sati italia s.p.a.

PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

# ELECTROMAGNETIC SHIELDING PRODUCTS 2011

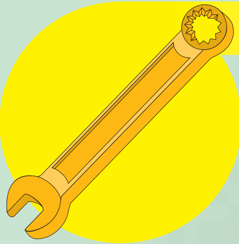
www.sati.it

GRUPPO Carpaneto Sati

PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

## we inform

Our digital communication programme features a series of newsletters sent to all customers included in our database.With Progresso Elettrico,the on-line news section of the Carpaneto Sati Group site, it is our goal to maintain an open dialogue with all the users who have shown interest in this project through: technical and sales information on our product range, what's new, promotions, meetings and trade shows.



## we assist

At the Carpaneto Sati Group , with our more than 70 sales professionals spread out throughout the country, offer free technical and sales assistance to all customers who specifically request it, even through the site. Our Internet site features e-mail technical assistance that puts the user in contact with our headquarters staff trained to provide information on assorted products.

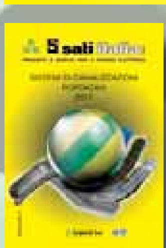
## we provide documentation

All commercial and technical documentation, in addition to being available in traditional format is always available on line in the download area that lets you download any type of document published by the Carpaneto Sati Group. This user-friendly tool lets you select even only part of the catalogue you may be interested in, making the choice of the documentation searched for flexible and fast.

## web

Thanks to our Internet ser vices, our customers can contact all the companies and offices of the Carpaneto Sati Group, rapidly consult the various technical and sales areas, sign up to receive our newsletter , download documentation, etc. In addition, using the METEL service, authorised customers can place orders and receive order confirmations, shipping notices and invoices.

## technical and sales documentation



The Carpaneto Sati Group offers a wide range of systems, components and ser vices dedicated to the electric installation sector.
All our products are presented in feature sections. All publications are functionally illustrated complete with technical characteristics for solving, in a comprehensive way, an y problem with planning, installation and assembly in the v arious fields of application.
All our publications can be consulted on line at wwwsati.it and are available in all Sati Italia S.p.A. offices , as well as in all the Branches and Dealerships.

**www.sati.it - www.carpaneto.it**


CERTIFICATO N.
CERTIFICATE N.
9105.SAT1

SATI ITALIA SPA

ISO 9001:2000

1997-05-20
2009-01-07
2011-12-12


THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

SATI ITALIA SPA

Quality Management System

ISO 9001:2000

Registration Number: IT - 514

President of IQNET

President of CISQ

**Quality as a strategic improvement factor of Sati Italia S.p.A..**

Quality Management has always been a steadfast commitment for the company policy of Sati Italia S.p.A..

Initially certified by CSQ in 1997, this pledge has grown with the UNI EN ISO 9001:2000 certification obtained in November, which highlights:

- “customer satisfaction” aimed at Sati Italia S.p.A. products and services
- the compliance of our products with CEE Directives for marking CE
- the lasting quality of our products, in accordance with applicable technical specifications and standards.
- the near future completion of the procedure for changing to the UNI EN ISO 9001:2008 standard.

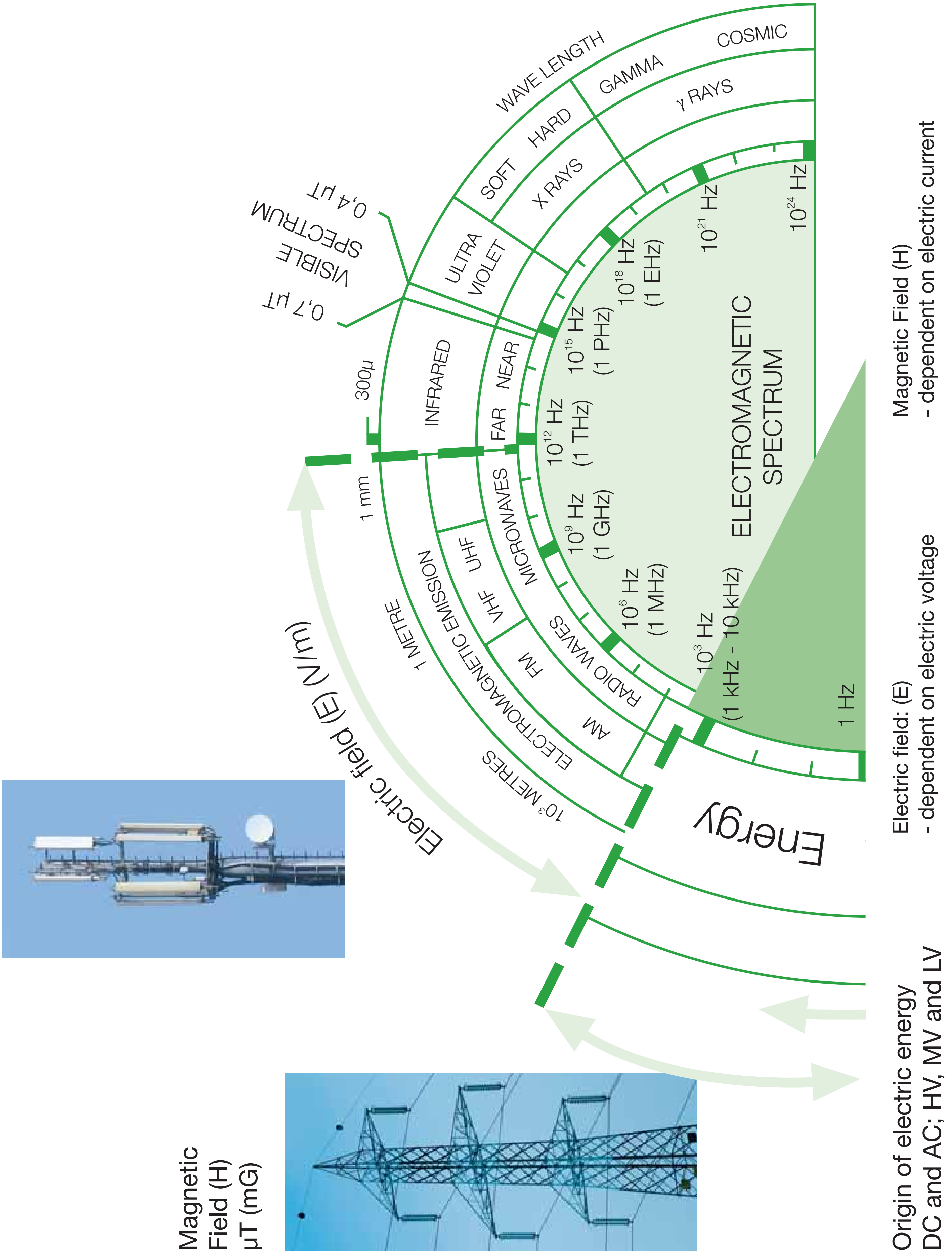
This r esult was made possible thanks to measur es taken by the company management and the constant and responsible commitment of the human resources department at Sati Italia S.p.A., working har d towards a strategy made of goals, organisation structures and cutting edge technical means.

## ELECTROMAGNETIC SHIELDING PRODUCTS



## ALPHANUMERIC INDEX

## ELECTROMAGNETIC SPECTRUM



## INTRODUCTION TO SHIELDING

In all domestic and business environments there are electromagnetic fields which may occur naturally, as a consequence of light itself, or which may be artificially generated by the extensive presence of electrical plants and devices. In the twentieth century, environmental exposure to artificial electromagnetic fields has steadily increased as a result of a huge increase in energy demand, the continuing development of wireless technologies and because of changes in communication and work practices.

When people are exposed to electromagnetic fields their body absorbs energy. This causes an imbalance to the body's natural equilibrium and, while the scientific and medical community is still looking for conclusive evidence, it is important to protect people from the possible long-term effects of electromagnetic fields.

Interest in electromagnetic pollution has increased in recent years as a result of extensive research and studies. Standards and technical documents have been drafted and specific laws approved to protect the environments most at risk, such as the work place. It is important therefore that the risk to human health be evaluated and measures taken to limit electromagnetic exposure in order to guarantee health and safety at work.

As well as possible effects on human health, electromagnetic fields can create disturbance and cause interference with electronic equipment. European legislation has therefore set limits to guarantee the adequate and safe performance of instruments.

As a result, the use of appropriate screening systems is essential in all industrial processes that involve high current intensity or the use of intense electric or magnetic fields. This is to protect both workers and electric equipment near to the field sources.

Sati Italia S.p.A. ofers a wide range of shielding solutions capable of mitigating magnetic fields at civilian and industrial frequency (up to kHz). All products are manufactured at the Rivoli Cascine Vica (To) plant and come with a quality certificate issued by the Politecnico di Torino.

Sati Italia S.p.A., in partnership with NoField S.r.l., is also able to provide all the necessary technical support from the designing to the implementing of the most appropriate shielding solutions.

## EFFECT OF ELECTROMAGNETIC FIELDS ON PEOPLE

Electric and magnetic fields that vary over time interact with the electrically charged particles which matter is made of. Of particular interest is the interaction with biological systems ranging from basic cellular structures to complex organisms such as plants and animals.
To properly quantify the energy absorbed by a material, especially by human tissue, dosimetric quantities are used. Dosimetry expresses the current and power density and the energy absorbed per unit area or volume as defined below:

- CURRENT DENSITY ‘J’: is the current flowing through a cross section of a conductor such as the human body or a part of it. It is measured in terms of $A/m^2$.
- DENSITY OF POWER ‘S’: is used for very high frequency types of current where depth of penetration is small. It is calculated as the radiant power perpendicular to a surface divided by the same surface area and is expressed in $W/m^2$.
- SPECIFIC ENERGY ABSORPTION ‘SA’: is defined as the energy absorbed per unit of mass of biological tissue and is expressed in Joule/kg.
- SPECIFIC ABSORPTION RATE OF ENERGY ‘SAR’: This is the rate of absorption of energy per unit mass of body tissue averaged over the entire body or specific parts of it. It is used to assess and eventually limit excessive energy deposition in small parts of the body resulting from particular exposure conditions. Both SAR, averaged over the whole body, as well as local body part values are used. It is measured in W/kg.

The quantities mentioned above are used as references to measure the effects on the human body and to define exposure limits. These, however, cannot be measured directly on the individual exposed to assess the intensity of radiation. Instead, measurable physical quantities such as magnetic field and induction are used. This limitation means that the quantities, which are obtained through mathematical models simulating the behaviour of the human body, are defined in terms of modules of magnetic flux density and magnetic field.
At low frequencies the tissue of the body are able to shield and so mitigate the electric field, by contrast, magnetic fields or magnetic induction are not shielde by the tissues and therefore does not attenuate its effect. Consequently, it is clear that at low frequencies the magnetic field is the main pollutant factor as far as affecting biological properties is concerned. The direct, short-term or acute effects due to electromagnetic fields are well represented by current density ($A/m^2$).

| Current density J [$mA/m^2$] | Symptoms |
|---|---|
| J > 1000 | Extrasystoles and fibrillation |
| 100 < J <1000 | Tissues stimulation: possible risks |
| 10 < J < 100 | Possible symptoms on the nervous system |
| 1 < J < 10 | Minor effects |

## EFFECT OF ELECTROMAGNETIC FIELDS ON PEOPLE

Another type of impact on health which is the result of prolonged exposure (perhaps even years) to electromagnetic field levels even lower than those associated with the short-term effects, must be measured in the long-term. All that is known about the effects of electric and magnetic fields changing in time is in relation to the induction of fields and currents inside the exposed body.
Electric fields exert forces on any electrically charged particles, as for example ions in liquids. Accordingly, all particles covered by an electric field move to achieve an electrostatic balance, for which reason the field is null in the human body. In cases where the electric field is variable in time the electric charges, constantly trying to reach equilibrium, change their position according to the sign of the field, thus creating a fluctuating motion of charges on the surface (electric current induced by the electric field variable) which increases intensity with the increasing frequency with which the inducing field changes.
However, as far as a time-varying magnetic field is concerned, a different mechanism occurs as this generates an electric field in the surrounding space that changes over time. If the variable electric field is produced within the human body, it generates an electric current in accordance with Ohm's law: $J = \sigma E$.
While an electric field as a main source generates currents on the surface of the body, a magnetic field causes the movement of currents within the body thus affecting more delicate parts.
The electric field generated by a magnetic field has a variable spatial distribution that can be shown as lines of force which close in on themselves and link up with the lines of the magnetic field strength (see Figure 1).

