# SensFloor Care Installation Manual

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# 1 Introduction

The SensFloor system determines the position of people by measuring the change of capacitance brought about by their feet/body moving across the floor covering. As no mechanical pressure is involved, the system works likewise underneath hard and soft floor coverings such as parquet, laminate, vinyl, carpet, ceramic tiles etc. However, materials which themselves have a high influence on the electrical characteristics may not be used on top of the underlay. Therefore, only tested and certified floor constructions and materials are allowed. As the installation requires profound knowledge in the field of floor construction and electronics, the SensFloor system may only be installed by the manufacturer or personnel trained and accredited by Future-Shape.

The document on hand is intended for planners, project engineers and installers who want to set up a SensFloor system at a customer's site. After describing the required components and their amounts depending on the customer's ground plan, the necessary preparations and prerequisites are explained. Various options for the layer construction of the floor depending on the intended final floor covering are presented. The reader learns how to lay out the SensFloor patches and how to connect them. Wiring diagrams explain the options for powering the underlay and the room terminal. We describe how to integrate the room terminal into an existing home automation- or nurse call system.

The post installation procedures such as the mapping of the sensor fields and the configuration of the alarm events is explained in the separate manual **"SE10 Room Terminal".**

The optional installation of a ward terminal, its configuration and operation is described in the separate manual **"Ward Terminal**".

The document closes with a list of operating instructions, frequently asked questions and troubleshooting advice.

This documentation assumes that all required components have been purchased from Future-Shape (see section "Request for Quotation" below). For the actual installation, the points mentioned in the next section must have been clarified with the customer and the necessary preparations must have been completed before the installation.

## 1.1 Electronic project directory

When a new project is started, a so-called electronic project directory should be created. During the project, this directory should be filled with the following documents which are either received from the customer or generated by you:

- Communication with customer
- Tender documents
- Contracts
- Floor plans, pictures from the construction site
- Requests, offers, orders, order confirmations, packing lists, invoices
- Data sheets of third-party products
- Minutes of meetings
- Calculations, schedules
- Checklists
- SensFloor layout and parameters
- Photos of the progress of the SensFloor installation
- Documentation of deficiencies
- Copies of all the documents that are handed over to the customer at acceptance.

The following description of a typical SensFloor installation assumes that at the time of installation, all required components have been purchased from Future-Shape (refer to the section "Request for Offer"). Before the installation, all items mentioned in the next section must have been clarified with the customer and the required preparations must have been performed and terminated.

## 2 General Preparation

Before the SensFloor underlay can be installed, a number of preliminary works have to be carried out. In the following, we briefly describe the required steps. **Please do also refer to the document "Preliminaries by the customer" available from Future-Shape**. That document has to be signed by the customer in order to guarantee that all necessary preparations have been understood and will be finished before the installation of the underlay begins. **In particular the heights of the subflooring in relation to different floor constructions must be clarified in time!**

**Ground plan:**

The customer has provided ground plans for all rooms that are to be equipped with SensFloor. For these plans, an appropriate layout of SensFloor patches has been selected as described in the section "Patches" below.

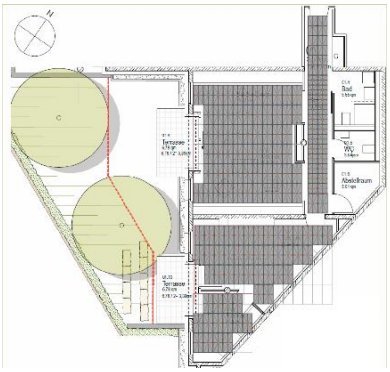


Fig. 1: Ground plan with SensFloor layout (example)

**Floor covering:**

The customer has decided for a floor covering which has been tested for its compatibility with the SensFloor measurement principle. A list of floor coverings that have been used in SensFloor projects is contained in the document "Floor Construction" available from Future-Shape. If in doubt, a 1m²-sized sample can be sent to Future-Shape for testing.

Fig. 2: SensFloor beneath vinyl design covering

**Floor construction:**

**For the selected floor covering an appropriate floor construction has been selected according to the documentation "Floor Construction" available from Future-Shape**. In particular, it has been clarified what loads the floor will have to withstand (e.g. moving hospital beds) and whether the floor covering is lied out floating or glued (**attention: glue must be certified by Future-Shape! Refer to the aforementioned document!**).

Further, the height of the selected floor construction including SensFloor underlay, potentially a stabilizing intermediate layer and the floor covering has been considered when fitting the subfloor (e.g. the screed).

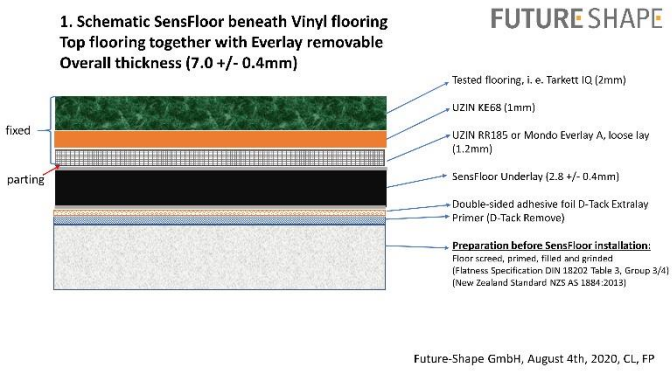



Fig. 3: Schematics of floor construction (example)

**Power connection:**

For every room to be equipped with SensFloor, one of the following two options has been installed for powering the underlay:

Option A A concealed electrical double box (depth 47mm) with existing 230/110VAC supply lines (incl. ground/PE line) and ductwork to the bottom (directly above screed level) is provided for installation of the in-wall power supply (AC/DC adapter) and the 12VDC cable to the underlay (Fig. 4, bottom row).

If a key switch for switching the SensFloor was planned, the double box must be equipped with another ductwork to a single concealed box which will host this key switch (Fig. 4 upper row).

Option B: A DIN rail power supply in the room's electrical installation box is used to power the underlay. This requires 4 free units (ca. 8cm) on the DIN rail and a ductwork equipped with a 2-wire DC cable from the electrical installation box to a single concealed junction box and from there to screed level (Fig. 5 left).

