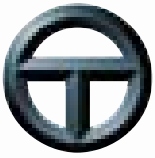


THE **POWER** OF TECHNOLOGY



TRENCH®



TRENCH®

TRENCH®: A specialized manufacturer of high voltage electrical equipment dedicated to serving the electrical industry world-wide through engineering, service and commitment.

There are many reasons why power companies, research institutes and electrical engineering companies in many nations rely on the superior technologies of Trench®. Our product line is based on in-depth competence in development and manufacturing. A highly significant fact in this concept is the independence of Trench® in all of its key core competencies including: insulation, windings, capacitors, electronics and systems engineering technologies. We develop and master these key technologies in-house, which provides a significant quality factor and increases our ability to solve customer problems.

Innovation is another key principle: the development of new technologies is funded with an above-average percentage of sales. Affiliations with leading research institutes gives Trench® the opportunity to be at the forefront of technological change.

The company is well represented throughout the world with four manufacturing plants in North America, six manufacturing plants in Europe, two in Asia and one in South America. A worldwide sales network ensures efficient knowledgeable communications with our customers.

The people that make up Trench are also its biggest asset, from a world wide sales network to highly qualified engineers and technicians who deliver fast and reliable support whenever and wherever required.

Trench depends on the imaginations, intelligence and curiosity of its employees to drive the growth of our businesses, and strengthen our leadership position in the marketplace.

Trench® is an international market leader, with strengths that translate into a maximum benefit for our customers.



TRENCH



Trench® Austria GmbH

Trench® Brasil Ltda

Trench® Canada - Ajax

Trench® Canada - Scarborough

Trench® China - Shanghai

Trench® China - Shenyang

Trench® France S.A.

Trench® Germany GmbH

Trench® Italia

Trench® Switzerland AG

Trench® (UK) Limited

Air Core - Dry Type Reactors

For more than 40 years, Trench® has supplied air core dry type reactors to the electric power industry. Versatility, confirmed capability and compliance with the most stringent quality standards ensure that Trench® maintains a world-wide leadership position for these products.

Features of Trench® air core dry type reactors:

- Epoxy resin impregnated, fiberglass encapsulated construction
- Aluminum construction throughout with all current carrying connections welded. Copper construction is also available upon request
- Highest mechanical and short-circuit strength
- Essentially zero radial voltage stress, with uniformly graded axial voltage distribution between terminals
- Low noise levels maintained throughout the life of the reactor
- Design service life in excess of 30 years
- Weatherproof construction, with minimum maintenance requirements
- Designs available in compliance with ANSI/IEEE, IEC and other international standards

Shunt Reactors

Shunt reactors compensate for capacitive VARs generated by lightly loaded transmission lines or underground cables. They are normally connected to the transformer tertiary winding but can also be directly connected on systems up to 138 kV. Shunt reactors are extensively used in static VAR systems where reactive VARs are adjusted by thyristor circuits.

Current Limiting Reactors

Current limiting reactors reduce the short-circuit current levels within the ratings of the equipment on the load side of the reactor. Applications of current limiting reactors range from the simple distribution feeder reactor to large bus-tie and load balancing reactors on systems rated up to 800 kV, 2100 kV BIL.



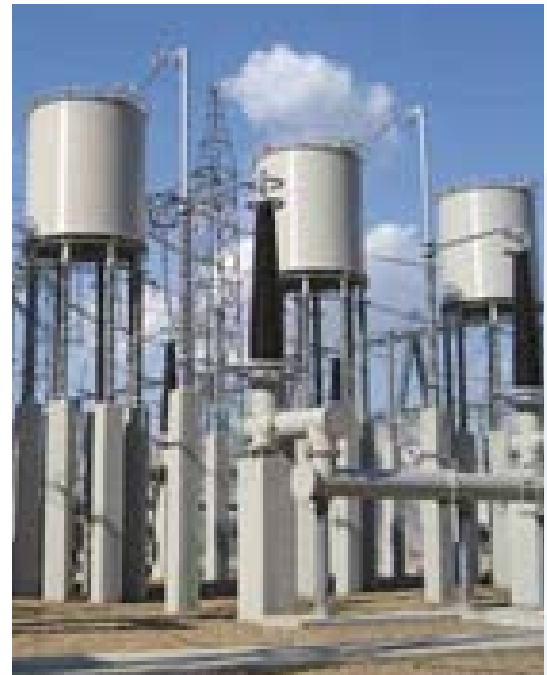
Thyristor controlled reactors in a static var compensator (SVC)



13.8kV, tertiary connected shunt reactors



500kV, Capacitor reactors



345kV, transmission current limiting reactors

Capacitor Reactors

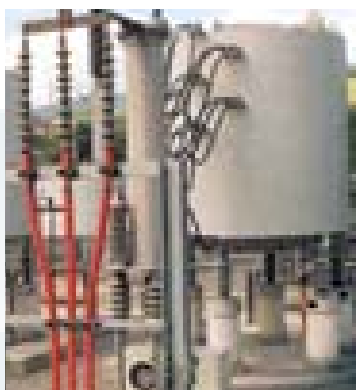
Capacitor reactors are designed to be installed in series with a shunt connected capacitor bank to limit inrush currents due to switching, to limit outrush currents due to close-in faults and to control the resonant frequency of the system due to the addition of the capacitor banks. These reactors can be installed on systems rated up to 800 kV, 2100 kV BIL.