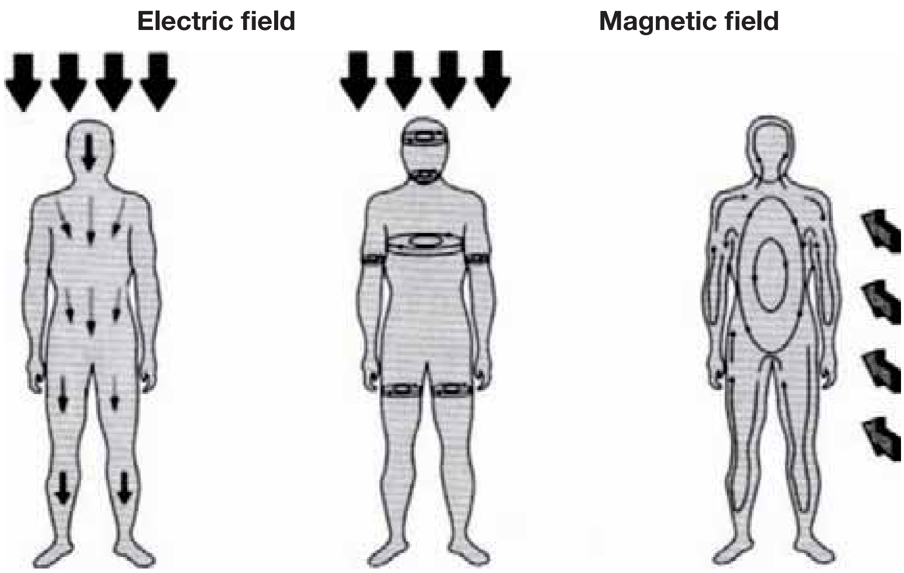



**Figure 1 - Induced currents in the body as a consequence of exposure to a (vertical) field E or a (vertical or horizontal field) field H**

The induction of electric fields and currents inside the human body causes two biological effects, both potential health issues. The first one elates to the electrical stimulation of muscles and nerves, while the second is the so called Joule thermal effect.
When the effects of these two phenomena occur immediately after exposure to the fields, one can speak of short-term effects. When they occur after a number of years after a prolonged exposure to lower field values we talk about long-term effects.

## LEGISLATION, REGULATIONS AND RECOMMENDATIONS

About protection of population from exposure to electromagnetic field the European situation is not homogeneous. A first differentiation can be made between states that have voluntary instruments, as guidelines, recommendations, and states that have mandatory instruments as laws or decrees. A second division is made on whether the nations consider as a reference the limits defined by guidelines ICNIRP or not. Some nations do not consider ICNIRP limits and have stricter values. Russian Federation still has stricter values: 10 µT for population and 100 µT for workers (50 Hz). In Poland the limit values are 48 µT for population and 160 µT for workers (50 Hz). Other countries have additional precautions [see references [1-2-3]. For example in Switzerland ICNIRP reference levels are applied for protection against proven adverse health effects: they must be respected at all places accessible to persons. Moreover Switzerland has precautionary emission limitations, called Installation Limit Values, for places of sensitive use (for example apartments, schools, hospitals, permanent workplaces, children playground). For electric power lines, transformer stations, substations and electric railways the ILV is 1 µT.
Finally the Italian legislation is based on a general policy law that sets the general criteria for protection from electromagnetic fields and on some implementing decrees that define the limit values for different types of electromagnetic fields for protection of population. With the law 36/2001 Italy adopted a precautionary approach against possible long-term effects, hypothesized but not established, and thus the limit values differ from those set by the European Union

### • Italian Legislation:

The Law 36/01 of 22 February 2001 on protection from exposure to electric fields, magnetic and electromagnetic fields, is the most important law on electromagnetic fields regulation.

The law which regulates electromagnetic shielding applies to all civilian and military facilities, systems and equipment that can cause electromagnetic exposure, from 0 Hz (Hertz) to 300 gigahertz (GHz), to both workers in the sector as well as the general public.

The legislation provides for different ‘levels’ of exposure

- Exposure levels that must not exceed, under any conditions, the limits which cause acute effects on human health;
- Warning levels, which draw attention for the need to protect against possible long term effects - these levels must not be exceeded in areas where individuals may be exposed for prolonged periods of time;
- Quality targets to be pursued in the short, medium and long term that aim to minimise exposure with reference to possible long term effects.

Further the **DPCM 8/7/2003** (Decree of the President of the Council of Ministers) establishes exposure limits, attention values and quality targets to protect the public from exposure to electric and magnetic fields at mains frequency (50Hz). It also determines the buffer zones by providing:

- maximum electric field: **5** kV/m.
- exposure limit: **100** µT.
- attention value: **10** µT.
- quality target: **3** µT.

# LEGISLATION, REGULATIONS AND RECOMMENDATIONS

## European Standard:

**• Dir ectory**

At European levels, exposure limits have been determined by ICNIRP for both workers at risk due to the natur e of their occupation (T able 6) and for the general public (Table 7). These levels were obtained using dosimetric models.

**Table 6. ICNIRP reference values of exposure limits for workers at risk due to the nature of their occupation .**

| Frequency | Electric field /metre (V/m) | Magnetic field /metre (A/m) | Magnetic induction (µT) |
|---|---|---|---|
| ≤ 1 Hz | - | $1.63 \cdot 10^5$ | $2 \cdot 10^5$ |
| 1 - 8 Hz | 20000 | $1.63 \cdot 10^5 / f^2$ | $2 \cdot 10^5 / f^2$ |
| 8 - 25 Hz | 20000 | $2 \cdot 10^4 / f^2$ | $2.5 \cdot 10^4 / f^2$ |
| 0.025 - 0.82 kHz | 500 / f | 20 / f | 25 / f |
| 0.82 - 65 kHz | 610 | 24.4 | 30.7 |
| 0.065 - 1 MHz | 610 | 1.6 / f | 2 / f |
| 1 - 10 MHz | 610 / f | 1.6 / f | 2 / f |
| 10 - 400 MHz | 61 | 0.16 | 0.2 |
| 400 - 2000 MHz | $3 \cdot f^{1/2}$ | $0.008 \cdot f^{1/2}$ | $0.01 \cdot f^{1/2}$ |
| 2 - 300 GHz | 137 | 0.36 | 0.45 |

**Table 7. ICNIRP reference values of exposure limits for the general public.**

| Frequency | Electric field /metre (V/m) | Magnetic field /metre (A/m) | Magnetic induction (µT) |
|---|---|---|---|
| ≤ 1 Hz | - | 32000 | 40000 |
| 1 - 8 Hz | 10000 | $32000 / f^2$ | $40000 / f^2$ |
| 8 - 25 Hz | 10000 | $4000 / f^2$ | $5000 / f^2$ |
| 0.025 - 0.8 kHz | 250 / f | 4 / f | 5 / f |
| 0.8 - 3 kHz | 250 / f | 5 | 6.25 |
| 3 - 150 kHz | 87 | 5 | 6.25 |
| 0.15 - 1 MHz | 87 | 0.73 / f | 0.92 / f |
| 1 - 10 MHz | $87 / f^{1/2}$ | 0.73 / f | 0.92 / f |
| 10 - 400 MHz | 28 | 0.073 | 0.092 |
| 400 - 2000 MHz | $1.375 \cdot f^{1/2}$ | $0.0037 \cdot f^{1/2}$ | $0.0046 \cdot f^{1/2}$ |
| 2 - 300 GHz | 61 | 0.16 | 0.2 |

- **Electronic equipment**

Current regulation, in addition to establishing exposure limits for people, also sets out protection values for electronic equipment. **CEI EN 61000-4-8** requires that equipment not be exposed to fields with magnetic induction above **3,75 µT**.

[1] J. Baumann, G. Goldberg, “Regulation for the protection of the general population in Switzerland”, www .bafu.admin.ch/elektrosmog/

[2] G. Kelfkens, M. Pruppers, Magnetic Field Zoning in the Framework of the Dutch Power Line Policy, (http://www .rivm.nl/milieuportaal/images/Magnetic%20field%20zoning.pdf).

[3] S. Kandel. “ELF Policies worldwide - Protection of general public”, (WHO Workshop, Geneve 20-21 June 2007).

# OUTPUT OF MV / LV TRANSFORMERS

One of the main causes of magnetic field exposure in MV / LV electrical substations is represented by the output of the LV transformer.
As shown in Fig 2, the output is equivalent to the three sections of the conductor which are spaced out the same distance as the terminals of the transformer (D) on the transformer side. They are closer together (d) on the other side, where they form the bundle of cables directed toward the LV distribution substation. The height of the cables is a parameter that can vary depending on the installation mode. The distances on the different axis (with reference to Fig 2) when magnetic induction is equal to 3 μT (quality target) have been calculated on the basis of the nominal power and therefore on the basis of the secondary LV currents. The results are shown in Tables 1, 2 and 3 respectively for x, y and z.

It is clear from the tables that the output LV is a substantial pollutant component and that in the case of major power supplies the distances affected can be significantly more than 10 metres.

**When substations are located in the vicinity of civilian, commercial or industrial settings where the quality target must be satisfied, it is necessary to implement shielding systems for almost all power supply levels.**

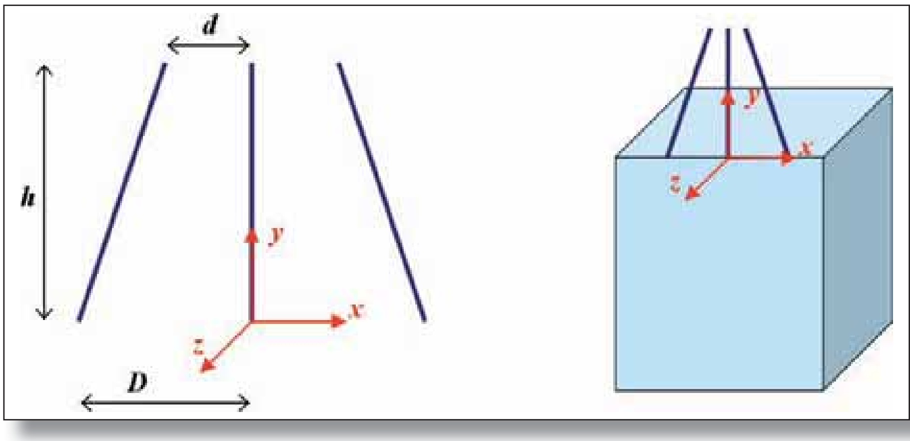



**Figure 2 - Graphic representation of a MV/LV transformer with the LV output pointing upwards.**

### Table 1. Distance from the centre of the system's coordinates along the X axis to obtain 3 μT .

| Rated power (kVA) | Rated secondary power (A) | h=0.5 (m) | h=0.6 (m) | h=0.7 (m) | h=0.8 (m) | h=0.9 (m) | h=1.0 (m) |
|---|---|---|---|---|---|---|---|
| 250 | 361 | 2.47 | 2.69 | 2.90 | 3.09 | 3.26 | 3.43 |
| 315 | 455 | 2.77 | 3.03 | 3.25 | 3.47 | 3.68 | 3.86 |
| 400 | 577 | 3.13 | 3.41 | 3.68 | 3.92 | 4.14 | 4.36 |
| 500 | 722 | 3.49 | 3.81 | 4.11 | 4.38 | 4.64 | 4.88 |
| 630 | 909 | 3.91 | 4.28 | 4.61 | 4.92 | 5.22 | 5.49 |
| 800 | 1155 | 4.41 | 4.82 | 5.20 | 5.55 | 5.88 | 6.19 |
| 1000 | 1443 | 4.93 | 5.39 | 5.81 | 6.21 | 6.58 | 6.93 |
| 1250 | 1804 | 5.50 | 6.03 | 6.50 | 6.94 | 7.35 | 7.75 |
| 1600 | 2309 | 6.23 | 6.81 | 7.35 | 7.86 | 8.32 | 8.77 |
| 2000 | 2887 | 6.96 | 7.61 | 8.22 | 8.78 | 9.31 | 9.81 |
| 2500 | 3608 | 7.78 | 8.51 | 9.19 | 9.82 | 10.41 | 10.97 |