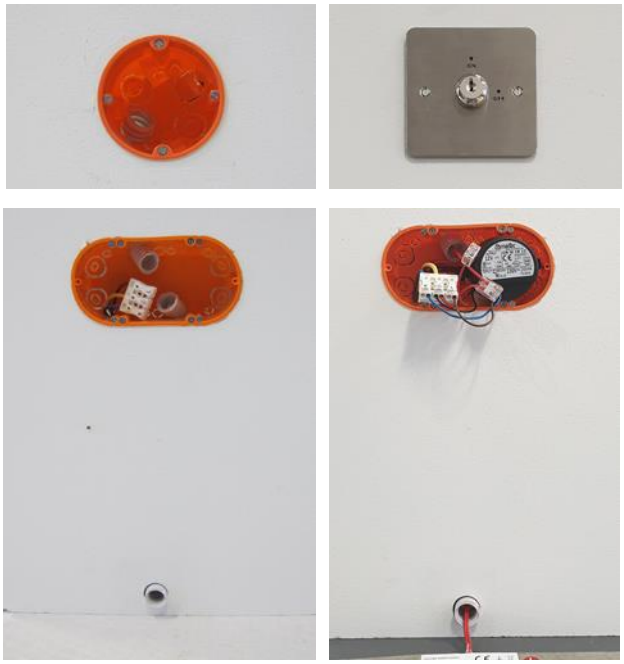


Fig. 4: Option A with key switch.
Empty concealed boxes (left) and finished installation (right)

**Power switch:**

A switch for the power supply of the SensFloor underlay must be installed in order to de-activate the SensFloor if required. There are three options:

Option A: A concealed electrical box (depth 47mm) with space for a key switch is provided in the pathway of the DC power cable from the 12VDC power supply to the underlay (see Fig. 4), or

Option B: For every room, a unipolar switch (0.5 units=1cm) is installed on the DIN rail near the 12VDC DIN rail power supply for the SensFloor underlay. By means of these switches, the SensFloor in each room can be switched separately. In Fig. 5 lower right there are 4 switches.

Option C: The 230/110VAC power supply for the underlay is switched by some existing building automation system.

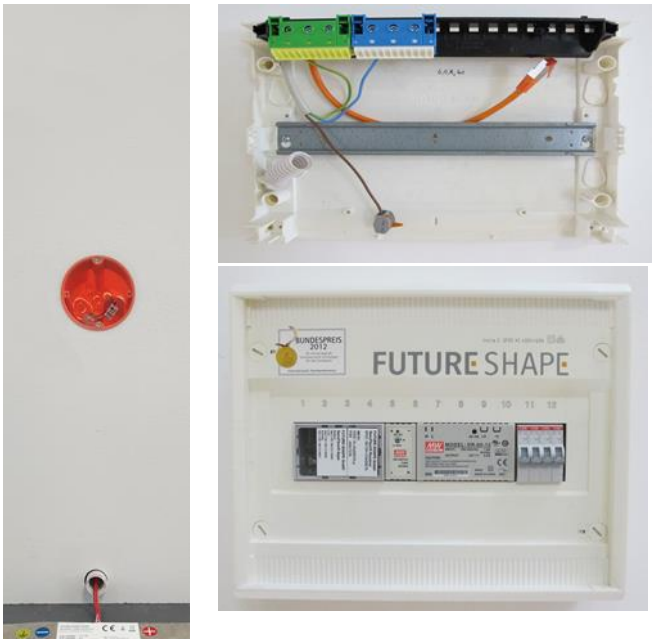



Fig. 5: Option B with junction box (left), SensFloor power supply and unipolar switches in the electrical installation box (right). The ductwork in the installation box leads to the junction box. 230/1120VAC and network cable (orange) must exist in the installation box. On the lower right the finished installation box is shown (example).

**SE10 Room Terminal (Receiver):**

As the SensFloor underlay sends out its sensor information wirelessly, a SensFloor receiver SE10 must be installed in a distance <=15m from the most distant part of the underlay. For this, at least 6 free units (12cm), a 230/110VAC power supply cable and an RJ45 LAN connection must be available on the DIN rail in the room's electrical installation box (Fig. 5 upper right) The picture on the right shows an SE10 with power supply on the DIN rail in the connection box. The black screw terminals supply 8 potential-free ("dry") relays (see below).


Fig. 6: Room terminal SE10 with power supply

**Connection to Building Automation or Nurse Call Systems:**

If lamps or other devices shall be controlled directly by the SE10, one unit (ca 2mc) per device must be free for an AC relay on the DIN rail.

For connecting to a building automation system (e.g. KNX), a BUS controller with one binary input per desired function must be available on the DIN rail. Fig. 7 shows a KNX BUS controller with binary inputs.

For connection to a nurse call system, one potential-free ("dry") input per desired function (e.g. fall detection, presence alarm,..) must be available in the electrical installation box of the room.

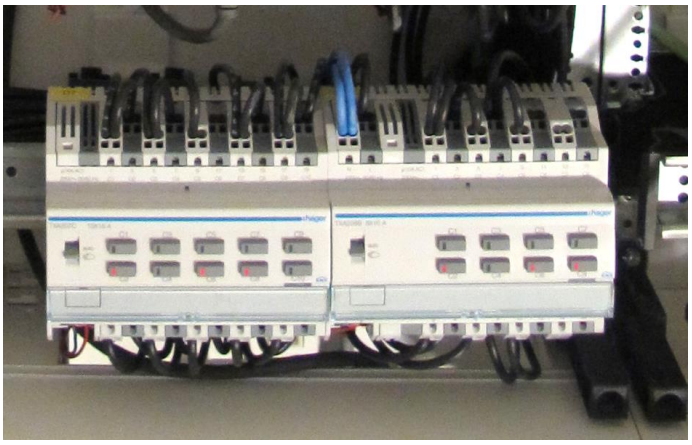


Fig. 7: KNX BUS controller with binary inputs (example).

**Connecting to a SensFloor Care Ward Terminal:**

If the installation of a ward terminal is intended, two 230/110VAC outlets and an RJ45 LAN connection with access to the TCP/IP network of the room terminals must be available at the planned location. If later remote maintenance is desired, the network must have connection to the internet.


Fig. 8: Ward terminal

Further information is contained in the manuals for the SE10 room terminal and for the ward terminal, which are available from Future-Shape.

# 3 Prerequisites for the Installation of the Underlay

The SensFloor underlay is attached to the sub flooring by means of double-sided adhesive foil. This can be either Sigan® 1 from the company UZIN (www.uzin.com) or Extra-Lay® from the company D-Tack (www.d-tack.de). According to the data sheets available on the websites, these foils require a flat surface that needs to be prepared. It is mandatory that the installers adhere to the data sheets of all products mentioned below. Please refer also to the **"Checklist for the required preparations by the customer"** which is available from Future-Shape.

Fig. 9: levelled and sanded screed

The surface must be sound, flat permanently dry, clean and free of cracks or materials that could impair adhesion. For screed, this is achieved by levelling and grinding.

According to DIN18202 line 3, column 3, a roughness below 4mm on 1m length is mandatory.

