HANS VON MANGOLDT

REACTOR TECHNOLOGY AT ITS BEST!

REACTORS

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Hans von Mangoldt

Our Beginning - 1941

Hans von Mangoldt GmbH & Co. KG (HvM) was founded as a transformer factory by Mr. Hans von Mangoldt in the Austro-Bohemian border region of Lower Austria in 1941. The company was lost completely at the time of the Soviet Russian invasion. In 1949, the company restarted in Aachen, Germany, the hometown of the founder's wife. The company started in the business of electrical transformer repair but soon expanded into a complete transformer manufacturing facility. Their initial focus was on the production of transformers for the neon signs and industrial machinery. 1965 saw the construction of a new building at the company's present location, the first of many expansions to follow. The company's founder died in 1966, and responsibility for the company's future fell on his eldest son, Burkhard. In 1973 he was joined by his younger brother Ruprecht, an engineer. In 1985, they were joined by the youngest of the family, Henning.

Blocking Filter Technology Acquisition - 1974

In 1974, the company acquired a business involved in the production of audio-frequency blocking filters. Blocking filters are used by the electrical power industry to prevent power factor improvement capacitors from absorbing audio frequency signals. In many utility networks, audio-frequency signals are emitted by the utility companies to energize or de-energize equipment which helps to control energy flow.

Specialization in Reactors for Power Electronics and Power Capacitor Applications - 1976

During the early 1970's the world energy crisis prompted electric power suppliers to demand higher power factor from their consumers. This resulted in the increased demand for reactive power compensation (power capacitors). At the same time, the capacitor industry was removing PCBs from all capacitors and replacing it with non-hazardous insulation materials. Due to international bans on PCBs, capacitors of this type were being replaced with foil-insulated capacitors. While foil-insulated capacitors achieved low power losses, they have the disadvantage of being prone to damage when subjected to harmonic distortion. These new capacitors required reactors to protect them against harmonics, and to realize their expected service life.

The company responded to these changes in the electric utility industry and refocused its production capabilities to the needs of this new market by specializing in the design and production of reactors. They understood capacitor applications, utility networks and the new requirements of the capacitor industry due to their experience in the audio blocking filter business. They entered this new capacitor protection industry by supplying reactors that were specially engineered to achieve high performance and reliability in applications where harmonic distortion was prevalent.

In addition to supplying capacitor protection reactors, Mangoldt engineered reactors that enabled customers to tune capacitors so they could remove harmonic distortion from the power system. Reactors and capacitors continue to play an important role for electric utilities and industrial facilities that strive to improve overall system efficiency and network power quality. Nearly one million reactors produced by Hans von Mangoldt are in use world-wide in low voltage and medium voltage power systems. These include capacitor protection reactors, harmonic filter reactors, line reactors, compensating reactors, SCR commutation reactors and smoothing reactors. The applications typically involve capacitors, motor drives as well as other power electronic applications.

Neon Products Acquisition – 1977

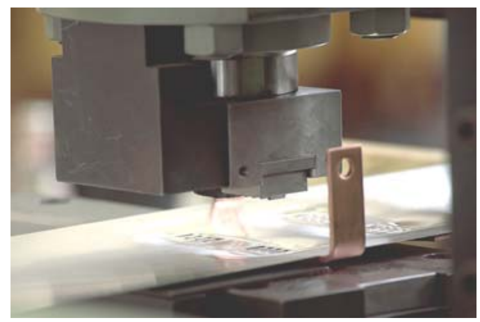
1977 saw the acquisition of a subsidiary company, Neon Products GmbH (NP), manufacturing cold cathodes for high-voltage neon tubes. Since this product was for the same application sector as the transformers which the company had been producing since its inception, this was an ideal way to expand. In the following years, Neon Products (NP) developed into an independent company group, which today, in addition to Aachen, has manufacturing facilities in Brazil (Jundiaí-SP), USA (Dallas), Thuringia (Großrudestedt), as well as numerous sales offices both in Europe and overseas. The manufacture of all products for the neon sign sector passed to NP, thus establishing a clear delineation of production range between parent and subsidiary.

1980 – Pioneered new PolyGap™ Core Construction

1980 marked the introduction of Mangoldt's exclusive core construction method, appropriately named PolyGap™ , for its use of numerous air gaps. PolyGap™ core construction is designed to optimize the core's ability to handle harmonic frequencies and to minimize losses. Mangoldt has the capability to design reactors with the precise number of air gaps, length of each individual gap and location of each gap to maximize the overall performance of the reactor, based on the specified harmonic current spectrum.

Terminal Attachment – 1992

In 1992 Mangoldt developed a superior method of attaching terminals to sheet conductors that would withstand the stresses of field wiring attachment, temperature variations and prevent galvanic action relating to the attachment of aluminum and copper materials. Mangoldt's cold pressure welding terminal attachment system has produced absolutely zero defect termination attachment since its implementation.



Factory Automation – 1993

Mangoldt began its investment into automated winding equipment in 1993 and has continued this strategy ever since. The use of automated process equipment begins with the initial production phases such as winding and extends all the way through to the final stage – product testing. Mangoldt's first automatic, large coil winding machine was purchased in 1993 and since that time they added three more computerized winders. These winders enable Mangoldt to produce perfectly wound coils with the highest degree of repeatability by controlling the winding tension and performing of the winding conductors. Multilayer coils achieve optimum heat transfer when wound using this type of equipment because this method virtually eliminates trapped air pockets within the coils which could otherwise develop into hot spots. Each reactor is assigned a unique serial number during the initial stages of manufacturing which directs each reactor through the production process and ultimately controls the computerized testing procedures for each reactor.

Research & Development Program – 1995

1995 marked the establishment of our research and development department. Since that time our R&D department has been responsible for many innovative technological breakthroughs such as our terminal attachment technique, programmable harmonic current generator development and further studies involving our PolyGap™ core construction which achieves superior performance and power loss minimization in applications involving harmonics and other high frequencies such as PWM voltage. The research and development program has also been responsible for internal development of reactor design software and continuous improvements in reactor design, construction and performance. The R&D group evaluates new technologies, materials and construction techniques using a combination of research and design tools such as finite element analysis and actual testing under exact conditions. Today, Mangoldt is one of a few, if not the only reactor company in the world with a funded research and development department. This unique commitment by Mangoldt continues to serve many industries with new technological developments and knowledge regarding complex reactor applications.

High Current Test Laboratory - 1995

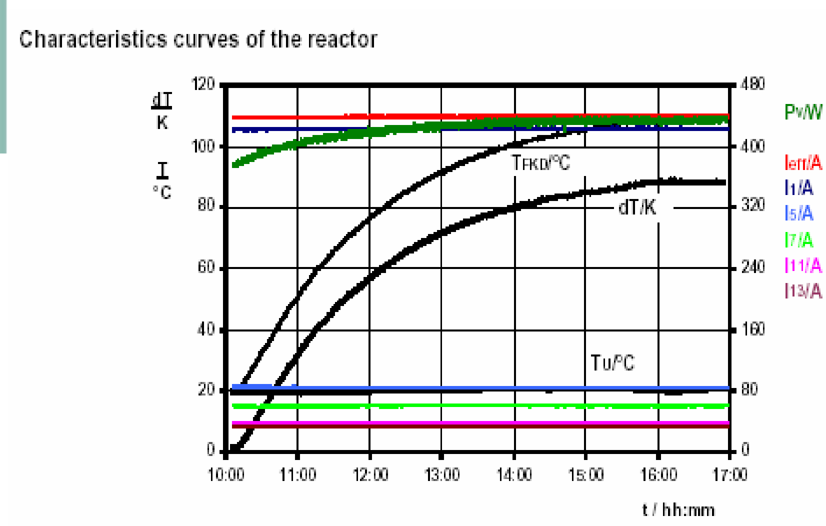
To support the needs of customers in the low and medium voltage capacitor and harmonic filter businesses, Mangoldt has continuously improved their testing capabilities. In 1995 they made a key investment into high current power supplies for testing both AC and DC reactors. This programmable test equipment enables Mangoldt to test small and large reactors at their full load ratings and to acquire data such as inductance, power loss, saturation characteristics, temperature rise and other parameters under real life full load operating conditions.

DC High Current Power Supply

AC High Current Power Supply

Programmable Harmonic Current Generator – 1999

1999 marked the dawn of a new era in the reactor industry, when Hans von Mangoldt enhanced their testing capabilities with a Programmable Harmonic Current Generator (PHCG). The first of its kind, Mangoldt engineers, along with a major power electronics company, developed a proprietary IGBT based test system that enables Mangoldt to generate real harmonic currents for testing reactors in their real life circuit conditions. Never before could reactor manufacturers actually test reactors to confirm their suitability for complex waveform applications such as harmonic filters, capacitor detuning, PWM voltage, and active regeneration applications. The PCHG allows free programming of harmonic currents and phase shift for individual harmonics including 3, 5,7,11, and 13, in addition to the fundamental current. The 900KVA harmonic current generator can test most low and medium voltage reactors with full current, to obtain power loss, inductance, Q-factor, temperature rise with real life conditions applied. In those cases where the reactor's combined voltage, current and inductance require more capacity than available from the PHCG, reactors can be tested to the maximum harmonic loading with extrapolation from this point upward.