Buffer Reactors for Electric Arc Furnaces

The most effective use of electric arc furnaces is achieved by operating the furnace at low electrode current and long arc length. This requires the use of a series reactor in the supply system of the arc furnace transformer for stabilizing the arc throughout the melting process.

Neutral Grounding Reactors

Neutral grounding reactors limit the line-to-ground fault current to specified levels. They are connected between the transformer neutral and ground. *(See also Resonant Grounded Systems)*



EAF reactors with off load tap changers



Duplex Reactors

Duplex reactors are current limiting reactors which consist of two half coils, wound in opposition. These reactors provide a desirable low reactance under normal conditions and a high reactance under fault conditions.

Filter Reactors

Filter reactors are used in conjunction with capacitor banks to form series tuned harmonic filter circuits, or in conjunction with capacitor banks and resistors to form broad-band harmonic filter circuits. The reactors can be supplied with inductance taps, special patented de-Q'ing rings for quality factor control and can be manufactured with closely controlled tolerances.



230KV, AC filter reactors with seismically designed support structures

Air Core - Dry Type Reactors

Test Reactors

Test reactors are used in high voltage and high power test laboratories. Typical applications include current limiting, synthetic testing of circuit breakers, inductive energy storage, artificial lines, etc.

Smoothing Reactors

Smoothing reactors reduce the magnitude of the ripple current in DC systems.

They are used in power electronics applications such as variable speed drives and UPS systems. They are also required on HVDC transmission lines and are available for system voltages up to 500 kV and 500 MVA equivalent power ratings.

Load Flow Control Reactors

Load flow control reactors change the line impedance characteristics such that flow can be controlled, thus ensuring maximum power transfer over adjacent transmission lines. These reactors are series connected on transmission lines up to 800 kV.

Acoustic Noise Modeling and Shielding

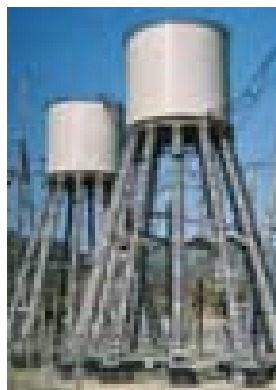
Trench leads the industry with inherently low audible sound level reactor construction augmented by detailed acoustic modeling, special reduced sound level designs and sophisticated sound shielding techniques.

Seismic Analysis and Design

Trench products have satisfied the most demanding seismic requirements in the world. A variety of different seismic modeling and design techniques are employed depending on ground acceleration, insulation level and the physical arrangement of the equipment.



138kV, variable impedance series load flow reactors



500kV, 2250A DC smoothing reactors



115kV, 30 ohm, series load flow reactors



500kV, transmission bus tie reactor

Other Design Services

- Magnetic field analysis and mitigation techniques
- Electrical system studies and analysis
- Transient Recovery Voltage mitigation techniques
- Support structure design and turnkey installation



350kV HVDC smoothing reactor with seismic damping system



500kV COT (A) bushing under seismic testing



AC harmonic filter reactors with sound mitigation shields

Iron Core - Iron Shielded - Oil Immersed Reactors

Resonant Grounded Systems

The most common type of failure in electric power systems is the single-phase to ground fault. It is the reason for up to 80% of all disturbances on high voltage systems. Significant improvement in power quality is achieved through the reduction of power outages by operating a network as a resonant grounded system (also known as a compensated system) by connecting the system's neutral to ground through one or more high impedance devices. By utilizing an iron core reactor (Arc Suppression Coil (ASC), also known as Petersen Coil), which is tuned to the total system capacitance to ground, the original capacitive fault current (up to a few 100 A) is compensated by the inductive current of the ASC.

Consequently, the remaining residual current through the point of failure is considerably reduced and mainly of ohmic nature. Its magnitude is typically only 5 to 10% of the original fault current.

