MATERIAL CATALOGUE

We Prevent Corrosion
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ANODES

- Impressed Current Anodes

**High Silicon Cast Iron Anode (FeSi)**

**Characteristics**

Silicon Iron Anodes are used for Impressed Current Cathodic Protection Systems in a wide variety of Industrial Applications. Silicon Iron and Silicon Chromium Iron Alloys corrode relatively slowly. The low cost anode material offers long life at economical price.

**Materials**

There are two different alloy grades:

“Normal” silicon iron anodes are used in neutral soils and fresh water.

“Chrome” silicon iron anodes are used in aggressive acidic or alkaline soils and in sea-water environments.
Applications

Silicon Iron Anodes are suitable for a wide range of industrial applications, in particular the following:

- Industrial Use Type of Anode Installation
- Pipelines Horizontal, Vertical or Deep well Groundbeds
- Storage Tanks (External) Horizontal, Vertical or Deep well Groundbeds
- Around Tanks
- Water Storage Tanks (Internal) Anodes string suspended from tank roof
- Jetties, Bridge Piling, Horizontal in the sea / River Bed
- Sheet piling seawall or suspended between piles.

Chemical Analysis

<table>
<thead>
<tr>
<th></th>
<th>Type SL</th>
<th></th>
<th>Type SH</th>
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<tr>
<td></td>
<td>Normal</td>
<td>Chrome</td>
<td>Normal</td>
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<tr>
<td>Silicon</td>
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<tr>
<td>Chromium</td>
<td>-</td>
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<tr>
<td>Sulphur</td>
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<td>0.01</td>
<td>0.10 max</td>
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<tr>
<td>Phosphorus</td>
<td>0.02</td>
<td>0.02</td>
<td>0.25 max</td>
<td>0.25 max</td>
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<tr>
<td>Iron</td>
<td>Balance</td>
<td>Balance</td>
<td>Balance</td>
<td>Balance</td>
</tr>
</tbody>
</table>
Cable Types

Various cable types are available to meet client’s requirements include Poly Vinyl Chloride (PVC), Poly Ethylene (PE), Cross Linked Poly Ethylene (XLPE), High Molecular Weight Poly Ethylene (HMWPE), Poly Vinyl Fluoride (PVDF), Chloro Sulphonated Polyethylene (CSP), Ethylene Propylene Rubber (EPR) in various Combinations as insulating or sheathing.

Anode Dimensions & Weight

<table>
<thead>
<tr>
<th>Rod. Dia.</th>
<th>Length</th>
<th>Head Dia.</th>
<th>Surface Area</th>
<th>Approx. Wt.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>SA</td>
</tr>
<tr>
<td>mm</td>
<td>in</td>
<td>mm</td>
<td>in</td>
<td>sqm</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>915</td>
<td>36</td>
<td>50</td>
</tr>
<tr>
<td>38</td>
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<td>915</td>
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<td>63</td>
</tr>
<tr>
<td>38</td>
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<td>38</td>
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<tr>
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<td>915</td>
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<td>90</td>
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<tr>
<td>63</td>
<td>2.5</td>
<td>1220</td>
<td>48</td>
<td>90</td>
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<td>63</td>
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<td>3</td>
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<td>90</td>
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<td>75</td>
<td>3</td>
<td>915</td>
<td>36</td>
<td>100</td>
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<tr>
<td>75</td>
<td>3</td>
<td>1220</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>75</td>
<td>3</td>
<td>1525</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

Alternative range of anodes in various lengths and weights, single or double ended are available on request.
Canister Anodes

Silicon iron anodes are available pre-packaged in galvanized mild steel canisters or cotton bags filled with coke-backfill.

Canister anodes are the perfect impressed current anode for shallow vertical and horizontal surface groundbeds, as well as wet, marshy soil conditions where caving is likely to occur.
The primary anode element (FeSi Anode) is placed in a galvanized steel Canister filled with Coke backfill. The stable anode element passes current to this highly conductive calcined petroleum coke backfill.

The backfill is well compacted inside the galvanized steel canister. To allow moisture to quickly migrate to the coke backfill for increased electrical conductivity, the anode is electrically connected to the steel canister, thereby accelerating the canister corrosion rate once the anode has been installed and energized.

**Mixed Metal Oxide Anode (MMO)**

To obtain the highest level of protection from an impressed current Cathodic Protection system, an anode with a very low consumption rate and high current capacity will be perfect. With mixed metal oxide anode, you get powerful protection and unsurpassed stability. The anodes are made using titanium substrates which are coated with a mixed metal oxide catalyst. The catalyst is thermally applied to the titanium to form an extremely chemical resistant bond. This special composition brings together the stability of titanium with the conductive properties of the mixed metal oxide catalyst to achieve superior performance and a very low consumption rate.

<table>
<thead>
<tr>
<th>Maximum allowable operating voltage</th>
<th>12 V</th>
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</thead>
<tbody>
<tr>
<td>Consumption rate</td>
<td>1 mg/A.y</td>
</tr>
<tr>
<td>Maximum Current density (in Sea water)</td>
<td>500 A/m²</td>
</tr>
<tr>
<td>Maximum current density (in Coke or Fresh water)</td>
<td>100 A/m²</td>
</tr>
<tr>
<td>Maximum anode life</td>
<td>50 year</td>
</tr>
</tbody>
</table>
Applications

Mixed metal oxide anodes have proven to operate effectively in all types of environments including areas with extremely low pH levels less than 1, and high chloride concentrations.

**MMO Rod anode**

MMO rod anodes perform well in all types of environments. Their mixed metal oxide coating prevents substrate attack in even highly acidic environments. The anodes have been used with great success in deep and conventional groundbeds, and in fresh, brackish and salt water electrolytes. These anodes can be used either bare or packaged in canisters containing petroleum coke breeze. For aqueous environments, the anodes can also be provided in a specially designed PVC perforated tube that directs current flow and provides extra protection to the anode.

**Dimensions**

<table>
<thead>
<tr>
<th>Rod length</th>
<th>150 – 2500 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rod diameter</td>
<td>4 / 6 / 8 / 10 / 12 / 16 / 20 / 25 mm</td>
</tr>
</tbody>
</table>

**MMO Tubular anode**

To obtain the highest level of protection from an impressed current Cathodic Protection system, you need an anode with a very low consumption rate and high current capacity. With tubular mixed metal oxide anode, you get powerful protection and unsurpassed stability. The anodes are made using tubular
titanium substrates, which are coated with a mixed metal oxide catalyst. The catalyst is thermally applied to the titanium to form an extremely chemical-resistant bond. In soil and fresh water applications, the anodes have a recommended current density of approximately 100 amp/m², and can be operated over 500 amp/m² in sea water environments. Even at these relatively high discharge levels, the anodes will be consumed at less than 1.0 mg/amp-yr.

The tubular configuration provides a larger surface area, which in turn permits greater current output and lower anode-to-electrolyte resistance. The tubular style also means lead wire connections can be made in the center of the anode. This connection is protected from moisture intrusion by a waterproofing sealant, which fills the entire anode tube. The ends of the anode are then covered with shrink tubing for a completely sealed electrical connection.

Mixed metal oxide anodes have proven to operate effectively in all types of environments including areas with extremely low pH levels less than 1, and high chloride concentrations. They can be used singularly; their unique configuration also makes them ideal for use in strings on offshore platforms, deep well groundbeds or above ground storage tanks. In addition, the string anodes can be installed parallel to transmission pipelines, or used for other special applications.

This anode can be used also in Canister.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>mm</td>
<td>ft</td>
<td>mm</td>
</tr>
<tr>
<td>0.75</td>
<td>19.1</td>
<td>2.0</td>
<td>610</td>
</tr>
<tr>
<td>0.75</td>
<td>19.1</td>
<td>4.0</td>
<td>1219</td>
</tr>
<tr>
<td>1.0</td>
<td>25.4</td>
<td>3.3</td>
<td>1006</td>
</tr>
<tr>
<td>1.25</td>
<td>31.8</td>
<td>4.0</td>
<td>1219</td>
</tr>
</tbody>
</table>
MMO Chain anode

The tubular anodes are assembled as anode chain for deep groundbed installation. The cable “feed through” centre connection ensures that current passes from the centre of any tube to the next. The materials used for the different parts of anodes and anode chains are suitable for satisfactory performance with regards to low pH-value and high chloride content of water as well as high concentration of chlorine gas. Anode chains are assembled with the desired length of cable and number of anodes to meet the design requirements.

Tube length 2500 mm
Tube diameter 25.4 / 40.0 / 45.0 / 50.8 mm

MMO Mesh anode
MMO Mesh Anode is designed specially for Cathodic Protection of steel in concrete. It is composed of a precious metal oxide catalyst sintered to an expanded titanium mesh substrate. It is perfect for CP systems in armed concrete structure of bridges, park houses, towers and jetty decks. MMO Mesh Anode is usually installed on the surface of concrete structure with cable connection to the TR unit.

**MMO Wire anode**

MMO Wire anodes are copper cored titanium wire with a mixed metal oxide coating. The mixed metal oxide is a crystalline, electrically conductive coating that activates the titanium and enables it to function as an anode.
Applications

- Canistered Anodes
- Continuous Horizontal Groundbeds
- Discontinuous Horizontal Groundbeds
- Shallow Vertical Groundbeds
- Above Ground Storage Tanks
- Underground Storage Tanks
- Natural Water
- Electrical Cable Shielding
- Water Storage Tanks
- Water Treatment Equipment

** MMO Ribbon anode**

Mixed metal oxide ribbon anodes are designed for use on both newly constructed aboveground storage tanks with secondary containment liners, and existing tanks utilizing double bottom construction. Unlike other impressed current tank bottom anodes, MMO ribbon anodes do not require coke breeze. They can be used in sand with various levels of moisture and salt content, and can be designed to provide effective protection for 50 years.

**Nominal Dimensions**

<table>
<thead>
<tr>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>mm</td>
</tr>
<tr>
<td>in</td>
<td>mm</td>
</tr>
<tr>
<td>0.25</td>
<td>6.4</td>
</tr>
<tr>
<td>0.5</td>
<td>12.7</td>
</tr>
<tr>
<td>0.025</td>
<td>0.6</td>
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</table>
MMO Disk anode

Disk anodes are designed to operate in fresh, brackish, and seawater environments, other suitable applications include marine structures, water tanks, and vessels. With an optional primary seal spacer gasket, it can be used on the inside of pipes, tanks, or other curved surfaces.

The mixed metal oxide coated disk is secured into a 12” diameter x 1/2” thick dielectric shield made of a durable, chlorine resistant, molded FRP-vinyl ester. This FRP shield has been designed to resist damage from floating debris and ice, as well as serving to enhance the current distributing capability of the disk. The shield also minimizes excessive current damage to the coating on surrounding steel.

MMO Anodeflex Cable anode

MMO Flexy anode system brings together the lightweight and high performance characteristics of copper-cored, mixed metal oxide anodes with a rugged fabric jacket filled with calcined petroleum coke. This anode utilizes copper-cored, mixed-metal oxide, and titanium based anodes that enhance the linear conductivity of the anode element. Because the mixed metal oxide anode is surrounded by high carbon content powder backfill, the MMO Flexy anode system can be installed without the need for additional carbonaceous backfill.
Connections to the continuous insulated conductor are made redundantly every 17-20 m, further ensuring a minimum voltage drop along the entire anode length. Flexy systems come standard with about 12.2m of insulated conductor “pigtails” at each end, to allow for bi-directional power feeds. The proprietary Flexy manufacturing process assures that the anode assembly is centered in the backfill. The outer jacket of the Flexy package is a Chlorine/low PH resistant porous fabric that is covered with a protective cross braid for superior abrasion and damage resistance.

### Technical Data

<p>| | |</p>
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<tbody>
<tr>
<td><strong>Package Diameter</strong></td>
<td>35-50 mm nominal</td>
</tr>
<tr>
<td><strong>Anode Assembly Weight</strong></td>
<td>1.10 kg/m</td>
</tr>
<tr>
<td><strong>Minimum Bending Radius</strong></td>
<td>500 mm</td>
</tr>
<tr>
<td><strong>Fabric Jacket Abrasion Resistance ASTM D-4157</strong></td>
<td>219 cycles to failure</td>
</tr>
<tr>
<td><strong>Chlorine Resistance Internal Immersion</strong></td>
<td>6 months - passed</td>
</tr>
<tr>
<td><strong>UV Resistance ASTM G-53</strong></td>
<td>55% tear strength loss</td>
</tr>
</tbody>
</table>

MMO Flexy anode systems perform well in virtually any environment. The anodes can be installed as an integral part of a Cathodic Protection system for such structures as above-ground storage tanks, pipelines, congested petrochemical facilities and power plants. Trench, cable plow and directional bore can be used to install MMO Flexy cable anode.
**Graphite Anodes**

Graphite anodes are usually operated at lower current densities than those for Silicon Iron anodes. Because of their light weight and large surface area they are useful for deep well installations, as well as for conventional horizontal groundbeds. Graphite anodes are manufactured in two standard sizes 3” diameter up to 60” long and 4” diameter up to 80” long and in plain for ordinary soil conditions and in linseed impregnated graphite for saline soil or sea water application.

<table>
<thead>
<tr>
<th>Rod Dia.</th>
<th>Length</th>
<th>Surface Area</th>
<th>Approx. Wt. SL</th>
<th>Approx. Wt. SH</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>in</td>
<td>mm</td>
<td>sqm</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in</td>
<td>sqft</td>
<td>lb</td>
</tr>
<tr>
<td>75</td>
<td>3.0</td>
<td>1525</td>
<td>0.36</td>
<td>11.4</td>
</tr>
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<td></td>
<td></td>
<td>60</td>
<td>3.9</td>
<td>25</td>
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<td></td>
<td></td>
<td>80</td>
<td>7.0</td>
<td>63</td>
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</table>
Various cable types are available to meet client’s requirements include PVC, PE, XLPE, HMWPE, EPR, CSP, and KYNAR in various combinations as insulating or sheathing.

Graphite anodes are available pre-packaged in a galvanized mild steel canisters or cotton bags filled with coke-backfill.

Graphite anodes can be machined to form a central connection to have anodes in strings or chains which are suitable for Deep Well Groundbed. Each chain consists of a number of anodes, depending on the anode weight, and a double insulated cable passing through all anodes. Special sizes and shapes can be furnished upon request.

**Platinized Titanium-Niobium Anodes**

Platinized anodes are suitable for use in impressed current system for jetties, pipelines protected by Deep Well groundbeds, power stations and water storage tanks.

**Products**

- Rod Anodes
- Sheet and disk Anodes
- Tube Anodes
- Wire Anodes
- Expanded Mesh Anodes
Platinized Titanium Rod & Tube anode

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Titanium</td>
<td>99.3 %</td>
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<tr>
<td>Tensile Strength</td>
<td>46 kg/mm²</td>
</tr>
<tr>
<td>Density</td>
<td>4.5 g/cm³</td>
</tr>
<tr>
<td>Platinum Coating Thickness</td>
<td>2.5-10 µ</td>
</tr>
<tr>
<td>Consumption Rate</td>
<td>10 mg/A.year</td>
</tr>
<tr>
<td>Nominal Output</td>
<td>250-500 A/m²</td>
</tr>
<tr>
<td>Maximum Output</td>
<td>750 A/m²</td>
</tr>
<tr>
<td>Max Voltage</td>
<td>8-10 V</td>
</tr>
</tbody>
</table>

Platinized Titanium tubular anodes consist of titanium tubes coated with very thin electrochemically active platinum layer. A feeder electric cable is passed through one or more of these tubular anodes to form a string of anodes. Platinised tubular anodes are suitable for use in ground, seawater and freshwater deep well applications.

This anode has an extremely low consumption rate, measured in terms of milligrams per ampere-year. As a result of this low consumption rate, the platinized anode’s tubular dimensions remain nearly constant during the life of the anode.

While operating in soil, freshwater, mud, or seawater, the platinum coating demonstrate very high chemical stability - even in environments with very low pH values. Unlike sacrificial anodes, the platinum coating of titanium tubular anodes is not affected by the generation of chlorine.

Platinized Titanium Rod anodes perform well in all types of environments such as process vessels, water condenser boxes, heat exchangers, water intake structures, groundbed applications etc. Platinized Titanium Rod anodes with platinum coating prevent substrate attack even in highly acidic environments.
Platinized Niobium Wire anode

Platinized Niobium wire anodes are designed for use in all types of aqueous storage and process equipment. The anode operates effectively in fresh, brackish and salt water, and is not adversely affected by high chloride concentrations. Because of its low consumption rate, the anode is proper to be employed in a Cathodic Protection system to achieve a design life of 20 years or more.

The anode is constructed of a copper core, which is surrounded by a niobium substrate. Metallurgically bonded to the substrate is a platinum coating. By using these three metals in combination, an anode with superior protection characteristics is produced. Platinized Niobium wire anode is highly conductive and can be operated at a maximum current density of 1000 A/m². The anode is also very lightweight, flexible, and strong. Because the niobium substrate is resistant to corrosion, the anode remains dimensionally stable over its operating life and consumption of the platinum coating is extremely low 40 to 80 mg/A-yr.

Wire anodes can be used in numerous geometries. In water storage tanks and wastewater clarifiers, the anode is often suspended by rope in configurations which follow the circumferences of the structure. It also produces a Cathodic Protection system that is not susceptible to damage from icing. Because the anode is a continuous wire, failures due to poor wire connections are eliminated.

Platinized Titanium-Niobium Probe anode
Probe anodes are used in steel vessels, such as condenser water boxes, heat exchangers and heat treaters, where access is difficult and space is limited. The anodes are made using either titanium or niobium-rod substrates which are covered with a platinum coating. An oxidizing film inherently coats the surface of titanium and niobium, assuring that the substrates will remain stable, and will not change shape or be consumed during operation. The film also makes the substrate surface relatively nonconductive, and electrical discharge therefore occurs across the platinum coating. The coating is electroplated to the substrates in thicknesses ranging from 100 to 300 µ-inch, and is consumed at a rate of 8 to 16 mg/A-yr in salt water environments. The recommended current density for both types of probe anodes is between 500 and 3000 A/m² in salt water electrolytes. The voltage across the titanium or niobium at the electrolyte interface, however, should not exceed the breakdown voltage of the protective oxide. The anodes are also adaptable for mounting while the vessel is under pressure.