Partial Discharge Test Lab – 2002

To maximize and verify the reliability and life expectancy of their reactors, Mangoldt installed partial discharge testing equipment. This equipment enables them to perform corona inception testing at voltages up to 10kV and helps to detect weaknesses in the reactor insulation system that are not detectable during normal visual inspection.

Lamination Cutting - 2002

Continuing on our path to process and productivity improvements, in 2002 Mangoldt made an investment in two lamination cutting lines and installed one at each factory. The core structure design combined with air gap placement is critical to reactor performance especially when harmonics or PWM frequencies are present. This equipment provides us with increased flexibility plus complete control over core geometry, quality and core manufacturing time.

North America – 2003

In 2004, Mangoldt embarked on a new venture to develop OEM business in North America, by providing sales and technical support through a central USA based technical support office. Low voltage reactors are both UL and CUL approved as well as IEC 76 and IEC 289. Medium voltage reactors comply with IEC 76 and IEC 289.

Divestiture of Neon Products – 2004

In an effort to focus on their core competencies and to leverage their unique design, production and testing capabilities, Mangoldt divested themselves of the NP business in 2004, and converted the modern factory to a reactor production facility. Today their efforts are focused entirely on the research, development, design and production of reactors.

Mangoldt Today

Hans von Mangoldt GmbH & Co. KG, an ISO-9001 registered company, is appropriately equipped to meet the demands of the most rigorous reactor applications. They have earned a leadership position in the international reactor markets and currently export, on a regular basis, to over thirty countries. A highly motivated and experienced workforce makes a vital contribution to the success of the company. The use of state-of-the-art production systems, together with self-defined high demands for quality and reliability allow our customers to have absolute confidence and trust in the products supplied by Hans von Mangoldt. The management of HvM looks to the future, firmly determined to maintain its success in meeting this quality objective. Today the entire company group HvM has an 80-man strong workforce at two production sites and two sales offices (Germany and USA). Mangoldt has two production facilities with complete reactor manufacturing capabilities. Both factories include everything from lamination cutting, computerized winding, assembly and vacuum and pressure impregnation systems.

Quality System

At Hans von Mangoldt GmbH & Co. KG, all products are calculated, designed and manufactured to international standards, including IEC, VDE and UL. During 1996 our corporate Quality Management System, including both factories) achieved registration to DIN EN ISO 9001, (Certificate Registration No. 09 100 6544) and later earned registration to ISO-9001:2000, as well as ISO-14001. Mangoldt has received UL component recognition for both USA and Canada, of reactors (UL File # E173113) as well as insulation system recognition (UL File # E254727).

Hans von Mangoldt

Reactor Technology at its Best!

HANS von MANGOLDT GmbH

Reactor Technology at its Best!

Mangoldt - Low Voltage and Medium Voltage Reactors

The Company

- **Headquarters**
  - Aachen, Germany
- **Factories**
  - Aachen, Germany
  - Grossrudestdt, Germany
- **85 employees**
- **Founded in 1949**
- ***Specializes in Reactors***

Modern Factories

Aachen, Germany

Grossrudestedt, Germany

Near Erfurt

Quality · Standards

- **ISO-9001:2000**
  - (DIN EN cert # 09 100 6544)
- **ISO-14001**
- **UL, CUL**
  - (UL-508, File E173113)
- **IEC**
- **VDE**

Our Typical Customers

- **OEMs**
  - **Power Electronics**
  - **Harmonic Filters**
  - **Wind Power Turbines**
  - **Capacitor Banks**
  - **Ski Lift**
  - **Cable Car**
  - **Elevator**
  - **Drives and Inverters**
  - **Active Filters**

Product Offering

- Reactors for OEM applications
  - DC or AC (1 or 3 phase)
  - Made to your spec, or our spec
  - Low voltage (600 volt class)
  - Medium voltage (up to 35 kV)
  - Iron Core, Air core





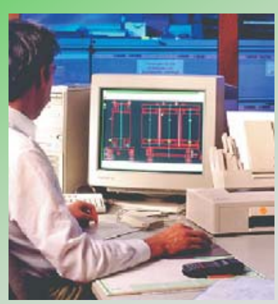
Typical Applications

- Filter Reactors
- Inverter Reactors
- Current Limiting
- Current Smoothing
- Inter-phase Reactors
- Capacitor Protection
- PWM Reactors
- IGBT filters
  - Active filters
  - IGBT regenerative drives
  - Motor protection filters



Unique Engineering Expertise

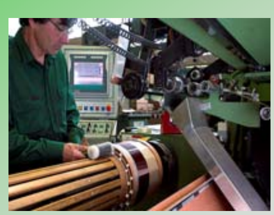
- Our technical expertise originates from:
  - Research & development
  - Internal software development
  - Imaginative design & manufacturing
  - Uniquely innovative test & measurement equipment
  - Application experience
  - Dedication to excellence



Computerized Winding Equipment

Conductor Varieties

Aluminum sheet



Copper wire

Copper Terminal Attachment

Lamination Production

- 800 laminations per minute production rate
- One machine at each manufacturing facility

Coil & Core Assembly

Construction Techniques

Mangoldt construction achieves maximum life expectancy
Expect 20+ years of satisfactory life

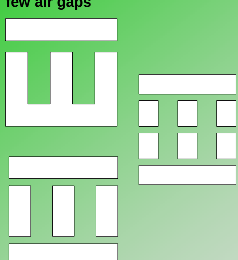
- **Optimized heat removal**
  - Coil cooling slots
  - Core cooling slots
  - Air gap control
  - Flux density control
- **Low audible noise**
  - Secure clamping
  - Coil support
  - Flux density control

PolyGap™ Construction

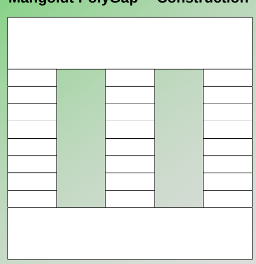
- An air gap is necessary, but for harmonics applications, more small air gaps are much better than a large air gaps.
- Prevents magnetic flux leakage
- Reduces noise
- Reduces power losses

Core Construction

Competitors typically construct Reactors using only a single or few air gaps

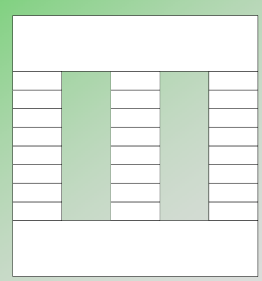


Mangoldt PolyGap™ Construction



PolyGap™ Benefits

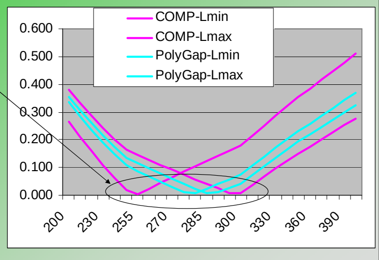
- Inductance is balanced in all three phases
  - +/- 3% tolerance for inductance (mH) for all three phases
  - Precise filter tuning in all 3 phases
- Superior harmonic filter performance



Filter Performance Requires accurate and balanced Inductance

Filters with PolyGap™ reactors are accurately tuned and remove more harmonics.

Filters that DO NOT use PolyGap™ reactors may have wide tuning tolerance and may not remove as much of the harmonics.



Computerized Testing

Programmable AC current source

- *AC inductance testing at rated rms current*
- *Test report generation*

Computerized Testing – cont'd

Programmable DC Current source

- DC inductance testing
- Test report generation

- Corona inception testing
- Test report generation

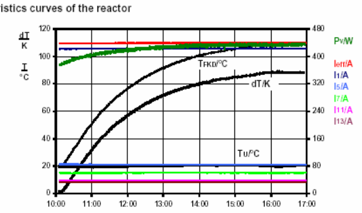
Partial discharge test facility

Programmable Harmonic Current Generator

- Test using exact harmonic spectrum
- Test report generation

Testing with Harmonic Currents Applied

Characteristics curves of the reactor



Currents during heat run test	I_1=423,4 A I_5=84,6 A I_7=59,6 A I_{11}=39,0 A I_{13}=33,7 A I_{RMS}=438,9 A
Switch off values	Ambient temperature $T_{Ambient}$ = 20,8 °C
	Temperature of the sensor $T_{Reactor}$ = 109,4 °C
Sensor for the temperature	PT100 two wires
Measuring point of reactor sensor	Center coil; next to inner copper bar

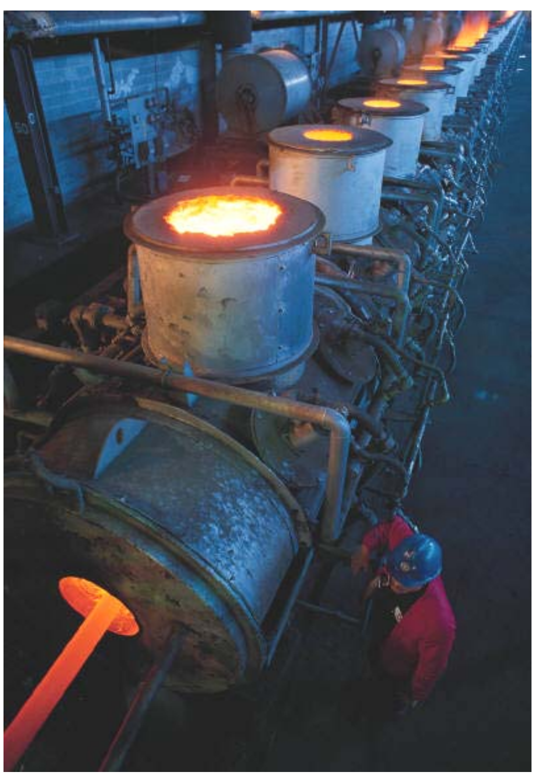
Vacuum & Pressure Impregnation

Superior noise abatement process

Reactor Technology at its Best!

