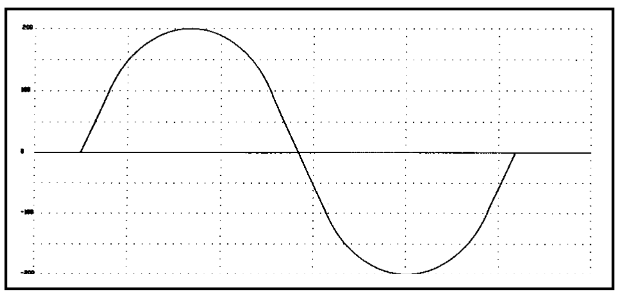
Why Choose A Line Reactor?

Utilizing variable speed drives to control motor speed has impacted industry both in energy savings and increased efficiencies. The challenge for today's designers is dealing with non-linear wave shapes generated by solid state devices.

By choosing a line reactor, many line problems can be eliminated. Additionally, performance, life expectancy and efficiency of both the motor and the drive itself are significantly enhanced.

ELIMINATE NUISANCE TRIPPING

Transients due to switching on the utility line and harmonics from the drive system can cause intermittent tripping of circuit breakers. Furthermore, modern switchgear, equipped with solid state trip sensing devices is designed to react to peak current rather than RMS current. As switching transients can peak over 1000 volts, the resulting overvoltage will cause undesirable interruptions. A reactor added to your circuit restricts the surge current by utilizing its inductive characteristics, and therefore eliminates nuisance tripping.



Normal sine wave from the utility supply.

EXTEND THE LIFE OF SWITCHING COMPONENTS

Due to the attenuation of line disturbances, the life of your solid state devices are extended when protected by the use of a line reactor.

SATURATION

Due to the care in the selection of the core material with its optimum flux density, Line reactors will not saturate under the most adverse line conditions. Since the inductance is linear over a broader current range, equipment is protected even in extreme overcurrent circumstances.

EXTEND THE LIFE OF YOUR MOTOR

Line reactors, when selected for the output of your drive, will enhance the waveform and virtually eliminate failures due to output circuit faults. Subsequently, motor operating temperatures are reduced by 10 to 20 degrees and motor noise is reduced due to the removal of some of the high frequency harmonic currents.

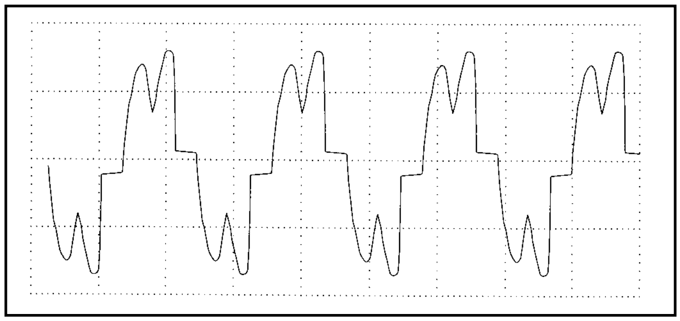
LOW HEAT DISSIPATION

Particular attention has been focused on the design and field testing of this product line. The result is reactors with ideal operating features including low temperature rises and reduced losses. Reactors will operate efficiently and heat dissipation in your equipment will be of minimal concern.

MINIMIZE HARMONIC DISTORTION

Non-linear current waveforms contain harmonic distortion. By using a line reactor you can limit the inrush current to the rectifier in your drive. The peak current is reduced, the waveform is rounded and harmonic distortion is minimized. Current distortion typically is reduced to 30%.

Severe harmonic current distortion can also cause the system voltage to distort. Often, high peak harmonic current drawn by the drive, causes “flat-topping” of the voltage waveform. Adding a reactor controls the current component, and voltage harmonic distortion is therefore reduced.



The total harmonic distortion of variable speed drives produces complex wave shapes such as the phase current shown above. The challenge for today’s designers is to effectively minimize these line problems.

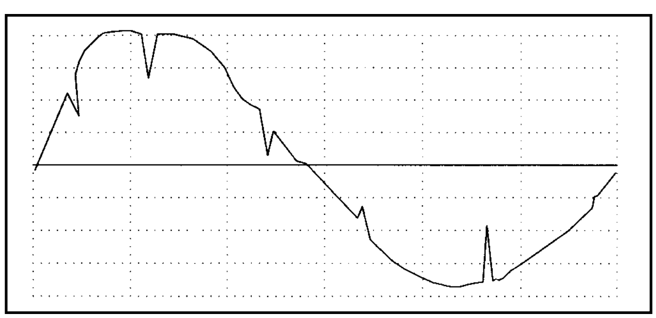
SHORT CIRCUIT CAPABILITY

Line reactors can withstand current under short circuit conditions, reducing the potential of severe damage to electronic equipment. In a short circuit, the inductance of the coil is necessary to limit overcurrent after the core has saturated. We have extensive experience in designing and testing dry-type transformers to withstand short circuits for the most demanding applications, and this experience has been applied to line reactor design.