The CM value (moisture) must be <1.8% or <2% (with or without floor heating, respectively) for cement screeds and <0.5% or <0.3% for anhydrite or calcium sulphate floating screeds.

**No moisture shall ever enter the screed from below or from the walls!**

The floor temperature during installation must be >=15°C

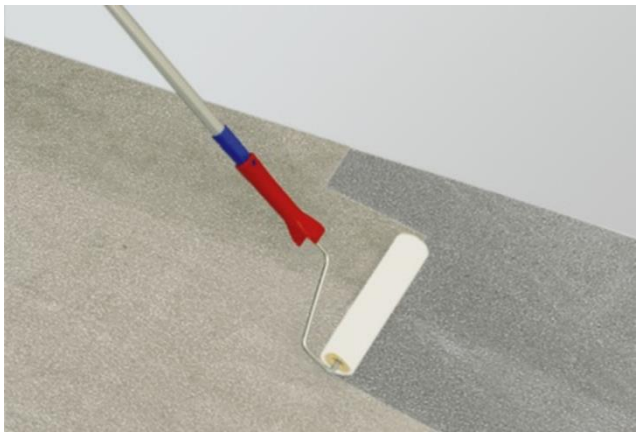


Fig. 10: Precoating with film former

Both adhesive foils require the application of a film-forming pre-coating (UZIN *Planus* or D-Tack *Remove*).

The containers must warm up to room temperature and be shake well before use.

The liquid is applied crosswise with a fine-pore foam roller evenly and thinly. Bubbles, drops or grooves must be avoided.

Equipment is cleaned with water and the surface must dry out for 1-12 hours depending on climatic conditions.

After drying, the surface must show a thin film.

Fig. 11: Installation of the double-sided adhesive foil

For applying the double-sided adhesive foil, the corresponding manuals must be adhered to.

For Sigan 1, first a 50mm wide stripe along the walls and doors must be installed a) to even out uneven walls, b) for increased adhesion in the edge areas, c) for gluing areas that are difficult to access.

The protective paper must still remain attached!

The tape must not be overlapped but mounted edge to edge or cut back to a butt-joint where overlapping.

Then the wider roll (Sigan = 75cm, D-Tack= 1m) must be installed according to the manufacturer's manual.

The roll must be installed in the running or working direction of the new floor covering – with a slight pressure on the roll – preferably rolled out overlapping, rubbed down well and then cut back to the joint using a trapezoid knife, or rolled out edge to edge directly (max. 3 mm gap allowed, no overlapping). The subfloor must not be damaged.

Sigan 1 may overlap Sigan 1 tape but must be cut back to fit edge to edge. The last run of the foil must start from the wall and the resulting overlap must be cut back to fit edge-to-edge using a trapezoid knife. The substrate must not be damaged while doing this.

**Only the same amount of double-sided adhesive foil should be rolled out as the amount of floor covering that will be installed on the same day!**

# 4 Procedure for Installing and Testing the Underlay

The SensFloor underlay is delivered in the form of **patches** (see below). After the double-sided adhesive foil has been installed with the protective paper still attached, the following steps must be performed to install the underlay.

- The patches must be arranged on the floor according to the prepared plan.
- The patches are fixed on the floor one by one
- The patches are interconnected electrically
- Power lines, power connection and AC/DC adapter are installed
- The room terminal is installed, connected to home automation/nurse call system and configured
- The SensFloor is mapped and tested
- Height levelling material is installed
- Intermediate layers are installed (e.g. PE foil, stabilizing layer or wooden underfloor system) according to the selected floor construction
- The floor covering is installed
- If required, the ward terminal is installed, connected to the room terminals or home automation, and configured
- The complete system is tested and handed over to the customer

In the following, these steps are described in detail. **Note: During installation, protective overshoes must be worn to prevent damage of the underlay!**

## 4.1 Patches

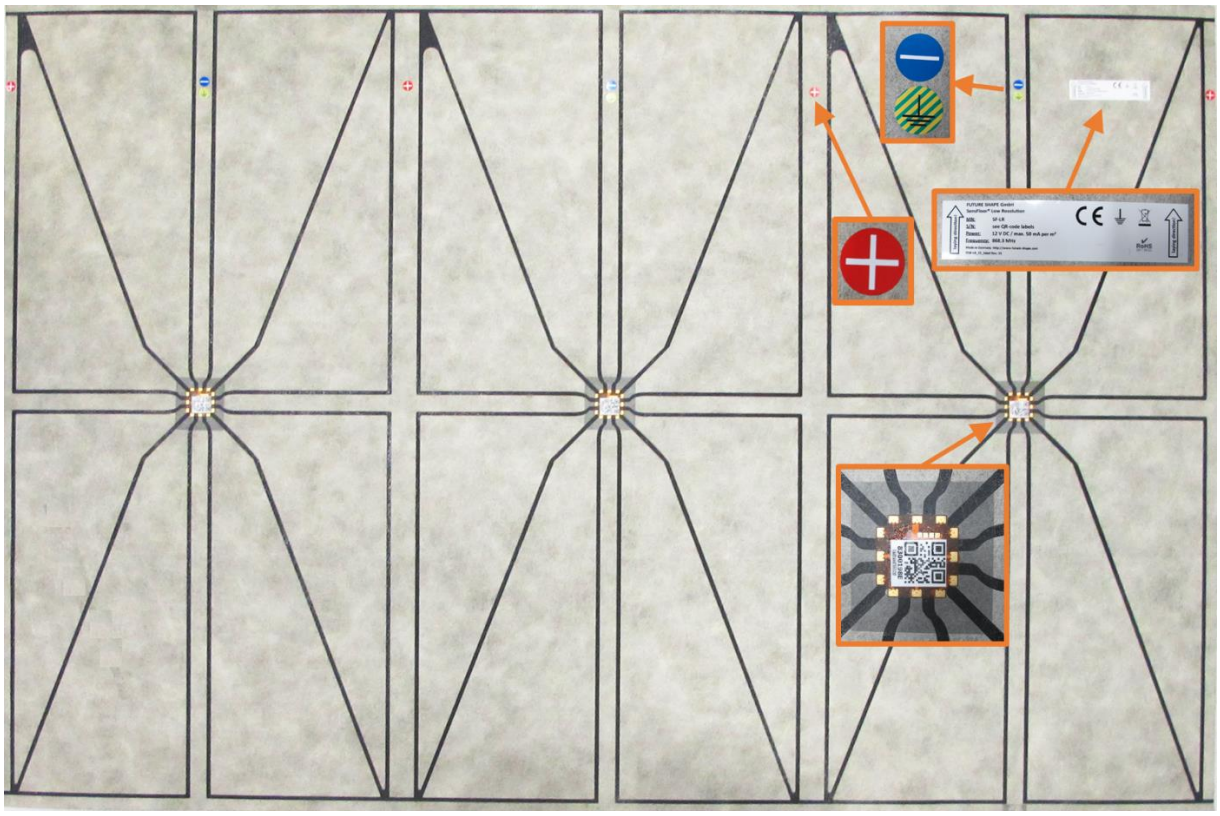


Fig. 12: Standard patch in low resolution LR Type A, portrait orientation.