**Sacrificial Anodes**

**Magnesium Anode**

Magnesium Anodes have been used as galvanic (sacrificial) anodes for the protection of buried pipelines, tanks, marine structures and condenser boxes. They can be laid horizontally, vertically, screwed or welded to steel structures.
There are two types of Magnesium Alloy Anodes known as of Standard potential (-1.55 V w.r.t. Cu/CuSO₄) and of High Potential (-1.75 V average w.r.t. Cu/CuSO₄).

<table>
<thead>
<tr>
<th>Chemical Composition</th>
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<tbody>
<tr>
<td><strong>Element</strong></td>
</tr>
<tr>
<td>Aluminum (Al)</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
</tr>
<tr>
<td>Copper (Cu)</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
</tr>
<tr>
<td>Iron (Fe)</td>
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<tr>
<td>Nickel (Ni)</td>
</tr>
<tr>
<td>All Others</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
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<table>
<thead>
<tr>
<th>Characteristics</th>
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<tbody>
<tr>
<td><strong>Capacity</strong></td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
</tr>
<tr>
<td><strong>Consumption Rate</strong></td>
</tr>
</tbody>
</table>

Magnesium Packed anode
Magnesium packed anodes in cotton bag containing a rapid wetting, moisture retaining backfill are normally used for the Cathodic Protection of buried pipelines, buried tanks, external tank bottoms and similar structures. The backfill powder reduces the soil resistivity surrounding the anodes and improves the anode performance. Alternative cable insulation, size and length are available on request.

**Standard Backfill Composition**

- powdered gypsum: 75 %
- granular bentonite: 20 %
- sodium sulphate: 5 %
Magnesium Ribbon Anodes

Extruded flexible ribbon anode with a continuous steel core can be used for the following applications in Cathodic Protection of external surfaces of pipes and interior surfaces of tanks, large pipes and condensers:

- Rapid polarization
- High resistivity soil conditions
- Boilers, tanks and fresh water

Ribbon anode offers the following advantages:

- Minimum resistance to earth per unit weight of anodes installed. Current output is approximately three to seven times greater than the conventional cast anode of the same weight.
- Efficient current distribution along the structure being protected, reduces current requirements to minimum.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Standard</th>
<th>Ribbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Sec.</td>
<td>9.5 x 19 mm</td>
<td>9.5 x 19 mm</td>
</tr>
<tr>
<td>Mg wt. per meter length</td>
<td>0.34 kg (approx.)</td>
<td>0.28 kg (approx.)</td>
</tr>
<tr>
<td>Core diameter</td>
<td>3 mm</td>
<td>3 mm</td>
</tr>
<tr>
<td>Current density in Sea water</td>
<td>2.4 A/m</td>
<td>3 A/m</td>
</tr>
<tr>
<td>Current density in soil (5000 ohm.cm)</td>
<td>10 mA/m</td>
<td>12 mA/m</td>
</tr>
<tr>
<td>Current density in water (15000 ohm.cm)</td>
<td>3 mA/m</td>
<td>4 mA/m</td>
</tr>
</tbody>
</table>

Alternative sizes and coil lengths can be supplied on request.
**Aluminum Anodes**

Aluminum alloys have been used as galvanic (sacrificial) anodes for the protection of steel by Cathodic Protection since many years.

Aluminum alloy anode is suitable for use as a general purpose alloy for marine, off shore, jetty and submarine application, in particular where environment is in the temperature range of 10 –30 °C. Other aluminum alloy anodes are suitable for internal protection of tanks and buried pipelines where higher temperature than 50 °C exists. Aluminum alloy anodes have a capacity over three times that of zinc and a driving potential of 250 mV against the protected steel. Some aluminum anodes are suitable for use in seabed mud, at high temperatures as well as in sea water and may have a driving potential of 300 mV against the protected steel.

The chemical composition and the characteristic of some of the aluminum alloy anodes are

<table>
<thead>
<tr>
<th>Composition</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Al Anode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>0.13 max.</td>
<td>0.13 max.</td>
<td>0.12 max.</td>
<td>0.13 max.</td>
</tr>
<tr>
<td>Si</td>
<td>0.11 – 0.21</td>
<td>0.11 – 0.21</td>
<td>0.08 – 0.21</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Cu</td>
<td>0.006 max.</td>
<td>0.006 max.</td>
<td>0.006 max.</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Zn</td>
<td>0.35 – 0.5</td>
<td>3.0 – 6.0</td>
<td>2.0 – 4.0</td>
<td>0.5 – 5.0</td>
</tr>
<tr>
<td>Hg</td>
<td>0.030 – 0.050</td>
<td>0.030 – 0.050</td>
<td>0.030 – 0.050</td>
<td>0.01 – 0.02</td>
</tr>
<tr>
<td>Others (each)</td>
<td>0.02 max.</td>
<td>0.02 max.</td>
<td>0.02 max.</td>
<td></td>
</tr>
<tr>
<td>Al</td>
<td>remainder</td>
<td>remainder</td>
<td>remainder</td>
<td>remainder</td>
</tr>
<tr>
<td>Potential Ag/AgCl</td>
<td>-1.05 V</td>
<td>-1.05 V</td>
<td>-1.10 V</td>
<td>-1.10 V</td>
</tr>
<tr>
<td>Max. Capacity ampere hours</td>
<td>2875 per kg</td>
<td>2750 per kg</td>
<td>2700 per kg</td>
<td>2550 per kg</td>
</tr>
</tbody>
</table>
Type I has been of a higher capacity, provides protection with a minimum weight of material and used in sea water.

Type II is suitable for use in sea bed mud and at higher temperatures. It is mainly used as a bracelet anode for pipeline protection.

Type III that is mentioned also as Galvalum III operates satisfactorily at high temperatures, in saline mud and estuarine locations as well as in open sea water or sea bed. It uses Indium instead of Mercury as an activator and as a higher driving potential (300 mV) against steel and slightly lower capacity than Type I.

Aluminum anodes can be cast in various shapes and sizes to suit individual applications and normally have steel cores for connection to the structure by welding, bolting or clamping.
Aluminum anodes are also very common to be used in storage tanks in order to internal protect of the tanks. Alternative specification shapes and sizes to customer’s own requirement can be supplied on request.

**Zinc Anodes**

Zinc Anodes have been used as galvanic (sacrificial) anodes for the protection of steel by Cathodic Protection since the last century. High purity zinc (99.995 %) alloyed with other materials is at present cast as Cathodic Protection anode, widely used for many applications. Zinc alloy anode is suitable for use as a general purpose alloy for marine, offshore, jetty and submarine pipeline protection. Zinc anodes perform reliably in water and mud with resistivity up to 1000 ohm-cm and have a driving potential of 250 mV (w.r.t. Ag/AgCl) against protected steel at normal ambient seawater temperatures. This driving potential reduces as the temperature rises. For temperatures above 30 °C and up to 50 °C, the formulation of the alloy can be modified. At temperatures above 50 °C, aluminum alloys are to be recommended in preference to zinc. The capacity of zinc remains almost constant despite changes in operating current density.
### Chemical Composition

<table>
<thead>
<tr>
<th>Alloy</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead Pb</td>
<td>0.006 max.</td>
</tr>
<tr>
<td>Iron Fe</td>
<td>0.005 max.</td>
</tr>
<tr>
<td>Cadmium Cd</td>
<td>0.025 – 0.15</td>
</tr>
<tr>
<td>Copper Cu</td>
<td>0.005 max</td>
</tr>
<tr>
<td>Aluminium Al</td>
<td>0.10 – 0.50</td>
</tr>
<tr>
<td>Silicon Si</td>
<td>0.125 max.</td>
</tr>
<tr>
<td>Zinc Zn</td>
<td>Remainder</td>
</tr>
</tbody>
</table>

### Characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>780 Ah/kg</td>
</tr>
<tr>
<td>Efficiency</td>
<td>90 %</td>
</tr>
<tr>
<td>Consumption Rate</td>
<td>11 kg/A.Y. (approx.)</td>
</tr>
<tr>
<td>Potential (w.r.t. Ag/AgCl)</td>
<td>-1050 mV</td>
</tr>
</tbody>
</table>
Zinc Ribbon Anode

zinc ribbon anodes are available in both cast and extruded forms. The cast anodes are produced in a variety of weights, and are designed for use in low-resistivity soil environments. These anodes are manufactured with lead wires, in diamond-shaped ribbon coils. The elongated shape allows for lower resistance to earth than conventional zinc anodes, and permits easy installation on a multitude of structures.

<table>
<thead>
<tr>
<th>Zinc</th>
<th>Super</th>
<th>Plus</th>
<th>Standard</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>1” X 1-1/4”</td>
<td>5/8” X 7/8”</td>
<td>1/2” X 9/16”</td>
<td>11/32” X 15/32”</td>
</tr>
<tr>
<td>Core diameter</td>
<td>0.185”</td>
<td>0.135”</td>
<td>0.130”</td>
<td>0.115”</td>
</tr>
<tr>
<td>Weight</td>
<td>3.57 kg/m</td>
<td>1.79 kg/m</td>
<td>0.89 kg/m</td>
<td>0.37 kg/m</td>
</tr>
<tr>
<td>Coil length</td>
<td>approx. 30 m</td>
<td>approx. 60 m</td>
<td>approx. 150 m</td>
<td>approx. 300 m</td>
</tr>
</tbody>
</table>
Accessories

Anode Backfill

Coke Backfill

When buried impressed current anodes are surrounded with low resistivity backfill, the anode to earth resistance decreases and the life of the anodes increases.

There are two types of backfill materials to suit:

- Shallow horizontal and vertical anode installations
- Deep well anode installations.

Metallurgical Coke-Breeze

This material lowers anode-to-earth resistance, provides a uniform environment for current discharge, and extends the anode’s life. The Metallurgical Coke-Breeze usually is used for shallow and horizontal groundbeds and has the following typical analysis:

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>84-90 %</td>
</tr>
<tr>
<td>Sulphur</td>
<td>1%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1%</td>
</tr>
<tr>
<td>Ash</td>
<td>7%</td>
</tr>
<tr>
<td>Moisture</td>
<td>5% max.</td>
</tr>
<tr>
<td>Volatiles</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density</td>
<td>675 kg/m³</td>
</tr>
<tr>
<td>Resistivity</td>
<td>50 ohm/cm</td>
</tr>
<tr>
<td>Particle Size</td>
<td></td>
</tr>
<tr>
<td>Plus 12 mm</td>
<td>2 %</td>
</tr>
<tr>
<td>12 – 7 mm</td>
<td>17 %</td>
</tr>
<tr>
<td>7 – 4 mm</td>
<td>21 %</td>
</tr>
<tr>
<td>Less than 4 mm</td>
<td>60 %</td>
</tr>
</tbody>
</table>
In order to increase the water absorption of this backfill, slaked lime can be added.

**Calcined Petroleum Coke**

For deep well groundbed and canister containers has the following typical analysis:

<table>
<thead>
<tr>
<th>Chemical Analysis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>97 - 99 %</td>
</tr>
<tr>
<td>Sulphur</td>
<td>2-4 %</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Ash</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Moisture</td>
<td>0.5%</td>
</tr>
<tr>
<td>Volatiles</td>
<td>1.5 % max.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk density</td>
<td>850 kg/m³</td>
</tr>
<tr>
<td>Resistivity</td>
<td>5 ohm/cm</td>
</tr>
<tr>
<td>Particle Size</td>
<td></td>
</tr>
<tr>
<td>Plus 1 mm</td>
<td>2.1 %</td>
</tr>
<tr>
<td>0.5 – 1.0 mm</td>
<td>41 %</td>
</tr>
<tr>
<td>0.12 – 0.5 mm</td>
<td>42.6 %</td>
</tr>
<tr>
<td>Less than 0.65 mm</td>
<td>3.7 %</td>
</tr>
</tbody>
</table>
Backfill for Galvanic Anodes

In order to decrease the electrical resistivity between the sacrificial anodes specially Mg anode, backfill with Standard composition as below is usually used in packed anode:

- **Powdered Gypsum 75 %**
- **Granular Bentonite 20 %**
- **Sodium Sulphate 5 %**

Deep Well Groundbed Accessories

UPVC Well Casing & Screens

Plastic casings are normally used for deep well groundbeds instead of steel casings to avoid interference problems with surface steel structures. UPVC Casings are used for their chemical resistance against all types of ground water, diluted acids and Alkalines. There are two types of deep groundbeds, namely closed borehole and open borehole.

For closed borehole, UPVC casings are used down to the anodes section and the anodes are surrounded with coke breeze backfill. For open borehole deep well groundbeds, UPVC
Cathodic Corrosion Protection

Casings are used down to the anodes section, where anodes are immersed inside below the deep well static water level and require no coke breeze backfill.

Casings & Screens

The casings and screens are manufactured to withstand the external pressure loading caused by geological formation, groundbed depth, the ratio of bore hole diameter to casing and screen diameter and position of dynamic water level.

Screens are provided with slots of 20% open area and may be covered with HDPE wire mesh to prevent the ingress of silt etc. after installation. Both casings and screens are supplied with trapezoidal thread joints.

<table>
<thead>
<tr>
<th>Nominal Diameter ND (inch)</th>
<th>Nominal Diameter ND (mm)</th>
<th>Outer Diameter (mm)</th>
<th>Wall Thickness (S) (mm)</th>
<th>Weight kg/m</th>
<th>OD at connection (mm)</th>
<th>Screwed Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>100</td>
<td>113</td>
<td>5.0</td>
<td>2.60</td>
<td>124</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>140</td>
<td>6.5</td>
<td>4.15</td>
<td>154</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>165</td>
<td>7.5</td>
<td>5.65</td>
<td>183</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>225</td>
<td>12.5</td>
<td>10.86</td>
<td>247</td>
<td>70</td>
</tr>
<tr>
<td>10</td>
<td>250</td>
<td>280</td>
<td>12.5</td>
<td>15.50</td>
<td>297</td>
<td>85</td>
</tr>
<tr>
<td>12</td>
<td>300</td>
<td>330</td>
<td>14.5</td>
<td>21.19</td>
<td>350</td>
<td>85</td>
</tr>
<tr>
<td>14</td>
<td>350</td>
<td>400</td>
<td>17.5</td>
<td>31.50</td>
<td>430</td>
<td>85</td>
</tr>
</tbody>
</table>

Length available in 2, 4, 6 meters – other lengths and thicknesses are available on request.

The installation of an open hole deep groundbed with replaceable anode chains allows an economical design up to 300 m depth and requires the presence of a static water level.

The advantages compared to closed hole groundbeds are as follows:
• Trouble-free unlimited life compared to erratic and short (5 years) life time of closed hole groundbeds.
• Possibility of anode replacement, inspection, repair and replacement of chain components.
• The unlimited lifetime of replaceable groundbeds is ensured by non-conductive, corrosion resistant casings.
The offered casings consider the external pressure loading which are caused by geological formation, groundbed depth, the ratio of borehole diameter to casing diameter and the position of dynamic water level. Perforated casings are provided with slots which run perpendicular to pipe axis, thus resulting in a minor decrease of collapse resistance compared with pipes having longitudinal slots. The perforated (open) area covers minimum 20 % surface of the casing around anodes. Micro fine HDPE wire mesh is durably fixed over the perforated casings to prevent the ingress of silt etc. after installation. Both perforated and imperforated casing sections are supplied with thread joints which allow a quick assembly at site.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>1.4 g/cm³</td>
</tr>
<tr>
<td>Elasticity coefficient</td>
<td>3000 N/mm²</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>&gt; 55 N/mm²</td>
</tr>
<tr>
<td>Impact strength</td>
<td>no break</td>
</tr>
<tr>
<td>Notch impact strength at 20 °C</td>
<td>5 kJ/m²</td>
</tr>
<tr>
<td>for rigid UPVC</td>
<td></td>
</tr>
<tr>
<td>Vicat softening temperature</td>
<td>80 °C</td>
</tr>
</tbody>
</table>

**Installation Equipment / Accessories**

- Hoisting devices for lifting and lowering of the pipe string
- Sump pipes for silt deposit
- Centralizers for centralization of casing in the borehole during installation
- Wooden plugs for fastening to the bottom end of casing or sump pipe
- Wooden clamps faced with leather for holding the casing on the ground level
TRANSFORMER RECTIFIERS & ELECTRICAL DEVICES

- **T/R Units**

**AC Power Rectifiers**

Cathodic Protection of buried or immersed structures is applied by using direct current (D.C.), fed from D.C. source such as a Transformer Rectifier. Transformer Rectifiers are normally supplied from the mains.

**Types**

There are two main types of Transformer Rectifiers, the air-cooled and the oil-cooled. The choice depends on the ambient temperature, climate, location and rating.

**Selection**

It is always best to select the simplest Transformer Rectifier unit possible for a particular application. The simplest is an air-cooled, single-phase, bridge type unit which is economic up to about 3 kW.

Three-phase units are normally selected where conditions are such as to require oil or the area is a hazardous one. It is often better to install an air-cooled unit outside the hazardous area even though this might require much more cable runs and if ambient temperature, climate and rating permit such installation.
Output Control

For output control, a manually (in steps or continuous) or automatically controlled units can be chosen, depending on certain conditions such as changing environmental conditions or existence of stray D.C. currents. Automatic units can also provide operational control of the Cathodic Protection parameter.

The automatic unit can be either constant current, which maintains the output current at a preset value regardless of changes in external circuit resistance or mains fluctuations. Or constant potential, which maintains a constant structure to electrolyte potential by varying automatically the current output to compensate for changes in electrolyte resistivity, coating resistance (or efficiency), main variations and other factors such as tidal conditions which may affect current requirements.