REDUCE LINE NOTCHING

Whenever AC power is converted to DC by a rectifier using a non-linear device, such as an SCR, the process of commutation occurs. The result is a notch in the voltage waveform. The number of notches is a function of both the number of pulses and the number of SCR’s in the rectifier.

Line reactors are used to provide the inductive reactance needed to reduce notching, which can adversely effect equipment operation.



A voltage waveform illustrating line notching. Line reactors are used to provide the inductive reactance needed to reduce such notches.

Why Choose A Line Reactor continued...

IMPEDANCE RATINGS

Definition:

$$\% Z = \frac{(VD \times 100)}{VS} \times \sqrt{3}$$

Z = IMPEDANCE (three phase)

VD = VOLTAGE DROP ACROSS REACTOR

VS = VOLTAGE SUPPLY FOR RATED CURRENT TO FLOW THROUGH REACTOR

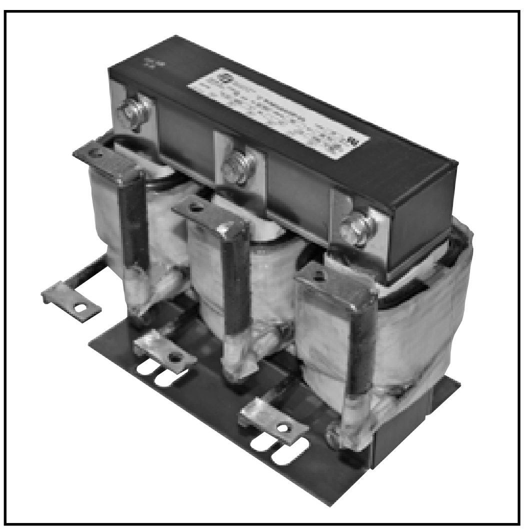
SELECTION - 3% OR 5% IMPEDANCE REACTOR

Choose 3% impedance reactors to satisfy most solid state applications in North America. Reactors rated for 3% impedance are ideal for absorbing normal line spikes and motor current surges, and will prevent most nuisance line tripping of circuit protection devices or equipment.

Where considerably higher line disturbances are present, a 5% impedance reactor may be required. Additionally, if the application is overseas, or when it is necessary to comply to IEEE 519, the higher impedance reactor is recommended. These units may also be selected to further reduce harmonic current and frequencies if desirable or to both extend motor life or diminish motor noise.

LINE REACTORS OR DRIVE ISOLATION TRANSFORMERS ?

When true line isolation is required, such as limiting short circuit current, or where it is necessary to step up or step down voltage, use a drive isolation transformer. We carry an extensive line of drive isolation transformers in stock. Refer to Section 4 for information on Drive Isolation transformers.



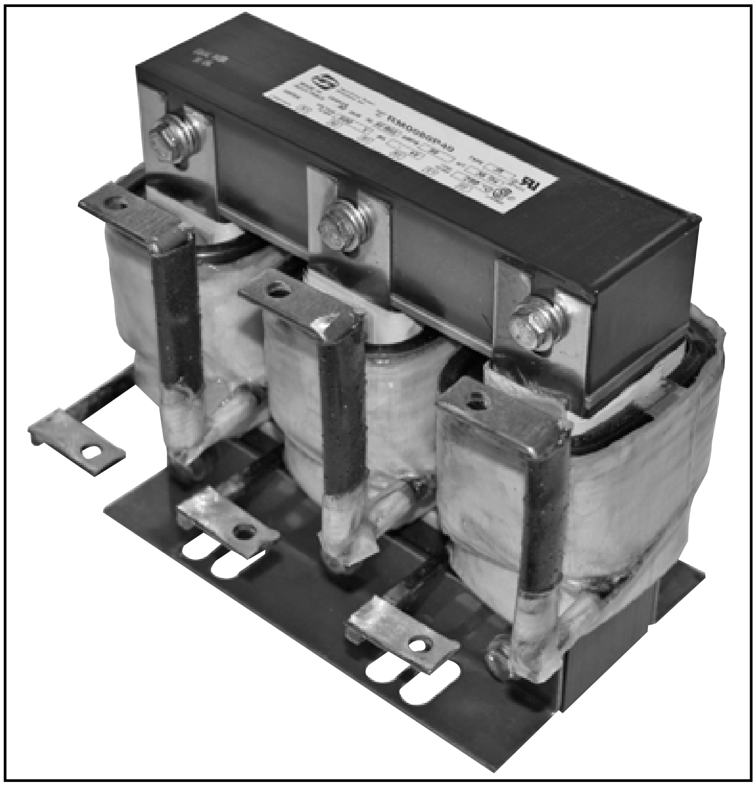
The Line Reactor . . .