The SensFloor underlay is delivered in patches (see Fig. 12). The picture shows a standard-patch with three electronics modules (squares with QR code label) each of which measures 8 sensor fields (grey triangles). The patches are laid out side by side such that the floor of a complete room becomes a continuous sensor area. The QR codes and labels must be on the upper side while the aluminium, foil points towards the floor. The label on the upper right contains technical details and indicates the laying direction. It is important that the arrows on the labels of all patches in a room point into the same direction. Another hint for knowing the correct orientation of the patches is given by the special form of the left upper sensor field the corner of which is slightly rounded. In all patches this field must be in the same position.

The sensor data is transmitted wirelessly: yellow labels indicate a radio frequency of 920MHz (USA, Canada, Australia) while white labels indicate 868MHz (Europe).

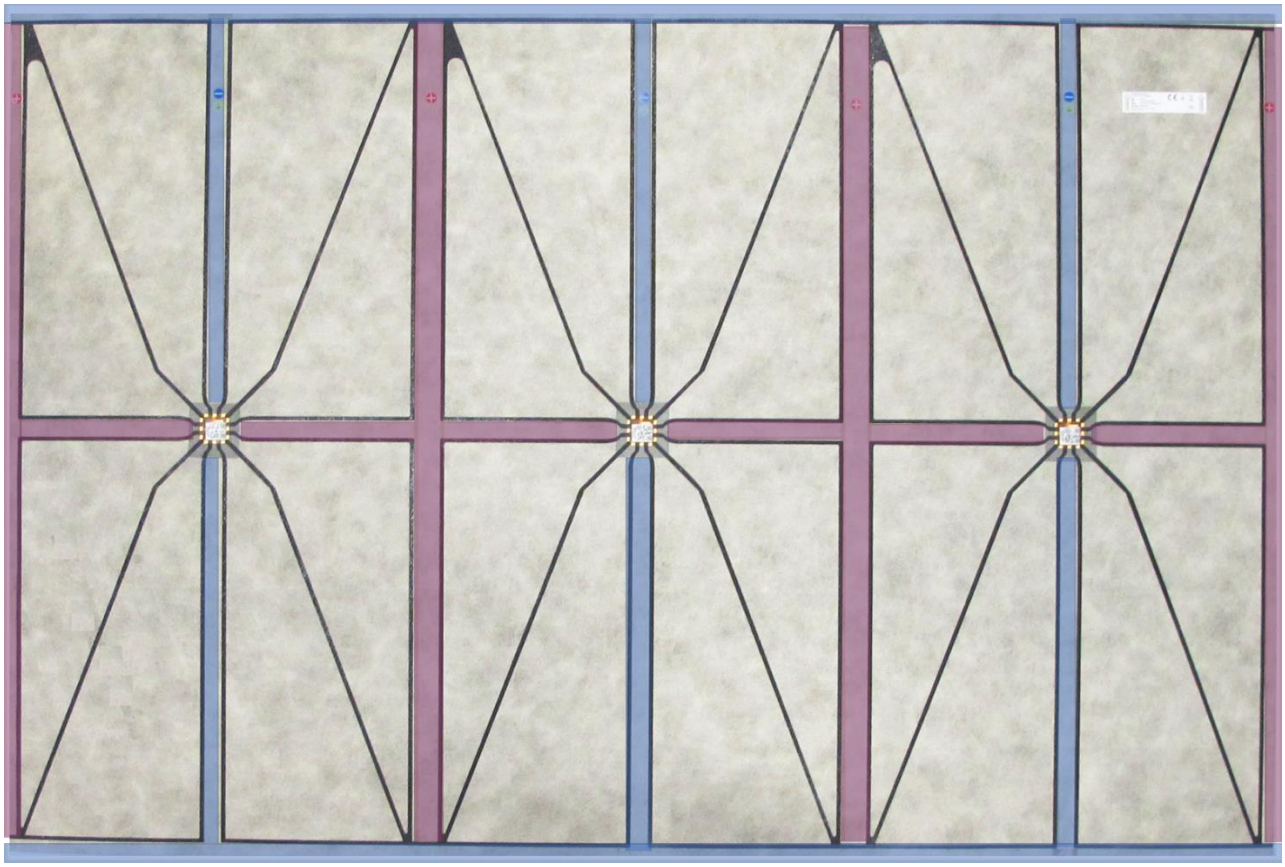


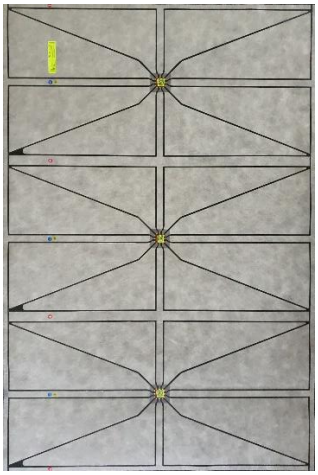
Fig. 13: Schematics of plus- (red) and minus- (blue) power lines in the patches.

DC power is provided to the electronics modules redundantly from two opposing sides by means of conductive textile areas and an AC/DC adapter connected to a corner. *Plus* areas (highlighted in red in Fig. 13) and *minus/ground* areas (highlighted in blue) are marked by stickers (see Fig. 12).

When placing patches side by side, care must be taken that no short circuit is produced, i.e. *plus* areas should never touch *minus* areas. The aluminium foil on the back of the patches is electrically connected to *minus/ground* and must always face down to the floor.