- **Mangoldt offers high performance reactors for:**
  - **Harmonic filters,**
  - **Capacitor banks,**
  - **Motor drives,**
  - **PWM inverters,**
  - **Active filters,**
  - **Current limiting.**

Reactor Technology at its Best!



For all your reactor needs

- Reactive Compensation
- Harmonic Filtering
- Capacitor Protection
- PWM Inverter Filtering
- Inrush Current Reduction
- Transient Absorption

HANS VON MANGOLDT

BASIC REACTOR THEORY

AIR CORE REACTORS

Air core reactors provide excellent control of inductance over an extremely wide range of current and frequencies. This type of reactor has traditionally been used for current limiting applications due to their ability to maintain inductance even when subjected to extremely high currents. Although they can handle high frequencies well, the use of air core reactors is not common for small and medium sized harmonic filters, due to the relatively high inductance requirements. Large harmonic filters, however, using large amounts of capacitance require smaller magnitudes of inductance and higher current ratings—making the air core reactor a reasonable selection.

Traditionally, air core reactors have been used for outdoor applications due to the external electromagnetic field they create. The stray magnetic field strength increases with intensity as the current and inductance increase and may cause heating to occur in nearby metallic structures or enclosures. Certain electronic equipment such as video monitors and proximity sensors may be sensitive to its electromagnetic field.

In the axial direction from each coil end, the electromagnetic field typically extends as far as 110% of the coil length. In the radial direction from the sides of the reactor, the electromagnetic field can extend as far as 50% of its diameter. Air core reactors are only practical for relatively low inductance requirements (less than about xxx uH) because the physical size becomes rather unwieldy for larger values of inductance. For this reason, their use is typically limited to current limiting applications, where relatively low inductance values are common.

3-Phase Air Core Reactor Assembly

Mangoldt supplies air core reactors to limit fault current and to reduce capacitor switching transients for indoor applications.

IRON CORE REACTORS

3-Phase Iron Core Reactor

Iron core reactors made with Mangoldt's exclusive PolyGap™ construction are used in a wide variety of applications involving high frequencies or high current, including those formerly satisfied only with an air core reactor.

Due to the use of an electromagnetic (iron) core that magnifies the inductance produced by an individual coil (air core reactance), the iron core reactor is capable of providing very large values of inductance. Inductance values can range from micro-henries to milli-henries and even henries.

Iron core reactors experience much lower magnitudes of external magnetic field strength because most of this field was contained within the core itself. The external field is primarily the result of magnetic flux that bridges the air gap regions of the reactor. Nevertheless, the field strength associated with traditional iron core reactors can still be sufficient enough to cause interference with electronic equipment located nearby and to cause enclosure or support structure heating when those metallic members are in close proximity to the reactor.

Unlike air, the iron core will saturate and lose inductance when forced to carry current above its normal capacity. When the core reaches full saturation, inductance of a traditional reactor may drop to as little as five percent (5%) of the original value. For this reason, traditional iron core reactors were not well suited to current limiting applications due to their core saturation characteristics. Additionally, the magnetic core watts loss and flux density can increase appreciably for frequencies above the fundamental frequency. The predictability of losses and temperature rise associated with harmonic frequencies has proven to be the most difficult task for reactor designers.

Iron core reactors are commonly used for harmonic filters, protecting power factor correction capacitors, inserting in series with power electronics equipment to absorb transient over-voltages, to increase circuit reactance, and to provide electrical network reactive compensation.

Producing the Perfect Reactor

Superior Reactor Design Engineering

It all starts with our internally developed reactor design software. Using extensive knowledge acquired through extensive research and development, Mangoldt understands exactly how to design reactors so they can handle harmonic frequencies without the adverse side effects. Based on a customer specification, we design the optimum reactor for the exact harmonic currents. We include the 'right" number of air gaps, in the right places, to virtually eliminate any external magnetic field, to minimize eddy current and stray losses, to control flux density, improve inductance linearity over a wide range of current and to minimize audible noise. Our designers specialize in the design of reactors for complex waveforms (ie: harmonic content, PWM waveforms, etc). Based on individual reactor design criteria, the drawings, construction details, and testing procedures are computer generated and sent directly to the computerized factory production and quality management systems.

Computerized Winding Equipment

To maintain the best controls over coil construction, while reducing the labor cost associated with an otherwise tedious job, Mangoldt utilizes precision automated winding equipment. Coil tension is controlled, winding insulation is perfectly inserted, and terminals are accurately located using computerized process automation controls.

Programmable Harmonic Current Generator

Every Mangoldt reactors is designed for the exact amount of harmonic currents as specified by our customers. Type testing using our exclusive programmable harmonic current generator is performed on all product ranges to confirm performance under real life operating conditions.

Exclusive PolyGap™ Core Construction

The presence of harmonic currents or PWM switching frequency currents can significantly complicate reactor design and has greatly diminished the ability of reactor designers to predict temperature rise, audible noise, power losses and external magnetic field strength. Special applications for reactors such as harmonic filters, active filters and active regeneration power supplies, and inverter output reactors have long been plagued with problems such as excessive audible noise, temperature or electromagnetic interference. Mangoldt's PolyGap™ core construction is the answer for reactors in PWM and harmonic current environments.

Air Gap is Vital to Reactor Performance

The air gap is a vital factor in reactor design. A larger air gap improves inductance linearity over a wide range of currents, but a large air gap can increase losses and even induce heating in nearby steel structures (enclosures). The typical factors associated with audible noise in reactors include flux density, magneto-strictive forces and mechanical construction. The operating temperature of structural components in and around the reactor is increased primarily due to the presence of an electromagnetic field across the air gap. Larger air gap typically have larger magnetic fields. This magnetic field can heat any ferrous (and even some non-ferrous) materials within the range of this filed. Computer monitors can also be adversely affected by these stray fields.

Mangoldt's PolyGap™ core construction solves each of these problems and achieves optimum performance of reactors in applications where harmonic or PWM switching frequency currents are present. By distributing the total air gap into many tiny air gaps, Mangoldt controls the magnetic flux density and achieves the benefits of a large air gap without the unpleasant side effects. Mangoldt specializes in the design and manufacture of reactors for complex applications such as wind turbines, active filters, harmonic filters, power factor capacitor systems, inverters and motor drives, transportation, ski-lift and cable cars, and many more. They supply reactors for both low voltage and medium voltage requirements, all the way up to 36kV.

Proprietary Construction Technique

PolyGap™ core construction is just one of the many proprietary construction techniques developed through ongoing research and development programs at Hans von Mangoldt GmbH. This technique achieves the benefits of a sizable air gap, without the adverse effects that are often experienced in and around a typical reactor.

Some of the benefits associated with PolyGap™ core construction are

- **Constant inductance over a wide range of current and frequency,**
- **Elimination of external magnetic fields,**
- **Reduced fringing losses and**
- **Superior audible noise control.**

HANS VON MANGOLDT

Reactor Technology at its Best!

No doubt!

If you ever purchased reactors for power electronics applications, you've undoubtedly gone through the painstaking trial and error process as suppliers made futile attempts to meet your needs. Seldom did the prototype meet your needs the first time. You suffered program setbacks, frustration and increased costs.

Not so with Mangoldt. Our sole business is designing custom iron core reactors for power electronics and harmonic filter applications. We offer both low voltage and medium voltage reactors, made to your specification.

No substitute!

There is no substitute for Mangoldt's experience and expertise. Our investment in R&D programs has enabled us to pioneer proprietary design and manufacturing techniques that optimize our products and minimize your cost.

Mangoldt is an industry leading producer of custom AC and DC reactors. We design and build reactors that meet your exact requirements. Our state-of-the-art manufacturing facilities assure maximum productivity with tight controls over all aspects of quality.

No Guessing!

Computerized design and test procedures assure that your needs will be met. Our exclusive 1000KVA programmable frequency generator tests reactors for applications such as: filter reactors, capacitor detuning reactors, reactors for power electronic applications and many others involving harmonic frequencies. Mangoldt takes the guesswork out of reactor design.

Mangoldt applies the actual harmonics currents while testing for inductance, power loss and temperature rise.