Air-Cooled Units

These units are used in indoor or outdoor locations at ambient temperatures from −10° up to +45° C as standard. The enclosure can be made of steel or non metallic such as polyester with weatherproof protection IP 55 or IP 65 suitable for pole, wall or plinth mounting.

Oil-Cooled Units

The units are designed for long term operation in outdoor environments for the Cathodic Protection of steel structures including pipelines, tank farms and jetties, in desert, on-shore and off-shore locations.

The units are in the “Oil Natural Air Natural (ONAN)” cooling category. The oil tank is heavy duty welded steel enclosure with weatherproof protection IP 65 suitable for use in hot dusty exposed environments and at ambient temperature from −10° up to +50 C. Oil-Cooled are for special climatic conditions such as high humidity and high ambient temperature.
Units for Hazardous Areas

Transformer Rectifier units which have to be installed in hazardous areas can be supplied as air-cooled or oil-cooled in certified flameproof and explosion proof enclosures.

Design

The equipment can be designed to meet the requirements of various standards such as German Industrial Standard (DIN), British Standard (B.S.), American Standard (ASTM) or International Electro-technical Commission (IEC).

Any input-output, cooling system, enclosure and control system due to the needs of the project can be manufactured upon request.
Typical Specification

- **Input voltage**
  - 115 V or 240 V single-phase
  - 380 / 415 / 460 V three-phase

- **Frequency**
  - 50 or 60 Hz

- **Output**
  - can be supplied in various currents and voltages ranging from 12 to 100 volts and 10 to 500 Amperes.

- **Voltage**
  - 12, 18, 24, 30, 36, 40, 50, 75, 100 V

- **Current**
  - 10, 20, 30, 40, 50, 60, 75, 100, 150, 200, 300, 400 or 500 A

- **Control**
  - Manual – continuously variable or adjustable in 15, 20, 24 or 63 steps
  - Automatic – constant current or constant potential

- **Protection**
  - output fuse and lightning arrester

- **Output Rating**
  - continuous at full output

- **Main standard**
  - Auto and double wound transformer components
  - Silicon or selenium bridge rectifier
  - Output ammeter and voltmeter
  - Surge arrester
  - Fuses
  - Enclosure

- **Standard Tank**
  - Lockable weatherproof control cabinet with viewing window
  - Fittings
  - Oil filling cap and drain plug (for oil-cooled units)
  - Thermometer pocket and level gauge
  - Silica gel breather and spare cartridge
  - Earthing terminal
  - Lifting lugs

- **Optional extras**
  - Sunshade
- Dial thermometer
- Cable glands / conduit hubs
- Current interrupter (adjustable synchronous timer)
- Lightning arrestor
- Reference electrode voltmeter
- Input watt/hour meter
- Mains / DC alarms / indication
- Cabinet equipped with air condition and vitalization system

T/R unit model KSG-R

The protection system KSG-R has been constructed specifically for Cathodic Protection purposes. The adjustment of the output voltage and of the maximum output current will be carried out according to customer requirements. This also includes customized high power models with several separated outputs needed for Local Corrosion Protection or at offshore facilities.

According to the specific requirements the protective voltage or protective current can be adjusted continuously by the controlling transformer. The adjusted values can be read directly from an analog or digital display. Optionally a potential measurement module with analog or digital display can be integrated in the protection system. The protective current output is equipped with disconnect terminals, test jacks and an effective overvoltage protection which enables measuring of the single currents and guarantees an effective protection of the rectifier.

The cooperativeness of the rectifier can be inquired by a potential-free contact. Due to its rugged design we ensure an almost maintenance-free operation of the rectifier.
**Technical Data:**

**Enclosure:**
- Steel plate wall cabinet with powder coated stove-enamel finish
- Color RAL 7032
- System of protection IP40
- Dimensions (W/H/D) 400/600/210 mm.
- Ventilation’s slits for passive and active ventilation
- Left hand side door stop
- Cable inlet at the bottom

**Operation:**
- By master switch and controlling transformer

**Equipment Description:**
- Distribution voltage 230V 50Hz
- Protective current up to 30A
- Output voltage up to 50V
- Operating hours counter
- Output power up to 1500 Watt
- Power supply warning light
- Input circuit overload protection
- Shock proof socket
- Controlling transformer as autotransformer
- Safety controlling transformer according to DIN 570/EN 61558-1
- Bridge rectifier with lightning protection
- Output safety fuse for short-circuit protection
- Anode single current measurement by disconnect terminals
- Low ohmic output current measurement by Shunt
· Output voltage measurement
· Optionally potential measurement
· Optionally test jacks for measurement display
· Cathode and anode terminals as disconnect terminals up to 40A, > 40A use of standard screw terminal
· PG-cable screw connections for feed and outlet cables

**T/R Unit Model KSG-R19Z**

The model 19Z has been developed for the installation in control cubicles. According to the specific requirements the protective voltage or protective current can be adjusted continuously by the controlling transformer. The adjusted values can be read directly from an analog or digital display. Optionally a potential measurement module with analog or digital display can be integrated into the protection system.

The protective current output is equipped with an effective overvoltage protection which guarantees an effective protection of the rectifier. The operation of the rectifier can be inquired by a potential-free contact.

**Technical Data:**

**Enclosure:**

· 19“-Aluminum-Rack for the installation in a control cubicle
· System of protection IP20
· Ventilation slits for passive ventilation
· Connection by ready-made cable with plug
Operation:

- By master switch and controlling transformer

Elements of Equipment:

- Distribution voltage 230V 50Hz
- Protective current up to 25A
- Output voltage up to 50V
- Operating hours counter
- Output power up to 600 Watt
- Power supply warning light
- Controlling transformer as autotransformer
- Safety controlling transformer according to DIN 570/EN 61558-1
- Bridge rectifier with lightning protection
- Output safety fuses for short circuit protection
- Anode single current measurement by disconnect terminals
- Low ohmic output current measurement by Shunt
- Output voltage measurement
- Potential measurement on request
- Protection current output saved by overvoltage protection

Protective Current System Casing

The protective current system Casing has been constructed specifically for the installation in control cubicles. Special models with higher power and several separated outputs needed for local corrosion protection and at offshore facilities can be constructed according to customer requirements. Depending on the specific requirements the protective current or protective voltage can be adjusted continuously by the controlling transformer. The values can be read from the allocated measuring instruments.

Every single protective current outlet is safeguarded against short circuit by an automatic cut-out. The protective current outlet is equipped with test jacks which enable measuring of the output protective current. The protective current can be controlled by a master switch with an integrated overload protection.

The system can be provided with an external central cut-off and clocking which can be used when servicing the system.
Technical Data:

Enclosure:
- Steel plate wall cabinet with powder coated enamel finish and integrated pivoting frame
- Color RAL 7032
- System of protection IP20
- Dimensions (W/H/D) 800/1800/500 mm
- Base H200
- Right hand side doorstop with cable inlet from the bottom
- Transparent door on enquiry

Operation:
- By master switch and controlling transformer

Elements of Equipment:
- Distribution voltage 230V, 50Hz
- Protective current according to customer requirements
- Output voltage according to customer requirements
- Operating hours counter
- Power supply warning light
- Shock proof socket
- Bridge rectifier
- Safety controlling transformer according to DIN 570/EN 61558-1
Cathodic Corrosion Protection

- Output safety fuse for short-circuit protection
- Digital or analog output current measurement
- Digital or analog output voltage measurement
- Cathode and anode terminals as disconnect terminals
- Cable support rack for feed and outlet cables
- Maximum 3 protective current units to be inserted per control cubicle door
- Integration of Monitoring System ISM on enquiry

Multi Output Channel T/R Unit for LCP

The protective current system LCP has been constructed for local Cathodic Protection. The device can be regulated manually by variable-ratio transformers. The single protection currents or voltages will be adapted to the overall plan of the facility. Depending on the specific requirements protection currents and voltages can be adjusted by the variable-ratio transformers. The values can be read from the allocated measuring instruments.

This T/R system has been developed in order to have a multi channel output for different local anodes and gives you the ability to have control on each single anode individually for the current and potential. Every single protective current output is safeguarded against short circuit. The separated protection current outputs are equipped with test jacks which enable the measuring of the single currents.
By means of a function selector the protection current can be
· switched off centrally
· can be switched into protection current mode
· or into clock mode

The system can be provided with an external central cut-off and clocking which can be used when servicing the system.

**Technical Data:**

**Enclosure:**
- Steel plate wall cabinet with powder coated stove-enamel finish and integrated pivoting frame
- Color RAL 7032
- System of protection IP20
- Dimensions (W/H/D) 800/1800/500
- Base H200
- Right hand side doorstop with cable inlet at the bottom
- Transparent door on enquiry

**Operation:**
- By toggle switch and controlling transformers
Elements of Equipment:

- Distribution voltage 230V 50Hz
- Protective current up to 25A
- Output voltage up to 50V
- Operating hours counter
- Power supply warning light
- Internal shockproof socket
- Bridge rectifier
- Safety controlling transformer according to DIN 570/EN 61558-1
- Output safety fuse for short-circuit protection
- Digital or analog output current measurement
- Digital or analog output voltage measurement
- Cathode and anode terminals as disconnect terminals
- Cable support rack for feed and outlet cables
- Integration of Monitoring System ISM on enquiry

Protective Current Unit GLR2001

The protective current Unit GLR2001 is designed for the operation at pipes with a low or an average protective current demand. Through its high efficiency it is especially useful for the application at solar power driven stations.

The variants of housing, the high efficiency, the manifold control functions as well as the integrated clock pulse allow a universal application.
The integration into the CPMS KKS Management System allows the constant monitoring of all the essential data of the protective installation. The parameters of the protective device can be adjusted easily from the project site station at any time it is needed. Integration into the existing control center is possible by optionally usable interfaces (software). The protective voltage is controlled by a switching regulator with high efficiency. At an uncontrolled distribution voltage of the control module of 24 – 30 V DC the control range is at about 2 – 20 V. All inputs and outputs are provided with an efficient overvoltage protection. In order to guarantee an operation at lightning strokes an additional coarse protection has to be installed. The SGL2001 can be delivered in a 19” version or with a housing for wall-fitting.

**Technical Data:**

**Performance Data:**

- Indication of output voltage, output current and potential (electrode required))
- Exact pre-setting of output voltage (by keyboard input)
- Potential Control (optional)
- Current control (optional)
- Clock operation (optional, antenna required)
- Optional communication module GSM, analogue 14.4, ISDN, various bus systems
- Integration into the CPMS KKS-Management System

**Housing versions:**

- Wall cabinet IP65 dimensions including cable lead-ins (W/H/D) 310/250/95 mm
- 19” plug-in cassette 42TE

**Display**

- LC Display 4 lines / 16 characters, optionally shining

**Keyboard**

- 8-key membrane key board

**Features**

- Efficient lightning protection of all inputs and outputs (earthing electrode required)
- High efficiency by use of a switching regulator
- Pluggable clamping joints

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<th>Max.</th>
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<td>2000</td>
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Solar Power Stations

In order to achieve a protection from corrosion in the open field it might be unreasonable or impossible to use an AC power supply or it may be much too expensive. In such a case the installation of a solar power station considered as a spot solution may be a useful alternative.

The GLR has been developed for the operation by solar technology. The housing variants, the high efficiency, the manifold control functions as well as the integrated clock function allow a universal application. In order to monitor and adjust the operating data, there are interfaces to the usual remote monitoring systems. The rectifier voltage is controlled by a switching control with a high efficiency.

The control range varies between 1.2V to 2V below the input voltage. By putting a bridge by means of stuck elements the input voltage can be adjusted from 0V up. However, this possibility shall only be applied, when it is necessary, as the efficiency will deteriorate a bit. All inputs and outputs are provided with an efficient overvoltage protection but an appropriately dimensioned high-voltage fuse has to be installed as well.

For the manual control a potentiometer helps to adjust the rectifier voltage. The software is confined to the visualization of the measuring values and the clock operation.

System Specification

In addition to the groundbed, the specification for a typical solar power system comprises four major component parts: the solar array, which generates the power; a battery bank to store surplus array power for use at night and during adverse weather conditions; a battery charge controller to prevent excessive charge or discharge of the batteries; the CP output control unit which automatically converts the power to the optimum current and voltage levels required.

Given a fixed geographical location, it is the CP load power that determines the size of the solar array and the battery bank that is required. Overall it is these factors that govern the eventual cost of the system.
The current required to suppress corrosion, which in turn is proportional to the number and levels of activity of the corrosion cells, increases with time. Generally, a corrosion engineer will expect a 20-year life for the pipe, and his design calculations will be based on the worst possible scenario for current requirements at the end of this period. A system designed to protect a pipe in “its worst condition” may therefore operate at a fraction of its design capacity for most of its life, needlessly tying up depreciating capital in equipment that will not require that level of protection for many years, if ever at all.

**Tailor-Made Systems**

Steffel KKS has specialized in making each CP system tailor-made exactly not only to the customer's requirements but to afford the optimum operational performance in the respective geographic location. To design a reliable but cost-effective system our experts need to know the site location and the CP output power required. This information is fed into a sophisticated computer sizing program for analysis. The computer’s initial task is to sift through an extensive meteorological database and derive the daily average temperatures and insulation (sunshine) levels for this particular location. Having isolated this data, the computer then calculates the optimum size and tilt of the solar array and the battery capacity required to meet the proposed load consumption. Finally, an outlet is produced of the optimum operational recommendations for the site including the meteorological data used and the average monthly performance of the proposed system.

**Thermoelectric Generator**
Thermoelectric Generators are a proven, reliable, continuous DC power source for Cathodic Protection. They are used when AC grid power is unavailable. The generator system is supplied with fuel from a gas pipeline, gas wellhead, or from fuel storage tanks. A thermoelectric generator converts heat directly into electricity with no moving parts. As heat moves from a gas burner through the thermoelectric module, it causes an electrical current to flow. The heart of a thermoelectric generator is a hermetically sealed thermoelectric module (thermopile), which contains an array of lead-tin-telluride semiconductor elements.

The generators operate on propane, butane, or natural gas. In many locations pipeline or wellhead gas may be used making operational costs negligible. The generators supply DC power continuously, eliminating the need for storage batteries. In the event of fuel interruption, the generators will re-ignite automatically upon resumption of fuel flow.

Thermoelectric Generators are regularly used for Cathodic Protection in the following criteria:

- Gas pipelines
- Wellheads
- Offshore platforms

According to the current need and location of project the proper thermoelectric generator will be chosen and designed.

- **AC Arrestor**
Steffel AC Arrester Unit LAN 100A/02 is a device for the leak conduction of corrosion-causing AC loads at high voltage installations such as natural gas pipelines.

In addition, the device is capable of generate a controlled DC load from the AC leakage current, which makes the arrester as a protective current unit with a leak conduction as well. In the operation mode of DC-current generation the device with a leak conduction as well. In the operation mode of DC-current generation the device works as a mere AC-arrester offering the advantage that the earthing system does not work as an external cathode because of its decoupling at the DC side. So an undisturbed operation of the Cathodic Protection from corrosion can be achieved despite of alternating current leakage. Furthermore the arrester unit can operate in a measuring mode, enabling the usual measuring of Cathodic Protection from corrosion with an active AC leakage current. In order to operate the AC-arrester LAN 100A no additional distribution voltage is necessary as the operation voltage is generated from the leak conduction of the alternating current. In this case a minimum leak current of 300 mA is required. The leak current is dependent on the load of the influencing system (e.g. high-voltage overhead wires) and electrical characteristics of the earthing system.

**Technical Data:**

- Nominal current (25 °C) 100 A
- Nominal impulse current 3 kA
- Nominal output (25 °C) 500 W
- Controlling precision DC +/- 5 mA
- Protective current (Max) 3 A
- Response time \(< 0,5\) sek
- Protective mode, housing \(\text{IP00}\)
- Temperature range \(-20^\circ\text{C}\) up to \(+70^\circ\text{C}\)
- Dimensions in mm \(375\times 280\times 160\) (W x H x D)

### Spark Gap

Buried pipelines for oil, gas and other inflammable materials are normally provided with Cathodic Protection as a form of corrosion control. This in turn requires the use of insulating flanges at terminal points in the pipeline system, such as at tank farms, governor stations, etc., in order to limit the extent of the applied Cathodic Protection and prevent the loss of protective current to other buried metallic structures. In these locations, in the event of a lightning strike on to any above ground pipe work or connected structure, or an electrical fault causing a voltage surge on the pipe, a flash-over across the insulating components of the flange could occur.

Any potential hazards caused by such an incident in an area classified as “Hazardous” due to the possible presence of an explosive atmosphere can be avoid by the use of an Explosion-Proof Spark Gap.

The Spark Gap is connected in parallel across the insulating flange and, since the connection is made using a flexible cable, the one type can be used for all sizes and ratings of flanged joints.
Technical Data:

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<th>Type</th>
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<th>Flange Dimensions</th>
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<tr>
<td>ExFS2</td>
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<td>220 – 320 mm</td>
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<tr>
<td>ExFS-ISO</td>
<td>For under ground installation at insulation couplings</td>
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</table>

- Threshold alternating voltage (50 Hz) \( \leq 1 \text{kV} \)
- 100%-threshold lightning impulse \( \leq 2,2 \text{kV} \)
- System of protection special protection (Ex)s according to DIN VDE 0171, spark group 4
- Cabinet Zinc casting plastics zinc casting with humidity-proof PVC
- Connection screw M10 or connection cable (NSLFF 25 mm²) with cable terminal and screw/nut M10 connection cable (NYY-J, 25 mm²) with a length of 1.5 m from both sides
- Dimensions 63 mm Ø 64 mm Ø
               90 mm (L) 157 mm (L)
**High Voltage Field Interference Capacitor Separator**

In order to meet the existing limiting values for a short- and long-term interference (contact voltage), pipelines being installed in the sphere of influence of high-voltage facilities, have to be equipped with appropriate instruments for the leakage of alternating current.

To avoid a negative impact on Cathodic Protection from corrosion at pipelines, means of alternating current leakage can get connected with the pipe by capacitor demarcation units.

The capacitor demarcation unit effects a direct current based separation between the object which is influenced by high voltages and the means for alternating current leakage (DC-decoupling).