## 4.2 Variants of the Patches

SensFloor is available in two spatial resolutions: LR=low resolution with 16 and HR=high resolution with 32 sensor fields per m². Various sizes of patches are available so that arbitrary ground plans can be equipped:



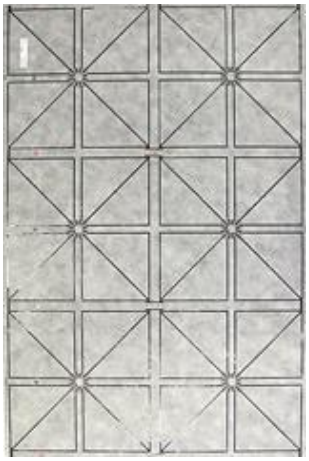
**LR Type A:**

**1m x 1.5m = 1.5m²**

**3 sensor modules**

**24 sensor fields**

**This is the standard size patch**

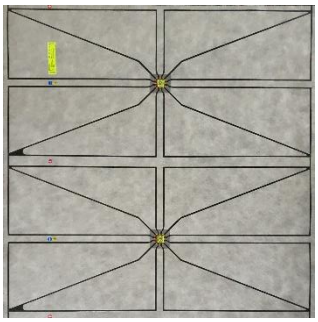


**HR Type A:**

**1m x 1.5m = 1.5m²**

**6 sensor modules**

**48 sensor fields**



**LR Type B:**

**1m x 1m = 1m²**

**2 sensor modules**

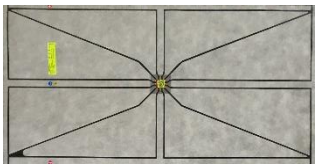
**16 sensor fields**

**HR Type B:**

**1m x 1m = 1m²**

**4 sensor modules**

**32 sensor fields**

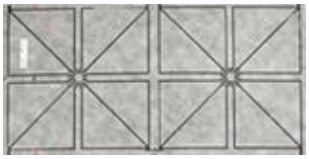


**LR Type C:**

**1m x 0.5m = 0.5m²**

**1 sensor module**

**8 sensor fields**

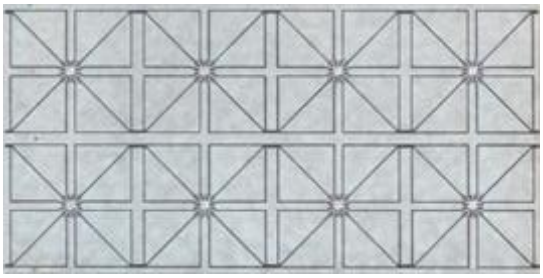


**HR Type C:**

**1m x 0.5m = 0.5m²**

**2 sensor modules**

**16 sensor fields**



**GR Type Standard**

**0.76m x 1.52m = 1.16m²**

**8 sensor modules**

**64 sensor fields**

Fig. 14: Variants of SensFloor patches

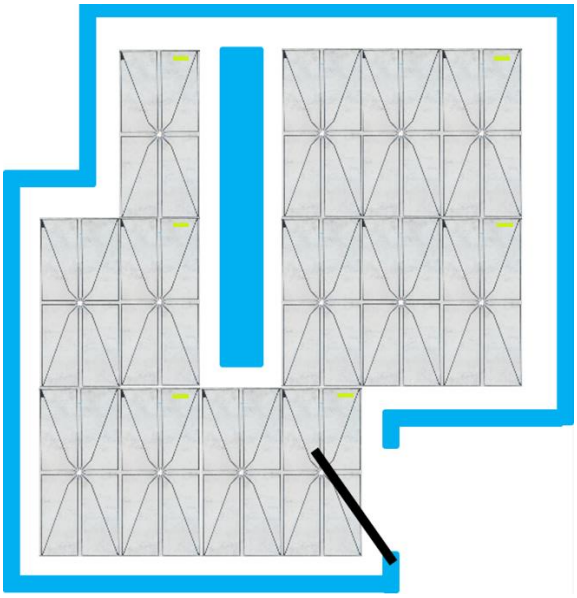


Fig. 15: Sample ground plan with SensFloor patches

When planning a SensFloor installation each room of a ground plan should be filled with patches such that a distance of 10 to 20 cm to the walls is kept. Fixed assemblies can be spared out (blue area in Fig. 15) but not any movable objects (e.g. beds). As a rule of thumb, in a typical SensFloor installation, 2/3 of the actual floor area are covered with the SensFloor underlay.

In Fug. 15 two patches of type A, three of type B and one of type C were used. In the image all patches are laid in the same orientation, indicated by the labels and the rounded corners of the left upper sensor fields. All arrows, which indicate the laying direction, point into the same direction.


Fig. 16: Label with technical information (920MHz-version) and indication of the laying direction.

It is possible to cut away parts of the sensor fields if necessary, however this must be done carefully to prevent short circuits. It may be necessary, to cut back the aluminium foil on the backside (GND). Refer to the document “Cutting Patches”. If cutting results in a patch without label, the rounded corner of the left upper sensor field may serve as hint for the correct orientation.

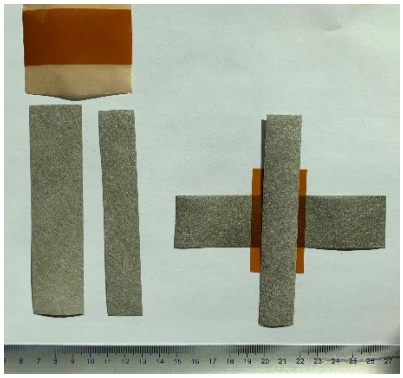
The example in Fig. 15 comprises 6 patches (LR Type A,B,C). When ordering SensFloor patches, the number of required patches of each type should be indicated in the form “Request for a Quotation” (see further below).

## 4.3 Attaching the Patches on the Floor

When the arrangement of the patches on the floor is finished, they are attached to the floor one by one as follows:

- the protective paper of the double-sided adhesive foil is carefully cut around each patch by holding the blade upwards in order not to cut the foil itself.
- one edge of the patch is lifted while holding the other edge down on the floor so that it cannot move horizontally during this process. Two persons best do this.
- a stripe of about 20cm width of the protective paper is folded back under the patch
- the lifted edge of the patch is laid back down onto the adhesive stripe, now the patch cannot move horizontally anymore
- the other edge of the patch is lifted and the rest of the protective paper is teared away
- the complete patch is pressed down to the floor so that it sticks firmly to the adhesive foil

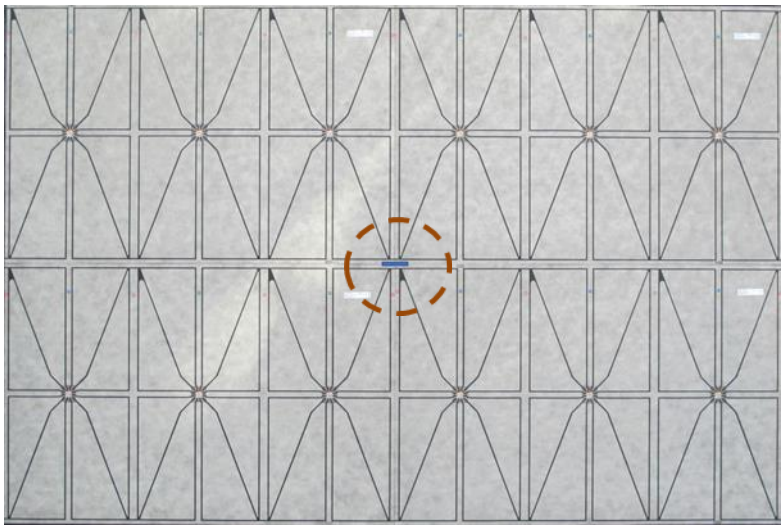
## 4.4 Connecting Patches



Patches that are installed side by side must be connected electrically to ensure that power is provided to every sensor module. This is achieved by so-called **connection stripes** that are made of conductive textile (light grey) with a thermoplastic adhesive on the back (dark grey). The 12cm long stripes are available in two widths (2cm and 3cm).