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www.mangoldt.com

USA contact:
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Low & Medium Voltage Reactors

The rigorous requirements of power distribution & power electronics applications are met with our high efficiency, low audible noise reactors. Pressurized vacuum impregnation along with our proprietary design and construction techniques assures the quietest operation possible for economical reactors. Call us for applications such as:

Current limiting reactors
Capacitor protection
Harmonic filters
Active filters
Neutral grounding
Line reactors
Load reactors
Motor dv/dt filters
Inter-phase reactors
DC link chokes
Commutation reactors
DC filter and smoothing reactors

Our testing capability includes:

- **Partial discharge**
- **Inductance**
- **Temperature rise**
- **Harmonic loading**

Custom designed reactors are our specialty. Our success is driven by our sound engineering, attention to detail, innovative manufacturing and unique test & measurement equipment.

Proprietary design & construction techniques prevent magnetic leakage while ensuring audible noise levels and highest efficiency.

Meets international standards

ISO-9001:2000 and ISO-14001certification
cUL & UL approvals up to 600 volts (File E173113)
IEC, VDE and other standards approvals

We meet customer needs!

For on-time delivery, trouble free operation, long life, compact size, efficient designs, economical solutions.

Some of the many industries we serve are:

Adjustable speed drives · Wind power · Harmonic Filters · Power factor correction
Ski lift · Cable car · Elevator · Machine tool · Power Quality
Active compensation · Fast switching capacitor systems · Active filters
12-pulse rectifiers · 18-pulse rectifiers · 6-pulse rectifiers
Battery chargers · Robotics · Induction heating · Rolling mills · Arc furnaces

Form M-1401A
01/12/2005

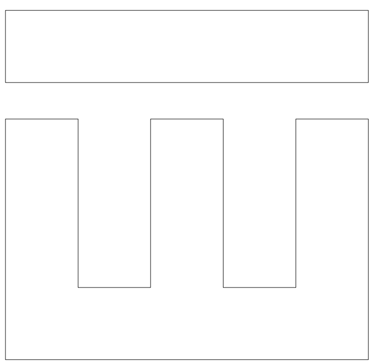
HANS VON MANGOLDT

We look forward to serving you!

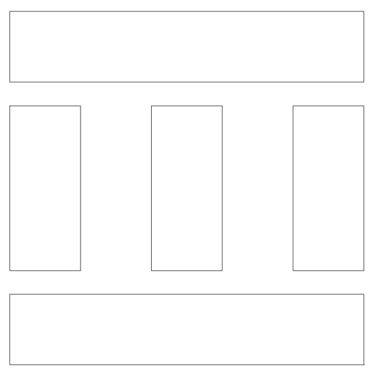
PolyGap® Reactor Core Construction

A physical air gap is an important characteristic of an iron core reactor. In addition to providing a simple means to make adjustments to the nominal inductance, the air gap also defines the saturation curve of the reactor. A larger total air gap generally means the reactor can withstand higher current before going into saturation, where its nominal inductance drops sharply. As the total air gap is increased in length, saturation characteristics typically improve, however, stray magnetic flux and power losses increase. For those applications where harmonics are prevalent, significant localized heating may occur in the winding, core and support brackets. Magnetic flux will span across the air gap and extend outward away from the core and into nearby conductors, adding significant losses in the reactor and may cause circulating currents in the coils and brackets. Stray magnetic fields can radiate from the air gaps of a reactor causing electromagnetic interference with sensitive electronic and medical equipment. Through extensive research and development involving actual harmonic loading of reactors, Hans von Mangoldt GmbH has learned the effects that air gaps have on reactor performance. As a result, Mangoldt has developed the technique to accurately design the air gaps for optimum, length, quantity and placement within the reactor core.

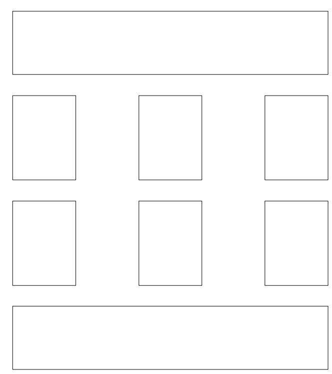
Many reactor companies still construct reactors with a single (and large) air gap, while others have learned that large air gaps deteriorate reactor performance and have therefore gone the route of “multiple air gaps”. For them, this simply means dividing the total air gap into two, three or possibly even four individual air gaps. They know that smaller air gaps are better, but typically that is the extent of their knowledge. They have not learned the methods to accurately design the air gaps - that is the actual length and placement of each individual air gap.



Single air gap
1 air gap per phase

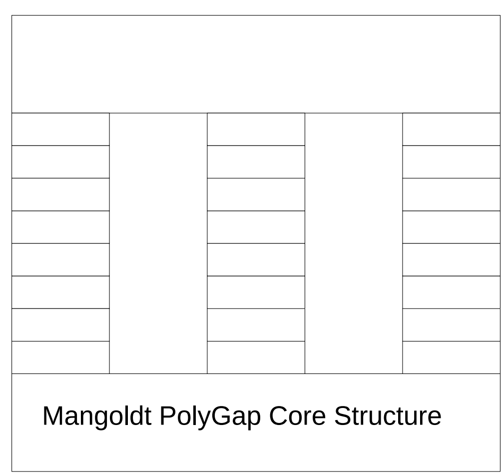


Multiple air gaps
2 gaps per phase



Multiple air gaps
3 gaps per phase

Mangoldt’s PolyGap® core construction takes advantage of proprietary knowledge acquired through many years of testing with real life harmonics, combined with extensive research and development. Optimum reactor performance requires complex analysis to determine the number of gaps, actual placement of each air gap in the core and the actual length of each individual air gap. Mangoldt has the knowledge and capability to design each individual air gap for precise length and placement within the core structure. Mangoldt’s exclusive PolyGap®core construction uses many tiny air gaps and then accurately sizes them and strategically places them within the core to achieve the optimum performance. Optimum performance means lowest watts loss, lowest temperature rise, and virtually no stray magnetic field. Depending on the application Mangoldt may use up to dozens of tiny air gaps as required to optimize reactor performance. Mangoldt’s strict control of the air gap enables them to virtually eliminate stray magnetic fields, allows them to offer economical low temperature rise reactor designs with the highest degree of reliability.



Mangoldt PolyGap Core Structure

HANS VON MANGOLDT REACTORS

The Ultimate Reactors for Harmonic Filters
Low and medium Voltage—up to 35kV

Highly Engineered - Competitively Priced

***PolyGap®* core construction assures superior performance in harmonic filter applications with low power loss and minimum stray magnetic field. Ongoing investment in automated processes such as design, coil winding, core cutting and testing assures consistent product quality at globally competitive prices.**

Quotes in 2-3 days
- **Prices**
- **Drawings**
- **Dimensions**
- **Watts Loss**

PolyGap® Core Construction

Benefits of PolyGap®core construction:

1) Precise inductance means accurate tuning of filters.
   +/- 3% tolerance is standard
   +/- 2% and +/- 1% available on request
   Traditional reactors are constructed with tolerances as high as 5% to 20% which can significantly reduce the effectiveness of a harmonic filter.

2) Inductance balanced in all three phases means superior attenuation of harmonics.
   Traditional 3-phase reactors can have as much as 12% variation between the center coil inductance and the outside coils, reducing filter effectiveness in at least one phase.

3) Minimizes eddy currents and fringing flux losses.
   Traditional reactors have few large air gaps which result in higher fringing flux and eddy current.

Harmonic testing available using our 1MVA Programmable Harmonic Current Generator

Capacitor Protection Reactors

UL File: E173113
For USA & Canada

ISO-9001: 2001

ISO-14001: 1996

- Medium Voltage
- Low Voltage

Protect power factor correction capacitors against:

- Excessive capacitor heating due to harmonic resonance.
- Effects of partial discharge in capacitor caused by excessive harmonic voltage drops across capacitor elements.
- Capacitor overload due to excessive harmonic currents.

We export to OEMs in over thirty countries

HANS VON MANGOLDT

USA Office
Cedarburg, WI 53012

Phone: 1-262-618-2403
Fax: 1-262-618-2303
E-mail: info@alliedindustrialmarketing.com

Form M-1407

Reactors fully tested using our exclusive 1000 KVA programmable harmonic frequency generator

Specification Submittal Form — Capacitor Protection Reactors

☐ Use Standard Mangoldt Specification

LOW VOLTAGE SPEC

System Voltage (V_N): ( )600V ( )480V ( )415 ( )380 ( )240V ( ) 208V
System Frequency: ( ) 60hz ( ) 50hz
Phases: ( ) 3-phase ( ) 1-phase
Tuning frequency: 4.08 x fundamental frequency (hz)
Inductance / tolerance: _____________ mH, +/ - 3% of L_{Nom}
Assumed power system harmonic voltage distortion: V_{H3} = 0.5%, V_{H5} = 6.0%, V_{H7} = 5.0%, V_{H11} = 3.5%,V_{H13} = 3.0% (9.26% THVD)
Fundamental current: 1.10 x I_{CN} (where I_{CN} = nominal capacitor current based on KVAR and nominal voltage)
Harmonic current capability: I_3 = 3%, I_5 = 56%, I_7 = 17%, I_{11} = 5.8%, I_{13} = 4.7% (relative to I_{CN})
Capacitor terminal voltage: 1.064 x V_{L-L}
Thermal current (I_{RMS}) 1.25 x I_{CN}
Core linearity (I_{LIN}): 2.36 x I_{CN} (with 0.95 x L_{Nom})
Maximum ambient temperature: 50° Celcius
Over-temperature switch: 1in center coil ( ) N.C. ( ) N.O.