Use of an ASC offers the following operating benefits:

- Essentially lower ground fault currents when compared to resistor grounded or isolated systems
- Minimization of dangerous effects to personnel and equipment
- Reduces risk of re-strike and intermittent ground faults
- The majority (up to 80%) of single-phase to ground faults are self-healing and hence do not cause any interruptions in power supply
- For the remaining low number of permanent ground faults, uninterrupted service during fault conditions is allowed, therefore unscheduled power outages are minimized

Trench® is the world leader in offering complete solutions for resonant grounded systems:

• Arc Suppression Coil (ASC)

Several different designs are available:

Plunger core ASC: continuously on-load adjustable by moveable cores

Step-type ASC: off-load adjustable via winding taps

Fixed-type ASC: non-adjustable

Neutral aggregate: artificial neutral-point former combined with an ASC, for applications without available neutral-point

Trench® has over 30 years of experience in this special equipment.



Water cooled DC-Reactor



ASC 10kV, 400 KVAR



ASC 10kV, 1000 KVAR

• **Earth Fault Compensation controller (EFC)**

This electronic device can be supplied to provide automatic tuning of the continuously adjustable ASC to the actual system capacitance to ground. Trench® has been the standard driving manufacturer of such equipment for more than 25 years.

• **Earth Fault Detection system (EFD)**

This system is able to detect the faulted feeder not only in low ohmic ground faults but for extremely high ohmic cases (up to a few 10kOhm). Trench® was the first company able to deliver such high-performance protection systems.

Besides the traditional air core dry type reactors, Trench® designs and manufactures specialty reactors which utilize iron core, iron shielded and/or oil immersed construction.

Applications of these reactors include:

- DC reactors to reduce ripple currents in DC drive systems
- Three-phase variable shunt reactors with ratings up to 145kV, 40 MVar
- Arc suppression reactors (Petersen Coils) for resonant grounded systems up to 145 kV, 35 MVar



EFC



ASC 20kV, 5000 KVar

Instrument Transformers

Instrument transformers transform currents and voltages to measurable levels. Worldwide Trench® is one of the largest suppliers of instrument transformers with the broadest and most complete product line for high and extra-high voltage applications. All instrument transformers feature quality, outstanding characteristics and an excellent price/performance ratio.

Trench® designs and manufactures oil insulated and SF₆ gas insulated instrument transformers for current and voltage measurement. All are suitable for revenue metering and protection applications and comply with all ANSI/IEEE, IEC and another international standards. In addition, all instrument transformers can be supplied with porcelain or composite insulators.

230kV oil insulated capacitor voltage transformers



245kV, SF₆ insulated current transformers

Insulation Systems

From 25 kV to 800 kV, Trench® offers current transformers (CT), potential transformers (PT) and combined instrument transformers (CIT) utilizing oil/paper or SF₆ gas insulation systems. Our customers have the option of selecting the insulation which best suits the operational requirements of the power system.

The oil/paper dielectric system is based on many decades of successful experience and utilizes conservative designs with highly processed pure kraft paper and mineral oil. An excellent understanding of stress distribution, coupled with mechanical designs for explosion resistance result in reliable and safe instrument transformers.

Instrument transformers utilizing the SF₆ gas insulation system, normally supplied with a composite insulator housing, offer many operating features including: non-aging insulation system, explosion proof operation, high seismic strength and lightweight construction.



245kV, SF₆ insulated, combined instrument transformers



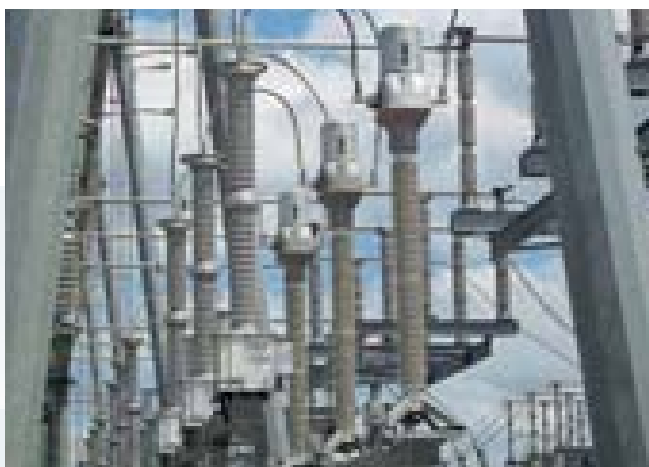
300kV, oil insulated current transformers

Current Transformers

Current transformers are available for applications from 25 kV to 800 kV systems, for relaying and/or metering circuits. Multi-ratio relaying cores, metering cores and special anti-remenance cores are offered in various combinations.

All Trench® current transformer designs are based in “top core” or “head type” construction. Features of this design and construction include:

- Extremely high mechanical strength under short-circuit conditions
- Immunity to localized core saturation
- Negligible voltage drop across primary winding
- Hermetically sealed construction
- High seismic withstand
- Low partial discharge levels at test voltage
- Optional ground fault CT's and capacitance taps
- High accuracy designs (0.10%)
- Broad range metering from maximum to less than 1% of rated current



245kV, oil insulated current transformers and capacitor voltage transformers



500kV, SF₆ insulated current transformers with composite insulators

Instrument Transformers

Potential Transformers

Inductive voltage transformers are designed for 25 kV to 800 kV systems and are used to provide voltage for metering and protection applications.