At the edges between the patches where the *plus* and *minus* lines meet, a crossing can be realized without short circuit by putting isolating adhesive stripes made of 4x6cm **Kapton®** material (brown stripes) between the connection stripes.

Fig. 17: Connection- and Kapton stripes

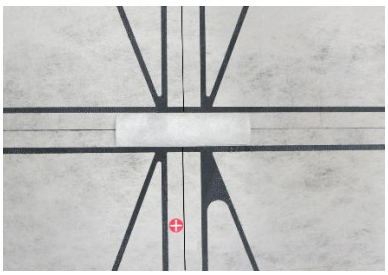


The placement of the connection stripes is described for the example of four type A standard patches: The patches must be aligned accurately to avoid short circuits at the edges.

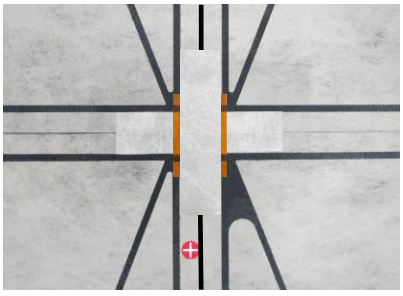
At first, the *minus* lines must be connected by means of the 3cm wide connection stripes (placement indicated in blue).

The working area shown in the following pictures is indicated by a brown circle in Fig. 18.

Fig. 18: Electrical connection of the patches

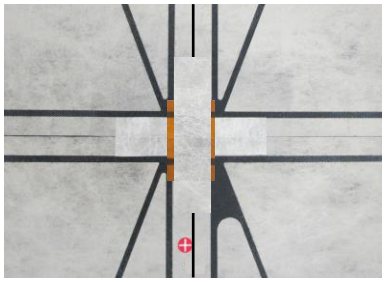


After a stripe is placed on the junction between two patches with the light grey side facing upwards, the adhesive is activated by means of a **thermode** (145°C, no steam!) that is pressed down for 10 seconds. **Silicone paper** must be used to avoid contamination of the thermode's metal.



The lines are safely connected mechanically and electrically when the connection stripe has acquired a slightly darker shade of grey.

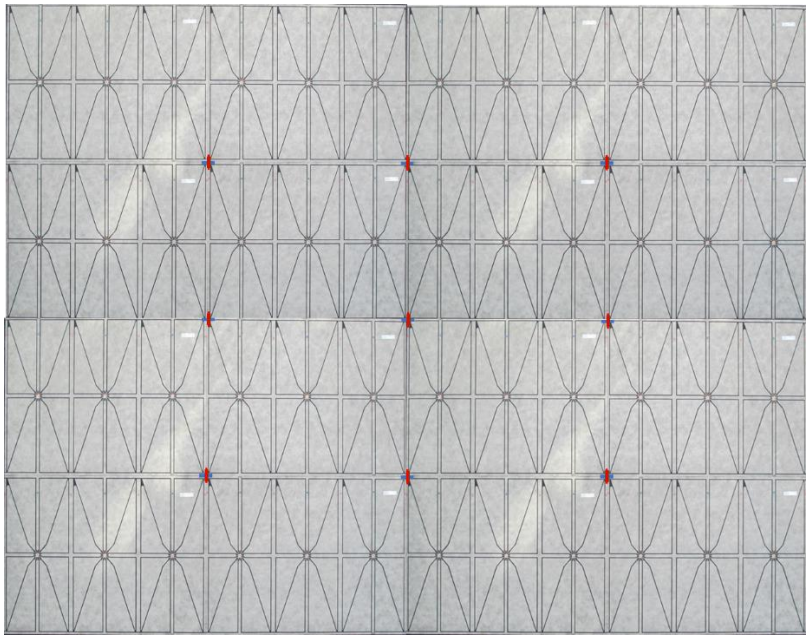
To connect the *plus* lines, the *minus* line must be crossed, so for isolation a self-adhesive Kapton stripe is attached as indicated.



A 3cm wide connection stripe is arranged carefully on the Kapton in order not to make contact to the *minus* line.

After another ironing process, the *plus* lines are connected as well.

Fig. 19: working steps to produce an electrical cross connection



In Fig. 20 a sample of a large-area installation with 24m² underlay is shown. On average only one cross connection per patch is required to connect all plus and minus lines. The special sensor pattern ensures that multiple redundant electrical pathways are present within the complete underlay so that even the breakdown of one connection does not result in a malfunction of the whole system.

When being placed in a regular grid, only two connection stripes of 3cm width and one Kapton stripe are required per standard patch.

Fig. 20: Required cross connections in a large-area installation

## 4.5 Power Connection

The electronic modules in the SensFloor underlay are powered through the grid of plus and minus areas. To ensure that power is distributed with low resistance safely to all ranks and columns of this grid, a frame of so-called **power spines** must be installed around the area. The power spines are 10cm wide and consist of the same materials as the SensFloor. The top side is equipped with conductive textile (grey) with an isolating margin of 1cm width. The power spines are provided on reels and can be cut to the desired length by means of a (hooked) knife.

Fig. 21: Power spine

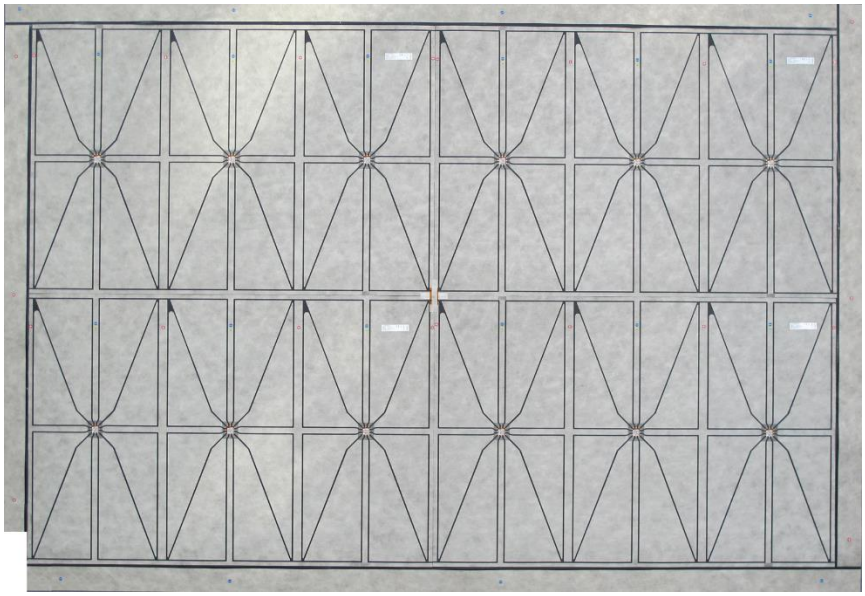


Fig. 22: Arrangement of the power spines

By arranging the black margin towards the edge of the SensFloor the area is framed with the power spines.