For the alternating current impact which is to be derived \( f = \frac{162}{3} \text{ Hz and/or 50Hz} \) the conducting resistance of the capacitor demarcation unit is extremely low.

The capacitor demarcation unit consists of the three modules overvoltage protection, reverse-connect protection and DC-decoupling.

**Technical Data:**

- **Constant current limit** 30 A\(_{\text{eff}}\)
- **Max permissible operating voltage** +/- 75 V
- **Time of use at \( \theta_u \)** < 50 °C > 250,000 h
- **Housing protection** IP 54
- **Dimensions** 370 x 240 x 160 mm
Stray Current Protector

The switch gear for stray current protection type LAN 200-1000 is equipped with a power supply and is applied for the protection of pipelines or other metal installations in the soil from AC and DC currents. In case of failure the metal installation in the soil is bridged to the influencing system or earthing system to achieve stray current conduction.

The potential between the pipeline and the trail or earthing electrode is measured mono- or bipolar via a high-resistance amplifier. The switching threshold comes along with a pre-set value of $U_s = 85 \text{ mV}$ at delivery. If the potential between the pipeline and the trail or earthing electrode gets higher than $U_s = 85 \text{ mV}$ parallel arranged MOS-FET-transistors are being connected through. If the difference is getting less than the pre-set switching threshold, an automatic cut-off of the MOS-Fet-switch is activated, thus electrically separates the pipeline and the rail or earthing electrode again.

Through the high-resistance measuring and quick switching sequence in msec. range, the device works faster than every high-performance contactor and actually only in case of failure (voltage between pipe and rail > 85mV). A contactor needs about 90msec to activate the device. Moreover the separation of the potentials after a failure ($U < 85\text{mV}$) is also activated in the msec. range. The switching cycles are displayed by an 8-digit battery-fed display.

Technical Data:

- Auxiliary voltage: Lithium batteries with a 7 year service life
- Nominal switching current: 200 A at switching resistance 0,75 m-Ohm
- Maximum pulsed current: 1200 A
- Switching frequency: 1 kHz
- Reverse voltage: 50 V
- Transient protection: 4 Joule (WS) becomes actively at transients with voltages over
- Temperature range: -20°C up to +60°C
The basic unit switches 200 A (peak current: 1200 A) and can get connected in cascade arbitrarily in 200 A steps each.

- **Polarization Cell**

Polarization (Kirk) cells control the flow of potentially dangerous AC and DC current on buried metallic structures. They are often used on buried oil, gas, and water pipelines that share the same right-of-way as high voltage power lines. Because the cells produce various gases that can be explosive, they should be installed with proper venting. They should also be routinely inspected to ensure adequate electrolyte levels are present. The cells can be operated in temperatures ranging from -40°C to 60°C.

The Polarization Cell consists of multiple pairs of stainless steel plates immersed in a potassium hydroxide electrolyte solution. An oil seal floating on the electrolyte prevents evaporation, absorption of atmospheric gasses and excessive foaming under high current flow. DC current flow through the Polarization Cell causes a film of gas to form on the plates, offering high resistance to low voltage DC current. As the applied voltage across the cell increases, current flow through the cell increases, causing the thickness of the polarization gas film to increase. When the leakage threshold is exceeded, the film starts to break down, and the cell resistance quickly decreases as the applied voltage increases. AC voltages and higher DC voltages see the Kirk Cell as a dead short.
Polarization cells can be installed above or below grade. For exterior installations, a series of galvanized steel enclosures are offered.

CABLES & ACCESSORIES

- **Cables**

**NYY 0.6 / 1 kV**

PVC insulated, PVC sheathed NYY type cables are extensively used in indoor installations, in cable ducts, outdoors and underground in trenches for power stations, industrial plants as well as in local supply systems where mechanical damage is unlikely.

*Design and tests:* DIN VDE 0271

*Special application:*

Permissible operating temperature 70 °C
Permissible short-circuit temperature 160 °C

1. Copper conductor, solid or stranded
2. PVC insulation
3. Filling compound inner covering
4. Outer PVC sheath, black
The cross linked polyethylene, XLPE insulated cables are extensively used indoors, in cable ducts, outdoors and underground in trenches for power stations, industrial plants as well as in local supply systems subject to extreme operating conditions, such as high ambient temperatures, high capacity utilization, grouping of cables.

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<td>1.8</td>
<td>22</td>
<td>1.830</td>
<td>60</td>
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</tr>
</tbody>
</table>

RE Conductor circular solid
RM Conductor circular stranded

**XLPE/PVC 0.6 / 1 kV**

The cross linked polyethylene, XLPE insulated cables are extensively used indoors, in cable ducts, outdoors and underground in trenches for power stations, industrial plants as well as in local supply systems subject to extreme operating conditions, such as high ambient temperatures, high capacity utilization, grouping of cables.

1. Copper conductor, stranded
2. XLPE core Insulation
3. Extruded or lapped PVC bedding
4. Outer PVC sheath, black
Design and tests: IEC 502, BS6360

Cathodic Protection adapted to BS 5467

Special application:

Permissible operating temperature 90° C

Permissible short-circuit temperature 250° C

<table>
<thead>
<tr>
<th>Cores and cross-section</th>
<th>Thickness core insulation mm</th>
<th>Thickness overshoot mm</th>
<th>Outer diameter approx. mm</th>
<th>Resistance DC at 20 °C Ohm/km</th>
<th>Current Capacity at 20 °C A</th>
<th>Weight kg/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 10</td>
<td>0.7</td>
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<td>1.8</td>
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<td>x 10</td>
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<td>2.5</td>
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<td>430</td>
<td>5330</td>
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</table>
XLPE/SWA/PVC 0.6/1 kV

The XLPE insulated cables are extensively used indoors, in cable ducts, outdoors and underground in trenches when greater protection is necessary or where the cable is subjected to greater tensile stress during installation or operation, for power stations, industrial plants as well as in local supply systems subject to extreme operating conditions, such as high ambient temperatures, high capacity utilization, grouping of cables.

Design and tests: IEC 592, BS5467

Special application:

Permissible operating temperature 90° C

Permissible short-circuit temperature 250° C
**Splicing Kit**

These inline jointing sleeves are used for making reliable and weather-proof joints on solid insulated or mass impregnated paper insulated cables. Designed for those customers whose preference is an epoxy resin cold pours jointing system. The basic kit is rated up to 6 kV and includes pre-shaped moulds, tape to seal the mould ends and epoxy resin. Each kit can also be used with various cable types and sizes for example power cable accessories with nominal voltage up to 30 kV, Joints above 1 kV.

<table>
<thead>
<tr>
<th>Cable outside diameter</th>
<th>Max. cross section mm²</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>up to 1 kV</td>
</tr>
<tr>
<td>7-16 mm</td>
<td>4 x 4</td>
</tr>
<tr>
<td>8-22 mm</td>
<td>4 x 10</td>
</tr>
<tr>
<td>14-30 mm</td>
<td>4 x 25</td>
</tr>
<tr>
<td>23-35 mm</td>
<td>4 x 50</td>
</tr>
<tr>
<td>28-47 mm</td>
<td>4 x 95</td>
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<tr>
<td>33-55 mm</td>
<td>4 x 150</td>
</tr>
<tr>
<td>45-70 mm</td>
<td>4 x 240</td>
</tr>
<tr>
<td>50-77 mm</td>
<td>4 x 300</td>
</tr>
</tbody>
</table>

**Y, M or T Splicing Kits**

The Y, M and T-Splice kits have the same basic construction but different shapes for different applications (2 cables connection or 3 cables connection). All kits include the mould, funnels, end sealing tape, insulating and sealing compound. These kits are rated up to 1 kV.

Power cable accessories with nominal voltage up to 30 kV, Joints up to 1 kV.
Termite Welding

The exothermic welding process is a simple and safe method which does not require an external source of large heat or electric power for making copper to copper, copper to steel or steel to steel connections for the conduction of electricity. A graphite mould is used for making connections by this process. The mould is placed over the conductors to be joined. The weld powder is poured into the mould cavity after placing the thin metal disc to block the downward passage of the powder. The top lid is closed and a spark is produced by a flint gun to ignite the powder inside the mould. The ignition of weld powder causes high temperature exothermic reactions and the formation of Aluminum oxide slag and molten copper.

The molten copper melts the thin disc blocking its downward passage and flows through onto the conductors to be joined. A fusion weld is formed between the conductors in this process. The majority of exothermic welding connections have at least twice the cross sectional area of the conductors welded and equivalent or greater current carrying capacity. Since the connection is a fusion of virtually pure copper it can withstand high current surges and does not loose or corrode at the point of weld. A termite weld can further join stainless steel, steel rail, plain steel, Nichrome V, Monel, brass, bronze, copper clad steel (Copper bond, Copper weld), Chromax and galvanized steel. The selection guide shows the typical materials necessary for Cathodic Protection connections.
Standard Components:

- Mould holder with graphite mould
- Welding cartridge which should be proper to the size of cable
- Set of tools

**Pin Brazing**

The Portable Pin Brazing unit is suitable for all types of installation and maintenance work. It is primarily for the user who needs a simple, rugged and low cost machine. The unit is portable and easy to transport. The brazing process is controlled by means of the fuse wire on the brazing pin. The capacity is approximately 15 brazes with the standard type of brazing pin per battery charge but it can easily be increased by a battery charger mounted in a vehicle, the batteries being charged up during transportation between workplaces. When alternating between charging and brazing it is possible to increase the capacity up to 5 times during a working day.
Unit Components:

- Brazing Gun
- Earth Cable
- Grinder (optional)
- Battery Pack (the batteries are sealed to prevent acid spill) and Battery Charger
- Attache Case for the Gun, Earth Cable and Grinder

The unit complete weight is approximately 30 kg.

Available pins:

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Description</th>
<th>Dimensions</th>
<th>Pack Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Direct Brazing pin, standard (without fuse wire)</td>
<td>Ø 8 or 9.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Direct Brazing pin, standard (with fuse wire)</td>
<td>Ø 8 or 9.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Threaded brazing pin (with fuse wire)</td>
<td>M8</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Threaded brazing pin (with fuse wire)</td>
<td>M10</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>Threaded brazing pin (with fuse wire)</td>
<td>M12</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>Ferrule</td>
<td>for 8 mm direct pins</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>Ferrule</td>
<td>for 9.5 mm direct pins</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>Ferrule</td>
<td>for all threaded pins</td>
<td>100</td>
</tr>
</tbody>
</table>

The working temperature of the brazing solder in the brazing pins is 610 ºC, in line with the classification of the operation as hard soldering. A new ferrule must always be employed in pin brazing (the ferrule must be changed after each brazing operation). The purpose of the
The ferrule is to prevent spattering of the molten solder, to prevent oxidation of the molten solder, and to protect the operator against radiation from the arc. The ferrule must be stored dry.

Cable lugs are specially manufactured in the intended material for pin brazing. The lugs are made in two different types. M1 is pin brazed to the cable. M2 is crimped to the cable.

**Available lugs:**

<table>
<thead>
<tr>
<th>Suitable for</th>
<th>Pack size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm² Cable</td>
<td>100</td>
</tr>
<tr>
<td>16 mm² Cable</td>
<td>100</td>
</tr>
<tr>
<td>25 mm² Cable</td>
<td>50</td>
</tr>
<tr>
<td>35 mm² Cable</td>
<td>50</td>
</tr>
<tr>
<td>50 mm² Cable</td>
<td>40</td>
</tr>
</tbody>
</table>

**Connectors**

For circular stranded copper conductors to DIN 48 201 and circular stranded/sector shaped copper conductors to DIN VDE 0295

**Material:** copper bar or electro tinned

- **Compression cable lugs**
  Cross section form 6 mm² up to 1000 mm²

- **Compression joints**
  Cross section form 2.5 mm² up to 1000 mm²
For circular stranded copper conductors and circular stranded/sector shaped copper conductors.

**Split bolt connector**
*Material: high-strength copper alloy*

**Universal tap connectors**
*Material: brass, electro tinmed*
*Bolts: Steel 8.8, hot galvanized*

**Handy Cap & Cable Contact Hood**

**Handy Cap**

**IP Model (no Primer is needed)**
Handy Cap IP is a prefabricated assembly designed to provide quick, field-applied corrosion protection to anode and test lead wire welds on metal pipe and tanks. This economical product is ideal for use in limited access applications. New Handy Cap IP now adds the innovative technology of Tapecoat Gray Adhesive to its unique design. The integration of a primer in Tapecoat Gray makes field application of Handy Cap IP easier and more economical.
- Ideal for Keyhole Applications
- Dome and Tunnel Provide Easy Access
- Tapecoat Gray Adhesive Eliminates Liquid Primer
- Elastomeric Compound Encases Weld Profile
- Serrations Conform to Small Diameters

Ideal for Keyhole Applications
Dome and Tunnel Provide Easy Access
Tapecoat Gray Adhesive Eliminates Liquid Primer
Elastomeric Compound Encases Weld Profile
Serrations Conform to Small Diameters

Typical Properties:

<table>
<thead>
<tr>
<th>Construction</th>
<th>Molded plastic dome filled with corrosion resistant compound on a base of thick elastomeric tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>Overall: 4” x 4” Plastic Sheet: 2.75” x 4” (serrated) Sheet Thickness: 10 mils Plastic Dome: 1.625” diameter/ .8” height</td>
</tr>
<tr>
<td>Adhesive Thickness</td>
<td>165 mils</td>
</tr>
<tr>
<td>Weight</td>
<td>80 gr</td>
</tr>
<tr>
<td>Application Temperature</td>
<td>-29°C to 49°C</td>
</tr>
<tr>
<td>Service Temperature</td>
<td>-40°C to 66°C</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>Rotate yearly</td>
</tr>
</tbody>
</table>

Tapecoat Gray Adhesive bonds the tough outer shell of the Handy Cap IP to the bare metal weld area and surrounding plant applied coating. Innovative Tapecoat Gray incorporates an integrated primer in its adhesive and provides exceptional bonding without the costly application of liquid primer. A protective compound within the dome molds itself over the irregular welded profile and encases the exothermic connection.
Cable Contact Hood

By means of the cable contact hood passive protection from corrosion at cable connections, used for the Cathodic Protection at the pipe, can be achieved safely and economically. Due to its construction and the choice of material the shape of the cable contact hood enables a use at pipes with diameters ranging from 80 – 1600 mm. Three different case sizes cover the space requirement for up to four welding points (contacts) and for all cables with a diameter between 9 and 17 mm. The casting resin inside the two chamber bag is user- and environmentally friendly and enables the use at PE- and bitumen coatings.

The cable contact hood contains:
- Case with a closing cap
- Grouting compound
- Emery paper
- One-way gloves
- Templates for removal of PE-wrapping
- 2 adhesive tapes for possible re-sealing of cable insulating

Technical Data:

<table>
<thead>
<tr>
<th>Type</th>
<th>Item number</th>
<th>Case length</th>
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<tbody>
<tr>
<td>1</td>
<td>KVS 10</td>
<td>130 mm</td>
</tr>
<tr>
<td>2</td>
<td>KVS 12</td>
<td>230 mm</td>
</tr>
<tr>
<td>3</td>
<td>KVS 14</td>
<td>340 mm</td>
</tr>
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</table>
COATINGS, INSULATION MATERIALS & TAPES

- **Pipeline Cold Wrappings and Tapes**

In order to isolate and protect the pipeline surface from chemical and mechanical damages caused by surrounding environment, cold apply pipe coating wrapping tapes are very common.

These kinds of tapes are applied with an adhesive or primer. The old types have inner and outer separate wrapping tapes that should be applied in combination together but the newer material designed tapes are 2 or 3 ply tapes that can be applied individually only with (or even without) primer.

The new wrapping tapes are high performance for the protection from corrosion of above and below ground pipelines, girth welds and fittings. These tapes incorporate an integrated primer into these protective tapes and eliminated the dangers of emissions and hazardous waste associated with the application of liquid primers. They can be applied over a wide range of ambient temperatures for the protection of most metal surfaces.

**Specifications:**

- **Integrated Primer:**
  - replaces flammable and hazardous liquid primers
  - eliminates VOC emissions
  - eliminates dangers of a toxic material spill
  - eliminates need to dispose of hazardous wastes
  - labor-saving application
  - aggressive tack gives consistent application
Adhesive Coating:
- aggressive bond to steel and other metal pipe substrates
- cohesive strength as well as flexibility
- excellent resistance to Cathodic disbandment

3 Layer Tapes
The corrosion protection tapes comprise symmetrical and asymmetrical three layer wrapping tapes and butyl rubber tapes. The bottom butyl adhesive layer makes these tapes adhere to the metallic surface and the upper adhesive butyl layer makes them amalgamate with the subsequent layer. This results in a sleeve-like coating, which is almost impermeable to water and oxygen.

In symmetrical three layer wrapping tapes, the adhesive butyl layers on both sides are of equal thickness.
Asymmetrical three layer wrapping tapes are distinguished by a much thicker adhesive butyl rubber layer on the side facing the metallic material. The outer butyl adhesive layer serves only to amalgamate with the subsequent layer of tape. The thick butyl layer evens out irregularities in the metallic surface. Co-extruded layer between film and adhesive layers prevents peeling off in adjoining surfaces under peel stress. Pure butyl rubber tapes have only a very thin (25-70µm) polyethylene film as an intermediate layer. This intermediate layer stops the tape from overstretching when spirally wrapped. These tapes are primarily distinguished by a very plastic and supple behavior and are particularly suited to the wrapping of complex geometrical shapes.

**Mechanical protection tapes**

To increase mechanical resistance, corrosion protection tapes can be combined with mechanical protection pipe wrapping tapes. Particularly with butyl rubber tapes, this increases resistance to impact and indentation stress.

A distinction is made between 2 layer wrapping tapes and purely adhesive tapes. 2 layer wrapping tapes consist of a polyethylene film and a butyl adhesive layer, both linked by a co-extrusion layer. The butyl adhesive layer amalgamates with the corrosion protection layer to make an impermeable butyl rubber layer. Adhesive tapes display adhesion here only because of the hot adhesive coating.
- **Heat Shrink Sleeves**

Heat shrinkable corrosion protection sleeve specifically developed for installation on welding beams, flanges or mechanical couplings that are already in place.