# OUTPUT OF MV / LV TRANSFORMERS

**Table 2. Distance from the centre of the system's coordinates along the Y axis to obtain 3 µT.**

| Rated power (kVA) | Rated secondary power (A) | h=0.5 (m) | h=0.6 (m) | h=0.7 (m) | h=0.8 (m) | h=0.9 (m) | h=1.0 (m) |
|---|---|---|---|---|---|---|---|
| 250 | 361 | 3.10 | 3.14 | 3.16 | 3.20 | 3.23 | 3.26 |
| 315 | 455 | 3.54 | 3.57 | 3.60 | 3.63 | 3.67 | 3.69 |
| 400 | 577 | 4.10 | 4.13 | 4.16 | 4.19 | 4.22 | 4.25 |
| 500 | 722 | 4.65 | 4.68 | 4.70 | 4.73 | 4.77 | 4.79 |
| 630 | 909 | 5.27 | 5.30 | 5.32 | 5.35 | 5.39 | 5.41 |
| 800 | 1155 | 6.05 | 6.08 | 6.11 | 6.14 | 6.16 | 6.20 |
| 1000 | 1443 | 6.87 | 6.90 | 6.93 | 6.96 | 6.99 | 7.02 |
| 1250 | 1804 | 7.86 | 7.88 | 7.90 | 7.94 | 7.96 | 7.99 |
| 1600 | 2309 | 9.05 | 9.07 | 9.09 | 9.12 | 9.14 | 9.18 |
| 2000 | 2887 | 10.37 | 10.39 | 10.42 | 10.45 | 10.47 | 10.50 |
| 2500 | 3608 | 11.94 | 11.96 | 11.98 | 12.01 | 12.04 | 12.07 |

**Table 3. Distance from the centre of the system's coordinates along the Z axis to obtain 3 µT.**

| Rated power (kVA) | Rated secondary power (A) | h=0.5 (m) | h=0.6 (m) | h=0.7 (m) | h=0.8 (m) | h=0.9 (m) | h=1.0 (m) |
|---|---|---|---|---|---|---|---|
| 250 | 361 | 3.26 | 3.36 | 3.47 | 3.59 | 3.70 | 3.82 |
| 315 | 455 | 3.72 | 3.83 | 3.95 | 4.07 | 4.21 | 4.33 |
| 400 | 577 | 4.29 | 4.41 | 4.54 | 4.68 | 4.81 | 4.96 |
| 500 | 722 | 4.86 | 4.99 | 5.14 | 5.28 | 5.43 | 5.59 |
| 630 | 909 | 5.51 | 5.66 | 5.81 | 5.97 | 6.14 | 6.32 |
| 800 | 1155 | 6.32 | 6.48 | 6.65 | 6.82 | 7.01 | 7.20 |
| 1000 | 1443 | 7.18 | 7.34 | 7.52 | 7.71 | 7.92 | 8.13 |
| 1250 | 1804 | 8.17 | 8.35 | 8.54 | 8.75 | 8.96 | 9.19 |
| 1600 | 2309 | 9.39 | 9.59 | 9.80 | 10.02 | 10.26 | 10.50 |
| 2000 | 2887 | 10.74 | 10.94 | 11.17 | 11.40 | 11.65 | 11.92 |
| 2500 | 3608 | 12.33 | 12.53 | 12.76 | 13.02 | 13.28 | 13.56 |

**Notes:**
(1) The D parameter is an average value which is not linked to any particular make of transformers.
(2) The d parameter is calculated on the basis of the diameter of the output cables.

## DISTRIBUTION LINES AND SHIELDING CHANNELS

Unipolar power cables are commonly used for high current distribution lines in industrial and civilian environments. A classic example is the power supply of air conditioning system engines where it is common to find more cables used in parallel, adding to thousands of amperes. The exposure level caused by induction is clearly to be kept within the quality target (3 µT), but sometimes more stringent limits are required (0.1 µT near electronic microscopes for example).
Figure 3 shows the coloured map of the magnetic induction of a three-phase line with 400 mm$^2$ cables with an ampacity of 605 A.
It can be seen that in order to stay below 3 µT the distance from the centre of the line is about 1.4 m. Table 4 shows the buffer zone values associated with the induction of 3 µT for lines up to 2000 A consisting of single core cables in parallel.

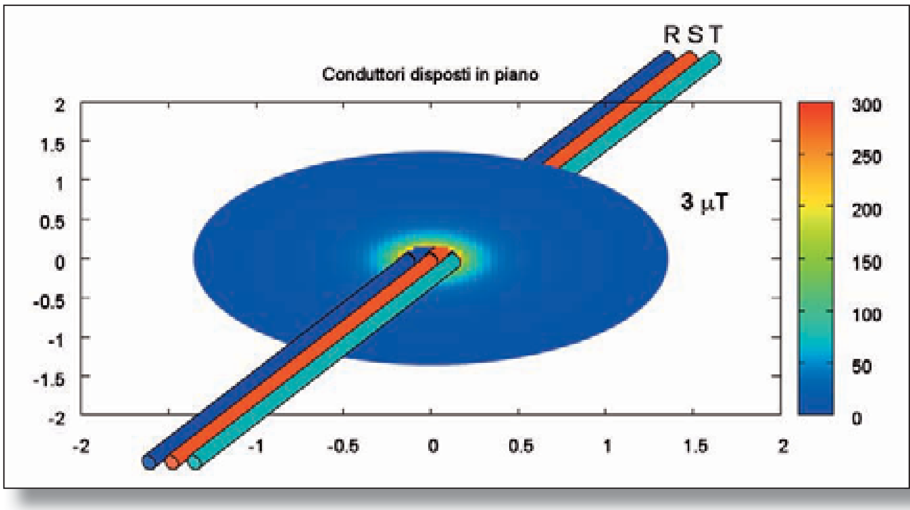



**Figure 3 - *Coloured map of the magnetic induction of a three-phase line with 400 mm² cables with an ampacity of 605 A.***

**Table 4.**

| Thermal capacity of the line (A) | Nominal diameter of the conductors [mm$^2$] | Phase layout | Protection distance at 3 µT (m) |
|---|---|---|---|
| 88 | 16 | RST | 0.24 |
| 117 | 25 | RST | 0.30 |
| 144 | 35 | RST | 0.37 |
| 175 | 50 | RST | 0.45 |
| 222 | 70 | RST | 0.55 |
| 269 | 95 | RST | 0.65 |
| 312 | 120 | RST | 0.74 |
| 355 | 150 | RST | 0.83 |
| 417 | 185 | RST | 0.95 |
| 490 | 240 | RST | 1.10 |
| 530 | 300 | RST | 1.21 |
| 605 | 400 | RST | 1.39 |
| 834 | 2x185 | RRSSTT | 1.90 |
| 980 | 2x240 | RRSSTT | 2.20 |
| 1251 | 3x185 | RRRSSSTTT | 2.85 |
| 1470 | 3X240 | RRRSSSTTT | 3.30 |
| 1668 | 4X185 | RRRRSSSSTTTT | 3.80 |
| 1960 | 4X240 | RRRRSSSSTTTT | 4.4 |

## DISTRIBUTION LINES AND SHIELDING CHANNELS

Shielding channels have a high shielding performance with an average screen factor of approx 30. Figure 4 shows a coloured map of the magnetic induction of a three-phase line with 400 mm $^2$ cables with an ampacity of 605 A. The comparison with induction levels in the absence of shielding is obvious. The reduction in levels of induction involves a significant reduction in buffer zones. Table 5 shows the bands with respect to the different lines inserted into the shielding channel while Figure 4 shows the comparison between the buffer strips with and without channel shielding.

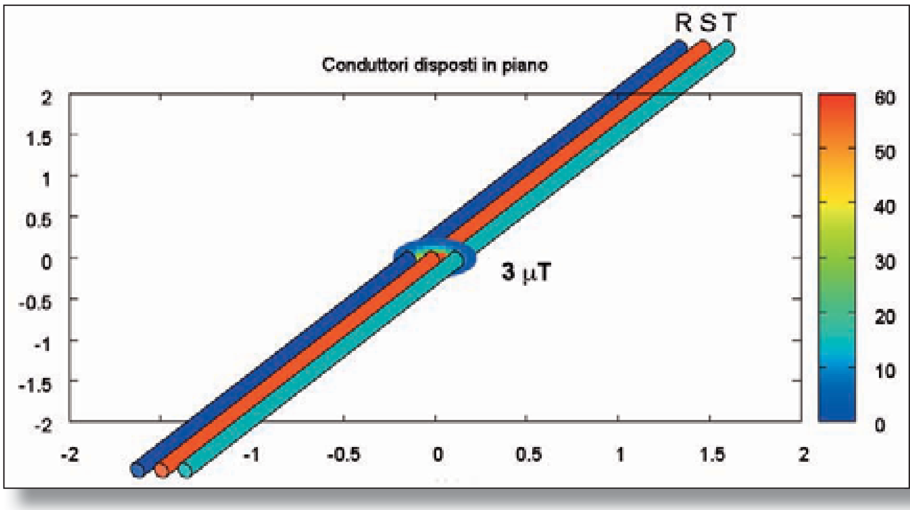


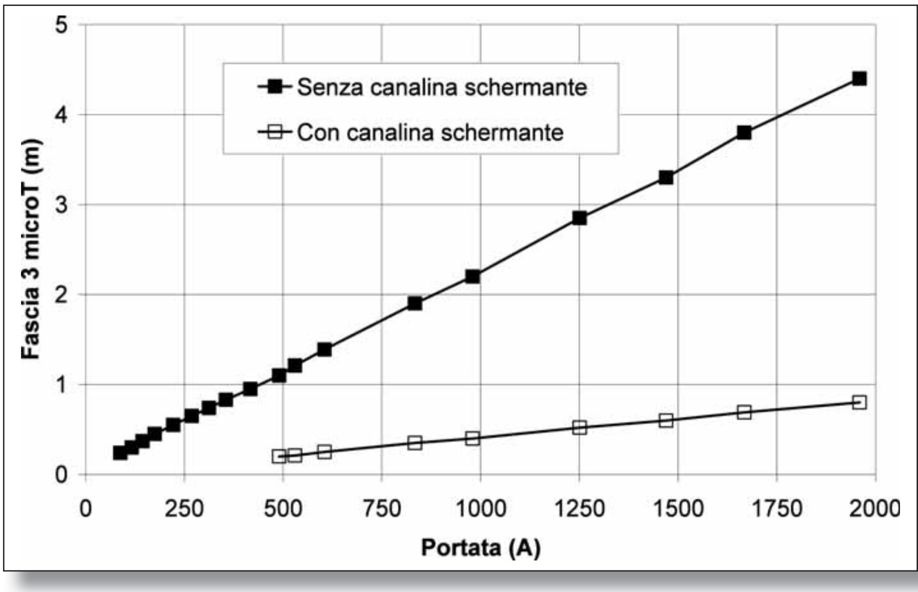

**Figure 4 - Coloured map of the magnetic induction of a three-phase line with 400 mm² cables, with an ampacity of 605 A, placed within a shielding channel.**

### Table 5.

| Thermal capacity of the line (A) | Nominal diameter of the conductors [mm²] | Phase layout | Protection distance at 3 µT (m) |
|---|---|---|---|
| 88 | 16 | RST | - |
| 117 | 25 | RST | - |
| 144 | 35 | RST | - |
| 175 | 50 | RST | - |
| 222 | 70 | RST | - |
| 269 | 95 | RST | - |
| 312 | 120 | RST | - |
| 355 | 150 | RST | 0.15 |
| 417 | 185 | RST | 0.17 |
| 490 | 240 | RST | 0.20 |
| 530 | 300 | RST | 0.21 |
| 605 | 400 | RST | 0.25 |
| 834 | 2x185 | RRSSTT | 0.35 |
| 980 | 2x240 | RRSSTT | 0.40 |
| 1251 | 3x185 | RRRSSSTTT | 0.52 |
| 1470 | 3X240 | RRRSSSTTT | 0.60 |
| 1668 | 4X185 | RRRRSSSSTTTT | 0.69 |
| 1960 | 4X240 | RRRRSSSSTTTT | 0.80 |

## DISTRIBUTION LINES AND SHIELDING CHANNELS

Comparison between the pr otection distance at 3 μT (m) with and without shielding channel.




