*$I_{lin} = 1.6I_n$

*Hilkar reserves the right to make any changes in dimensions without prior notice.

LV Iron Core Motor Starting Reactors

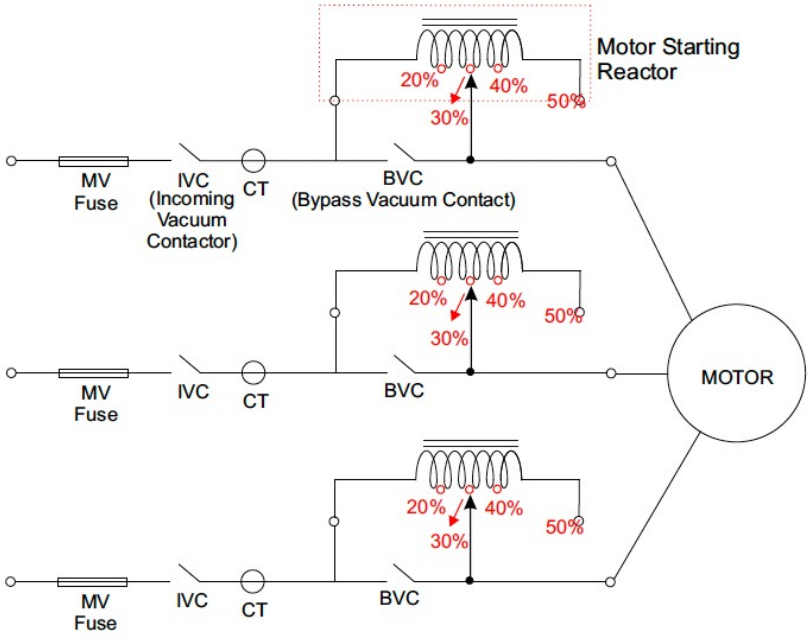
Up to 1000 V

Motor starting reactors are used to reduce voltage during starting of large 3 phase motors while limiting inrush currents.

Large motors generally draw 6-8 times more current than their nominal current from the grid. Normally, they are started with 70% of voltage and the rest of the voltage, that is normally about 30%, is dropped across the motor starting reactor. After 15 - 20 seconds, the reactor is by-passed by contactors in the system.

Technical Specifications

- Voltage: Up to 1000 V
- Power: Up to 1 MW motors
- Frequency: 50 Hz / 60 Hz
- Winding: Aluminum or copper winding
- Temperature: -30ºC to 55ºC
- Insulation Class :F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Standards: IEC 60076-6, IEC 61558
- Options:
    - Enclosure
    - Taps
    - DIN or NEMA terminal configuration



Advantages

- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Maintenance-free design

LV Iron Core Smoothing Reactors

Up to 1000 V

Smoothing Reactors are serially connected reactors inserted in DC systems to reduce harmonic currents and transient over currents and/or current ripples in DC systems. They are necessary in order to smooth the direct current wave shape to reduce losses and improve system performance. Smoothing Reactors reduce the occurrence of alternation failure in inverters caused by the dips in AC voltage at the converter bus. They prevent consequent communication failures in inverters by reducing the rate of rise of direct current in the bridge when the direct voltage of another series connected bridge collapse.

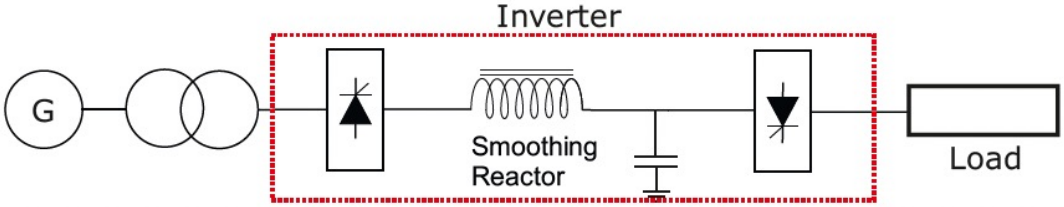
Smoothing Reactors smooth the ripple in the direct current in order to prevent the current becoming discontinuous for light loads. They decrease harmonic voltages and currents in DC lines. They limit the crest current in the rectifier due to a short circuit on the DC line.

Technical Specifications

- Voltage: Up to 1000 V
- Type: Iron core, dry type
- Frequency: 50 Hz / 60 Hz
- Winding: Aluminum or copper winding
- Temperature: -30ºC to 55ºC
- Insulation Class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Standards: IEC 60076-6, IEC 61558
- Options configuration

Advantages

- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Maintenance-free design



MV Iron Core Oil-Immersed Shunt Reactors

Up to 36 kV, 5 MVAr*

Iron core Oil-immersed Shunt Reactors act as an absorber of reactive power to increase energy efficiency of the power system.

Shunt Reactors are used in order to compensate capacitive reactive power generated by long and lightly loaded transmission lines as well as underground cables, thus allowing the flow of more active power through the system and avoiding over voltages. Shunt Reactors can be directly connected to the power line or to a tertiary winding of a three-winding power or distribution transformer.

The main windings and the magnetic circuit are immersed in oil. The insulation oil acts as the cooling medium, which can both absorb heat from the reactor windings and conduct the heat away through the oil.