CORE

The quality and performance of a line reactor is fundamentally dependant on its ability to withstand harmonics and transients in what is clearly a difficult environment. The bonding and clamping techniques of the gapped core also significantly impacts its performance characteristics.

We have paid particular attention to these basics to ensure both reliable and consistent performance.

Core materials, manufacturing and assembly processes have been carefully evaluated to produce optimum losses and sound levels necessary for this product.



COILS

Conductors are precision wound for optimum short circuit withstandability and electrical balance are used throughout the RM line. Choice of conductors, winding techniques and cooling ducts are precisely selected to assure the highest continuous, reliable performance.

INSULATION SYSTEM

Line Reactors are designed to meet the most difficult temperature environments. On units up to 160 amps, RM line reactors have a 115°C temperature rise designed for 200°C Insulation Class. This results in a permissible 24 hour maximum ambient of 50°C and an average of 40°C continuously.

On units larger than 160 amps, Class 220 Insulation is used throughout with a maximum permissible continuous ambient temperature of 60°C. These temperature tests are all measured at 150% rated 60 Hz current. For further information on temperature rises, please consult our sales offices.

VPI IMPREGNATION

Every reactor is fully VPI vacuum and pressure processed with VT (vinyl-toluene) Polyester Resin. This modern, vinyl-toluene based resin with its thicker build, offers significant benefits for electrical, mechanical and thermal properties.

This impregnation process and material results in a much improved dielectric constant, dissipation factor, bonding strength and dielectric breakdown (volts per mil) than any other impregnation material including the more traditional oil modified epoxies and varnishes.

Vacuum impregnation is considered vital for the integrity of electrical equipment located in such sensitive locations. The core and coil assembly is finished with a clear resin.

TERMINATIONS

Custom connections are provided for in several ways. Finger-proof-terminal blocks are provided on three model ranges, and terminal pads are supplied on higher current ratings. Refer to the dimensional summary for details. All connections are brazed to ensure electrical integrity.

. . . Features of Construction

ENCLOSURES

Enclosed reactors are standard as either NEMA 2 or 3R. Units in NEMA 3R enclosures are suitable for floor or wall mounting. Wall mounting is available on NEMA 3R units up to 600 lbs. Please consult customer service for details.

Enclosures are finished with a 7 stage phosphate process with baked enamel ANSI 61 grey.

QUALITY CONTROL

Every reactor is production line tested in accordance with the requirements for UL, ANSI, NEMA and CSA. This confirms that every unit meets our highest expectations for Quality Assurance.

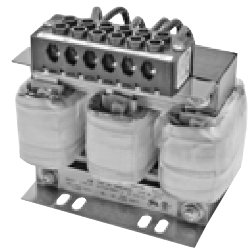
Additionally, line reactors have been short circuit tested at a certified laboratory to confirm the withstandability of our reactors to short circuits that may be present in a distribution system. Tests were done in accordance with ANSI C57.12.91 at 25 times rated current for 2 seconds. Those test results are available upon request successfully withstanding this test ensured that the Line reactor will survive power stresses such as short circuits that may be present in a distribution circuit.

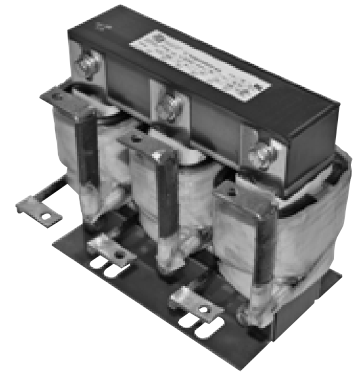
UL and CSA CERTIFICATION

A vital assurance for our customers is the approval of this product line to national standards.

Our open and enclosed style reactors are recognized by UL and certified by CSA as follows:

UL File No.:	E61431
CSA File No.:	LR3902





This approval is inclusive to 2000 amps and 8.6 kV class, and may be of interest for any special applications.