## DESCRIPTION OF SHIELDING MATERIALS

Mitigation of the magnetic flux density is achieved for both shielding plates and shielding channels by affixing magnetic shields made of two different materials:

- Material with high magnetic permeability.
- Material with high electrical conductivity.

The effect of incorporating both materials is clearly visible fr om simulations carried out using specific softwar e that allows viewing the evolution of the field lines for the shielding materials when they ar e affected by a magnetic field generated by a coil. Figure 5 which also shows the progress of the field lines in the absence of a shielding system clearly demonstrates the effectiveness of the shielding materials:

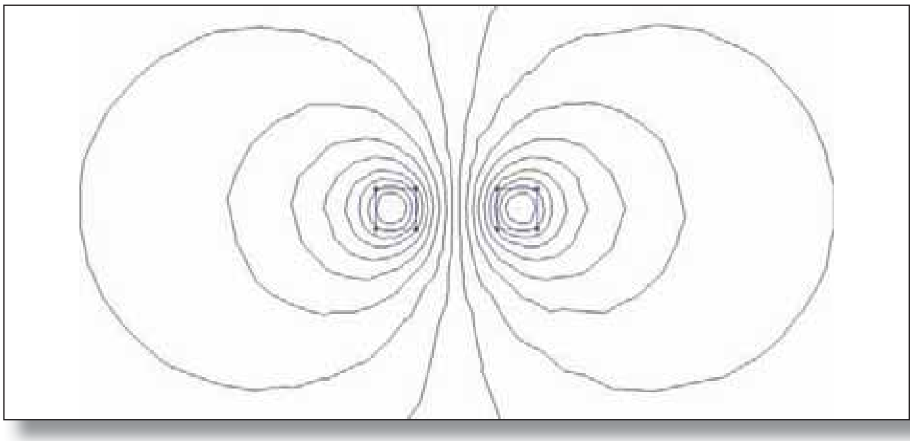


**Figure 5 - Magnetic field produced by a coil in the presence and the absence of shielding.**

## DESCRIPTION OF SHIELDING MATERIALS

The layer of material with high magnetic permeability eliminates magnetic induction through absorption of the magnetic field. Its behaviour is similar to a shielding "umbrella" as protection from the intensity of the magnetic field can be very high close to the shield, but tends to decrease away from it.

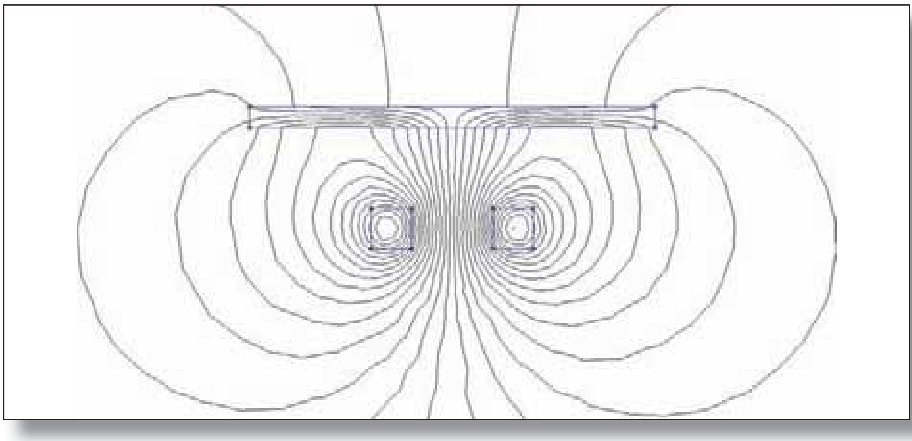


**Figure 6 - Magnetic field produced by a coil with ferromagnetic shielding.**

The layer of material with high electrical conductivity in the presence of a variable magnetic field (induction field) becomes the site of current movement, which in turn generates a magnetic field of reaction (induced field). The combined effects of the fields, induction and induced, results in a reduction in the overall total magnetic field.

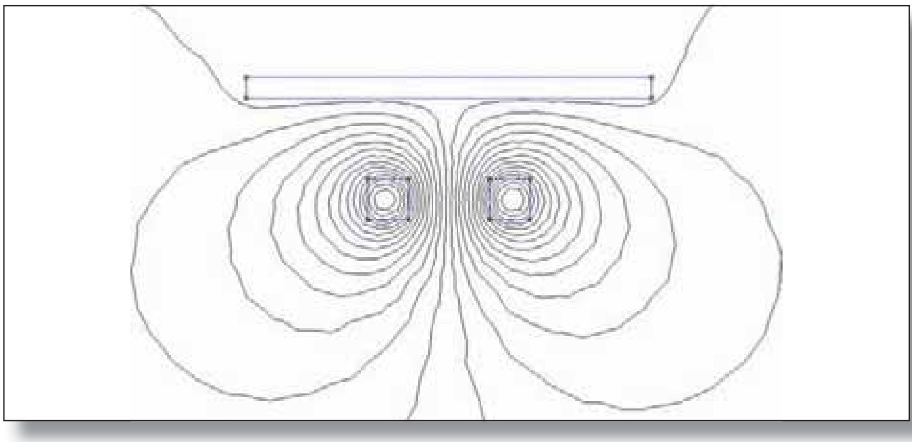


**Figure 7 - Magnetic field produced by a coil in with a conductive shield.**

The combination of the two materials, magnetic and conductive, can produce good shielding capacities both close up, thanks mainly to the magnetic shield, and far away, thanks to the conductive shield.

## SHIELDING PRODUCTS

### Shielding plates

Three types of shielding plates are available, each characterised by different shielding factors and thicknesses:

- **LT plates.**
- **MT plates.**
- **HT plates.**


POLITECNICO DI TORINO

Dipartimento di Ingegneria Elettrica

**LT Low Thickness plate - 2.7 mm**

The overall thickness of the plate is equal to 2.7 mm, with layers having the following features:

- 1st layer: high-permeability magnetic material composed of two overlaid plates each 0.35 mm thick.
- 2nd layer: material with high electrical conductivity 2 mm thick.

The shielding factor is shown in Figure 8.

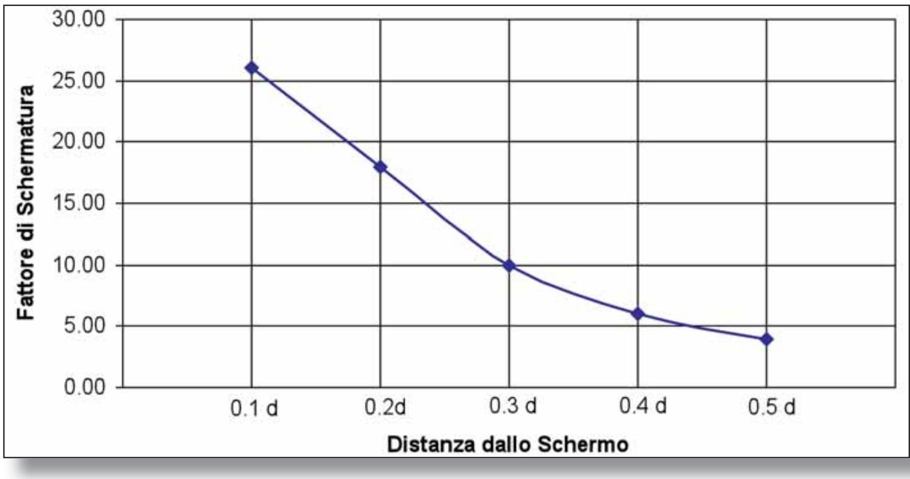



**Figure 8 - Shielding factor for LT Low Thickness plate**

**MT Medium Thickness plate - 4.7 mm**

The overall thickness of the plate is 4.7 mm, with layers having the following features:

- 1st layer: high-permeability magnetic material composed of two overlaid plates each 0.35 mm thick.
- 2nd layer: material with high electrical conductivity 4 mm thick.

The MT series has impr oved conductive shielding factors and is capable of maintaining high levels of protection at a distance from the shield.
The shielding factor is shown in Figure 9.

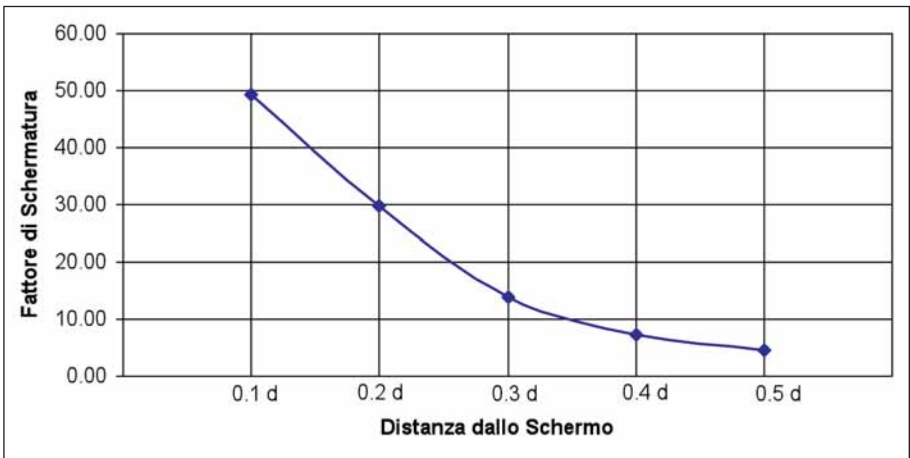



**Figure 9 – Shielding factor for MT Medium Thickness plate**

## SHIELDING PRODUCTS

**HT: High Thickness plate - 6.4 mm**

The overall thickness of the plate is equal to 6.4 mm, with layers having the following features:

- 1st layer: high-permeability magnetic material composed of four overlaid plates each 0.35 mm thick.
- 2nd layer: material with high electrical conductivity 5 mm thick.

The HT series has improved both conductive and ferromagnetic shielding factors. It offers high protection both near the shield and at a distance from it. The shielding factor is shown in Figure 10.

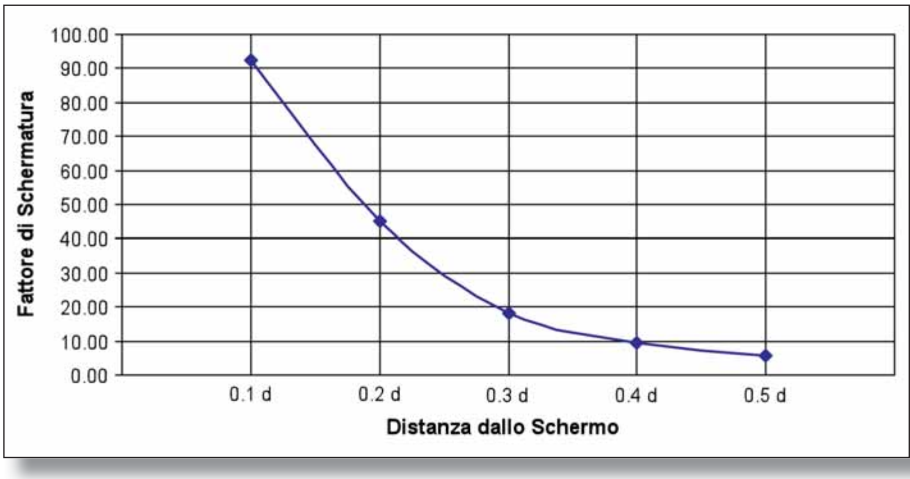



**Figure 10 - Shielding factor for HT High Thickness plate.**

### Shielding channels

Shielding channels are capable of ensuring a magnetic field mitigation factor of 25. The layout is shown in Figure 11.