PTFE or FEP sleeving is the ultimate choice for applications that need high resistance to temperature, chemicals, solvents, UV light etc. With a choice of shrink ratios up to 4:1, working temperature of up to 260° C, the applications for these materials is limitless.

Newly developed production methods mean that these heat-shrink sleeves can now be competitive with inferior polymers such as polyolefin and PVDF and with their use product quality can be improved with little or no extra cost.

PTFE heat-shrink sleeves are made from pure virgin PTFE with no fillers or additives and therefore offer all the exceptional properties of PTFE. The major characteristic is an upper continuous working temperature of 260° C. This exceeds that of any other heat-shrink polymer. In addition it is completely resistant to virtually all chemicals, and UV radiation. It is available in 4:1 and 2:1 shrink ratios, and the shrinking temperature is 327° C.

Like PTFE heat-shrink, FEP offers all the unique properties of Fluoroplastics, but with one exceptional addition. Whilst the maximum continuous working temperature of FEP is 200° C its shrinking temperature is only 110° C. This means it can safely be shrunk over temperature sensitive materials without damage. Couple this property with its transparency, complete chemical resistance, total UV resistance and non stick nature you have a very unique material.
High Shrink Sleeves are superior performance heat shrinkable products designed for corrosion protection of flanges, casings, bell and spigot joints and other high profile couplings. High Shrink Sleeves consist of a cross-linked polyolefin backing, coated with a protective heat sensitive adhesive which effectively bonds to steel substrates and common pipeline coatings including polyethylene and fusion bonded epoxy.

Heat Shrink Tape Construction:

**Two-layer system**
- First layer: Visco-elastic sealant
- Second layer: Thick-walled, radiation-cross-linked, high density polyethylene
Multi wrap construction

- Adhesives: Semi-crystalline mastic sealant, High-shear strength copolymer adhesive
- Backing: Flexible, radiation cross-linked, low density polyethylene

Heat shrink sleeves are available in a variety of sizes; eliminate the need for molding and filling compounds or jellies. The visco-elastic properties of adhesives in the installed product protect against pipe stresses caused by ground movement. The wall thickness of the installed product offers additional mechanical strength in the critical transition area.

**Features:**

- No primer is required
- Installation is carried out directly on the cleaned, dried and prepared pipe surface
- Compatible with standard commercial mill-applied coatings
- Highly Flexible, Easy to apply at both low or high temperatures and on pipes of small diameter
- Compatible with varying pipe diameters, minimizes inventory, thus saving money
- The installed sleeve possesses high mechanical strength
- Simple re-entry


- **Primer**

Primer is an elastomer-resin based formulation used as a corrosion resistant adhesive for adhering wrap to both metallic and non-metallic surfaces for underground service. It provides a strong bond between wrappings and all of the various surfaces commonly encountered in underground service. Its high degree of corrosion resistance enhances salt crouch performance and maintains excellent adhesion under adverse environmental conditions. Its heavy consistency retards settling in the container yet allows easy brush-our for thin film coverage.

Primer is usually used to adhere wrappings to the following substrates commonly used underground:
- Steel and galvanized metal
- Extruded polyethylene and polypropylene
- Coal tar and asphalt enamels - Micro crystalline wax
- Thermoplastic and thermoset thin film coatings
- Laminated and extruded pipe wraps

**Surface Preparation:**
In order to use primer, pipe surface should be dry and cleaned of all rust, scale, soil, mud, oil, grease and other contaminants by wire brushing, blasting or other methods. Mil applied coatings and pipe wraps should be dry and free from mud, soil, dust and oil.

**Application Temperature:**
Pipe heated by welding should be allowed to cool to 50° to 60°C before applying primer. Application may be made at temperatures below -17°C, but condensation of moisture must be guarded against at low temperatures.

**Drying Time:**
For rapid bond development primer should be allowed to dry to a non-glossy appearance
before applying wrapping. This will require only one to five minutes depending on variable application conditions Bond development over semi-dried primer is delayed somewhat, and over wet primer is delayed as much as 24 hours.

**Physical Properties:**

- **Composition:** Elastomer-resin based formulation in blended solvent system
- **Color:** Black
- **Viscosity:** 8500 cps
- **Typical Weight:** 8.1 +/- 0.02 lbs per gallon
- **Specific Gravity:** 0.97
- **Percent Solid:**
  - By Volume: 29%
  - By Weight: 38.7% +/- 1%
- **Flash Point:** 38°F Seta Flash Closed Cup
- **Shelf Life:** At least one year

**Insulating Tapes**

There are several types of tapes for electrical connections and splicing insulation.

- Electrical grade, rubber-based, elastic-type putty in tape form. Use it as a build-up compound on highly irregular surfaces, such as fittings and valves, to provide a smooth, waterproof taping surface.
- Highly conformable linerless ethylene propylene rubber (EPR) high-voltage insulating tape that provides excellent chemical dissipation of splice heat.

Vinyl tapes provide high dielectric strength as well as resistance to moisture, UV rays, abrasion, corrosion, alkalies and acids. The aggressive pressure sensitive rubber-based adhesive performs well over a range of temperatures. Fade-resistant colored vinyl tapes ensure fast identification of electrical phases, leads, piping and safety areas. Vinyl tapes provide primary electrical insulation up to 600 volts and can be used in jacketing application for high-voltage cables and wire harnessing.

- Self-fusing, rubber based thin insulating mastic compounds laminated to a flexible, all-weather grade PVC backing and are designed for moisture sealing of electrical connections up to 600 volts.
Insulating Kit

Flange insulating kits are effectively and efficiently used on Cathodic Protection systems of buried pipelines. The basic method is to separate one piece of metal from another by some form of non-conducting material.

The most common applications are:

- Electrically isolate a Cathodic Protection system from Cathodically unprotected structures (e.g. separate pipelines from terminal facilities of pumping stations).
- Electrically split-up long pipelines into distinctively effective Cathodic Protection systems to prevent long line currents.

With the flange insulation you may convert a normal flange joint into a Flange Insulation Joint acting as an electrical insulating gasket.

The application is not limited to new flange joints. The flange insulation is perfectly suitable for the conversion of existing flange joints into insulating joints, without modifications on the very flange joint.

All insulation flanges are suitable for norm flanges up to PN210 without doing any re-work.
Single ISO bolts or ISO flanges can be supplied for after- or retrofitting purposes or for complete kits. The kits will be compiled according to your requirements (operating conditions).

**ISO-kits for joint-ring flanges:**

Standard BE for operating pressure up to 100 bars (1500 psi)
ISO-Kit’s for smooth-face flanges:

Standard TM for operating pressure up to 40 bars (600 psi)

<table>
<thead>
<tr>
<th>ISO – Kit Standard TM</th>
<th>Pos.</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISO disk, thickness 20 mm (11/16&quot;)</td>
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</tr>
<tr>
<td>2</td>
<td>ISO washer, thickness 10 mm (5/32&quot;)</td>
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</tr>
<tr>
<td>3</td>
<td>Bold insulation (fiberglass or PVC)</td>
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<tr>
<td>4</td>
<td>ISO bolt</td>
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</tr>
<tr>
<td>5</td>
<td>Steel nut</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Steel washer, heat-treated</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Flat non-metallic gasket</td>
<td></td>
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</tbody>
</table>

Standard LA for operating pressure over 40 bars (600 psi)

<table>
<thead>
<tr>
<th>ISO-KIT Standard LA</th>
<th>Pos.</th>
<th>Component</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>ISO disk, thickness 20 mm (11/16&quot;)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ISO washer reinforced with steel shell</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stud insulation (fiberglass or PVC)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ISO stud</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Steel nut</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Metal, or metal-reinforced gasket</td>
<td></td>
</tr>
</tbody>
</table>

Standard LI for operating pressure over 40 bars (600 psi)

<table>
<thead>
<tr>
<th>ISO-KIT Standard LI</th>
<th>Pos.</th>
<th>Component</th>
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<tr>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>Metal, or metal-reinforced gasket</td>
<td></td>
</tr>
</tbody>
</table>
**Insulating Joint**

Monolithic Insulating Joints, similar to the function of the flange insulating kits, are used to electrically isolate pipelines from other “grounded” structures.

Monobloc insulating joints can be delivered as joints for service consumers and joints for main pipelines.

The service consumer joints which are normally for use on lower pressure small diameter pipelines are internally lined to give a high degree of electrical insulation and isolate the consumer’s plants from the main distribution pipeline. The insulating joints for main pipelines are used on high pressure large diameter transmission and distribution pipelines. These have a different internal arrangement of insulating rings and sealing gaskets and are available in ratings ranging from ANSI 150 to ANSI 600 and over. They normally supplied with ends prepared for welding.

Insulating spools which are used on pipelines carrying saline water are also available in various sizes and rating.
Advantages:
The advantages of a compact, prefabricated insulating joint as compared with a detachable, flanged connection are pointed out below:
- fully welded component
- flexural rigid construction (in accordance to the available pipe-forces respectively actual bending torques)
- pressure test possible at the works
- not removable
- no loss of pre-stress power
- homogeneous, seamless external insulation
- external insulation tested electrically in the works
- integrated annular spark gap

Range of applications:
- Media: oil, gas, combustible liquids, brine, acid
- Below- and above-ground pipe work
- Compressor stations
- Regulating stations, explosion protected
- Pipe work and compressor regulating station from PN 16 up to PN 320 bar and above, ANSI 150, 300, 400, 600 >
- Pipelines up to DN 1600 mm and above
- Temperature range standard −10 °C up to 50 °C
- Special design −40 °C up to 150°C
Rock Shield

Rock shield is the ideal protection where pipeline coatings are subjected to rocky terrain, mountain handling, excessive abrasion and damaging backfills. This easy applied product cushions pipelines against abrasion, impact and penetration, so protective coatings remain intact to fight corrosion.
Protecting the pipe coating by cushioning the impact of the backfill as it is reintroduced into the ditch and keeping harmful rock and debris from direct contact with the coating during and after the ditch has been closed. Pipe protection fleeces offer additional mechanical protection for corrosion protection coating on high-quality pipelines. They also decouple the pipe from the surrounding soil for relative movement based on temperature differences. High-quality pipe protection Rock shield is made of polypropylene, Polyethylene or PVC fleece. Its good permeability for soil electrolytes ensures that Cathodic Corrosion Protection will be unaffected.

Advantages:
- Load distributing
- Impact absorbing
- Heat resistant
- Resistant to chemicals
- Allows electric current passage
- Absorbs impact of uneven back fill
- Protects pipe during future excavations
- Protects pipe coating from protruding rocks in trench
- Minimizes abrasion of coating from pipe movement underground
- Is unaffected by temperature extremes and wet weather
- Cushions against concrete weights
- Easy to install
Casing Carrier Pipe Isolators

The insulator segments are specially designed for the requirements of Cathodic Protection with regards to insulation between the casing and carrier pipes which call for the insulator ring without metallic parts and connection of segments by means of plastic-wedges. Insulators are made of high density polyethylene. This material meets the high requirements expected from a plastic insulator.

Polyethylene has outstanding sliding properties and a remarkably low friction coefficient compared with steel. This is ideal for placing the carrier pipe inside the casing. The minor friction also prevents damages to coating and insulation of the pipes. The bending strength and the outstanding electrical properties make polyethylene as the best suited material. Low weight and high resistance against deflection are additional advantages of polyethylene.
All insulators are also available in a special version for high temperature up to 140 °C. This special type of insulator is manufactured from special fiber reinforced material.

Technical ratings:
- Dielectric strength as per DIN VDE 0303: 53 kV/mm
- Compressive strength at normal temperature app.: 6.5 N/mm²
- The composition of the insulator ring may be obtained according to the following rule:
  For every 4” DN (100 mm):  1 segment NMV
  For every 2” DN (50 mm):  1 segment NMV2

<table>
<thead>
<tr>
<th>Type</th>
<th>Skid height mm</th>
<th>Width</th>
<th>Number of skids</th>
<th>Plastic wedges for connection</th>
<th>Number shear-pins per segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMV 43</td>
<td>43</td>
<td>225</td>
<td>2</td>
<td>2</td>
<td>4</td>
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<tr>
<td>NMV 50</td>
<td>50</td>
<td>225</td>
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<td>NMV 2/125</td>
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<td>225</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
TEST STATIONS & JUNCTION BOXES

- **Test post**

*Test Post Marker Type 2K-DGBM*

The development of this test post is characterized by an uncomplicated assembly in the clamping area and by perfect use with regard to measuring and maintenance operations. This also includes a safe installation of modern data loggers and techniques of transmission. The result is a test post with diametrically arranged flaps. The front opening of the flap is fitted out with a lockable 3-cant-seal and has more than doubled its volume compared with the flap openings which previously were in use. This enables an optimal access on the pole terminals and on an optionally installed data logger. The back flap which is allocated to the cable feeding can only be controlled from inside what secures a cable assembly without removing the clamping plate. Because of its heightened assembly position an easy cable run at the clamping plate is guaranteed. The flaps being integrated into the outer diameter meet the technical and visual requirements.

The material of this test post is PVC but it’s also available in Galvanized steel with epoxy resin coat.
Technical data:

- Standard lengths: 200 cm / 250 cm / 300 cm
- Outside diameter: 110 mm
- Wall thickness: 6 mm
- Floor anchor: 3fold - splayfoot
  alternatively as a cross anchor with 2 crossways braces
- Installation depth: Identification mark at the foot as specified

Different color and sizes are available upon request.

**Aluminum Test Post Marker**

The mutual leaded top can be shoved highly and is equipped with a drawing-out limitation. Due to the increasing vandalism this theft protection of the top gives you an enormous advantage and thus taking security aspects into account. The 3 cant-seal with point lock being integrated at the surface is an additional contribution to security. The profiled surface with its 4 horizontal grooves (by 90° transposed) is proper for the mounting of indicating labels. The fastening by means of clips is not necessary anymore. The 4-fold splayfoot guarantees the stability in the ground.

By an eloxal-coating the post standard version is protected durably from corrosion. On request the posts can get powder coated in color.

The posts include a measuring facility with 12 logs for the mounting of the pole terminals with an integrated assembly device to hold a data logger.

The heightened position of the clamping plate ensures the best cable run from the post to the pole terminals. Thereby the removal of the clamping plate is possible but not necessary anymore.
Technical Data:

- Standard length: 150 cm / 200 cm / 250 cm / 300 cm
- Outside diameter: 108 mm
- Custom-build models:
  - Floor anchor as a cross anchor
  - Test facilities with profile-track
  - Color powder coating
Test Box:

Test box is usually used when we have more than one point to measure. In order to measure the potential and current of some points near each other or having more than one measuring points on one structure with individual reference cells for each point, the best selection is test box.

The test box is made of shock-resistant PVC and has been developed as an alternative to the test posts. Because of its large volume it has twice as much clamping space than a test post. By means of two cross running assembly profiles the box can be equipped individually. It is prepared for the installation of clamping plates to hold pole terminals or for the fastening of appropriate profile carrying-tracks. A combination with a data logger or the latest techniques of data remote transmission is possible as well.

A circulating profile in the frame and a profiled joint inside the door make this box waterproof. The door is equipped with a waterproofed 3-cant-seal and with a covered hinge. In case of wall-mounting the cables will be protected by an in colour adapted covering profile. The test box is available in an empty-standing version with a splayfoot post which serves as a ground anchor. If measuring facilities inside a test post should be too small, re-fitting with a special adapter is possible. The existing post has to be cut off in the desired height. Then the test box with the adapter only has to be slipped on and fastened.
**Technical Data:**

- **Dimensions:** 250 x 350 x 175 mm (W x H x L)
- **Material strength:** 5 mm
- **Colour:** yellow

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**Big Fink Test Post**

The big Fink Cathodic Protection test station is a versatile, high-impact resistant, non-conductive above-ground terminal for conveniently monitoring electrical currents and potentials associated with all types of underground piping, cables and other metallic structures.

The big Fink is used as a terminal for test leads to read:

- Underground structure-to-soil potentials
- Cathodic Protection anode currents
- The resistive integrity of insulation flanges and joints
- The integrity of insulation between all types of underground metallic structures, such as between a carrier and its casing
- Stray currents on all types of underground structures

---

**Features:**

- High-impact strength – molded of Lexan
- Has four times the impact strength of Aluminum
- One-half the weight of Aluminum
- Will not rust, corrode, shock, shatter, peel, add weight or absorb heat
- Has dimensional and electrical stability from −50 °C to +120 °C
- Stable under ultra-violet attack
• Terminals completely accessible from both sides of terminal board
• Maintenance free – eliminates painting – comes in an variety of colors
• Non-metallic Lexan drastically reduces shock hazard
• Available in your choice of colors, colors available on request
• Accessories include: Nickel plated copper bonding straps, calibrated shunts, power resistors, lightning arrestors, meters etc.
• Can be ordered with a lock
• Available in models to fit ¾”, 1 ¾” and 3” diameter conduit.

Materials:
Test Station: Lexan 
Hardware: Machine screws, washers, hex nuts plated (stainless steel hardware available as an option)
Conduit: Ultra violet stabilized polyethylene-predrilled in 1.5 m length with anchor and access holes for wires

Each test station consists of a lockable cover, a terminal board with integral compression fit base, a compression nut for clamping the base to the conduit and complete hardware. Conduit, wiring and other accessories are available on request.
Junction Box-Resistor Box

Basic Junction-Bond Box

For Basic Wire Connections Choosing the right electrical components, is an important part of any impressed-current Cathodic Protection design. The standard junction box is designed for basic wire connections that do not require shunts or resistors, and contains only terminal lugs. The electrical difference between a structure and its electrolyte is the most important measurement for determining the effectiveness of a Cathodic Protection system. To obtain this reading, a junction box with independent reference cell and structure terminals is equipped with this kind of terminal configuration. Also in some cases for connecting the anode groundbed cable or anodes cable to the sourcing power cable in the simplest way. The lugs have a parallel arrangement, and can be used to create between one and fifty circuits. They are provided in various sizes to accommodate numerous types of wires. The terminals are installed on NEMA grade C phenolic panels. The non-conductive panels are resistant to warpage and weathering. Protecting wire connections from dust, water, and moisture requires a truly sealed enclosure.