Our products are built in accordance with and meet UL 508, UL 506 and CSA C22.2 NO.66 standards.

INPUT AND OUTPUT SIDE REACTORS

Three phase Line Reactors are designed for both the input and output side of variable speed drives including Insulated Gate Bipolar Transistor (IGBT) type inverters.

SPECIALS

For special applications or for any features that you may require beyond the standard line listed, please contact our sales offices.

Standard Three Phase Line Reactor Specifications

RATINGS:

Nominal Inductance +/- 10% @ rated current.
95% of nominal inductance @ 150% rated current.
50% of nominal inductance @ 350% of rated current.

The above performance indicates that even at very substantial overload conditions (even beyond what other equipment in the circuit could tolerate), the RM Line Reactor will still provide current limiting performance against total harmonic distortion generated by the drive system.

TEMPERATURE RISE:

115° C on units up to 160 amps; average ambient of 40°C.
115° C on units larger than 160 amps; average ambient of 60° C.

INSULATION SYSTEM:

200°C Temperature Class up to 160 amps.
220°C Temperature Class over 160 amps.

FREQUENCY:

60 Hz Fundamental Current Maximum.

COOLING METHOD:

Natural convection

SYSTEM VOLTAGE:

1.2kV Maximum

APPROVALS:

UL File No.: E61431
CSA File No.: LR 3902
CE Mark (IEC 61558-2-20:2000)

SOUND LEVEL:

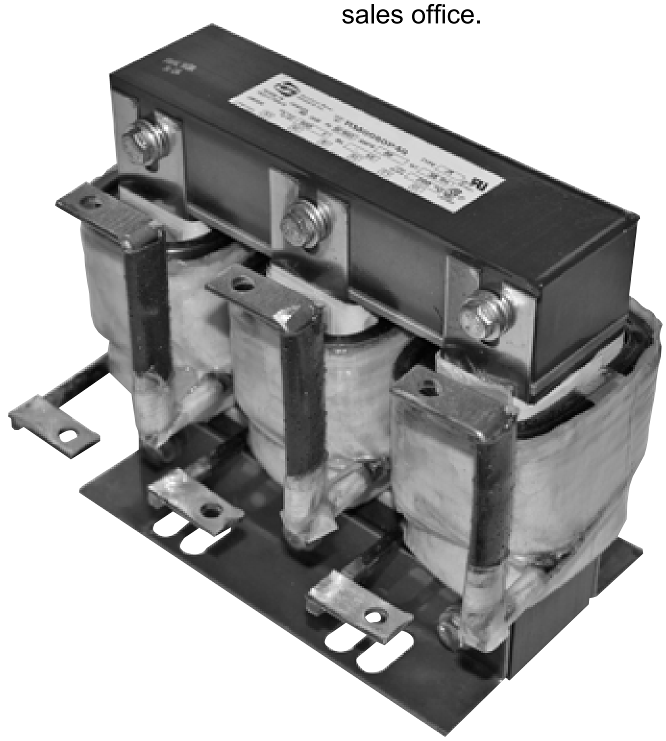
2 to 18 amps: 58 dBA
130 to 320 amps: 70 dBA
25 to 100 amps: 64 dBA
400 to 1200 amps: 75 dBA

ENCLOSURE: (when specified)

NEMA 2 or NEMA 3R, ANSI 61 Grey, UL50

HARMONIC WITHSTAND:

Reactors are designed to withstand typical harmonics associated with both the input and output side of AC variable speed drives including IGBT type inverter drives. For additional information, contact our sales office.



Understanding Percent Impedance

Introduction:
Drives use semiconductor devices for electrical power conversion. These devices are sensitive to power surges, voltage spikes, current surges, line distortion and power anomalies, all of which may have detrimental effects on semiconductor device operation. Line inductance reduces power surges. Inductive power circuit components such as reactors, inductors, chokes and transformers reduce rate of current change in the circuit and are used to "condition" power circuit. Inductance is often expressed in value of "percent impedance".

Definition:
Percent Impedance or Percent IZ (%IZ) is the voltage drop due to impedance, at rated current, expressed in a percent of the rated voltage.

Discussion:
Drives require certain line impedance for three important reasons:

1. Minimum inductance is necessary for proper commutation of semiconductor devices.
2. Line inductance reduces power sub-transient and transient surges.
3. Impedance reduces available short circuit current in case of malfunction.