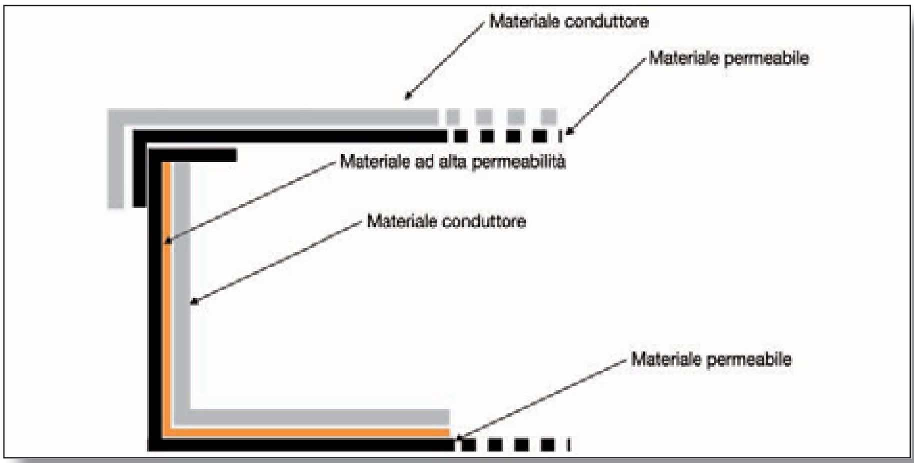



**Figure 11 - layout of shielding channel**

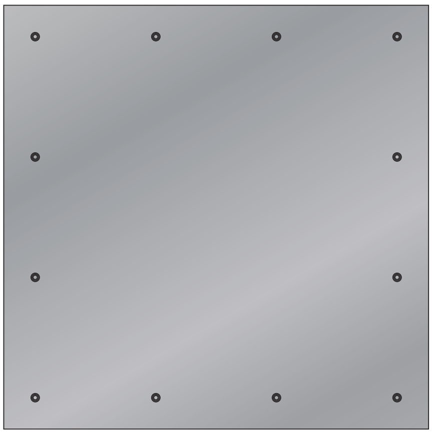
It is possible to choose different sizes of shielding channel all having the same shielding factor running through the entire length of the channel.

## PIASTRE SERIE LT

### Standard low thickness plate 2.7 mm (LT Low Thickness)

* For electrical continuity use flat profile: code 8080098.

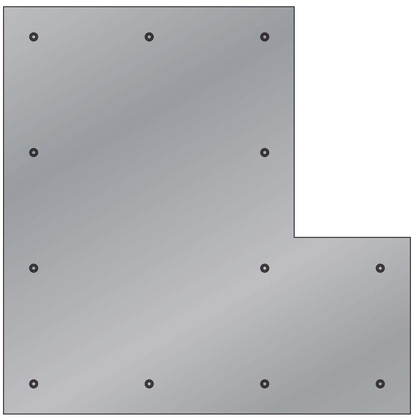
| | Code LT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|---|
| * | **8080101** | 2,7 | 500 x 500 | 2,724 |
| * | **8080102** | 2,7 | 500 x 1000 | 5,448 |
| * | **8080103** | 2,7 | 1000 x 1000 | 10,895 |

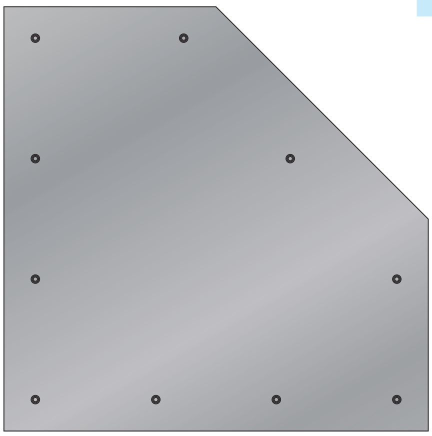


### Special low thickness plate 2.7 mm (LT Low Thickness)

* For electrical continuity use flat profile: code 8080098.

| | Code LT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|---|
| * | **8080111** | 2,7 | 500 x 500 | 2,724 |
| * | **8080112** | 2,7 | 500 x 1000 | 5,448 |
| * | **8080113** | 2,7 | 1000 x 1000 | 10,895 |



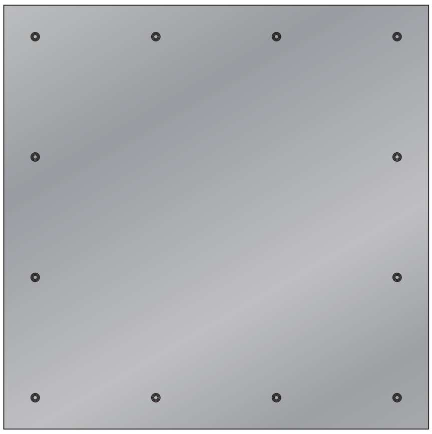


Examples of special design plates.

## PIASTRE SERIE MT

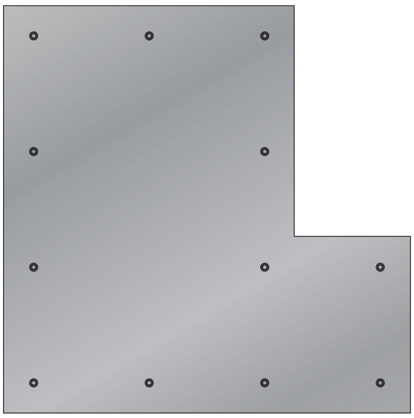
### Standard medium thickness plate 4.7mm (MT Medium Thickness)

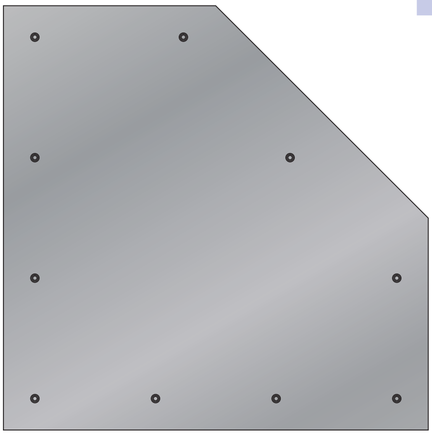
| Code MT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|
| **8080201** | 4,7 | 500 x 500 | 4,074 |
| **8080202** | 4,7 | 500 x 1000 | 8,148 |
| **8080203** | 4,7 | 1000 x 1000 | 16,295 |



### Special medium thickness plate 4.7mm (MT Medium Thickness)

| Code MT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|
| **8080211** | 4,7 | 500 x 500 | 4,074 |
| **8080212** | 4,7 | 500 x 1000 | 8,148 |
| **8080213** | 4,7 | 1000 x 1000 | 16,295 |



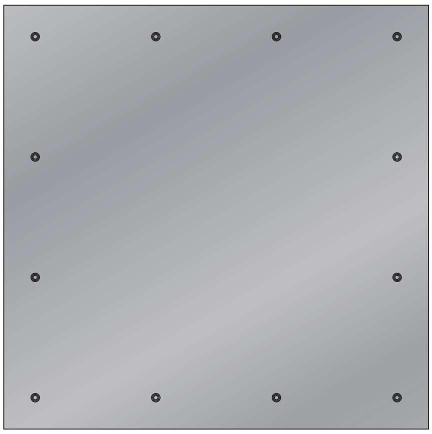


Examples of special design plates.

## PIASTRE SERIE HT

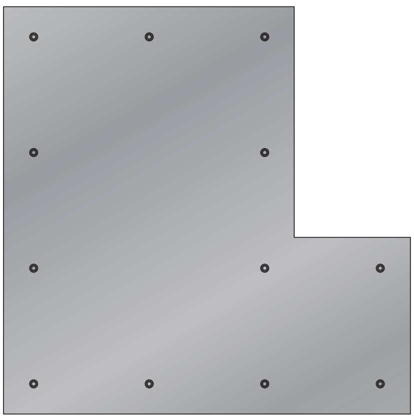
### Standard high thickness plate 6.4 mm (HT High Thickness)

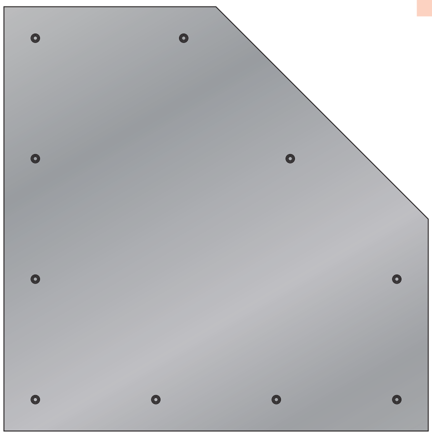
| Code HT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|
| **8080301** | 6,4 | 500 x 500 | 6,123 |
| **8080302** | 6,4 | 500 x 1000 | 12,246 |
| **8080303** | 6,4 | 1000 x 1000 | 24,490 |



### Special high thickness plate 6.4 mm (HT High Thickness)

| Code HT | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|
| **8080311** | 6,4 | 500 x 500 | 6,123 |
| **8080312** | 6,4 | 500 x 1000 | 12,246 |
| **8080313** | 6,4 | 1000 x 1000 | 24,490 |





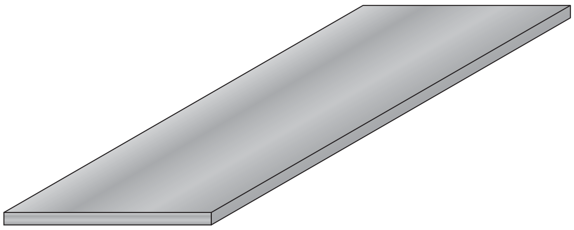
Examples of special design plates.

# PROFILES

## Flat profile

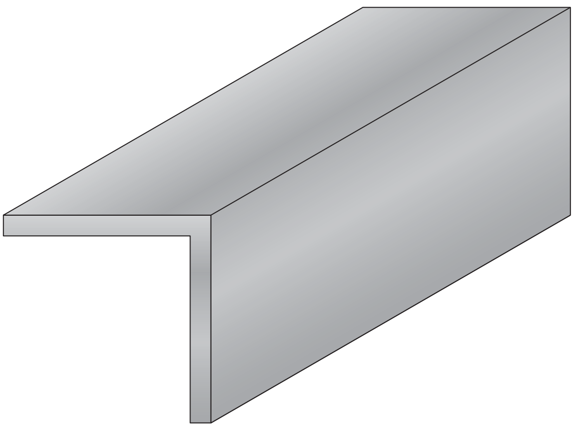
* The flat profile is recommended for LT shielding systems.

| | Code | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|---|
| | **8080097** | 3 | 100 x 1000 | 0,810 |
| * | **8080098** | 3 | 50 x 1000 | 0,810 |



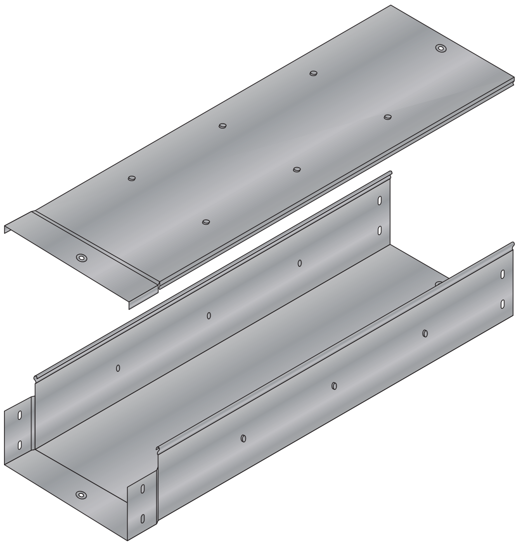
## Angular profile

| Codice | Thickness mm | Dimensions mm | kg./Pz. |
|---|---|---|---|
| **8080099** | 5 | 50 x 50 x 1000 | 1,283 |



# SHIELDING CHANNELS AND COVERS

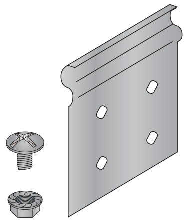
## Channel complete with snap fitting cover



| Lenght L | Height H | Base B | Code | kg./m |
|---|---|---|---|---|
| **3000** | 100 | 100 | **8080717** | 5,397 |
| | 100 | 200 | **8080719** | 8,432 |
| | 100 | 300 | **8080720** | 11,893 |
| | 100 | 400 | **8080721** | 15,142 |
| | 100 | 500 | **8080722** | 17,996 |

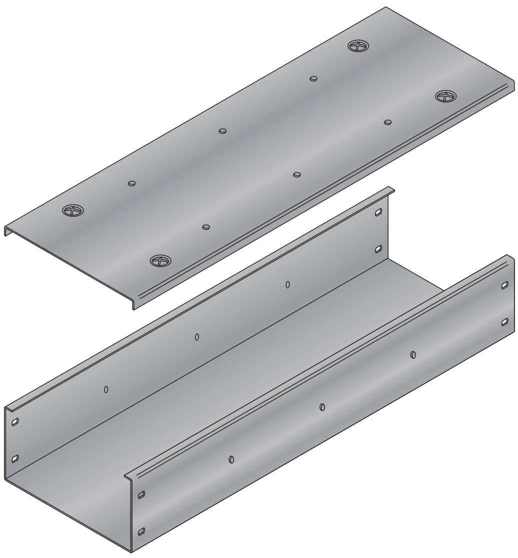
## Linear coupling

Complete with nuts and bolts M 6 x 10 mm.



| Height H | Code | kg./pz |
|---|---|---|
| 100 | **8080800** | 0,047 |

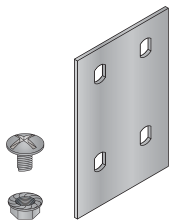
## Channel complete with lid with hooks



| Lenght L | Height H | Base B | Code | kg./m |
|---|---|---|---|---|
| **2000** | 100 | 100 | **8080741** | 9,887 |
| | 100 | 200 | **8080743** | 14,382 |
| | 100 | 300 | **8080744** | 18,877 |
| | 100 | 400 | **8080745** | 23,372 |
| | 100 | 500 | **8080746** | 27,866 |

## Linear coupling

Complete with nuts and bolts M 6 x 10 mm.