Features of Trench® PT's include:

- Modern, lightweight design with high dielectric and mechanical strength
- Hermetically sealed construction
- High thermal burden capability (2500 VA or higher)
- Power voltage transformers up to 30 kVA
- Available high accuracy designs
- Transmission line discharge capability
- Zero delay transient response
- Ferroresonance suppression designs

RC Voltage Dividers

Resistive-capacitive voltage dividers, named also resistive-capacitive voltage transformers, are designed for measurement of the voltage in HVDC transmissions systems, air insulated (AIS) or gas insulated (GIS) switchgear.

In AC transmission systems, the Trench® RC voltage transformers are used for the measurement of harmonics, indeed they give an accurate representation of the voltage over a wide frequency band, (typically from DC up to 500 kHz), and are not sensitive to the trapped charges phenomena.

For AIS, the Trench® RC dividers are available up to 800 kV, with composite or porcelain insulators, with oil or SF₆ Gas insulation.

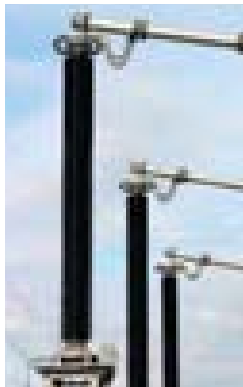
For GIS metal encapsulated switchgear, RC dividers are available up to 500kV.

Features of Trench® RC dividers:

- Hermetically sealed construction
- Stainless steel expansion chamber
- Composite insulator designs available
- High seismic withstand design available
- Oil or SF₆ insulation



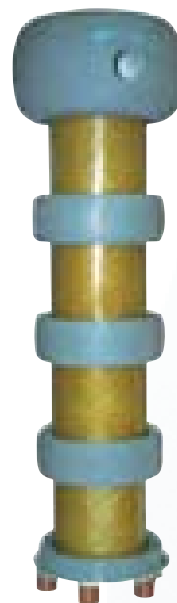
420kV, Oil insulated potential transformer



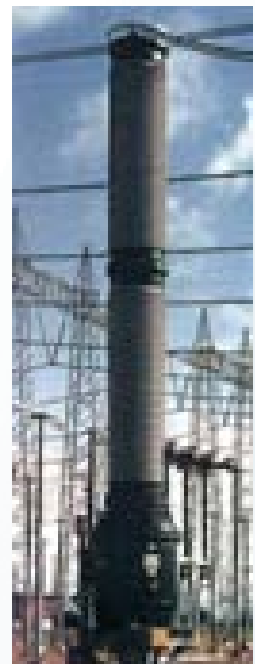
420kV, Oil insulated unit with porcelain insulator



500kV, SF₆ insulated unit with composite insulator



500kV, RC divider for GIS



765kV, SF₆ insulated potential transformer with composite insulator

Capacitor Voltage Transformers / Coupling Capacitors

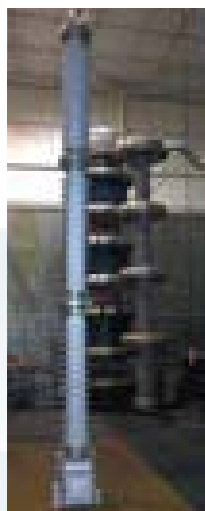
Coupling capacitors (CC's) are utilized to couple high frequency carrier signals to the power line. A CC supplied with an electromagnetic unit is called a Capacitor Voltage Transformer (CVT) and is used to provide voltage for metering and protection applications. The coupling capacitor is also utilized in HVDC applications in conjunction with thyristor valves and can be used for Transient Recovery Voltage (TRV) control in substations.

Features of CVT's and CC's include:

- Highly reliable insulation system
- Film/synthetic fluid dielectric
- High stability of capacitance and accuracy
- Hermetically sealed construction
- Stainless steel expansion chamber with controlled pressure release
- Extra high strength porcelain for line trap mounting
- Composite insulator designs available
- Oil insulated base box for maximum reliability



Epoxy resin impregnated/encapsulated line trap mounted directly on a coupling capacitor



500kV, Oil insulated capacitor voltage transformer with composite insulator

All CVT's are available with metering or relaying accuracy. Superior transient response and ferroresonance suppression performance is assured throughout the various CVT types manufactured. CC's and CVT's are offered for voltage ratings of 69 kV - 800 kV.