Quantity: ______________________

☐ Use Customer Specification

MEDIUM & LOW VOLTAGE SPEC

Nominal Voltage (V_N): ______________ Volts, specify ( ) L-L or ( ) L-N
Power system frequency: ________ hertz
Reactor phases: ( ) 3-phase, ( ) 1-phase
Tuning frequency: ________ (hz) or ______ harmonic
Inductance / tolerance: _________mH, + ____% / - _____% of L_{Nom}
Power system harmonic voltage distortion: V_{H3} = ____%, V_{H5} = ____%, V_{H7} = ____%, V_{H11} = ____%, V_{H13}= ____%
V_{H17} = ____%, V_{H19} = ____%, V_{H}___ = ____%, V_{H}___ = ____%
Fundamental current: 1.___ x I_{CN} (where I_{CN} = nominal capacitor current based on KVAR and nominal voltage)
Harmonic currents: I_3 = _____%, I_5 = _____%, I_7 = _____%, I_{11} = _____%, I_{13} = _____%
(relative to I_{CN}) ________, ________, ________, ________, ________, ________
I_{RMS} ______ x I(fund) or ______ x I_{CN}
Over-temperature switch(es): ( ) one ( ) three
Temperature switch type: ( ) N.C. ( ) N.O.

Quantity: _______________

CAPACITOR DATA — Please provide this ratings information about your capacitors.

Configuration: specify ( ) Delta or ( ) Wye connection
kVAr: ____________kVAr
Voltage rating: ___________ Volts (L-L)
Micro-Farads: ___________uF (per phase)

Company: ____________________________ Name: ______________________________________
Address: ____
City: ________________________________ St/Prov: __________________ PC/ Zip ______________
Tel: ________________________________ Fax: ______________________________________
Email: ____

HANS VON MANGOLDT

Harmonic Filter Reactors

UL File: E173113
For USA & Canada

ISO-9001: 2001

ISO-14001: 1996

- Medium Voltage
- Low Voltage

Reactors for Tuned Harmonic Filters

- Proprietary core construction minimizes harmonic frequency losses and audible noise.
- Tailor-made to your design specifications with true to life type testing performed on our exclusive programmable harmonic frequency generator.
- Engineering expertise to help you optimize reactor design to achieve maximum performance at the minimum cost.

We export to OEMs in over thirty countries

HANS VON MANGOLDT

USA Office

Cedarburg, WI 53012

Phone: 1-262-618-2403
Fax: 1-262-618-2303
E-mail: info@alliedindustrialmarketing.com

Form M-1408

Mangoldt reactors are fully tested using our exclusive 1000 KVA programmable harmonic current generator.

Specification Submittal Form — Harmonic Filter Reactors
HF Series

☐ Use Standard Mangoldt Specification

LOW VOLTAGE SPEC

Nominal Voltage (V_N):	( )600V ( )480V ( )415 ( )380 ( ) 240V ( ) 208V
Power system Frequency:	( ) 60hz ( ) 50hz
Phases:	( ) 3-phase ( ) 1- phase
Tuning frequency:	4.7 x fundamental frequency (hz); If other, indicate tuning frequency ___________
Inductance:	________mH
Inductance tolerance:	+/ - 3% of L_{Nom}
Fundamental current:	1.10 x I_{CN} (where I_{CN} = nominal capacitor current based on KVAR and nominal voltage)
Harmonic currents:	I_5 = 70%, I_7 = 35% (relative to I_{CN})
Capacitor terminal voltage:	1.047 x V_{L-L}
Thermal current (I_{RMS})	1.35 x I_{CN}
Core linearity (I_{LIN}):	2.65 x I_{CN} (with 0.95 L_N)
Maximum ambient temperature:	50° Celcius
Thermal switch in center coil:	( ) N.C. ( ) N.O.

Quantity: ___________________

☐ Use Customer Specification

MEDIUM & LOW VOLTAGE SPEC

System Voltage (V_N):	_____________ Volts, specify ( ) L-L or ( ) L-N
Power system frequency:	________ hertz
Reactor phases:	specify ( ) 3-phase, ( ) 1-phase
Tuning frequency:	________ (hz) or ______ harmonic
Inductance:	___________mH
Inductance tolerance:	+ ____%, - _____% of L_{Nom}
Power system harmonic voltage distortion:	V_{H3} = ____%, V_{H5} = ____%, V_{H7} = ____%, V_{H9} = ____%, V_{H11} = ____%, V_{H13} = ____% V_{H}___ = ____%, V_{H}___ = ____%
Fundamental current:	1.___ x I_{CN} (I_{CN} = nominal capacitor current based on KVAR and nominal voltage)
Harmonic currents:	I_3 = _____%, I_5 = _____%, I_7 = _____%, I_{11} = _____%, I_{13} = _____% (relative to I_{CN})
I_{RMS}	______ x I(fund) or ______ x I_{CN}
Over-temperature switch(es):	( ) one ( ) three
Temperature switch type:	( ) N.C. ( ) N.O.

Quantity: _______________

CAPACITOR DATA (Please provide the following ratings information about your capacitors):

Configuration:	specify ( ) Delta or ( ) Wye
kVAr:	____________kVAr
Voltage rating:	___________ Volts (L-L)
Micro-Farads:	___________uF (per phase)

Company: ____________________________ Name: _____________________________________

Address: ____

City: ________________________________ St/Prov: _________________ PC/ Zip _____________

Tel: _________________________________ Fax: ______________________________________

Email:____

HANS VON MANGOLDT

LR SERIES

Line Reactors

UL File: E173113
For USA & Canada
Also meets IEC, VDE

ISO-9001: 2001

ISO-14001: 1996

EXCLUSIVE
PolyGap™
Core Construction

PolyGap™ core construction eliminates stray magnetic flux, reduces power loss and also minimizes audible noise.

HANS VON MANGOLDT

USA Office
Cedarburg, WI 53012

Phone: 1-262-618-2403
Fax: 1-262-618-2303
E-mail: info@alliedindustrialmarketing.com

Reactors for Motor Drives & Inverters

- Reduces input harmonic current and voltage distortion.
- Prevents nuisance tripping of voltage source inverters.
- Reduces SCR voltage notching.
- PolyGap™ core construction minimizes stray magnetic flux, harmonic frequency losses and audible noise.
- Tailor-made to your design specifications.
- Engineering expertise to help you optimize reactor design to achieve maximum performance at the minimum cost.
- Available for low voltage and medium voltage (to 35kV).

This product line has been confirmed with actual harmonic currents using our exclusive 1000 KVA programmable harmonic current generator.

Form M-1409

Specification Submittal Form — Line Reactors   LR series

☐ Use Standard Mangoldt Specification

LOW VOLTAGE SPEC

Nominal Voltage (V_N): ( ) 600V ( ) 480V ( ) 415 ( ) 400 ( ) 380 ( ) 240V ( ) 208V
Power system Frequency: ( ) 60Hz ( ) 50Hz ( ) _______Hz
Phases: ( ) 3 ph ( ) 1 ph
Fundamental Current: _______ Amps rms
% Impedance: ( ) 1.5% ( ) 2% ( ) 3% ( ) 4% ( ) 5% ( ) _______ %
Inductance: _________mH
Inductance tolerance: +/ - 3% of L_{Nom}
Harmonic currents: See table below
Thermal current (I_{RMS}) See table below
Core linearity (I_{LIN}): 2.5 x I_{Fund} (with 0.95 L_N)
Ambient temperature: 50° Celcius (maximum)
Thermal switch in center coil: ( ) N.C. ( ) N.O.

Quantity: ____________________

Reactor Impedance	1.5%	2%	3%	4%	5%
Harmonic No.	**Magnitude of Current per Harmonic Frequency**				
1 (Fund)	1	1	1	1	1
5	0.51	0.46	0.39	0.35	0.32
7	0.28	0.23	0.17	0.14	0.12
11	0.11	0.09	0.075	0.065	0.06
13	0.07	0.06	0.05	0.043	0.04
17	0.04	0.035	0.03	0.025	0.024
19	0.03	0.028	0.023	0.02	0.02
Total Harmonics	0.60	0.53	0.44	0.39	0.35
Thermal Current Irms	1.17	1.13	1.09	1.07	1.06

☐ Use Customer Specification   ☐ Customer Specification Attached

Voltage: _____________Volts (rms)   Frequency: _____Hz   Phase: ( ) 3 ( ) 1

Current: _____________ amps (rms)

% Impedance: _________ OR ____________mH

Harmonics: (3)____, (5)____, (7)____, (9)____, (11)____, (13)____, (15)____, (19)____ OR
(__)____, (__)____, (__)____, (__)____, (__)____, (__)____, (__)____, (__)____

Company: ______________________________ Name: ______________________________
Address: ____
City: ______________________________ St/Prov: ________________ PC/ Zip _____________
Tel: ______________________________ Fax: ______________________________
Email:____

Reactor Technology at its best!