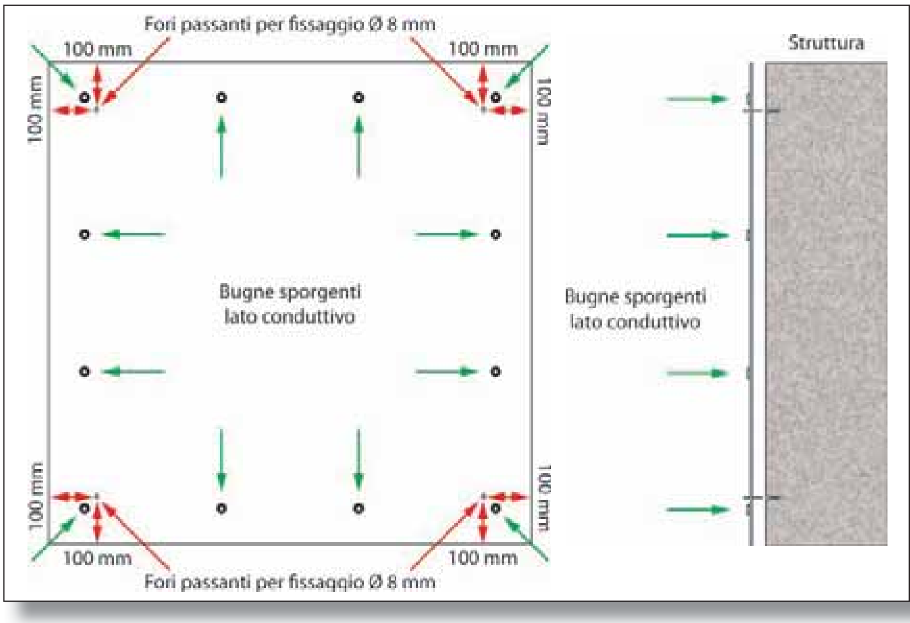


| Height H | Code | kg./pz |
|---|---|---|
| 100 | **8080851** | 0,090 |

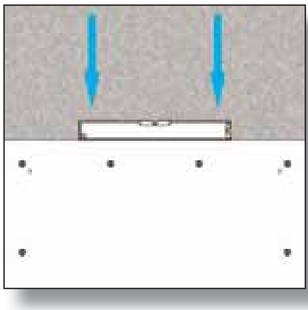
## INSTALLATION GUIDE FOR FLAT PLATES

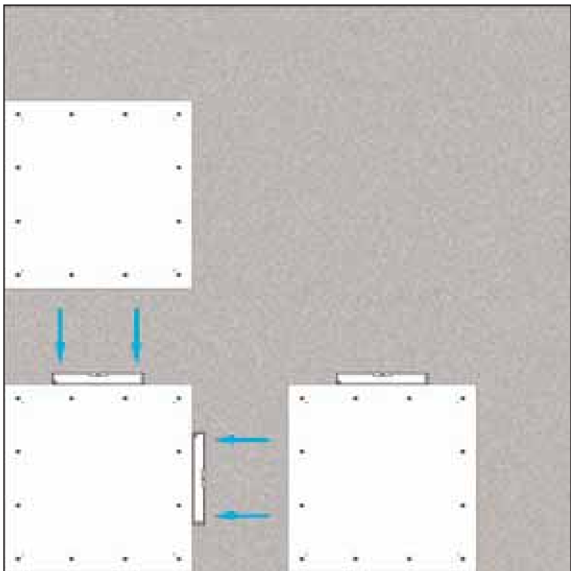
### Shielding system for walls or floors.

To fix the plates, drill the four marked points with an iron drill bit Ø 8 mm.




Usually it is better to place the conductive side of the plates faced to the sources and available to the installer for providing their electrical junctions. Laying of the first plate can be carried out starting from the right or the left. Check the alignment of the plates horizontally and vertically before proceeding with drilling. Choose appropriate fixing equipment, different plugs are available commercially for different types of construction (solid or perforated brick, solid or perforated concrete, plasterboard, etc.).



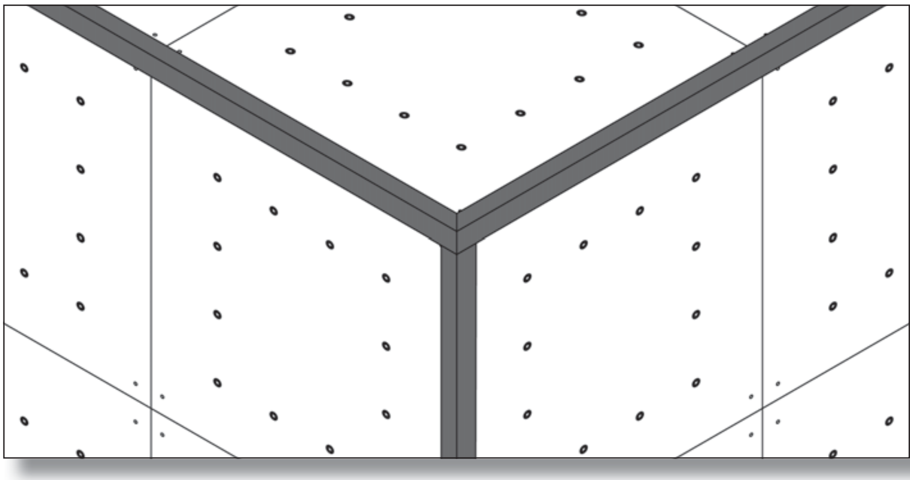


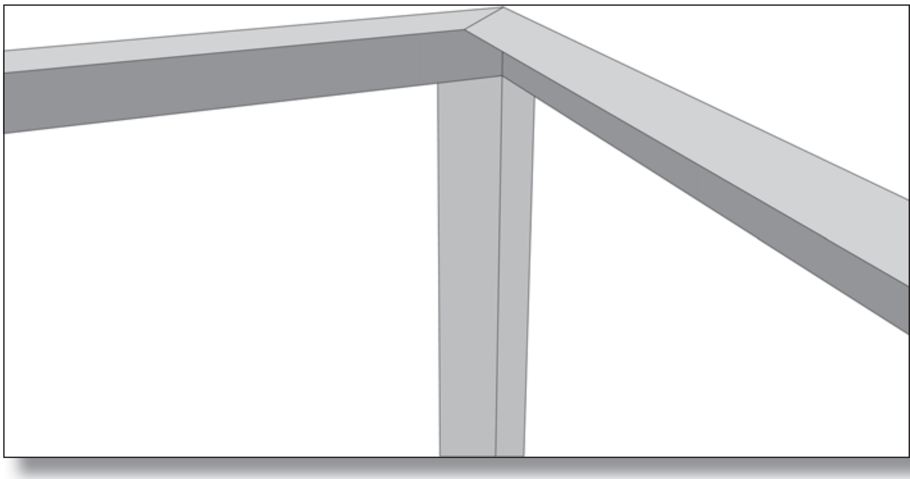
## INSTALLATION GUIDE FOR FLAT PLATES

After fixing the plates, move on to step two which is laying the angular profiles between the walls and/or between the walls and ceiling and/or between the walls and floor.

First lay the horizontal pr ofiles between the walls and ceiling/floor , then proceed with the vertical ones.

The horizontal sections should be cut at a 45° angle at the joints (see below).





To fix angular pr ofiles use galvanised scr ews UNI 6954 (Ø 4.2 x 6.5 mm or 9.5 mm depending on the thickness of the shielding plates used).

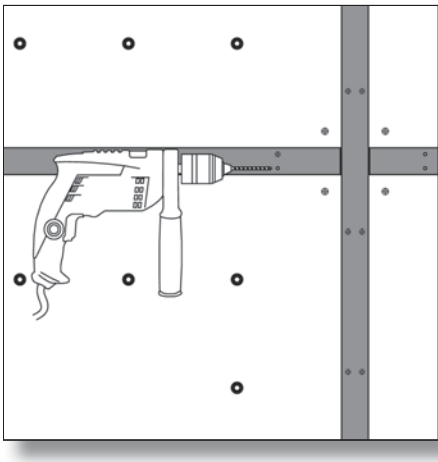
The thir d step consists of the installation of the flat pr ofiles between the shielding plates.

This process guarantees the electrical continuity of the shielding system, as well as the alignment of the plates on surfaces which are not perfectly flat.

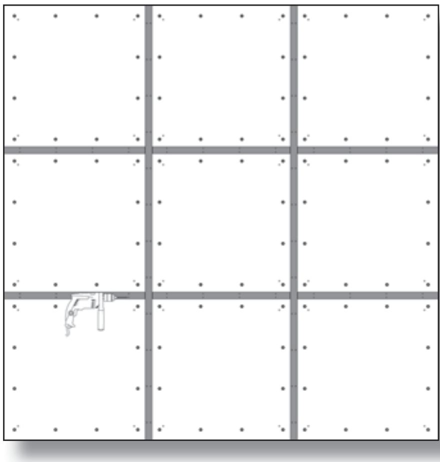
Use galvanised screws UNI 6954 (Ø 4.2 x 6.5 mm) for fixing flat profiles.

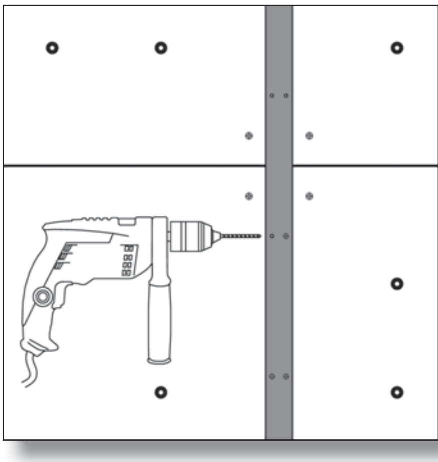
## INSTALLATION GUIDE FOR FLAT PLATES

First fix the flat pr ofiles in a vertical position and, subsequently , those in a horizontal position (no overlap is required).



Laying of flat horizontal profiles.





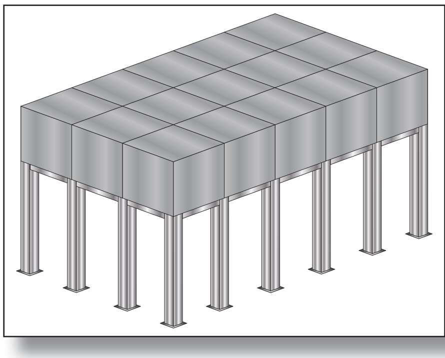
The fourth and last step of the installation is the connection of the earthing cable. Since ther e is continuity between the plates, it will be enough to connect the shielding system to an equipotential bonding of the electrical system using a copper conductor 25 mm² with appropriate end clamps.