230kV line trap mounted directly on a capacitor voltage transformer

230kV oil insulated capacitor voltage transformers

Instrument Transformers

Combined Instrument Transformers

The Trench® combined instrument transformer (CIT) offers the station designer the possibility of being able to accommodate the current transformer and the potential transformer in one, free-standing unit. This allows optimum use of substation space while yielding cost savings by elimination of one set of mounting pads and support structures. In addition, installation time is greatly reduced.

As with individual current transformers and potential transformers, Trench® CIT's are available with either oil/paper or SF₆ gas dielectric systems.

All operating and construction features are similar to those listed for the individual current transformers and potential transformers.

Trench® offers an unparalleled scope of supply with the ability to provide CIT's up to 800 kV.



245kV, Oil insulated combined instrument transformers



800kV, SF₆ insulated combined instrument transformer
(extended accuracy range)

GIS Instrument Transformers

Trench® is a major manufacturer of current transformers and potential transformers for use in gas insulated substations (GIS) or metalclad switchgear. These SF₆ insulated instrument transformers are normally supplied to original manufacturers of GIS equipment, but are also available for retrofit or maintenance applications. Special designs with extra functions such as IFS (integrated ferroresonance suppression) and IID (integrated isolation devices) are available.

GIS current transformers are mounted within the GIS equipment. GIS potential transformers are separately housed in a metallic tank and bolted to the GIS equipment.

Typical application range is from 72.5 kV to 800 kV. GIS instrument transformers are available in single-phase or three phase and comply with ANSI/IEEE, IEC and other international standards.



Low Power Transformers

Trench® has developed a range of voltage and current low power transformers, LOPO®, compatible with digital technology and meeting the requirements of IEC standards 60044-7 and 60044-8. These transformers can be used for a wide range of medium and high voltage applications where they replace the conventional transformers for measurements and protection purposes with new opportunities to optimize size, manufacturing, logistics and operation.

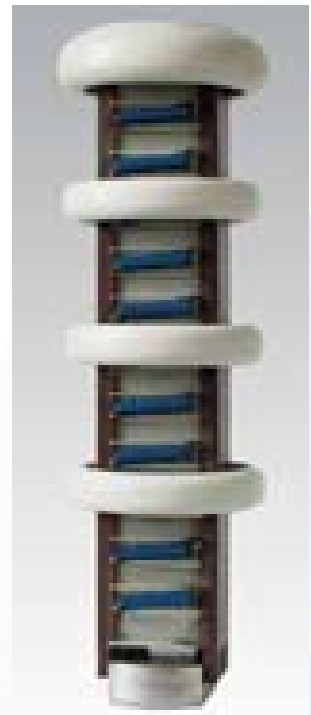
The Trench® low power voltage transformer LOPO® is a passive device based on resistive, and resistive capacitive dividers. These transformers provide a secondary voltage proportional to the primary voltage, without saturation.

The Trench® low power current transformer LOPO® is a passive device, based on the principle of a ring core transformer with an integrated shunt. This transformer provides a voltage output proportional to the primary current.

Advantages of the Trench® LOPO® transformers:

- Cost effectiveness:
 - A single sensor for measurement and various protection purposes

- Reduce size and weight: easy to handle, less space required
- The voltage transformer is able to withstand the on-line switchgear and cable voltage testing: no disconnection required
- Reduce inventory: one current transformer type can handle a large primary current range
- The LOPO® voltage transformer is ferroresonance free
- The LOPO® voltage transformer has a large frequency band, from DC to several kHz
- No secondary circuit problem: voltage and current transformers can have their secondary open or short circuited
- Increased operator safety with metal encapsulated housing (medium voltage)
- Environment friendly



Power Line Carrier Systems

Power Line Carrier (PLC) is a common method of power systems communication. It has become one of the most economical and reliable forms of communication in its application.

PLC utilizes the high voltage power transmission line as a transmission medium for high frequency communication signals. An efficient coupling path must be provided between the PLC transceiver and the proper combination of line traps, coupling capacitors and line tuners.

Line Traps

Line traps are connected in series with the transmission line, between the point of connection of carrier frequency signals and adjacent power system substation components. The line trap presents a low impedance to power frequency, but maintains a high impedance at power line carrier frequencies (30-500 kHz), limiting the attenuation of the carrier signal within the substation equipment.

Since line traps are series connected with the HV transmission line, they must be designed to withstand the high mechanical forces generated by the short-circuit currents associated with the HV transmission system. Trench® line traps are designed to meet ANSI C93.3,



500kV suspension mounted line trap

All tuning devices can be supplied as either fixed-frequency or adjustable-frequency.

Tuning options include:

- single-frequency
- double-frequency
- wide-band

IEC 353 and other international standards requirements.

The insulation of the internal tuning device is coordinated to ensure high reliability against transients.