Drives Installation and Operation Manuals list necessary minimum impedance and short circuit ratings. What do these impedance percentages really mean? As stated in the above definition, percent impedance is always expressed at rated base current. It is very important to understand that recommended percent impedance is based on drive full load current rating and not the reactor, transformer, or other device current rating.

Here are few examples:

A. 10HP, 460V, 14A, "IHH410"-E inverter drive requires 1% impedance and is rated for 5kA short circuit current. That means that line voltage drop at current level at 14A should be at 4.6V.

B. 10HP, 460V, 18A, Baldor line reactor LRAC01802 with 3 % impedance will have 13.8V voltage drop when conducting 18A.

C. 100kVA, 460V, 125A, power distribution transformer with 5% impedance and serving several drives will have 5% or 23V drop at full load of 125A.

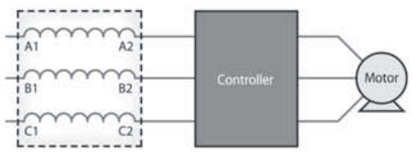
Calculating line impedance

The purpose of these examples is to illustrate the importance that percent impedance in drives application must be evaluated on drive current rating base. Lets us further examine the above examples. Let us assume that the 10HP, 460V, 14A drive above is the only load on this 100kVA transformer. How much will voltage drop on the transformer when transformer is loaded only with 14A of drive's current? In order to calculate this drop we use the simple ratio formula. If 125A drops 23V, then 14A will drop 14A/125A*23V or 2.6V. This value 2.6V is less then recommended drive input line impedance voltage drop of 4.6V. The conclusion is that 5% impedance 100kVA transformer does not meet the requirement of 1% impedance for 10HP drive.

Evaluating short circuit impedance

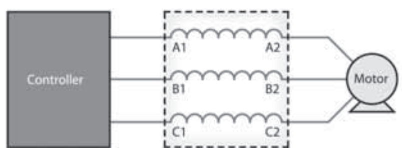
Power source impedance is also and easy way to evaluate available short circuit rating. In the above example, we have discussed H2, 10HP, 460V drive which has listed short circuit rating of 5,000A symmetrical RMS (root means square) current. Let us conduct and a simple short circuit study. Let us assume that 100kVA transformer has unlimited power available from the utility on the primary side (which is mostly a case in short circuit studies) and let us assume that there are no rotating motors on this power system to contribute to short circuit level (which is not a case in most short studies). In this circuit with the assumptions made, the phase to phase of short circuit in the drive, at the simplest calculation will be full load current divided by percent impedance or 125A/.05=2500A. The available short circuit current is less then drive listed short circuit rating. There is no reason for concern. Now let us look at 200kVA, 250A, transformer with 4% impedance. Short circuit current on the drive feed from this transformer would be 6.3kA, more then drive short circuit rating. Installing this 10HP drive on 200kVA transformer possibly compromises drive short circuit rating and increases the possibility of drive failure.

Three-phase AC Line Reactors can be used as an input filter for adjustable speed DC drives and as input or output filters for AC pulse width modulated variable frequency drives. They are bi-directional protective filtering devices and can be applied in a variety of configurations.



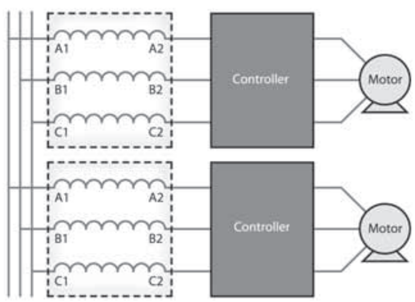
Input to Inverter/Drive

AC Line Reactors protect your sensitive equipment from noise generated by the drive or inverter. They protect the controller from power surges, spikes and harmonic distortion.



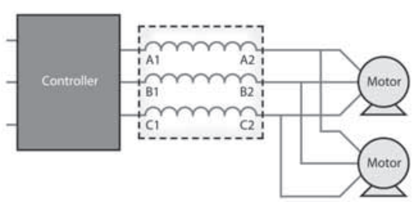
Output of Inverter/Drive

Motors run cooler and quieter with an AC Line Reactor placed between the inverter and motor. This application also reduces dv/dt and protects the controller from short circuits and surges.



Multiple Controllers on a Single Power Line

Each drive or inverter on a single power line requires its own AC Line Reactor in order to provide adequate surge protection, prevent crosstalk and reduce harmonic distortion.



Multiple Motors Controlled by a Single Drive

Multiple motors controlled by a single drive require only one AC Line Reactor between the controller and motors.