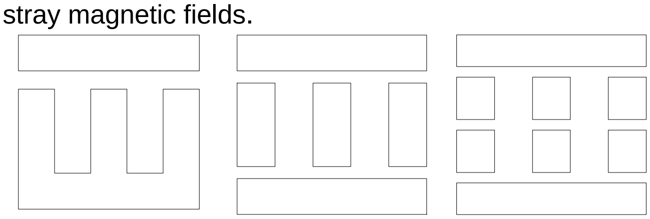
At Hans von Mangoldt, our only business is the design and production of reactors. No transformers, no filters, just the best reactors in the world. Mangoldt reactors are precisely engineered, manufactured and tested. Their continued investments into research and development, automated production equipment, real-life testing equipment and design expertise has propelled them into a world leadership role for low voltage as well as medium voltage reactors.

Mangoldt specializes in producing custom reactors for applications involving complex waveforms—those with harmonics, ripple or PWM voltage. Our reactors are supplied to the world's leading companies involved in the manufacture of:

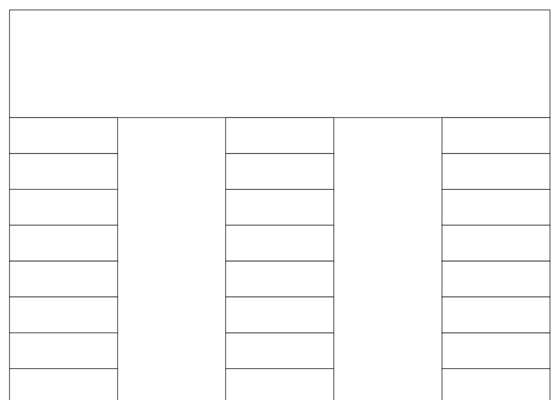
- Adjustable speed drives
- Active harmonic filters
- Tuned harmonic filters
- Reactive compensation
- Wind turbines
- Power factor capacitors
- Blocking filters
- Current limiting

PolyGap™ Core Construction

Exclusive PolyGap™ core construction, pioneered by Mangoldt, distributes the air gap into *numerous* tiny gaps, achieving lower harmonic losses, balanced phase-to-phase inductance and virtually eliminating stray magnetic fields.



Compare the difference. Reactors from competitors typically use from one to only a few large air gaps, thus experiencing greater harmonic heating, stray losses, and inferior performance.



Mangoldt PolyGap™ Core Structure

Programmable Harmonic Current Generator

Mangoldt testing capabilities include real life testing with both fundamental and harmonic currents. Electrical parameters such as inductance, Q-factor, power loss and temperature rise can be measured under real life operating conditions. Traditionally, for competitors, power loss data has typically been guesswork, or at best, measured under pure 60Hz conditions. Mangoldt takes the guesswork out of reactor design.

Programmable Harmonic Current Generator
1000kVA capacity

Reactor Technology at its best!

Product Specifications and Design Criteria

General Specifications

Voltage:	600 Volts maximum (for medium voltage to 35kV, contact factory)
Frequency:	50Hz/60Hz
Phases:	Three phase
Inductance:	+ / - 3% from rated mH, all phases
Insulation:	600V class, Class H insulation system
Ambient temp:	Suitable for 50C ambient temperature
Impregnation:	Vacuum & pressure, varnish impregnated
Altitude:	1000 meters maximum altitude without derating
Terminations:	Tab type terminals with clearance hole
Core type:	Exclusive PolyGap™ core construction for superior performance and inductance balance

Interpreting our Technical Data

Percent Impedance

Inductance ratings of Mangoldt Line Reactors offer precise impedance when applied at rated voltage and fundamental current.

Linearity Current

Mangoldt Line Reactors have extremely good saturation characteristics and will maintain at least 95% of their nominal inductance to approximately 200% of the fundamental current rating. Linearity amps for each reactor are stated in the selection tables.

Residual Harmonics (worst case at full load)

% Impedance	2.4%	3%	4%	5%
Residual Harmonics	48%	44%	38	35%

Harmonic Compensation

Mangoldt Line Reactors are designed for the worst case magnitude of residual harmonics that will be experienced under full load operating conditions at rated voltage and current. The Irms rated current is a continuous current.

Watts Losses

Unlike other reactor manufacturers, Mangoldt actually determines watts loss by measurement, while the reactor is fully loaded with both fundamental and harmonic currents. Since competitors typically publish and measure only 60HZ losses, Mangoldt publishes both 60Hz and the full rms losses in the selection tables.

Approvals

Mangoldt Line Reactors are UL / cUL approved (File E173113), meet IEC 289, IEC 76 and the EC low voltage directive.

Reactor Technology at its best!

Easy Line Reactor Selection Guide

480V/60Hz — 3 % Impedance

Part No.	HP	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190874	75	105	96	0.230	202	90	150
190875	100	135	124	0.178	261	100	180
190876	125	170	156	0.141	326	120	220
190877	150	196	180	0.123	376	130	230
190878	200	262	240	0.092	502	140	270
190879	250	329	302	0.073	631	190	340
190880	300	394	361	0.061	756	200	360
190881	350	452	414	0.053	865	240	480
190882	400	520	477	0.046	994	380	650
190883	450	576	515	0.043	1142	280	670
190884	500	644	590	0.037	1232	360	690

480V/60Hz — 5 % Impedance

Part No.	HP	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190885	75	101	96	0.383	183	120	200
190886	100	131	124	0.296	236	150	250
190887	125	165	156	0.236	296	170	290
190888	150	190	180	0.204	340	190	320
190889	200	254	240	0.153	454	220	360
190890	250	320	302	0.121	573	260	480
190891	300	382	361	0.107	685	300	540
190986	350	438	414	0.089	784	350	650
190892	400	505	477	0.077	904	360	650
190893	450	545	515	0.071	976	400	690
190894	500	625	590	0.062	1118	470	840

Reactor Technology at its best!

Easy Line Reactor Selection Guide

400V/50Hz — 3 % Impedance

Part No.	KW (max)	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190874	46	105	96	0.230	202	90	150
190875	62	135	124	0.178	261	100	180
190876	77	170	156	0.141	326	120	220
190877	93	196	180	0.123	376	130	230
190878	125	262	240	0.092	502	140	270
190879	155	329	302	0.073	631	190	340
190880	186	394	361	0.061	756	200	360
190881	220	452	414	0.053	865	240	480
190882	250	520	477	0.046	994	380	650
190883	280	576	515	0.043	1142	280	670
190884	310	644	590	0.037	1232	360	690

400V/50Hz — 5 % Impedance

Part No.	KW (max)	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190885	46	101	96	0.383	183	120	200
190886	62	131	124	0.296	236	150	250
190887	77	165	156	0.236	296	170	290
190888	93	190	180	0.204	340	190	320
190889	125	254	240	0.153	454	220	360
190890	155	320	302	0.121	573	260	480
190891	186	382	361	0.107	685	300	540
190986	220	438	414	0.089	784	350	650
190892	250	505	477	0.077	904	360	650
190893	280	545	515	0.071	976	400	690
190894	310	625	590	0.062	1118	470	840

Reactor Technology at its best!

Easy Line Reactor Selection Guide

600V/60Hz — 2.4 % Impedance

Part No.	HP	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190874	100	105	96	0.230	202	90	150
190875	125	135	124	0.178	261	100	180
190876	150	170	156	0.141	326	120	220
190877	200	196	180	0.123	376	130	230
190878	250	262	240	0.092	502	140	270
190879	300	329	302	0.073	631	190	340
190880	350	394	361	0.061	756	200	360
190881	400	452	414	0.053	865	240	480
190882	450	520	477	0.046	994	380	650
190883	500	576	515	0.043	1142	280	670
190884	600	644	590	0.037	1232	360	690

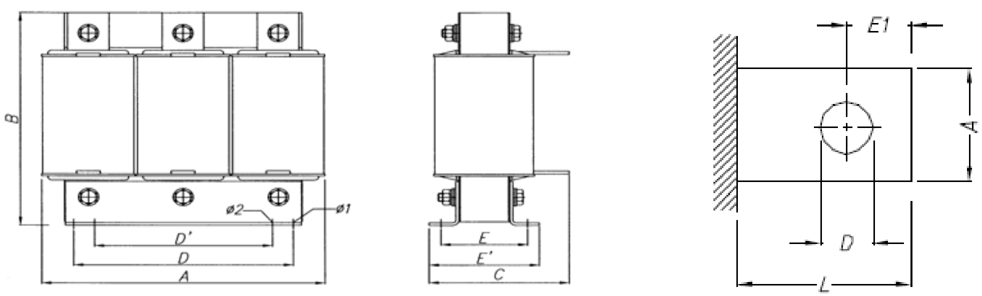
600V/60Hz — 4 % Impedance

Part No.	HP	I (rms)	I (fund)	mH	Amps Linear	Watts (60hz)	Watts (rms)
190885	100	101	96	0.383	183	120	200
190886	125	131	124	0.296	236	150	250
190887	150	165	156	0.236	296	170	290
190888	200	190	180	0.204	340	190	320
190889	250	254	240	0.153	454	220	360
190890	300	320	302	0.121	573	260	480
190891	350	382	361	0.107	685	300	540
1908986	400	438	414	0.089	784	350	650
190892	450	505	477	0.077	904	360	650
190893	500	545	515	0.071	976	400	690
190894	600	625	590	0.062	1118	470	840

Reactor Technology at its best!