Enclosure Material:
- PVC
- Aluminium
- Mild steel with painting
- Galvanized steel
- Stainless steel
- IP66 EEX (Explosion proof) for hazardous area
**Junction-Bond Box with Resistors/Shunts**

Resistance values of anodes on any given impressed current Cathodic Protection system are often different due to varying lead wire lengths and electrolyte conditions. To compensate for these unequal resistance levels, and to ensure uniform current output, junction boxes with shunts and resistors can be employed.

It is provided with shunts and resistors for creating circuits (the number of circuits depends on the size of enclosure). The shunts are precalibrated, and may be selected with various ohm/amp. combinations. The resistors can be adjustable vitreous style, and are either enamel or silicon coated. Like the shunts, they may be chosen from a wide range of resistance and current combinations to address numerous applications.

**Optional Features:**

- Enclosure material and size upon request
- Number of needed terminals upon request
- Pole Mounting Channel
- Jumper Wires (provision for resistors)
- Slide Wire Resistors
- Shunts
- Switches
- Vents for Heat Dissipation
- Lockable Latch
**Anode Control/Monitoring Panel**

*For Impressed Current Anode system:*

There are numerous ways to design the electrical circuitry on an impressed-current Cathodic Protection system. One of the more common methods is to connect anode leads from a rectifier to terminals in a junction box containing shunts. This type of design allows current to be measured on each anode to monitor performance and to identify potential problems. The terminal lugs in the box are made from solid copper, and are available in a variety of sizes to accommodate different types of wire. Shunts included with the box are pre-calibrated to measure current flow, and are offered in a range of resistance and current output combinations.

Anode control boxes are mostly provided with shunts to measure the current for individual anodes or groups of anodes and can be provided with small variable resistor to adjust and control individual current output or with one common variable resistor. A moving coil ammeter with selector switch can also be added.

The Ammeter shows the current flow for each anode or each ground bed. It can be analog or with digital display.
For Sacrificial Anode system:

The sacrificial anode control panel was designed for the tank market to provide both control of sacrificial anode system current and monitoring of the related tank potential. The panel is constructed in an enclosure and is separated into two sections: One for “control” and the other for “monitoring.” The “control” section is comprised of a structure connection terminal, anode bed connection terminal, on/off switch, adjustable rheostat, and a block style shunt for current verification. The “monitoring” section is comprised of a structure connection terminal, reference cell connection terminal, meter input selection switch potential/anode current, LCD display meter, and a battery (or other power sources).

Enclosure Material:

- PVC
- Aluminium
- Mild steel with painting
- Galvanized steel
- Stainless steel
- IP66 EEX (Explosion proof) for hazardous area
TEST & MEASURING EQUIPMENTS

- Reference Electrodes

**Cu/CuSO₄ Reference Cell**

Routine monitoring is an important part of any Cathodic Protection maintenance program. To simplify this testing procedure, 2 types of portable and permanent reference cells can be used.

**Portable Cu/CuSO₄ Reference Cell**

This electrode is usually used for maintenance and control of CP systems or measurement of potential of a metallic structure.
**Model RE-5**

![Model RE-5](image1)

**Model RE-5C**
Similar to Modell RE-5 except supplied with a cone-shaped CPT porous plug. For use in soft soils, provides lower contact resistance. When pushed into soft soils the shape of the plug helps the electrode to “stand up”. Approx. Overall Size: 1 3/8” dia. x 6 ¾” long. Dry Weight: 5 oz.

![Model RE-5C](image2)

**Model RE-7**
Long, slim model with beveled CPT porous plug. For general purpose use in soil or in a 1” diameter augured hole in pavement. Approx. Overall Size: 1” dia. x 8 ½” long. Dry Weight: 5 oz.

![Model RE-7](image3)
**Model RE-5/U**
For use on underside of bridge decks, parking garages, etc. in upside-down position.

**Model RE-3A**
Large diameter (3”) flat CPT porous plug provides greater contact area. Flat plug provides lower contact resistance than rounded or serrated plug when placed in direct contact with flat surfaces. Especially useful on pavements, dry sand, frozen soil, etc., stands by itself. Approx. Overall Size: 3” dia. x 5” long. Dry Weight: 16 oz.

**Extensions**

**Type A: Intermediate Electrode Extension**
760 mm long. The Electrode can be easily placed at the desired location inside manholes, water tanks etc., will fit through a 1” diameter augured hole.

**Type B: Electrode Extension**
760mm long. Side terminal connection allows use of the electrode without bending over or stooping. Extensions are also available in 380 mm lengths by special order.
Spare Plug Assembly
Replacement or spare plug assemblies are available for all electrodes and are supplied with an “O” ring gasket and a protective cap. Note that the RE-5 and RE-5C plugs are interchangeable.

Permanent Cu/CuSO4 Reference Cell

For the monitoring of Cathodically protected constructions and for the control of rectifiers a Cu/CuSO4 fixed measuring electrode is installed durably in the ground. There is no more phase out and no maintenance with these reference measuring electrodes. They are particularly suitable for the constant potential monitoring of protective objects with connection to a telecontrol transmission and potential regulated rectifier. Since 1985 these measuring electrodes are in use at different mineral oil and natural gas companies as well as at utility providers and town departments. Permanent Copper-Copper/Sulphate Reference Electrodes, designed for direct burial for long term monitoring of buried or earth contacting structures.

Features:
- Large surface area of exposed copper-sulfate mixture
- Long life - 20 years
- Use with rapid-wetting backfill in a cotton bag
- Encapsulate fill area for permanent water seal of wire connection
- Rugged construction

Electrode KMS 001

Potential referring to H2 - electrode: + 0.32 V

Temperature Range: 0° C - 55° C

Technical Data:
- Total length: 200 mm
- Diameter: 40 mm
- Measuring area: approx. 138 cm²
- Connection cable: 6 m (1 x 4 mm²)
Electrode KMS 001

Technical data:
- Total length: 145 mm
- Diameter: 25 mm
- Measuring area: approx. 85 cm²
- Connection cable: 6 m Oilflex (2 x 1.5 mm²)

Ground Reference Electrode KMS 003

Cu/CuSO₄ solid substance electrode for maintenance measurements.

Technical data:
- Diameter: 70 mm
- Measuring area: 40 cm²
Permanent Cu/CuSO4 reference electrodes are also used in cotton bags with backfill that is placed underground.

**Composition of backfill:**
- 70 % Bentonite
- 20 % Sodium Sulfate
- 10 % Gypsum

**IR Free Probe Cu-CuSO4**

Copper-Copper Sulfate Cu-CuSO4 IR-Free probe with 1-100 cm² coupon and Bullet Box interrupter providing ON & OFF potentials, 100mV shift for current readings in chloride free environments is used.
Cu/CuSO₄ for fresh water service

For structures located in fresh water, copper/copper sulfate cell, which is made using a 99.99% pure copper coiled element and surrounded by a supersaturated paste of copper sulphate, is used. To ensure a low-resistance connection, a lead wire is mechanically bonded and soldered to the copper element. This electrical junction is then encapsulated by a moisture-resistant shrink sleeve for a truly sealed connection. Electrical contact to the electrolyte is accomplished through a filtering plug at the end of the reference electrode. The plug allows accurate potential measurements to be obtained while preventing cell contamination.

In order for a reference to be effective, it must remain electrically stable over time. Deionized water is used to create the supersaturated solution of copper sulfate, and the copper element is treated with a special cleansing agent before it is installed into the cell’s plastic housing. The cell usually has a 30-year design life and the ability to maintain an electrical potential of within ±5 millivolts.

Application:

The application includes elevated water storage tanks, clarifiers, traveling screens, pasteurizers, locks, dams, and fresh water dock structures. The cell can be operated at temperatures of up to 57°C, but should not be used in waters containing high concentrations of chloride ions.

Technical Specification:

- Size: 25.4 mm diameter 203 mm long high impact resistant Lexan® tube
- Lead Wire: 1.5 m of # 14 RHH-RHW yellow wire
- Stability: ± 10 mV with 3.0 µA load
- Potential referring to H₂ – electrode: + 0.32 V
- Temperature Range: 0 °C to 57 °C
Zn/ZnSO4 Cell

This kind of reference electrode is usually packed in a bag containing backfill for underground use.

There is 2 usual type of this reference cell:

Type 1

- Prepackaged in a cotton bag containing non-polarizing bentonite backfill.
- Potential referring to H2 - electrode: -0.77 V
- Potential referring to Cu/CuSO4: -1.10 V
- Bag dimensions: 260 mm dia.
- Length: 560 mm
- Weight: approx. 28 kg
- Temperature Range: 0° C - 55° C
- Composition of backfill: 70 % Bentonite
  10 % Kieselgur
  20 % Sodium Sulfate

Type 2

- Size: 51 mm diameter
- 178 mm long high impact resistant
- Lexan® tube packaged in a red
- Cotton bag containing special backfill.
- Overall size 152 mm diameter x 254 mm long
- Weight approx. 6.8 kg
- Lead Wire 1.5 m of # 14 RHH-RHW red wire
- Stability ± 10 mV with 3.0 μA load
- Potential referring to H2 – electrode: - 0.77 V
- Temperature Range: 0 °C to 57 °C
Ag/AgCl Cell

For Buried Structures in High Chloride Areas

Chloride ions affect the stability of copper reference cells. For protected structures located in areas with high chloride ion concentrations, silver/silver chloride reference electrode is used. This cell is not susceptible to chloride contamination, and will deliver accurate potential measurements for up to 30 years. It is composed of a silver element, which is immersed in a glass tube containing a supersaturated gel of silver chloride.

This entire component is then housed in a durable non-conductive tube, which is further surrounded by a dense mixture of silver and chloride. From this multiple layer construction, cell purity is maintained through the restriction of ions in and out of the cell. Completion of these quality procedures provides the cell with an accuracy of ±5 millivolts. The cell is pre-packaged in a cloth sack containing a low-resistance backfill, and is ready for immediate installation. The cell is usually with HMWPE insulation but other types of cable are applicable. Once all wire connections have been made and the ground around the cell is moistened, the installation is complete.

Application:

It is ideal for taking potential measurements on pipelines, tanks, and other structures buried in coastal areas. It can also be used to test reinforced concrete structures. With this type of application, the cell is provided without a backfill. Operation of the cell is limited to electrolytes with temperatures between 0° and 60°C. The cell should not be installed in areas with high sulfide or bromide concentrations.
For Structures in High Chloride Sea Water

Ag/AgCl is a proper reference electrode for high chloride sea waters. It has 2 types for normal water depth and for deep water.

Normal Water Depth

Portable electrode designed for standard everyday use in 0 - 2.54 m water depths. It can be used in salt water and saturated saline water conditions such as offshore platforms, offshore pipelines, seawater docks and boats or ships.

Features

- High-impact ABS plastic housing with 50’of RHH-RHW cable.
- Pre-weighted.
- Special silver - silver chloride element allows for calibration and chloridizing if needed in the field prior to use.
- Ideal for medium to light potential work.
- Color coded blue for ease of electrode type determination,
- 25.4 mm dia. x 203 mm long.

Deep Water Electrode

This portable electrode is rugged for deep water use and can be used in salt water and saturated saline water conditions such as offshore platforms, offshore pipelines and seawater docks (SSP).
Features:

- Tapered end caps protect sealed connection and eliminate platform/dock snags.
- Special PVC housing for streamlined attachment of electrode weights.
- Electrodes color-coded blue for ease of cell type determination.
- Special silver-silver chloride rod allows for calibration and chloridizing repair if needed in field prior to use.
- Available in dual element upon request.
- Standard weights: 0.55kg, 1.2 kg, 1.7 kg.
- Electrode size: 33.5 mm dia. x 229 mm long.

Normal Permanent Electrode:

- Size: 1" x 8" long ABS plastic high impact blue tube.
- Contact Plug: 1" diameter porous ceramic.
- Lead Wire: 50' of #14 RHH-RHW black or blue wire.
- Stability: +/- 5 millivolts with 3.0 microamp load.
- Temperature Range: 32°F to 150°F
- Service Life: 20 years
Comparison of Copper/Copper Sulphate and Silver/Silver Chloride reference electrodes:

Potential in water:

<table>
<thead>
<tr>
<th>Electrode at 25°C</th>
<th>Sea Water 20 Ohm-cm</th>
<th>Brackish Water 100 Ohm-cm</th>
<th>Brackish Water 500 Ohm-cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu / CuSO₄</td>
<td>0.85 V</td>
<td>0.85 V</td>
<td>0.85 V</td>
</tr>
<tr>
<td>Ag / AgCl</td>
<td>0.79 V</td>
<td>0.83 V</td>
<td>0.88 V</td>
</tr>
</tbody>
</table>

Standard Potentials to Hydrogen:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>10°C</th>
<th>25°C</th>
<th>35°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag / AgCl / KCl 0.1 M</td>
<td>289 mV</td>
<td>288 mV</td>
<td>278 mV</td>
</tr>
<tr>
<td>Ag / AgCl / KCl 1.0 M</td>
<td>231 mV</td>
<td>222 mV</td>
<td>216 mV</td>
</tr>
<tr>
<td>Ag / AgCl / KCl 3.5 M</td>
<td>215 mV</td>
<td>205 mV</td>
<td>197 mV</td>
</tr>
<tr>
<td>Ag / AgCl / KCl saturated</td>
<td>214 mV</td>
<td>199 mV</td>
<td>189 mV</td>
</tr>
<tr>
<td>Cu / CuSO₄ / CuSO₄ saturated</td>
<td>330 mV</td>
<td>316 mV</td>
<td>303 mV</td>
</tr>
</tbody>
</table>

Holiday Detector

Holiday detection is testing of coatings and claddings with pulsating voltage to DIN 55670, 28055, 30672.

The use of pulsating voltages to test coatings and claddings for pores has proved to be a reliable method of testing. Due to the numerous advantages of this technique, the Holiday Detector test equipment is an indispensable aid to passive corrosion protection and to industrial quality assurance.

The range of the possible applications for the Holiday Detector is wide: coated and enameled tanks and basins, stirrers, rubberizing, plastics, internally and externally coated pipes, fittings and machine components. Pores and flaws are reliably detected everywhere where there is a combination of conductive and insulating layers.

Holiday Detector for Pipeline

Pipeline coating Holiday Detector supplies a range of output voltages suitable for the inspection of almost all protective coatings including thin film epoxies, vinyls, polyethylenes, etc. and thicker coatings such as hot applied coal tar, asphalt and heavy mastic materials. It is adaptable for use on both large and small diameter pipe as well as flat surfaces when such surfaces are coated with a high electrical resistant material and the surface beneath the
coating is electrically conductive. It operates well on damp surfaces, so is desirable where humid conditions prevail.

**Features:**

- Wide range of output voltages from 900V to 35 kV.
- PowerPaks, each with six (6) outputs determine range.
- Portable, belt-worn unit.
- Rechargeable 9.6V NiCad battery.
- Audible holiday indicator.
- Rugged injection-molded resin case.
- Specified and approved on specs around the world.
- Conforms to NACE International RP0188, RP0274, RPO490.
Specifications:

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output voltage ranges</td>
<td>0.9-3.4 kV, 3.5-10 kV, 6-16 kV, 12.5-35 kV</td>
</tr>
<tr>
<td>Environmental</td>
<td>-10°C to 50°C</td>
</tr>
<tr>
<td>Dimensions, carrying case</td>
<td>104 x 46 x 20 cm</td>
</tr>
<tr>
<td>Weight, carrying case</td>
<td>16 kg</td>
</tr>
<tr>
<td>Dimensions, instrument</td>
<td>17.2 x 21.6 x 8.9 cm</td>
</tr>
<tr>
<td>Weight, instrument</td>
<td>3.6 kg</td>
</tr>
</tbody>
</table>

**Holiday Detector for Other surfaces**

Holiday Detector has received wide acceptance in the corrosion control and industrial painting industry as a device for locating bare spots (or holidays) in the thin protective films which are sprayed or brushed on metal or concrete surfaces. This detector is non-destructive, and the applied voltage to the coating never exceeds 67.5 volts at any time.

The inspection electrode consists of a cellulose sponge which, when dampened with water, is moved over the coated surface. When the electrode passes a void or bare spot, a small current flows and actuates an audible signal in the instrument. The damp sponge provides an electrically conductive film that contacts the surface being inspected and insures good inspection even in corners and around irregular shapes where holidays are most likely to occur.
Features:

- Non-destructive holiday detector.
- Regulated 67.5V DC output.
- Push-button calibration check.
- Two resistance settings: 80Ω for tanks and pipe, 90Ω for coatings on concrete.
- Instant calibration verification
- Six cell battery pack of AA size batteries readily available.
- Optional comfortable headphones for high noise environments.
- Non-destructive detector case made of a tough ABS plastic.
GPS Data Logger for DCVG/CIPS

Mobile Data Collection System “MoData2”

MoData2, a computer-aided measuring system, has been developed to integrate the function and capability of several instruments used in the field of Cathodic Corrosion protection in one instrument only.