## STRUCTURAL DESIGN OF SHIELDING PLATES

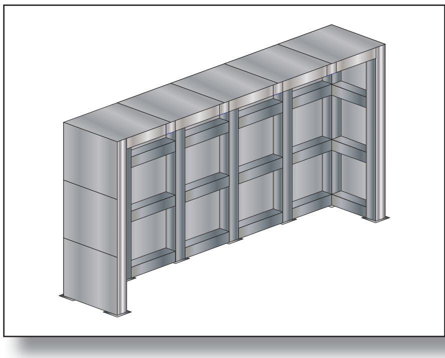
It is not always possible to position the shielding plates directly on the wall or ceiling. For this reason Sati Italia works with specialised companies which are able to provide and assemble metal structures on which to mount the plates.

This solution has made it possible, for example, to screen a distribution transformer located in a museum where the positioning of the shields directly on the wall or ceiling was not an option given the architectural value and the type of wall construction.

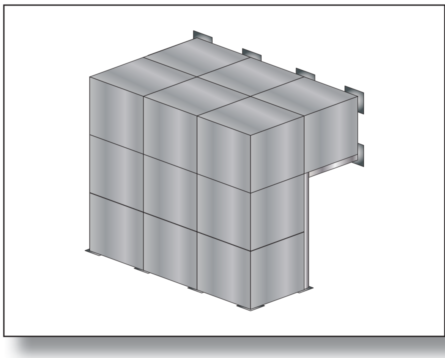
Example of self-supporting ceiling structure designed for the reduction of the magnetic field produced by MV / LV transformers positioned above the ceiling.



Example of a self-supporting wall structure designed for the reduction of the magnetic field produced by an electric distribution substation positioned on the adjacent wall.

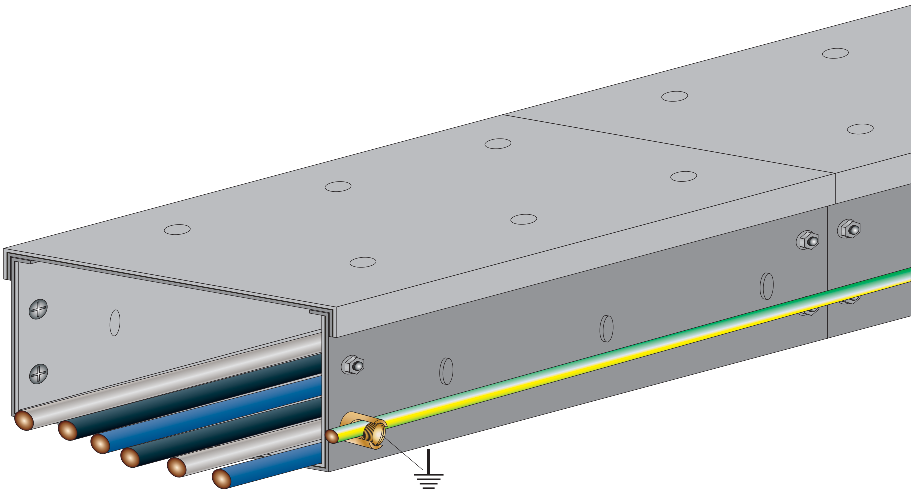


Example of a self-supporting wall/ceiling structure designed for the reduction of the magnetic field produced by an electric distribution substation positioned on the adjacent wall/ceiling.

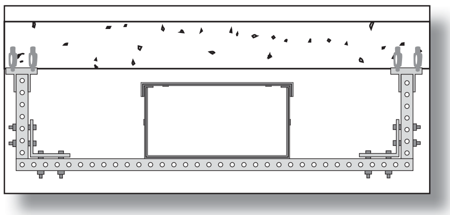


## GUIDE FOR THE INSTALLATION OF SHIELDING CHANNELS

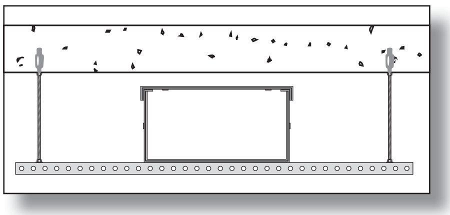
Connect the cable channel with a 25 mm$^2$ copper conductor to the earth.



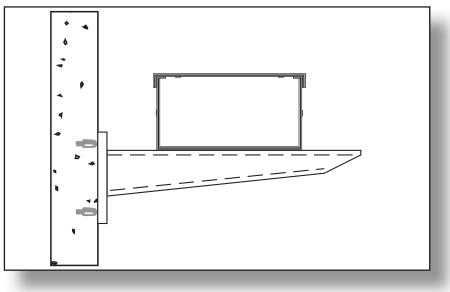
Example of suspension supports attached to concrete ceiling.



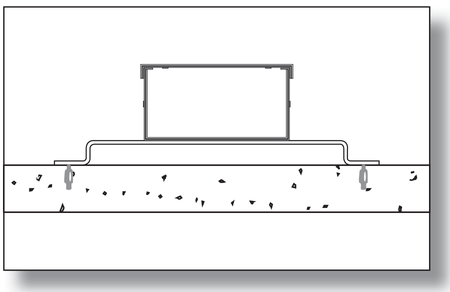
Example of suspension supports with threaded rod profiles.



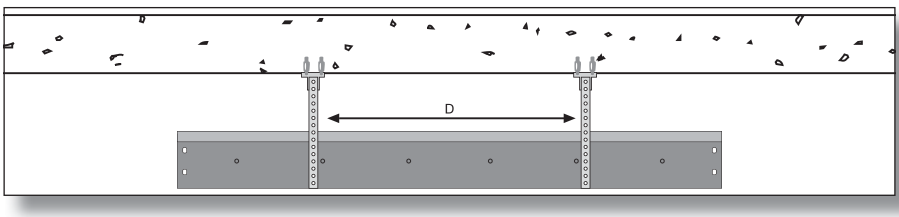
Example of wall installation.



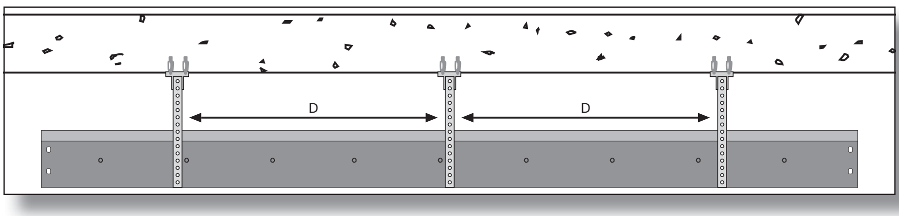
Example of floor installation.



The distance between supports should be D = 1 m.
Example of mounting with 2000 mm channel.



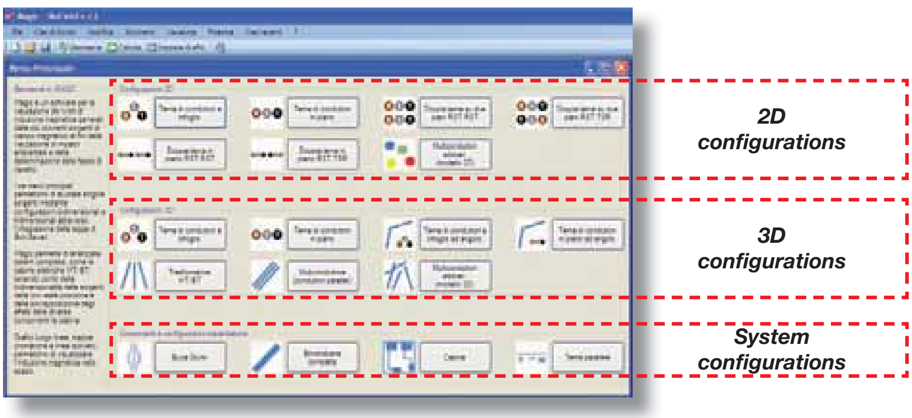

Example of mounting with 3000 mm channel.



# CALCULATING THE IMPACT OF MAGNETIC FIELDS ON THE ENVIRONMENT

The Carpaneto Sati Group and NoField S.r.l. cooperate closely to develop techniques and shielding solutions for the transportation and distribution of energy in civil and industrial sectors.
NoField S.r.l. was founded in Turin at the Innovative Enterprise Incubator of the Politecnico di Torino (I3P). It specialises in the field of environmental electromagnetic compatibility of electrical systems and devices as well as in the field of renewable energies, all of which is made possible through the collaboration of research institutions, laboratories, suppliers and installers of custom designed solutions.

The need for the evaluation of DPA (distance to first approximation), as required by legislation on the methodology and procedures for measuring and evaluating magnetic induction generated by power lines or power devices, often requires taking into account the complexity of the sources of the magnetic fields under consideration, their three-dimensional effects and of the effects caused by their combination (superposition of effects).
To meet these needs NoField S.r.l. has developed software which evaluates the impact of magnetic fields on the environment called MAGIC (Magnetic Induction Calculation). MAGIC 1.0 measures the level of magnetic induction generated by the most common sources of magnetic field, assesses the environmental impact and defines the appropriate levels of protection.
NoField S.r.l. was able to produce this software thanks to the experience it accumulated developing many “real scenario” applications.
The three main menus allow assessment of individual sources through two-dimensional and three-dimensional configurations and by integrating the Biot-Savart principle.
MAGIC 1.0 also allows analysis of complex systems such as MV/LV electrical substations, taking into account the three-dimensionality of the sources, their actual location and the overlapping effect of the different components in the electrical substation. Particular attention is given to the modelling of components, such as power transformers found in substations. Charts, colour diagrams and iso-level lines show the magnetic flux density in space.

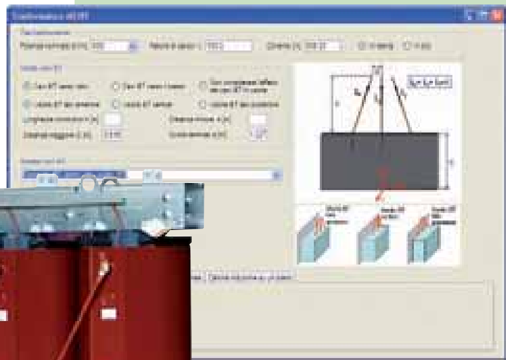



## Study of the engineering

There are typical configurations that frequently occur in everyday practice and which require the overlaying of different sources at the planning stage. MAGIC 1.0 has a dedicated section which is continuously updated with new types of sources in future versions. MAGIC 1.0 presents three types of sources: the area of junction of HV cable lines, MV / LV lines and positioning of HV cables alongside one another.

# CALCULATING THE IMPACT OF MAGNETIC FIELDS ON THE ENVIRONMENT

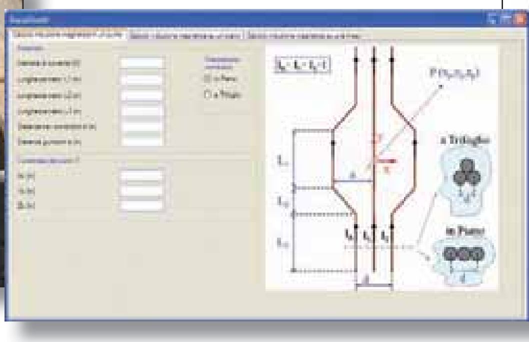
## Components

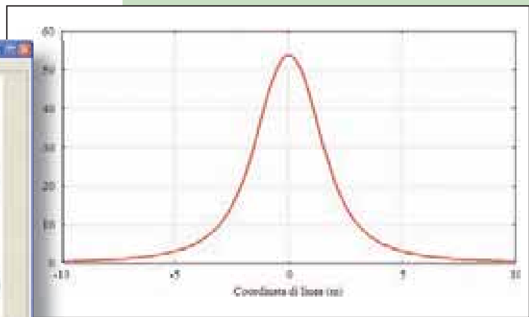


The toroidal winding model simulates sources such as dry type transformers which, unlike those oil-immersed transformers that are enclosed providing a shield for stray magnetic fields, can generate significant induction fields.
The modelling of toroidal winding was carried out using two approaches: a rigorous and a simplified one. The two models are therefore characterised by differing complexity and thus time calculation. To assess magnetic induction at distances greater than one meter from the transformer both models are adequate. However in the case of calculation points in close proximity to the transformer, the rigorous model is more accurate.
MAGIC 1.0 is the only commercial software which currently implements the exact model for the calculation of fields scattered by dry type transformers. The main geometric parameters are defined within the software on the basis of the power rating of the transformer. These allow the operator to calculate the magnetic induction without the need for any other data.