At the corner where the power will be connected, some space is left out for the power pad (see below).

The power spines are attached to the floor in the same way as the patches by removing a stripe of the protective paper of the double sided adhesive foil first while pressing the rest of the stripe to the floor to keep it immobile. After gluing the first part to the adhesive stripe, the rest of the protective paper is removed, and the power spine is pressed completely to the floor.

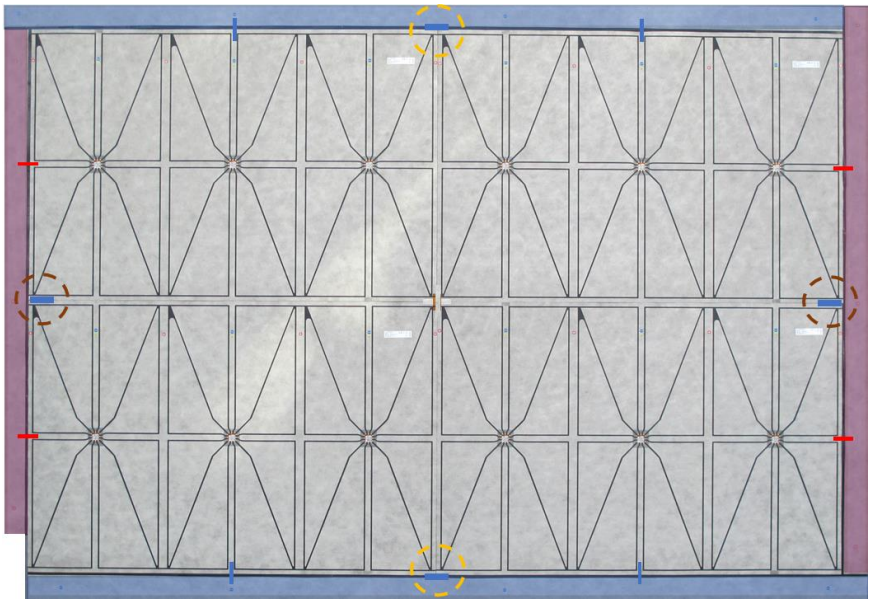


Fig. 23 Attaching the conductive stripes at the borders

The *minus* areas of the patches at the border must be connected to the *minus* power spine (highlighted in blue) and the *plus* areas of the patches at the border must be connected to the *plus* power spines (highlighted in red) by means of the 2cm wide connection stripes that are glued onto the conductive material by means of the thermode as indicated. For the *plus* lines 1 stripe and for the *minus* lines 2 stripes per meter are required.

As no cross-connections can be attached at the borders of the patches, the 3cm wide stripes must be attached instead as indicated in the brown and yellow circles in Fig. 23.

The SensFloor is powered by means of pre-assembled so-called **power pads**. From two different versions that one must be selected that fits to the position of the power outlet with respect to the arrangement of the *plus* and *minus* power spines. For the arrangement in the pictures, the power pad on top is the right one as the *minus* spine is horizontal while the *plus* spine is vertical. The power pads are attached to the floor in the same way as the power spines.

The power pads are equipped with larger connection stripes that must be ironed to the power spines once the pad is correctly arranged at the corner. During this process, particular attention must be paid not to produce a short circuit by overlapping *plus* and *minus* areas. **At this point, the power supply should not yet be connected to mains, as the complete system needs to be tested for short circuits before (see next chapter)!**

Fig. 24 Connection pad

The red cable must be connected to plus 12VDC of the power supply and the black/red cable to 0V of the power supply and simultaneously to ground. The ground connection provides a reference and shielding and is therefore essential for the correct function of the capacitive sensors. As the allowed current through the power pad is <=3A, a maximum of 120 sensor modules can be powered by a single power pad.

Fig. 25: Contacting the power pad

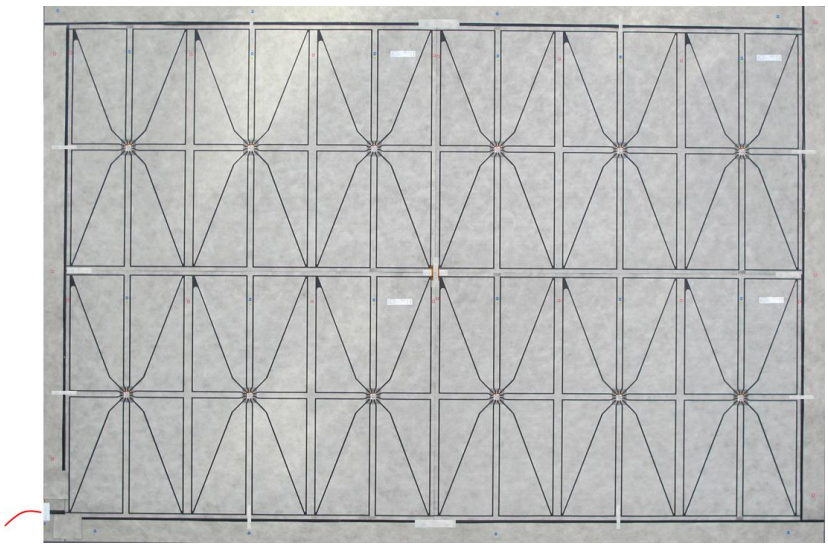


Fig. 26: Completely installed and connected underlay

When later the power pad is connected, power will go from the pad into the spines and from there into the grid of patches. This pathway allows for a power transport with low resistance such that even electronic modules that are located far away from the power source receive a voltage that is high enough for operation. Furthermore, in case that a power line is interrupted for some reason, there are multiple alternative pathways for the power in the grid.

For more cluttered ground plans the frame of power spines may be more complex. However, in any case the installer must ensure that all patches are redundantly connected to the power source.