Handheld PC Itronixfex21

- Dimensions: 190 x 150 x 37 mm (L x W x H)
- Weight: 800 g
- Protection: IP65 Protection against water jets
- Monitor: 6.5” with background lighting
- Resolution: 640 x 240 pixel, Touch screen, pen-operated
- Keyboard: Foil sealed keyboard, fluorescent
- Software: Windows CE, Handheld PC 2000
- Processor: Toshiba 129 MHz
- Memory: 32 MB
- ROM: 32 MB
- Interfaces: 2 x 9 pole serial, IR-Interface
- Modem: V34 analog
- Power supply: Lithium-Ionen Accu
- Operating time: approx. 8 h
- Working temperature range: -10 °C to +50 °C
MoData2

- **Housing:** Plastic
- **Dimensions:** 290 x 260 x 70 mm (L x W x H)
- **Weight:** 2.25 kg, (MoData2 with Handheld PC)
- **Interfaces:** 2 x 9 pole serial (1 x 9 pole for PC-Transfer or GPS receiver), 12 V charging socket
  (with internal electrical isolation) connection for synchronization cable or relay cable
- **Power supply:** Lead-accu 6 V / 1.3 Ah
- **Operating time:** approx. 10 h
- **Scope of delivery:** MoData2 including Handheld PC Itronix fex21
  - Pen for touch screen monitor
  - 230 V Battery charger
  - Synchronization cable
  - Data transfer cable
  - Instruction manual
- **Options:**
  - System case
  - Carrying strap "Sprint"
  - Carrying strap "Marathon"
  - 12 V Battery charger
  - GPS-receiver
  - Calibration certificate
The ER2006 electronic relay is designed for use in the field and independent of a main power supply. It switches both alternating and direct currents, making it capable of clocking protective current units, additional current feeds and AC voltage arresters. Used in conjunction with a DCF or GPS antenna, the unit ensures continuous synchronisation with other clock generators. The device runs on a single, commercially available 9V/400mAh alkaline battery. For constant operation during normal hours of business with a clocking cycle of 12/3 seconds, the battery has a lifespan of approximately half a year. The relay is switched through if there is no power supply or the unit is switched off, and remains conductive even if the battery is empty.

With the connection box, an external contactor can be controlled. This allows higher currents are switched. The switching power is then only limited by the upcoming deployment to the contactor. The relay box has been designed for multiple switching of small currents. There may four rungs per 60Watt simultaneously switch.

1. Y-Box zur Einspeisung einer externen Spannungsversorgung
2. ER2006 base unit
3. Main connection box for controlling a power contactor
4. Relay box for simultaneous cycles of 4 current paths


ER2006 Product Features:

- Battery-operated with several months battery life
- Freely selectable clocking cycles
- Freely selectable clocking times (during work hours, weekdays ...)
- Accessible using remote monitoring sensors (facilitating several years of operation)
- Installation possible in all Standard stations
- PC program for creating of complex switching operations
- Remote monitoring of sensors, controllable
- Control of Contactors
- Simultaneous switching of 4 current paths with small currents

Fixed-cycle operation:

The relay is easily configured using its 3 buttons and 3 LEDs. There are various switching cycles and operating times available, and additional cycle parameters can be set via the PC interface (doubles as an antenna jack) in order for example to be able to carry out specific measurements at periodically varying cycles or over extended off-periods.

The revised PC program "ER2006 PST" makes it very comfortable using timelines various switching programs generate. The different programs can be stored on your PC and managed. Up to 8 of these programs can then be transferred to the ER2006 via the USB interface.

Operation as external relay for a radio sensor:

The PC/antenna input also enables remote control of the relay via a floating connection. Since the unit clocks very infrequently in this configuration, using it this way increases its operating period considerably. The battery’s service life is longer than the operating time of a battery-operated radio sensor.

Specifications:

- Function: time-controlled electronic relay for use in the field.
- Operation: Battery-powered clocking for the CCP industry
- Can be mounted in a measuring post
- Housing: Anodized aluminium, black
- Protection rating: IP65
- Dimensions: approx. 200mm x 60mm x 50mm
- Power supply: 9V alkaline battery
- Switching capacity: 30 ampere =/=~
- Switching voltage: 200Vss
- Switching output: 4mm plug-in / clamp banana jacks
- Inputs: 5 pol. subminiature jack, Antenna input or PC connection

## Ultra Sonic Corrosion Detector

Ultrasonic Thickness gauge for accurate, error-checked, through-coating measurements using Multiple Echo technology. Highly versatile and simple to use for use in most industrial or shipping applications. The LCD display with automatic white backlight control is easily read in all light conditions, including outdoors. Menu-driven operation and "Deep-Coat" mode allow easy thickness gauging through coatings up to 20 mm. Supplied in a NEMA-4 (IP65) rated sealed aluminum enclosure and with a protective silicon sleeve. Optional belt/harness clip is extremely light and tough.

This equipment is used to determine the corroded spots under the coating and the depth of the corrosion on the surface wall.

**Advantages:**

- Multiple echo, single-crystal Ultrasonic Thickness Gauge.
- Coatings do not have to be removed - measures only the metal thickness.
- Accepted by major classification societies.
- No grinding - minimum surface preparation.
- Measures on rough corroded surfaces.
- Speed, accuracy and reliability.
- No false readings - repeatable results.
- Easy to use - minimum operator training.
- Greatly reduced inspection time and cost.
- Measures on metals and some other materials.
**Features:**

- Light, rugged, small and shock-proof within IP65 sealed aluminum enclosure.
- Gauge senses probe type and automatically adjust settings for optimum performance.
- Valid thickness measurements and minimum thickness function.
- LCD graphic display with automatic white backlight.
- Cygnus Echo-Strength bars assist thickness measurements.
- Simple gauge and menu operation with 3 tactile keys.
- Protective silicone sleeve offers maximum protection and versatility.
- Secure, twist-to-lock probe connection (BNC).
- Deep-coat mode for coatings up to 20 mm thick.
- Display Freeze function for easy measurement verification and logging.

**Applications:**

- Metal thickness monitoring on cranes, marine structures and conveying systems.
- Corrosion checks on ships' shell plates, bulkheads and structures.
- Metal thickness safety checks on steam and pressurized water systems, transportable gas containers and compressed air systems.
- Systematic wall thickness and corrosion monitoring of storage tanks and process vessels.
- Quality assurance metal thickness checks.
- Maintenance and safety checks on bridges and street lighting columns.
## Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
<td>Sound velocities between 2000 m/s and 7000 m/s</td>
</tr>
<tr>
<td></td>
<td>Covers virtually all common engineering materials.</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>3 mm to 250 mm with 2.25 MHz probe</td>
</tr>
<tr>
<td></td>
<td>2 mm to 150 mm with 3.5 MHz probe</td>
</tr>
<tr>
<td></td>
<td>1 mm to 50 mm with 5 MHz probe</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>± 0.1 mm or ± 0.05 mm</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>0.1 mm or 0.05 mm</td>
</tr>
<tr>
<td><strong>Probes</strong></td>
<td>Remote single-crystal, soft-faced compression.</td>
</tr>
<tr>
<td></td>
<td>6 mm - 5 MHz</td>
</tr>
<tr>
<td></td>
<td>13 mm - 2.25 MHz, 3.5 MHz or 5 MHz</td>
</tr>
<tr>
<td></td>
<td>19 mm - 2.25 MHz</td>
</tr>
<tr>
<td><strong>Power Source</strong></td>
<td>2 x AA alkaline batteries or rechargeable NiMH / NiCd</td>
</tr>
<tr>
<td><strong>Displays</strong></td>
<td>Large, clear LCD display with white backlight.</td>
</tr>
<tr>
<td></td>
<td>Automatically turns off in bright light conditions.</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>85 x 115 x 25 mm</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>275 g</td>
</tr>
<tr>
<td><strong>Operating Temperature</strong></td>
<td>0°C to +50°C</td>
</tr>
<tr>
<td><strong>Environmental Protection</strong></td>
<td>NEMA-4 (IP65)</td>
</tr>
</tbody>
</table>

### Ultrasonic Pipe – Tank Coating & Wall Thickness Gauge

**Wall Thickness Gauge (Positector UTG)**

Positector UTG measures the wall thickness of materials such as steel, plastic and more. Ideal for measuring the effects of corrosion or erosion on tanks, pipes or any structure where access is limited to one side. As illustrated above, the UTG Std measures the remaining wall thickness of steel, cast iron and more due to the effects of corrosion and...
erosion.

- 5 MHz dual element transducer.
- Scan Mode – measurement rate of 20 readings per second with on-screen min and max for quick inspection over a large area.

Specifications:

<table>
<thead>
<tr>
<th>Probe Type</th>
<th>5 MHz dual element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Single Echo</td>
</tr>
<tr>
<td>Measurement Range*</td>
<td>1.00 to 125.00 mm</td>
</tr>
<tr>
<td>Thru-Pain Capability</td>
<td>No</td>
</tr>
<tr>
<td>Measurement Rate, Normal</td>
<td>6 readings/sec</td>
</tr>
<tr>
<td>Measurement Rate, Scan</td>
<td>20 readings/sec</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.001” / 0.01 mm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.001” / ±0.03 mm</td>
</tr>
<tr>
<td>Conformance</td>
<td>ASTM E797</td>
</tr>
<tr>
<td>Size</td>
<td>146 x 64 x 31 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>165 g (5.8 oz.) without batteries</td>
</tr>
</tbody>
</table>

* Measurement range is for carbon steel and depends on surface condition, temperature and material.

**Heavy Duty Thickness Gauge**

Heavy duty metal wall digital thickness gauge for use indoors or outdoors. Measures remaining metal thickness without removing surface coatings.
Features:

- Heavy duty sealed unit - highly water / dirt / dust resistant.
- Rugged construction - shock proof.
- Stable calibration - linear accuracy - no zero adjustment.
- Self-verification of measurements to ensure accuracy.
- Various probe options.
- Displays sound velocity settings.
- Echo strength indicator to aid measurement.
- Bright LED display with polarized filter.
- Probe frequency selectable.
- Low battery warning.
- Metric / Imperial switchable.

Advantages:

- Multiple-echo, single-crystal ultrasonic thickness gauge.
- Coatings do not have to be removed - measures only the metal thickness.
- Accepted by major classification societies.
- No grinding - minimum surface preparation.
- Measures on rough corroded surfaces.
- Speed, accuracy and reliability.
- No false readings - repeatable results.
- Easy to use - minimum operator training.
- Greatly reduced inspection time and cost.
- Measures on metals and some other materials.
Applications:

- Metal thickness monitoring on cranes, marine structures and conveying systems.
- Corrosion checks on ships' shell plates, bulkheads and structures.
- Metal thickness safety checks on steam and pressurized water systems, transportable gas containers and compressed air systems.
- Systematic wall thickness and corrosion monitoring of storage tanks and process vessels.
- Quality assurance metal thickness checks.
- Maintenance and safety checks on bridges.

Data Logging Thickness Gauge

Ultrasonic hand-held digital thickness data logs up to 200,000 points and is easy to use. It can interface to a PC using Windows software.
Description

The Data logger is versatile and easy to program with simple menu operation. Templates provide solutions to recording various geometries such as tanks, cylinders, pipes and plant:

- Single Point for linear records.
- Multipoint for N-Readings per point records.
- Grid Point for two-dimensional X-Y records.
- Key Point for specifying ranges of readings with alarms for complex structures.

Windows Explorer style menu with measurements logged with one simple key press. The unit interfaces with a PC using Cygnus dedicated software which is Windows® compatible. The gauge has storage for up to 200,000 measurements.

Features:

- Can be carried on the waist belt for ease of climbing.
- Highly water / dirt / dust resistant.
- Rugged construction - shock proof.
- Stable calibration - linear accuracy - no zero adjustment.
- Self-verification of the measurements to ensure accuracy.
- Various probe options.
- Echo strength displayed to aid measurement.
- Dual display: bright LED & graphical LCD displays.
- Probe protected by a membrane against wear and tear.
- Metric / Imperial switchable.

Advantages:

- Multiple-echo, single-crystal Ultrasonic Thickness Gauge.
- Coatings do not have to be removed - measures only the metal thickness.
- Accepted by major classification societies.
- No grinding - minimum surface preparation.
- Measures on rough corroded surfaces.
• Speed, accuracy and reliability.
• No false readings - repeatable results.
• Easy to use - minimum operator training.
• Greatly reduced inspection time and cost.
• Measures on metals and some other materials

Applications:

• Metal thickness monitoring on cranes, marine structures and conveying systems.
• Corrosion checks on ships' shell plates, bulkheads and structures.
• Metal thickness safety checks on steam and pressurized water systems, transportable gas containers and compressed air systems.
• Systematic wall thickness and corrosion monitoring of storage tanks, process vessels and road tankers.
• Quality assurance metal thickness checks.
• Maintenance and safety checks on bridges and street lighting columns.
• Pipeline wall thickness monitoring in-situation.

- Insulating Tester

Under Ground Insulation Tester

Applications:

• Checks all types and sizes of buried insulators from remote test leads: Flanges, dressers, couplings, unions, carrier pipe to casing, whether parallel or in series.
• 100% accurate: Not affected by pipe-to-soil potentials or protection voltages.
• Indicates continuity of connection between pipe and test lead.
• Simple to operate: Simplified operation procedure reduces training time to 10 minutes, following step by step instructions.
• Cost-effective: Saves time compared to present test procedures.
Specifications:

- **Enclosure**: Molded glossy black Phenolic MIL-M-14, CFG. Designed to meet IP54 standard.
- **Power Source**: Two D size alkaline batteries and two AA batteries.
- **Operating Temperature**: -20°C to +55°C (limited by alkaline battery).
- **Storage Temperature**: -20°C to +35°C (limited by alkaline battery).
- **Output Voltage**: 1.5 VDC
- **Dimensions**: 17.8 x 13.3 x 10.2 cm (LxWxH)
- **Weight**: 1.36 kg

Above-Ground Insulation Checker

Applications:

- Checks all types and sizes of insulators: Flanges, dressers, couplings, unions -- whether parallel or in series.
- Locates shorted bolts: Eliminates costly and unnecessary replacement of good bolt insulators.
- Evaluates partially shorted insulators: Measures the degree and seriousness of short.
- Simple to operate: Simplified operation procedure reduces training time to 10 minutes, following step by step instruction sheet.
- Quick: Fast "touch probe" operation eliminates guesswork and additional wires, coils, etc.
Specifications:

- **Enclosure:** Heavy duty electronic instrument enclosure (black in color) with an average wall thickness of 3.3 mm. Moulded in flame retardant ABS plastic. Designed to meet IP54 standard.
- **Power Source:** Two C size alkaline batteries.
- **Operating Temperature:** -20°C to +55°C (limited by alkaline battery).
- **Storage Temperature:** -20°C to +35°C (limited by alkaline battery).
- **Output Voltage:** 174 mV AC (produced by an internal RF oscillator), frequency range, 130 to 160 kHz.
- **Dimensions:** 20.3cm x 12.7cm x 8.25cm (LxWxH)
- **Weight:** 0.7 kg

---

**Pipe & Cable Locator**

Even with network maps or a comprehensive knowledge of pipeline networks it is not always possible to determine the exact incomplete or inaccurate, wasted excavation and cable damage can result. This costs a lot of money. That’s why network operation needs a modern location system which functions well, is easy to use and saves both time and
money. The pipe & cable locator is a professional system which satisfies any practical demands you may make on it.
In addition current carrying cables and Cathodically protected pipes can also located quickly and exactly without transmitter with the passive method. The pipes can be determined according to

The receiver processes and displays the signal detected by the different options of signal probes.

- Active: 1.1 / 10 / 42 kHz (different frequencies available on request)
- Passive: 50/60 Hz - Power lines, 100 Hz - Pipes incorporating Cathodic Protection, 15 - 25 Hz – "radio"
Analogue and digital indication of the field strength
Auto-search function; the generator output frequency is automatically selected by the receiver when switched on
With the “press of a button”: optimisation of the indicated range
Automatically detects the type of signal probe connected and adjusts accordingly
Depth to object measurement, digital value
Position indicator (arrows): Indicates if the line is to the left or to the right
Large illuminated display
Acoustic output via built-in loudspeaker or headphones for areas with high ambient noise levels, traffic noise, etc.
Built-in rechargeable battery, integrated automatic charging/buffering function, battery-status display
Operating time: approx. 12 hours
Operating/storage temperature:
-10 °C ... +50 °C / -25 °C ... +70 °C
Protection class: IP 54
Weight: approx. 1.0 kg
Dimensions in cm:
approx. 12.5 x 18 x 6.5 (W x H x D)

*Generator G1:*
For the detection of particularly long metallic water and gas pipes Transmitter with high output power is used.
- Output power: max. 50 W (or 1 A)
- Pulsed or continuous transmission: power-saving
- Quartz-stable frequencies 1.1 / 10 / 42 kHz
- Frame coil is integrated in the G1 system case (allows for inductive coupling)
- Automatic impedance adjustment
- Indication of transmission current, frequency and battery status
- Operation either via rechargeable battery or via
- 12 V connection
- Integrated battery charger 12 V= with automatic charging/buffering function, indication of battery status
- Protection class: IP 54
- Operating time: 1.3 ... 21 hours
- Weight: approx. 6.6 kg
- Dimensions of the system case in cm: approx. 60 x 19 x 21 (W x H x D)

**Generator G2**

Designed for the detection of well-insulated metallic gas pipes or cables. Transmitter with medium output power.

- Output power: max. 1 W (or 100 mA)
- Pulsed or continuous transmission: power-saving
- Frequencies 1.1 / 10 / 42 kHz
- Built-in frame coil (inductive coupling)
- Automatic impedance adjustment
- Indication of transmission current, frequency and battery status
- Operating time: 8 batteries (C cell, R14, MN1400), either rechargeable or disposable 2 ... 80 hours (disposable) or 2 ... 25 hours (rechargeable)
- Weight: approx. 1.7 kg
- Dimensions in cm: approx. 28 x 14 x 10 (w x H x D)
**Earth/Soil Resistivity Tester**

*Multi-Function Ground Resistance Tester Model 6472*

The Model 6472 measures from 0.01 to 99.99kΩ and is auto-ranging, automatically seeking out the optimum measurement range, test frequency and test current. Easy-to-use – Simply connect the leads, select test mode, press Start and read the results. Up to 512 test results can be stored in internal memory for recall to the display or downloaded to a PC via software.

The large LCD is easy-to-read and indicates ground electrode resistance, test voltage, current and frequency as well as individual electrode resistance, battery status and more.

The Model 6472 is Cat IV rated to 50V and is over voltage protected to more than 250Vac against accidental live connection to live circuits. The voltage is also displayed on screen. In the event of a system fault, the Model 6472 can withstand 250Vac.