The core of an oil-immersed reactor is made of ferromagnetic materials, with one or more built-in air gaps. These air-gapped iron cores are designed to withstand not only the mechanical stresses during normal operation but also to withstand the fault conditions in the network. In high power and high voltage systems, shunt reactors should be used with RC snubber filters due to the fact that in such systems switching transient voltages are extremely high and the switching devices may get damaged without proper damping measures.

Technical Specifications

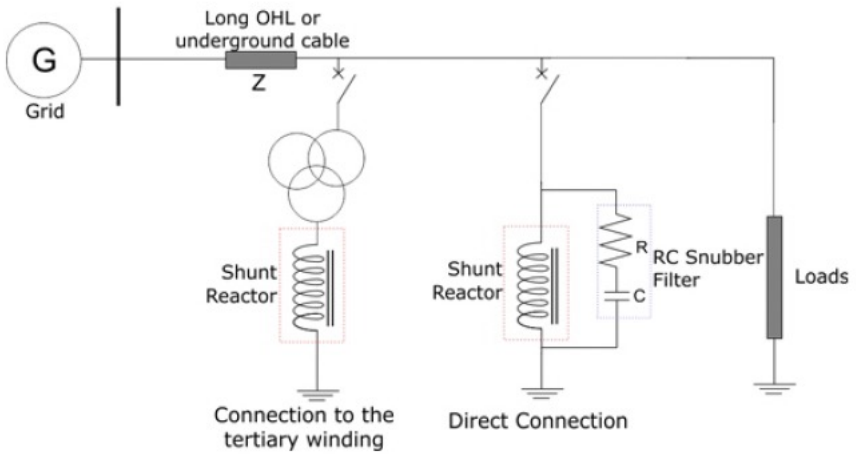
- Designed and tested to applicable IEC and IEEE Standards
- Voltage: Up to 36 kV
- Power: Up to 5 MVAr *
- Frequency: 50Hz / 60Hz
- Winding: Aluminum or copper winding
- Temperature: -30°C to 55°C
- Insulation Class: A class or custom specific design
- Cooling: ONAN, ONAF
- Standards: IEC 60076-6 or IEEE Std.C57.21
- Options
    - Enclosure
    - Taps
    - Complete solution with CBs, snubber circuit and protection relay
    - Oil level indicator
    - Silicagel

Typical Applications

It is mainly used for reactive power compensation of long or lightly loaded transmission lines as well as underground cables used in:

- Wind Farms
- Subways (Metro)
- Urban Distribution Systems
- Industrial Zones
- University Campuses
- Substations

Typical Connection Diagram



Neutral Earthing Reactors

Up to 170 kV, 20 kA*

Neutral Earthing Reactors – also known as Neutral Grounding Reactors - which resist current flow through inductive elements, are single phase reactors generally connected between ground and neutral of transformers or generators in order to control single line-to ground faults at a desired level.

Neutral Earthing Reactors are used in order to limit line-to-ground fault current to a value which will not damage the equipment in the power system, yet allow sufficient flow of fault current to operate protective relays to clear the fault. If the circuit is balanced, current flow through the reactor will be zero, thus, there will be no losses.

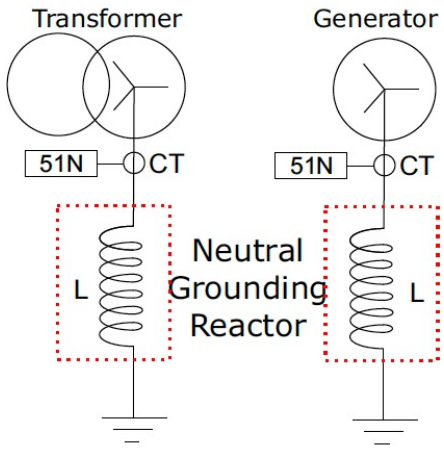
Neutral Earthing Reactors reduce short circuit stresses on station transformers for the most widespread type of fault in an electrical system. A loaded generator can develop a third-harmonic voltage. Providing impedance in the grounding path by Neutral Earthing Reactor, can limit the third-harmonic current.

Area of Usage

- Reducing single phase to earth fault currents which occur in electrical networks to prevent damages on transformers and generators
- Reducing temporary over voltages formed by braking instantaneous fault current
- Providing long-life for switchgear
- Reducing step voltages to a harmless level for personnel

Advantages

- Perfect mechanical strength to withstand high short-circuit forces
- Limited temperature rise enables longer lifetime
- Special surface protection against UV and pollution Class IV areas
- Maintenance-free design
- Low noise levels



Technical Specifications

- Voltage: Up to 170 kV
- Current: Up to 20 kA*
- Type: Air core, dry type
- Frequency: 50 Hz / 60 Hz
- Installation: Indoor / Outdoor
- Winding: Aluminum or copper winding
- Painting: RAL 7035 or other colors on demand
- Construction: Epoxy impregnated, fiberglass encapsulated construction
- Temperature: -40°C to 55°C
- Insulation Class: F class or custom specific design
- Cooling: AN (air-neutral) cooling method
- Options:
    - Taps
    - Enclosure available on demand
    - Available designs as per IEEE, IEC and others
    - DIN or NEMA terminal configuration