Trench® is the major supplier of line traps world-wide. All line trap designs are based on the need for high mechanical short-circuit strength, reliable tuning and low maintenance. These features are key requirements for any equipment that is installed in series with transmission lines. All line traps are available up to 800kV, 6000 A ratings.

Trench® offers line traps that utilize a well-proven winding system: the epoxy resin impregnated/encapsulated design. With the exception of self-tuned line traps, all line traps are supplied with internally mounted tuning devices and parallel connected lightning arresters.

Trench® line traps can be mounted or installed in many configurations including:

- single insulator support pedestal (allows mounting on top of coupling capacitor or capacitor voltage transformer)
- multi-insulator support pedestal
- insulated pedestal
- suspension mounting

Line Tuners

Trench offers line tuners for the following applications:

- Single-Frequency
- Double-Frequency
- Band-Pass
- High-Pass
- By-Pass



500kV line trap mounted onto a platform/composite foam filled insulated combination

Transmitters & Receivers

Trench® has the unique capability to offer a complete power line carrier system, ranging from line coupling equipment to a completely assembled, fully tested relay communication system, including the associated relays.

A complete assembly can consist of primary and backup communications and relays along with test panels, switches, fuses and indicator lights. This complete system, engineered by Trench®, is provided with full elementary and wiring diagrams along with instruction manuals covering the complete system.

Advantages of a complete system provided by a single manufacturer:

- System responsibility
- Customized engineering and drawings
- Assemblies with doors can be furnished with “LEXAN” inserts for viewing indicator lights, etc.
- Locking handles are standard
- Full system testing and back-to-back tests are provided

Programmable Carrier Terminal (PCT)

Trench® introduced to the market a new PLC terminal with many advanced features. Programmable Carrier Terminal (PCT) is designed to minimize lifetime operating costs of the terminal. Programming and level settings are all done automatically without use of jumpers or manual level adjustments. The terminal can be programmed to operate as FSK or ON-OFF over the 30 to 500 kHz frequency range.

Channel times and required RF bandwidths are selectable in either mode of operation, thus allowing use of the terminal in most of the communication assisted power line protection schemes. The terminal can operate from any of the standard substation battery voltages: 48 VDC, 125 VDC or 250 VDC.

There are no spare parts required – one terminal can be used as a spare for a number of terminals in the operation. This greatly reduces cost of operation.

Programmable Carrier Terminal (PCT) can be programmed to operate as either an FSK PLC terminal or as an On-Off PLC terminal. Programming of the mode of operation is achieved via a computer connected to either an Ethernet port at the rear of the terminal or to a RS232 port at the front of the terminal. All software that is required to program the terminal is located in the terminal. The computer must only have an Internet browser installed in it.

The terminal is programmed to monitor all its subassemblies and provide alerts or alarms if subassembly operation is outside of expected limits. Automatic system setup and system monitoring is also programmed into the terminal, thus eliminating a need for any manually initiated maintenance activities. This further reduces operating costs.

This versatile terminal can satisfy most telecommunication requirements of the power line protection schemes applied by the majority of the North American Utilities. Programming of the various parameters of the terminal is achieved by simple selection of the appropriate programming panel and activating the desired parameter by “point and click” of the computer mouse. The receiver sensitivity in either mode of operation is selectable within appropriate range of values. The transmitter power output can be programmed for any power level from 1-Watt to 100-Watt output.



The following legacy terminals are still available from Trench®:

Keyed Carrier PLC

The CS28A transmitter-receiver provides power line carrier protection channel for blocking type relaying. The keyed carrier system operates over power transmission lines in the frequency range of 30 to 500 kHz.

CS28A On-Off Carrier System with ACMS

An On-Off Carrier system, consisting of two or more (up to 7) CS28A, can be controlled and monitored by having ACMS modules installed in each CS28A unit in the system. One CS28A unit is designated “master” and all other units are “remotes.” Each remote unit has ID No. Master is always Unit 0, and remotes are Units 1-6. Initially, each CS28A unit is adjusted as per instruction manual.

Once the system is completely adjusted, initial transmit and receive levels can be obtained and saved in the “master” ACMS using a PC based CS28 ACMS program and following prompts on the screen.

The subsequent transmit and receive levels can be compared with the initial readings, and a system analyses performed to identify changes, if any, in the system levels. The results of such analyses can be displayed on a PC.

In addition to its relaying function, the CS28A can be used for voice communication and low speed supervisory control and telemetering.

Keyed Carrier Model CS28A

- Directional or Phase Comparison
- Voice Communication

Specifications

- 1.5 to 3.0 ms channel speeds
- Narrow band or wide band receiver
- Advanced checkback with system analyses
- Built in diagnostics
- Frequency programmable



Frequency Shift PLC

The CS28A 51 / 61 / 71C transmitter-receiver provides power line carrier protection channels for permissive or direct transfer trip relaying schemes and unblocking relaying. It can be either one-way, or two-way where line protection or breaker failure protection is required. It can be supplied for either single or dual channel operation. This frequency shift keyed (FSK) system operates over power transmission lines in the frequency range of 30 to 500 kHz. The three different models offer different bandwidths and channel speeds.