Additional features of the Model 6472 include; manual and automatic test frequency selection from 40 to 5078Hz; user selectable 3 or 4-Pole Fall of Potential or 4-Pole Soil Resistivity test methods and user selectable 2-Wire or 4-Wire Bond Resistance test method.

The Model 6472 is powered by 9.6V, 3.5 Ah NiMH rechargeable batteries. An external recharger powered from 120/230V, 50/60Hz is included and provides for testing while recharging. The Model 6472 can also be vehicle powered from an optional 12V battery adapter.
Applications:

- 3-Point measurements of resistance to ground of ground rods and grids. 3-Point measurements are generally used when the electrode or grid can be easily disconnected.

- 4-Point tests or soil resistivity measurements. Locating areas of lowest soil resistivity is essential for achieving an economical grounding installation.

- Touch and step potential testing measurements. These tests are recommended when the ground cannot be disconnected, where ground faults are highly likely to occur, or when the “footprint” of grounded equipment (the outline of the part of equipment in contact with the earth) is comparable to the size of the ground to be tested.

- 2- or 4-Wire tests for continuity tests on bonding or on grounding systems. This test is a DC resistive test using 250mA or more and is used to check bonding of all connection points on the ground system.

- Earth coupling measurement and display. Used to estimate the influence of two earth resistance systems that are not connected to each other.
Features:

- 2- and 4-Wire Bond Resistance/Continuity Measurement (DC Resistance) with automatic polarity reversal
- 3-Point Fall-of-Potential measurement with manual or automatic frequency selection
- 4-Point soil resistivity measurement with automatic calculation of Rho (ρ) and user selection of the Wenner or Schlumberger test method
- 3-Point earth coupling measurement
- Measures Ground Resistance using the 2 clamp method (selective ground testing)
- Measures Ground Impedance at frequencies up to 5 kHz to test lightning strike protection
- Manual and automatic frequency scans from 40 to 5078Hz for optimum test accuracy in electrically noisy environments
- Selectable test voltage of 16 or 32V up to 250mA of test current
- Auto-off power management
- Automatic recognition of all electrode connections and their resistance value
- Stores up to 512 complete test results
- Optically isolated USB communication
- Remote set up and operation of all measurements using software
- Automatic report generation including the fall of potential plot
- Rechargeable NiMH batteries from wall charger or vehicle power
- Rugged dustproof and rainproof field case
- Includes software for data storage, real-time display, analysis, report generation and system configuration
**Ground Resistance Tester GEOHM C**

Battery operated tester for the measurement of ground resistance meets international standards for performing such tests. This instrument allows measurement of soil resistivity and ohmic resistance by means of the ammeter-voltmeter test method.

**Features:**

- 3 or 4-wire measurement selectable from menu
- No balancing required
- Continuous monitoring of interference voltage and auxiliary earth electrode resistance with indication of limit value violations
- Indication is displayed if maximum probe resistance is exceeded at the beginning of the measurement
- Voltage measuring range: 0 to 250 V (with polarity display)
  Alternating voltage measuring range 0 to 300 V

**Applications:**

The GEOHM C is a compact instrument for the measurement of ground resistance in electrical systems in accordance with:

DIN VDE 0100 Installation of power systems with nominal voltages of up to 1000 V  
DIN VDE 0141 Grounding in AC systems with nominal voltages of greater than 1 kV  
DIN VDE 0800 Installation and operation of telecommunications systems including data processing systems: equipotential bonding and grounding  
Testing of lightning protection systems in accordance with DIN VDE 0185

The instrument is also capable of determining soil resistivity which is essential in calculating dimensions for grounding systems. It can thus be taken advantage of for simple, geological surveys, and for the planning of grounding systems.

Beyond this, ohmic resistance can be measured at both solid and liquid conductors, as well as internal resistance at conductive elements, as long as these are capacitance and induction-free.
Special Functions:

- Hold function: The measurement value is frozen at the display after the measurement key is released.
- Storage of measurement values to memory
- Data interface for the transmission of measurement values and for software updates
- Convenient report generating software, can be expanded into a comprehensive database

Operation:

The instrument is easy to operate. A multifunction key allows for one-hand operation for menu selections and the initialization of measurements. Basic functions and sub-functions are selected with the help of four soft keys.

The instrument functions in accordance with the ammeter-voltmeter principle, and thus requires no balancing. Automatic measuring range selection, limit value monitoring and direct selection of 3 or 4-wire measurement assure easy operation as well.
Nominal Ranges of Use:

- Temperature Range 0 °C - + 40 °C
- Battery Voltage 4.5 - 6.5 V
- Line Frequency 50/60 Hz - 0.2 Hz
- Line Voltage Wave shape sine (deviation between RMS and rectified value ≤ 1%)

Nominal Conditions of Use:

- Series Mode
- Interference Voltage < 3 V AC DC
  Additional Error caused by Probe and Auxiliary Earth
- Electrode Resistance < 5% of (RE + RA + RP)
- Max. Probe Resistance < 70 kΩ
- Max. Auxiliary Earth Electrode Resistance < 50 kΩ
- Max. Earth and Auxiliary Earth Electrode Resistance ≤ 50 kΩ of RH
REMOTE MONITORING & CONTROL SYSTEM

For a long time now, our remote monitoring Electronics division has been designing hardware and software solutions.

In the field of energy service provision we focus on measurement, control, regulation and communication specially in Cathodic Protection & Corrosion Control systems. Our products and consultation services expand from the proven standard solution to individually-designed original concepts.

Our remote monitoring system enables you to have a perfect control over your Cathodic Protection and Corrosion control system from your Office!

In order for different CP systems to be able to prevent corrosion reliably and without interruption or defect, it is vital to monitor the system by the way that the relevant operational data can be constantly recorded and evaluated.

In this case we developed a new high performance remote monitoring system named “CPMS”. With this innovative system solution you have considerable advantages over other Cathodic protection & Corrosion Control monitoring procedures. CPMS has a modular design and therefore perfectly can be adapted to the conditions of any metallic construction as pipeline or storage tanks or jetties, the existing infrastructure and to the specific
requirements. By the combination of different transmission paths every measuring point can be monitored. The synchronization of the sensors enables a measuring of on- and off potentials and of protective- and pipe currents within the whole system absolutely at the same time.

The evaluation and archiving of the readings is made in the CP-Management System software where all readings are managed even if their origin is from a manual measuring.

Remote monitoring – an overview:

- A combination of different transmission paths
- Simultaneous measurement of “on” and “off” potentials
- Monitoring of the protective installation and it’s function by CPMS software
- Remote clocking of the protective system

System Components:

- Radio Sensor PS 2005
- Modular Station Sensor CPMS ISM 2010
- Electronic Clocking ER 2006
- CPMS MS 2010 Management System Software
The guiding principles of developing CPMS were to increase safety while at the same time reducing costly on-location measurement procedures and to meet the requirements of daily operation. The result is an economical and innovative system solution that satisfies the requirements set out in the DVGW GW16 guidelines (Remote Monitoring of CP).

As a component of this system the CPMS PS 2005 e.g. can be mounted inside a standard marker post. This sensor is an intelligent, three-channel measuring module for potential, pipe current and AC –voltage measurement inside the measuring post. AC voltage is measured in parallel to the first two channels. Data is stored in the sensor and transmitted to the CP Management System via GSM-modem. The Data can be transmitted either online or via SMS. The change of batteries is done by means of a push connector meaning the sensor doesn’t have to be opened.
## Technical Data:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of case</td>
<td>195 x 66 x 42 mm</td>
</tr>
<tr>
<td>System of protection</td>
<td>IP 65</td>
</tr>
<tr>
<td>Power supply</td>
<td>10.8V / 19Ah Lithium Battery</td>
</tr>
<tr>
<td>Average battery working life</td>
<td>&gt;3 years (daily metering)</td>
</tr>
<tr>
<td>Number of inputs</td>
<td>3 DC / 2 AC in parallel to channel 1+2</td>
</tr>
<tr>
<td>Measuring range channel 1+2 DC</td>
<td>4000 mV, 40 V</td>
</tr>
<tr>
<td>Resolution</td>
<td>&lt; 0.5 mV, &lt; 5 mV</td>
</tr>
<tr>
<td>Measuring range channel 1+2 AC</td>
<td>± 4 V, ± 40 V, ± 150 V</td>
</tr>
<tr>
<td>Resolution</td>
<td>&lt; 0.5 mV, &lt; 0.1 V</td>
</tr>
<tr>
<td>Measuring range channel 3 DC</td>
<td>± 30 mV</td>
</tr>
<tr>
<td>Resolution</td>
<td>&lt; 1 µV</td>
</tr>
<tr>
<td>Input resistance</td>
<td>Channel 1+2 &gt;20k? channel 3 &gt;200k?</td>
</tr>
<tr>
<td>Maximal input noise voltage</td>
<td>150 V eff / 50Hz</td>
</tr>
<tr>
<td>Filter 16 ... 50Hz</td>
<td>&gt; 96 dB</td>
</tr>
<tr>
<td>A/D converter</td>
<td>16 Bit Sigma Delta</td>
</tr>
<tr>
<td>Nonlinearity of converter</td>
<td>± 0.003 %</td>
</tr>
<tr>
<td>Nonlinearity of multiplier</td>
<td>removed</td>
</tr>
<tr>
<td>Offset compensation</td>
<td>per Software</td>
</tr>
<tr>
<td>Zero adjustment</td>
<td>automatic before metering</td>
</tr>
<tr>
<td>Working temperature</td>
<td>-30 ... +75 °C</td>
</tr>
<tr>
<td>Synchronisation</td>
<td>battery buffered DCF77 - clock or GPS (worldwide outside buildings)</td>
</tr>
<tr>
<td>Time pattern control</td>
<td>variable at will (period and time domain)</td>
</tr>
<tr>
<td>Parameterization and firmware upload</td>
<td>by telecontrol and service laptop</td>
</tr>
<tr>
<td>communication</td>
<td>Integrated GSM-Modem</td>
</tr>
</tbody>
</table>

## Memory & Working Specification:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory PS2005</td>
<td>No data loss at power failure</td>
</tr>
<tr>
<td>Maindata-circle-memory</td>
<td>32768 records (by hourly measuring of 3 channels DC and channels AC, storage period approx. 300 days)</td>
</tr>
<tr>
<td>Logger</td>
<td>removed</td>
</tr>
<tr>
<td>Message circle - memory</td>
<td>1024 records (for limit value transgression and parameterizable system massages)</td>
</tr>
<tr>
<td>Parameterization</td>
<td>Non-volatile EEPROM</td>
</tr>
</tbody>
</table>
Modular Station Sensor CPMS ISM 2010

As a part of CPMS system the ISM 2001 is used as the central processing unit within protection installations (clocking of the rectifier) and stations. Due to the modular design of the sensor its components include one-channel measuring module with message contact up to a nine-channel sensor with potential separated measuring inputs, high memory capacity and a V.24 interface. The data transmission to the CP Management-System is done by an integrated modem (analog or digital or GSM). Data is transmitted online or via SMS. Customized versions like measured-value output via current outlets 0(4)-20 mA are possible. The Sensor ISM 2001 is also suitable for the installation into solar power stations.
Technical Data:

**Measurement range:**
- 1x 200 mV AC & DC, bipolar, floating
- 1x 20 VAC & DC, bipolar, floating
- 1x 150 V AC & DC, bipolar, floating
(Expandable to a maximum of 35 measurement channels)

**Output:**
optional 0/4-20 mA analog output cards

**Configuration:**
via configuration software

**Communication:**
RS232 interface
Modem, ISDN, mobile cell phone, Ethernet

**Time Synchronization:**
DCF, GPS internal

**Storage Memory:**
2MB archive memory (cycle: 1 min – 1 day)

**Power Supply:**
230 V AC via system power adapter (24 V DC),
8-32 V DC (e.g. via UPS, solar system etc.) or 16-32 V DC
when using a message relay (reason: <16 V = interference)

**Housing:**
Electronics housing, wall and rail mounting

**Dimension:**
160 mm x 80 mm x 55 mm

**Connection:**
0.75 mm² plug screw terminals

Operating Conditions:

- Operation of the ISM 2010 anywhere other than in a closed room is not permissible.
  (outdoor version is also to be housed in the standard outdoor distribution cabinets)
- Ambient temperature +5°C to +40°C (without strong fluctuations)
  or -15°C to +60°C for the “RM” version (without strong fluctuations)
- A mounting panel adequate for the weight of the device and free of vibrations. For
  the “RM”-Version, a stable mount in a standard outdoor distributor cabinet
- Maximum 85% relative humidity and non-condensing for temperatures up to 60°C
- The device must not be exposed to direct sunlight
- Under difficult climate conditions, the “RM” version is to be preferred
- Mains voltage fluctuation must not exceed +/- 10% of the rated voltage
### Electric Clocking ER 2006 (Interrupter)

The ER2006 electronic relay is designed for use in the field and independent of a main power supply. It switches both alternating and direct currents, making it capable of clocking protective current units, additional current feeds and AC voltage arresters. Used in conjunction with a DCF or GPS antenna, the unit ensures continuous synchronization with other clock generators. The device runs on a single, commercially available 9V/400mAh alkaline battery. For constant operation during normal hours of business with a clocking cycle of 12/3 seconds, the battery has a lifespan of approximately half a year. The relay is switched through if there is no power supply or the unit is switched off, and remains conductive even if the battery is empty.

With the connection box, an external contactor can be controlled. This allows higher currents are switched. The switching power is then only limited by the upcoming deployment to the contactor. The relay box has been designed for multiple switching of small currents. There may four rungs per 60Watt simultaneously switch.

1. Y-Box zur Einspeisung einer externen Spannungsversorgung
2. ER2006 base unit
3. Main connection box for controlling a power contactor
4. Relay box for simultaneous cycles of 4 current paths
ER2006 Product Features:

- Battery-operated with several months battery life
- Freely selectable clocking cycles
- Freely selectable clocking times (during work hours, weekdays ...)
- Accessible using remote monitoring sensors (facilitating several years of operation)
- Installation possible in all Standard stations
- PC program for creating of complex switching operations
- Remote monitoring of sensors, controllable
- Control of Contactors
- Simultaneous switching of 4 current paths with small currents

Fixed-cycle operation:

The relay is easily configured using its 3 buttons and 3 LEDs. There are various switching cycles and operating times available, and additional cycle parameters can be set via the PC interface (doubles as an antenna jack) in order for example to be able to carry out specific measurements at periodically varying cycles or over extended off-periods.

The revised PC program "ER2006 PST" makes it very comfortable using timelines various switching programs generate. The different programs can be stored on your PC and manage. Up to 8 of these programs can then be transferred to the ER2006 via the USB interface.

Operation as external relay for a radio sensor:

The PC/antenna input also enables remote control of the relay via a floating connection. Since the unit clocks very infrequently in this configuration, using it this way increases its operating period considerably. The battery's service life is longer than the operating time of a battery-operated radio sensor.

Specifications:

- Function: time-controlled electronic relay for use in the field.
- Operation: Battery-powered clocking for the CCP industry
- Can be mounted in a measuring post
- Housing: Anodized aluminium, black
• Protection rating: IP65
• Dimensions: approx. 200mm x 60mm x 50mm
• Power supply: 9V alkaline battery
• Switching capacity: 30 ampere =/~
• Switching voltage: 200Vss
• Switching output: 4mm plug-in / clamp banana jacks
• Inputs: 5 pol. subminiature jack, Antenna input or PC connection

**CP Management System Software CPMS MS2010**

The CP Management-System is a Windows-program (Windows 95®, Windows NT®, Windows XP® and Windows Vista®) and has been specifically designed for the remote monitoring of the Cathodic Corrosion Protection. The managing of the parent records, the evaluation and storage of the measuring data can be executed by this program.
All program functions can be accessed from a central starting panel. By some clicks on system, structure (pipe, tank, jetty, ...) measurement point etc. submenus can be invoked. From this level the user can easily execute all functions like e.g. modifications of main records, diagrams, print-out or evaluations. The measuring results are received via SMS or online by means of sensors. All transmissions, commands, messages and modifications are filed in a special registration book. At any time there is the chance to call-off data manually from the workstation.

For the graphical evaluation different representation forms are offered:

- Three-dimensional view
- Two-dimensional view
- Diagram of results at one measurement point
- Diagram of measurements at the pipe at particular time
- Diagram of protection current density
The 3D-graph clearly shows any modifications of measurements at the pipe course within the chosen time period. The graph can be turned to all view levels.

The two-dimensional view ensures an extremely fast fault detection. All measurements in the graph are designed according to the color range at the side. Potential deviations and potential drops can be recognized immediately.
The graph of results coming from all pipe measurement points at a selected time shows all measurements along the pipe made at the absolutely identical time. The computation of protection current density runs automatically. For this purpose formulae are stored in the master data management of the measuring places. Those measurement points where a computation is carried out are marked colored in the diagram.

**System requirements:**

System requirements are to be considered as a recommendation. From a technical view starting the program on a 80486 is possible. Then the processing time for special displays may last some minutes.

Therefore the computer configuration should not fall below the following values:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU – power</strong></td>
<td>300 MHz</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td>128 MB</td>
</tr>
<tr>
<td>Unrestricted hard disk</td>
<td>50 MB</td>
</tr>
<tr>
<td>memory</td>
<td></td>
</tr>
<tr>
<td><strong>Display – resolution</strong></td>
<td>1024 x 768, 16Bit depth of color</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>CD-ROM, mouse</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td>two unrestricted V.24-Ports (serial)</td>
</tr>
<tr>
<td><strong>Telecommunications</strong></td>
<td>lines must guarantee data flow</td>
</tr>
<tr>
<td><strong>Operating system</strong></td>
<td>Windows NT4 SP5, 2000, 95B2, 98, ME, XP, Vista</td>
</tr>
</tbody>
</table>
With the appropriate web browser and internet access installed on the server, even remote access while on the road is no problem. Pop-up windows must be enabled and a sufficient minimum resolution is required e.g. 800x480 as shown in the photo, or 960x640 as with newer models.
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