## HV lines: zone of conjunction

In the area of junction of unipolar cables of HV lines, the three conductors of the line itself are usually placed in close proximity in flat or triangular configuration, with a distance between them of up to one meter. This distance creates increased levels of magnetic induction, which at nominal current, can lead to overstepping the 100 µT exposure limit. The junction area is therefore often subject to accurate assessments of levels of magnetic induction and subsequent shielding, since the 100 µT limit associated with short-term effects must be satisfied at all times even in places where there is only temporary human presence (ICNIRP).
MAGIC 1.0 allows the user to easily assess the magnetic joint areas through a preset parametric 3D model. There is no need to construct the geometry of the system, instead a simple setting of the values of the design parameters is all that is needed.





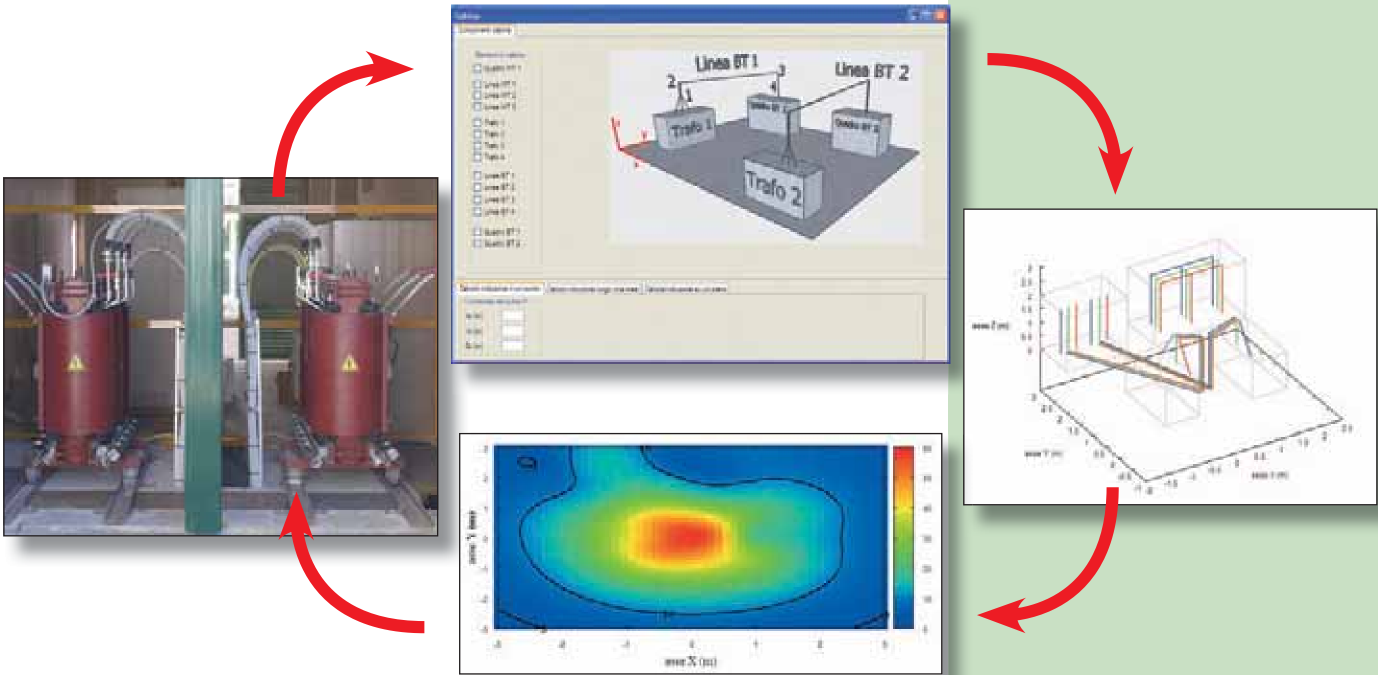
# CALCULATING THE IMPACT OF MAGNETIC FIELDS ON THE ENVIRONMENT

## Electrical substations

The need to evaluate the impact of magnetic secondary substations (e.g. MV/LV) is felt in a discrete number of cases. Some countries are under obligation to achieve the quality target (3 μT), but in others, such as Switzerland, the required limits are even lower (1 μT). It is estimated that about 1% of electrical substations, mainly in civilian environments, require mitigating action in order to bring down levels of induction to those required. As the number of power substations is estimated at several million units in Europe, the magnitude of the problem can be immediately envisaged.
The main components of a secondary substations, which have different levels of magnetic impact on the environment, are: the MV cables coming into the substation, the MV and LV connections between the transformer and the respective MV and LV panels, the MV and LV panels and the MV/LV transformer.
The connections between LV panels and cast resin transformer terminals appear to be especially crucial.

MAGIC 1.0 enables the study of electrical substations with up to four transformers, and takes into account different aspects of design and installation:

a) Choice of resin or oil transformer: in the case of a resin transformer the contribution of the scattered fields from the windings is considered in the calculation.
b) MV and LV lines and connections.
c) MV gearbox with power transformers and in-out.
d) BT gearbox connections.



## INSTALLATION EXAMPLES








# NOTE

# SATI ITALIA CODEX INDEX

# THE ACTIVITIES OF THE SATI ITALIA

sati italia s.p.a.
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

Sati Italia S.p.A. - Sede di SIZIANO (PV)

sati italia s.p.a.
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

Sati Italia S.p.A. - Branch of PADUA

sati italia s.p.a.
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

Sati Italia S.p.A. - Branch of LATINA

PROCAN S.r.l.

Unit of production - LATINA

NOBEX®
FASTENING PROFESSIONALS

Unit of production - SIZIANO

sati tunisia s.a.r.l.

Unit of production - Tunisia

s.s.t. s.a.r.l.
sati solar tunisia

Unit of production - Tunisia

# OTHER ACTIVITIES OF THE CARPANETO SATI GROUP

CARPANETO & C. S.P.A.
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

Carpaneto & C. S.p.A. (Headquarter)
Seat of RIVOLI CASCINE VICA (TO)

Wi-NEXT
EVERYTHING CAN BE PART OF A NETWORK

Wi-Next S.r.l.
Seat of RIVOLI CASCINE VICA (TO)

WIT

WIT S.A. - Saint Laur ent du V ar Cedex France
Remote management and technical installations

NoField S.r.l.

NoField S.r.l.
Seat of TURIN

GRUPPO Carpaneto Sati
PRODOTTI & SERVIZI PER IL MONDO ELETTRICO

Gruppo Carpaneto Sati
Middle East Representative Office - Cairo - Egypt

# NOTE

PRODOTTI & SERVIZI PER IL MONDO ELETTRICO

# SCHEDA VISITA SCHERMATURA ELETTROMAGNETICA

**Ragione Sociale:** ______________________

**Indirizzo:** ______________________

**C.A.P.:** __________ **Città:** __________ **Provincia:** __________

**Tel.:** __________ **Cell.:** __________ **Fax:** __________

**Contatti:** __________ **E-Mail:** __________

**Contatti:** __________ **E-Mail:** __________

**Categoria:**

| | |
|---|---|
| **S**tudio **T**ecnico | **I**nstallatore |
| **U**tilizzatore | **C**ostruttore |
| **V**arie | |

**Dipendenti Nr.:** __________

**Settore Attività:** __________

**Sito Web:** __________

| Prodotti Sati Italia | |
|---|---|
| Piastre piane | ☐ |
| Canali schermanti | ☐ |
| Prodotti di schermatura a disegno | ☐ |

| Prodotti e Servizi NoField | |
|---|---|
| Software Magic | ☐ |
| Valutazione impatto ambientale | ☐ |
| Consulenza per soluzioni di schermatura magnetica | ☐ |

**NOTE:**

| REGIONE | | Intervistatore | | DATA | |
|---|---|---|---|---|---|



☐ Acconsento ☐ Non acconsento



Data: ............................ Per accettazione ............................

# NOTE

NoField S.r.l.

# MODULO D'ORDINE SOFTWARE MAGIC

**Rag. Sociale:**______________________ **Legale Rap:** ______________________

**Comune:**______________________ **Indirizzo:**______________________

**CAP:**______________________ **PROV:**______________________

**Tel:** ______________________ **Fax:**______________________

**Sito web:** ______________________ **e-mail:**______________________

**Partita IVA:** ______________________ **Attività:**______________________

Il Software MAGIC è venduto con licenza a tempo mediante un contratto annuale, triennale o quinquennale. Il contratto triennale e quinquennale consente all'Utilizzatore di usufruire degli aggiornamenti annuali senza costi addizionali ed un canone annuale a prezzo "congelato" alla stipula del contratto. Il prezzo sotto riportato (valido per l'anno in corso) si riferisce alla singola licenza e per ogni anno di durata del contratto. La singola licenza è utilizzabile su di un singolo apparato. Nel caso di licenze addizionali il prezzo varia secondo la Tabella Prezzi sotto riportata. Per tutte le altri condizioni di acquisto riferirsi alle "Condizioni Generali che regolano la licenza d'uso del Programma".
Il canone annuale include inoltre:

- la partecipazione gratuita ad un User Group Meeting all'anno della durata di un giorno
- 2 Newsletter riservate con informazioni utili ed aggiornamenti tecnico-scientifici in tema di campi magnetici e di sistemi di mitigazione

**Tabella Prezzi MAGIC 2011: selezionare la richiesta**

| Durata del contratto di uso della licenza | Prezzo (€/anno a licenza) (IVA esclusa) | | |
|---|---|---|---|
| | Prima licenza | Seconda licenza | Terza licenza |
| 1 anno | ☐ 800 | ☐ 700 | ☐ 650 |
| 3 anni | ☐ 600 | ☐ 500 | ☐ 450 |
| 5 anni | ☐ 500 | ☐ 400 | ☐ 350 |

Oltre la terza licenza viene effettuato uno sconto di 50 €/anno (+ IVA) a licenza addizionale (fino ad un massimo di 6 licenze).
Sconto del 10% se la richiesta d'ordine avviene entro 10 gg dalla presentazione al workshop (la cui partecipazione è soggetta a verifica)

---

**INVIARE IL PRESENTE MODULO D'ORDINE COMPILATO IN OGNI SUA PARTE VIA FAX ALLO 011 0905126 O VIA EMAIL A MAGIC@NOFIELD.IT**

***INDICARE IL NOME DELLA PERSONA CON CUI HA AVUTO IL CONTATTO*** ------------------------------------

*Timbro Società*

------------------------------------------
**Cognome Nome (Legale Rap.)**

------------------------------------------ **Luogo e data**

------------------------------------------ **Firma**

Il/La sottoscritto/a, acquisite le informazioni fornite dal titolare del trattamento ai sensi dell'art. 13 del D.lgs. n. 196/2003, e consapevole, in particolare, che il trattamento riguarderà i dati "sensibili" di cui all'art.4 comma 1 lett. D, presta il suo consenso per il trattamento dei dati necessari allo svolgimento delle operazioni indicate nell'informativa.

Firma.................................................................

NoField s.r.l. • P.I. 10105760010
Sede: Incubatore di Imprese del Politecnico di Torino I3P • Corso Castelfidardo 30/A – 10129 Torino
Tel. +39 011 0905124 Fax: +39 011 0905126 • info@nofield.it • www.nofield.it

# NOTE

sati italia s.p.a.
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

Via Ferrero, 10 - 10098 Rivoli Cascine Vica (TO) - Italy
Tel.: +39.011.95.90.111 - Fax: +39.011.95.90.200
**www.sati.it**

GRUPPO Carpaneto Sati
PRODUCTS & SERVICES FOR THE ELECTRIC WORLD

9130073 - 5 - 2011 - GB