FSK Equipment CS51 / 61 / 71

- Transfer trip and line relaying Specifications
- 4 to 25 ms channel speeds
- Continuous monitoring
- Built-in diagnostics
- Frequency programmable



FSK Tone Equipment

Typical protective relaying schemes where the FSK audio tone equipment is specifically suitable are:

- Direct transfer trip for transformer, shunt reactor protection and breaker failure protection
- Direct underreaching transfer trip
- Permissive overreaching or underreaching transfer trip

Both the transmitter and receiver are fully programmable to any frequency in the audio range, from 1190 to 3315 Hz. The channel spacing may be 170, 240, 340, or 1000 Hz, with speeds from 17 to 4 ms.

FSK Tone Equipment Model NS40

- Transfer trip and line relaying
- 17 to 4 ms channel speeds
- Built-in diagnostics
- Frequency programmable



Capacitor/Filter Protection

The non-availability of capacitor/filter banks can be extremely costly for electricity users. The loss of capacitors and/or reactors result in maximum demand charges, affect plant production and is also associated with unacceptable thermal loading of transformers, cables and switchgear, poor voltage regulation and excessive harmonic distortion.

The capacitor/filter protection relay (CPR4) is a sophisticated and comprehensive microprocessor based on protection relay specifically designed for optimized protection of shunt capacitor banks and harmonic filter circuits.

The CPR distinguishes between a change in capacitor bank impedance, which indicates the existence of a fault, and harmonic overloading, which may require tripping in order to prevent a fault. As such, unavoidable faults are cleared with no risk or nuisance tripping, while avoidable faults are prevented. Unlike conventional relays, the CPR also considers low order harmonic voltage stresses which can cause partial discharge and eventual capacitor failure.

The CPR relays may be applied on comprehensive protection for capacitive, resistive and inductive elements of three phase medium and high voltage shunt capacitor banks and harmonic filter circuits. Also used in the protection of capacitor banks using externally or internally fused capacitor units and fuseless capacitor units connected ungrounded single or double star, grounded single or double star, delta and H-bridge configurations.

The following protective functions are available with the Trench CPR relays, providing highly optimized protection for capacitor/filter bank:

- Peak repetitive overvoltage
- Thermal overcurrent
- Star point unbalance

- “H” configuration unbalance
- Line current unbalance
- Earth fault
- Overvoltage & overcurrent
- Undercurrent
- Breaker Fail
- Capacitor bank discharge timer

The Trench CPR relays are adapted with an array of comprehensive features, such as:

- compact draw out design
- suitable for panel or 19 inch rack mounting
- fundamental frequency software selectable
- five customer configurable output relays
- one self supervision relay
- user configurable for wide range of relay settings
- wide range AC/DC auxiliary power supply
- enhanced resolution and accuracy
- normal or H-Bridge mode software selectable
- front RS232 port for direct PC connection
- rear port software selectable RS232 or RS485
- all ports communicate up to 115kBaud
- time stamping functionality for improved trip history management.



Grading Capacitors/Energy Storage Capacitors

Grading Capacitors

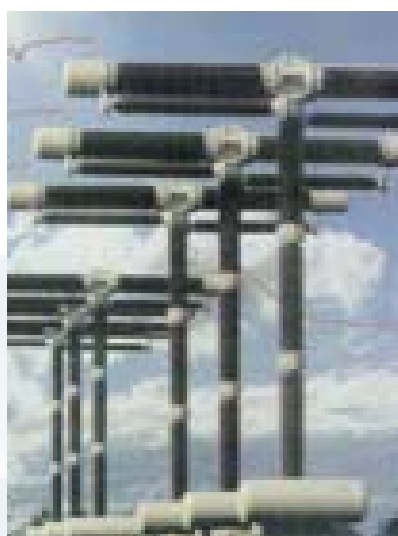
Grading capacitors are components used in modern high voltage circuit breakers. They assure uniform voltage distribution among all contact points for a multiple-break circuit breaker pole. In single-break circuit breakers, grading capacitors can be used to increase the switching capacity of the breaker. All grading capacitors are available for applications up to 800 kV.

Depending on application and individual customer preferences, Trench® grading capacitors are available with either oil/paper/composite insulation or SF₆/film insulation. This allows grading capacitors to be installed on outdoor live tank circuit breakers and within GIS switchgear.

Trench® grading capacitors are available as original equipment furnished with the respective circuit breakers or can be supplied as replacement items directly to the end user. Trench® grading capacitors should be specified in individual circuit breaker specifications.