Physical Properties

Part No.	Width (in / mm)	Height (in / mm)	Depth (in / mm)	Weight (lbs / kg)	Terminal Type	Terminal Size (mm)	Terminal Hole Dia.
190874	9.45 / 240	8.27 / 210	5.90 / 150	48 / 22	Cu tab	20 x 3	9mm
190875	10.43 / 265	9.45 / 240	6.10 / 155	62 / 28	Cu tab	20 x 3	9mm
190876	11.81 / 300	9.45 / 240	6.69 / 170	75 / 34	Cu tab	30 x 3	11mm
190877	11.81 / 300	9.45 / 240	6.69 / 170	77 / 35	Cu tab	30 x 3	11mm
190878	11.81 / 300	10.63 / 270	8.46 / 215	101 / 46	Cu tab	30 x 4	11mm
190879	11.81 / 300	11.81 / 300	8.46 / 215	112 / 51	Cu tab	30 x 5	11mm
190880	11.81 / 300	12.99 / 330	8.46 / 215	130 / 59	Cu tab	40 x 5	14mm
190881	14.17 / 360	13.97 / 355	9.05 / 230	158 / 72	Cu tab	50 x 5	14mm
190882	14.17 / 360	15.15 / 385	9.05 / 230	176 / 80	Cu tab	50 x 5	14mm
190883	16.53 / 420	18.50 / 470	9.84 / 250	246 / 112	Cu tab	50 x 5	14mm
190884	16.53 / 420	18.50 / 470	9.84 / 250	250 / 114	Cu tab	40 x 8	14mm



Part No.	Width (in / mm)	Height (in / mm)	Depth (in / mm)	Weight (lbs / kg)	Terminal Type	Terminal Size (mm)	Terminal Hole Dia.
190885	11.81 / 300	9.45 / 240	6.69 / 170	72 / 33	Cu tab	20 x 3	9mm
190886	11.81 / 300	10.63 / 270	7.87 / 200	81 / 37	Cu tab	20 x 3	9mm
190887	11.81 / 300	11.81 / 300	8.46 / 215	97 / 44	Cu tab	30 x 3	11mm
190888	11.81 / 300	11.81 / 300	8.46 / 215	108 / 49	Cu tab	30 x 3	11mm
190889	11.81 / 300	12.99 / 330	8.46 / 215	125 / 57	Cu tab	30 x 4	11mm
190890	14.17 / 360	13.97 / 355	9.05 / 230	161 / 73	Cu tab	30 x 5	11mm
190891	16.53 / 420	16.14 / 410	9.84 / 250	226 / 103	Cu tab	40 x 5	14mm
190986	16.53 / 420	18.50 / 470	9.84 / 250	253 / 115	Cu tab	50 x 5	14mm
190892	16.53 / 420	18.50 / 470	9.84 / 250	264 / 120	Cu tab	50 x 5	14mm
190893	16.53 / 420	18.50 / 470	9.84 / 250	264 / 120	Cu tab	50 x 5	14mm
190894	16.53 / 420	18.50 / 470	11.02/ 280	328 / 149	Cu tab	40 x 8	14mm

Reactor Technology at its best!

Consult Mangoldt for your other reactor needs:

Low Voltage: **600 volts or less**

Medium Voltage: **35kV or less**

Construction: **Iron core, Air core**

Phases: **1-phase, 3-Phase**

Types: **AC, DC**

Factory Contact Information:

Hans von Mangoldt GmbH
Hergelsbendenstrasse 18
D-52080 Aachen, Germany
Phone: + (49) 241 16607 0
Fax: + (49) 241 16607 35

USA Contact Information:

Allied Industrial Marketing, Inc.

Cedarburg, WI 53012
Phone: 1-262-618-2403
Fax: 1-262-618-2303

HANS VON MANGOLDT

Reactors for PWM Inverters

UL File: E173113
For USA & Canada

ISO-9001: 2001

ISO-14001: 1996

Typical Applications:

- Wind Turbines
- Fuel Cells
- Active Filters
- AC Motor Drives
- Active Re-Gen Drives
- Micro-Turbines
- Photovoltaic Systems
- AC Inverters
- Uninterruptible Power Supplies

We export to OEMs in over thirty countries

HANS VON MANGOLDT

USA Office

Cedarburg, WI 53012

Phone: 1-262-618-2403
Fax: 1-262-618-2303
E-mail: info@alliedindustrialmarketing.com

Form M-1410

Medium Voltage Reactors

Low Voltage Reactors

Exclusive PolyGap™ Construction

Our exclusive **PolyGap™** method of reactor core construction distributes the air gap into numerous tiny air gaps in order to achieve the minimum possible fringing flux losses, control audible noise and to virtually eliminate stray magnetic fields. Reactor eddy current losses are minimized while optimizing saturation characteristics.

Mangoldt has been supplying active filter reactors since the inception of IGBT input rectifiers.

Customer Submittal Form — PWM Reactors

Computerized design capabilities achieve tailor-made reactors based on specific customer requirements

Unique testing capability includes programmable harmonic current generator for testing in real life circuit conditions.

Customer Specification — Please tell us about your reactor preferences:

Nominal Voltage (V_N): _______________ Volts line-to-line ( ) 50hz or ( ) 60hz

Phases: ( ) Three phase ( ) Single phase

Switching frequency (f_S): _______________kHz

Inductance tolerance: + _____%, - _____% of L_{Nom}

Current spectrum (pk): _______A_{pk} at ________kHz, _______A_{pk} at _______kHz,
_______A_{pk} at ________kHz, _______ A_{pk} at _______kHz.

Thermal current (I_{RMS}) 1.____ x I_{fund}

Core linearity (I_{LIN}): 1.____ x I_{fund}

Maximum ambient temperature: _____° Celcius

Allowable temperature rise: _____° Celcius

Forced air cooling available: ____ LFM or ______ CFM

Fundamental current: ____________ Amperes

Inductance: _____________uH or
________________mH

Quantity: ____________

Special requirements: ____
____
____
____

Company: ____________________________ Name: ______________________________________

Address:____

City: ________________________________ St/Prov: ________________ PC/ Zip _______________

Tel: _________________________________ Fax: ____

Email: ____

SINGLE PHASE INRUSH CURRENT DAMPING REACTORS FOR MEDIUM VOLTAGE POWER CAPACITORS

ED09.2006

SINGLE PHASE INRUSH CURRENT DAMPING REACTORS FOR MEDIUM VOLTAGE POWER CAPACITORS

Contents

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1. General specification for inrush current camping reactors

1.1 International standard referred to: IEC 289 resp. IEC 76

1.2 Mounting conditions: Indoor

1.3 Rated current: $I_N = 1{,}1 \cdot 1{,}3 \cdot I_{CN} = 1{,}43 \cdot I_{CN}$ (This value respects a permanent overvoltage of 10 % as well as an overdimensioning of 30 % as prescribed in IEC 831 standard

1.4 Harmonic load: According to EN 61000-2-2. However care must be taken that the resonance frequency of the reactor/capacitor circuit is not tuned to one of the harmonic frequenies mentioned in the EN standard

1.5 Short circuit specification: $25 \cdot I_N$

1.6 Tolerances: 0 ... + 20 % of rated inductance acc. to IEC standard

2. Specific design details for inrush current damping reactors

Single-phase reactors without housing for indoor application IP 00, air cored, aluminium (Al) windings, electrical lay-out acc. to IEC 289 and IEC 76, insulation class T50/B, suitable for ambient temperature **50 °C**, coils impregnated under vacuum and overpressure in polyester resin class H and dried in furnace temperature of 150°C, assembled unit mounted on cast resin insulators acc. to BIL

3. Terminals

The terminals for the connection to line and load are realized by copper bars similar to DIN 46 206. Please note that reactors with aluminium windings also provide copper bars for the connection of the cables.

4. Prices

The indicated prices are unit prices based on the indicated quantities. For larger quantities please inquire

5. Payment and delivery conditions

The deliveries are acc. to the ORGALIME GENERAL CONDITIONS for the SUPPLY OF MECHANICAL. ELECTRICAL AND ASSOCIATED ELECTRONIC PRODUCTS - Brussels, Oktober 1992

Payment conditions: as agreed to between purchaser and supplier

Forwarding conditions: Incoterm code FCA Forwarder Aachen

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6. Definition of the abbreviations referred to

U_N	(V)	:	nominal line voltage
f_N	(Hz)	:	nominal line frequency
L	(µH)	:	inductance of the reactor
I_N	(A)	:	lay-out rms current as specified
N_V	(W)	:	total worst case losses at rms current
weight	(kg)	:	total weight of the reactor

Single Phase Inrush Current Damping Reactors for Medium Voltage Power Capacitors

following the rules of IEC 76 and IEC 289

designed for indoor mounting at normal ambient conditions (50 ° Celsius) and less than 1000 m above sea level

I_{rms} = 25 ... 120 A

I_{rms} = 25 ... 75 A								
L/µH	20	40	60	80	100	120	150	200
$N_V(I_N)$/W	37	39	49	58	66	71	82	77
a / mm	140	155	165	190	195	200	210	225
b / mm	140	140	140	140	140	140	140	150
c / mm	170	185	195	220	225	230	240	255
Weight / kg	2,4	2,9	3,2	3,5	3,7	4,0	4,3	6,0
EURO/unit 3 units **FCA**	108,00	112,00	116,00	130,00	132,00	135,00	138,00	153,00
EURO/unit 6 - 15 units **FCA**	106,00	108,00	112,00	126,00	127,00	131,00	135,00	147,00
EURO/unit > 15 units **FCA**	103,00	106,00	109,00	122,00	123,00	127,00	131,00	143,00

I_{rms} = 100 A								
L/µH	20	40	60	80	100	120	150	200
$N_V(I_N)$/W	36	48	53	58	80	87	98	100
a / mm	150	165	180	180	205	210	220	240
b / mm	150	150	150	150	150	150	150	150
c / mm	180	195	210	210	235	240	260	270
Weight / kg	3,2	3,8	4,6	5,0	5,1	5,5	6,0	7,3
EURO/unit 3 units **FCA**	115,00	120,00	127,00	133,00	147,00	150,00	152,00	166,00
EURO/unit 6 - 15 units **FCA**	112,00	117,00	123,00	129,00	142,00	146,00	148,00	161,00
EURO/unit > 15 units **FCA**	108,00	114,00	119,00	125,00	138,00	141,00	144,00	157,00

I_{rms} = 120 A								
L/µH	20	40	60	80	100	120	150	200
$N_V(I_N)$/W	45	68	65	77	110	125	110	125
a / mm	155	160	175	185	205	210	230	245
b / mm	150	175	175	175	175	175	175	175
c / mm	185	190	195	215	235	240	260	275
Weight / kg	3,4	4,0	5,4	6,1	5,4	5,8	8,4	9,0
EURO/unit 3 units **FCA**	117,00	125,00	139,00	146,00	151,00	155,00	174,00	183,00
EURO/unit 6 - 15 units **FCA**	114,00	120,00	136,00	141,00	146,00	149,00	169,00	178,00
EURO/unit > 15 units **FCA**	109,00	117,00	131,00	137,00	141,00	145,00	164,00	172,00

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Single Phase Inrush Current Damping Reactors for Medium Voltage Power Capacitors

following the rules of IEC 76 and IEC 289

designed for indoor mounting at normal ambient conditions (50 ° Celsius) and less than 1000 m above sea level

I_{rms} = 150 ... 200 A

I_{rms} = 150 A								
L/µH	20	40	60	80	100	120	150	200
$N_V(I_N)$/W	70	73	88	135	120	130	130	150
a / mm	150	175	175	200	220	225	250	265
b / mm	200	200	200	200	200	200	200	200
c / mm	190	205	205	240	260	265	290	305
Weight / kg	3,8	5,5	6,3	5,8	8,0	8,5	12,0	13,6
EURO/unit 3 units **FCA**	124,00	139,00	147,00	155,00	173,00	178,00	208,00	224,00
EURO/unit 6 - 15 units **FCA**	120,00	136,00	142,00	149,00	113,00	172,00	203,00	217,00
EURO/unit > 15 units **FCA**	117,00	131,00	138,00	145,00	163,00	167,00	196,00	211,00

I_{rms} = 200 A								
L/µH	20	40	60	80	100	120	150	200
$N_V(I_N)$/W	80	120	150	175	190	210	200	220
a / mm	160	180	210	220	225	230	255	270
b / mm	240	240	240	240	240	240	240	240
c / mm	200	220	250	260	265	270	295	310
Weight / kg	5,7	7,2	8,6	9,6	10,5	11,3	15,4	17,4
EURO/unit 3 units **FCA**	146,00	160,00	185,00	194,00	202,00	211,00	252,00	270,00
EURO/unit 6 - 15 units **FCA**	141,00	155,00	180,00	189,00	195,00	204,00	244,00	262,00
EURO/unit > 15 units **FCA**	137,00	151,00	174,00	183,00	190,00	197,00	237,00	254,00

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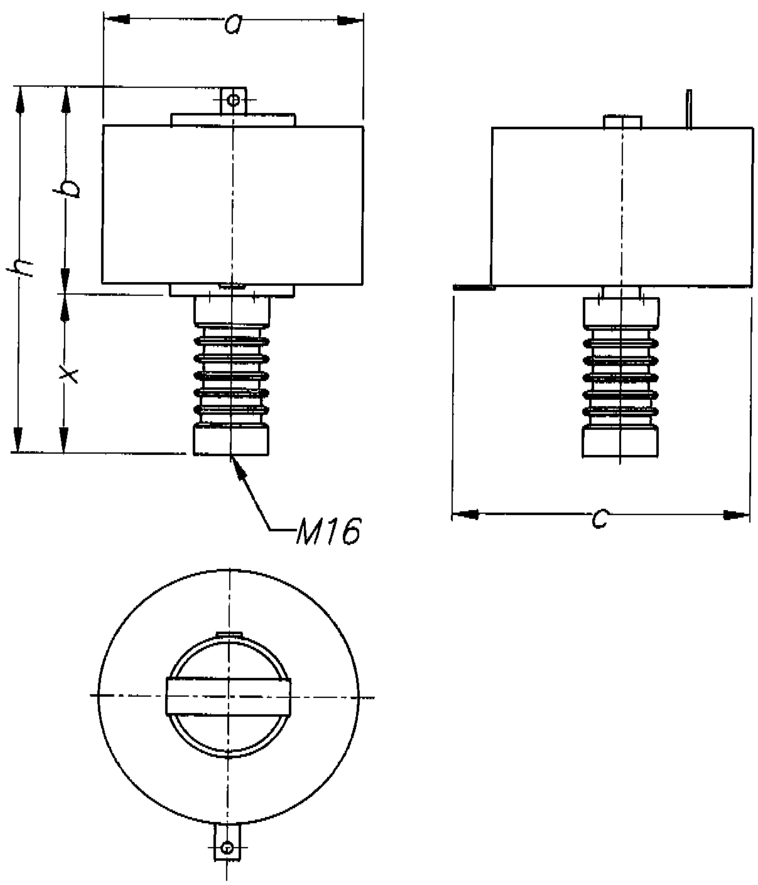

System voltage/kV	BIL	x/mm
7,2	60	95
12,0	75	130
17,5	95	210
24,0	125	210

Minimum magnetic distance between reactor and metall pieces (closed loops exclused)

Axial : 0,5 · a
Radial : 1,1 · a or 1 · a + 80 mm (the greater value)

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Hans von Mangoldt North America Sales Procedures

Ordering procedures
Orders may be sent to Allied Industrial Marketing. Purchase orders should be addressed to: **Hans von Mangoldt, Hergelsbendenstrasse 18, Aachen, Germany D-52080**. Order acknowledgement will be faxed to the customer once the factory schedule for production and testing has been determined.

Shipment
Shipment is typically made to an eastern coast (USA or Canada) seaport unless otherwise specified. Alternatives include westcoast port or airfreight direct to the customer facility. It is requested that the customer include complete contact information (including email) for their customs broker or freight forwarder on the purchase order. The bill of lading will be available either from the customer's freight forwarder or Hans von Mangoldt once the vessel has left port.

Sea Ports
Typical eastern seaports include: New York, NY, Miami, FL, Boston, MA, Philadelphia, PA, Halifax, NS, Montreal, QC, Quebec, QC. Typical western seaports include: Houston, TX, Los Angeles, CA, San Francisco, CA, Seattle, WA, Vancouver, BC,

Freight Charges
Normally, HvM quotations are stated as "c.i.f." and are inclusive of the cost of goods plus ocean freight and insurance to the specified port. Alternatively, prices may be quoted ex-works (f.o.b factory).

Invoices
Invoices will be sent via fax upon shipment of goods.

Payment
For approved credit, and unless otherwise specified, prices are stated in "euros" and payment is due 60 days after the invoice date. Payment should be made by SWIFT wire transfer to either Sparkasse or Commerzbank as follows:

SPARKASSE

Account No:	652 446
Bank Code:	390 500 00
SWIFT code Sparkasse Aachen:	AACSDE33
IBAN code Sparkasse:	DE85 3905 0000 0000 6524 46

COMMERZBANK AACHEN

Account No:	1 208 016
Bank Code:	390 400 13
SWIFT code Commerzbank Aachen:	COBADEFF390
IBAN code Commerzbank:	DE36 3904 0013 0120 8016 00

Any questions: Call 1-262-618-2403.