Features of Trench® grading capacitors include:

- physical size flexibility
- rugged mechanical design
- optimized interface to circuit breaker design
- hermetically sealed construction available for outdoor or GIS applications
- technical liaison with all circuit breaker manufacturers
- stable capacitance throughout extreme temperature range



Energy Storage Capacitors

Trench® offers a range of energy storage capacitors specially developed for needs in high voltage laboratories, universities and industrial applications. Some of these applications are: impulse voltage and impulse current generators, laser pumping, generation of sparks and light flashes, pulsed electron accelerators, flash x-ray generators, plasma physics, metal forming with pulsed power systems, pulsed welding systems, and rapid pulsed power generators.

Features of Trench® energy storage capacitors include:

- extremely low equivalent serial inductance (upon request)
- inversion coefficient up to 95%
- discharge current up to 800 kA
- paper/caster oil or film/synthetic oil or film/paper/synthetic oil dielectric



Bushings

Trench® is a leading manufacturer of high voltage AC and DC bushings. Experience in the design and manufacture of bushings dates back to 1915 with the first patent being awarded in 1918. During this time, Trench® bushings have earned the enviable reputation of being the highest quality, most reliable bushings available.

The Trench® bushing product range includes:

- transformer bushings, rated 24 kV to 1100 kV
- generator bushings, rated up to 36 kV to 45000 A
- wall bushings
- GIS bushings, rated 72.5 kV to 1100 kV and 8000 A
- electric railway system bushings

Trench® offers bushing designs utilizing the proven oil impregnated paper dielectric system, solid resin impregnated paper system, or the SF₆ insulation system. Additionally, bushings can be supplied with either porcelain or composite insulator housings, satisfying individual customer requirements for seismic withstand and explosion proof performance.

While Trench® bushings meet all international standards, including ANSI/IEEE, IEC and DIN, bushings are also custom engineered to meet individual specification requirements.

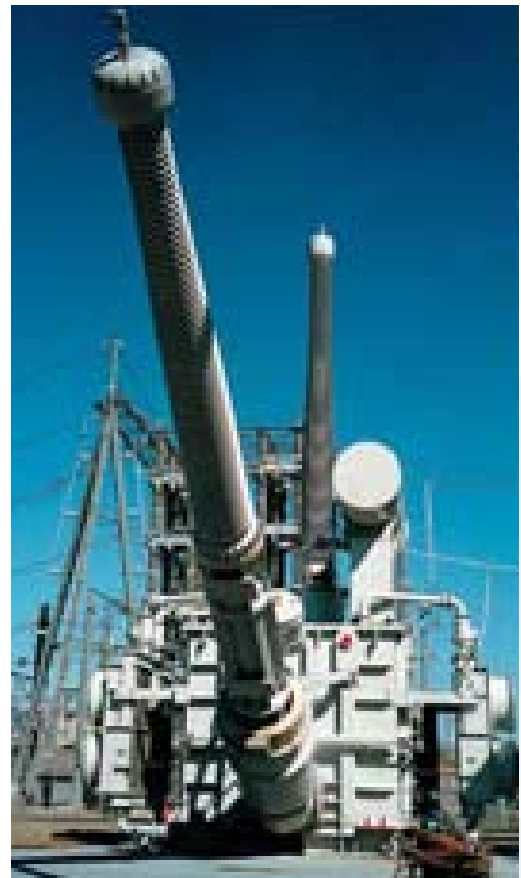
All bushings are available with original equipment transformers and switchgear, and are also widely utilized as replacement bushings.



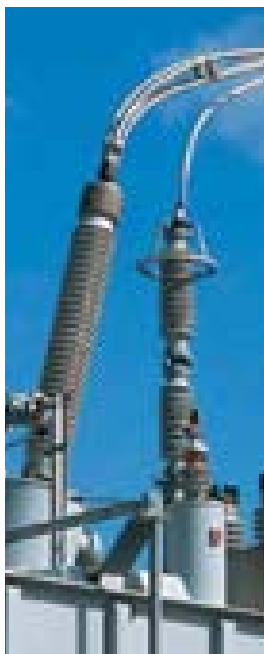
46kV oil insulated transformer bushings



245kV, SF₆ to Air bushings



550kV DC, oil insulated transformer bushings



COTA Air to Oil Transformer Bushing



36kV, 16,000A (HETA) high current bushings



145kV, (ERIP) epoxy resin impregnated bushings



420kV & 123kV oil insulated transformer bushings with composite insulators

"with acknowledgement to Alstom Schorch"



"with acknowledgement to Alstom Schorch"

420kV & 123kV oil insulated transformer bushings with composite insulators



800kV Extra HVDC Transmission Bushing

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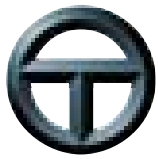
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