## 4.6 Powering the underlay

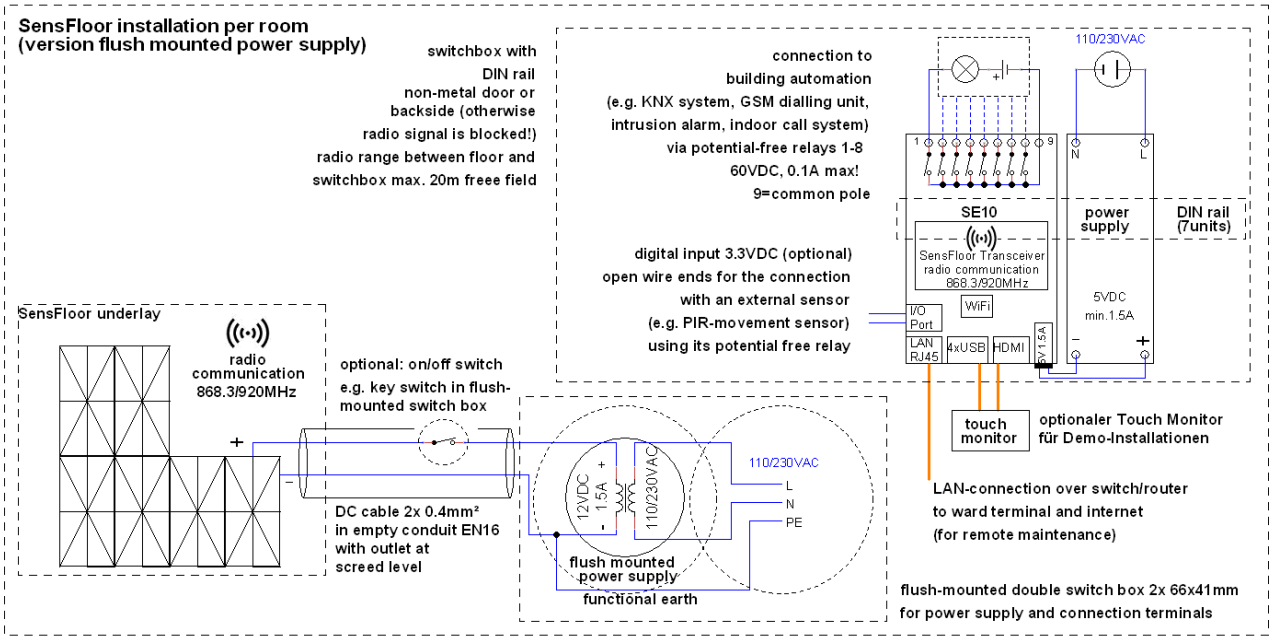



Fig. 27: Electrical wiring diagram. Variant A: Flush mounted power supply

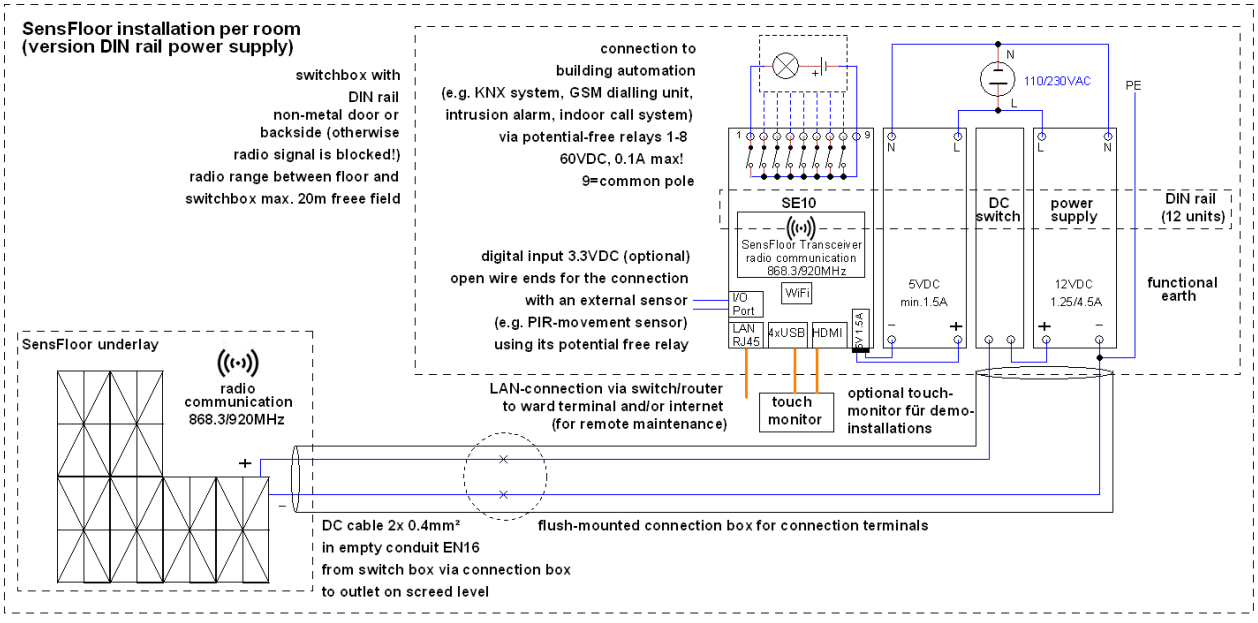



Fig. 29: Electrical wiring diagram. Variant B: Power supply on DIN rail

The figures 27 and 28 show the complete electrical connection for one room in two variants: A with the power supply in a flush mounted concealed box (Fig. 27) and B with the power supply on the DIN rail in the electrical installation box (Fig. 28). Ordinary SensFloor installations require just one SensFloor receiver per apartment. However, every connected SensFloor area (typically every room) requires one flush mounted power supply or one separate DC cable to the installation box.

In the left part of the wiring diagrams, the electrical connection of the underlay is displayed. Before powering the underlay, any objects must be removed from the SensFloor as they might produce a short circuit that can destroy the underlay or the power supply. A multimeter or continuity tester must be used to test for short circuits that might exist due to faulty application of the connection strips. The test is being done by measuring the resistance between plus and minus connection. The underlay is properly installed, if the resistance is in the range of several kilo-ohms or above. In case that a short circuit is measured, all ironed connections must be inspected until the error is found and rectified. Faulty connection stripes can be removed using tweezers by applying a stream of hot air to the strip to melt the adhesive. This must be done very carefully in order not to melt the polyester material of the underlay.

After the underlay has passed the check for a short circuit, it must be connected to the power supply. The maximum current of the power supply must be respected: to calculate the power requirement of the underlay, the number of connected electronics modules must be multiplied by 25mA.

Fig. 29 shows variant A with flush mounted power supply. For a stable capacitance measurement DC *ground* must be connected to earth potential (PE). The connection is done by means of a multiple-way connector (white) *Phase* (brown) and *neutral* (blue) is connected to the power supply. Simultaneously, DC *ground* (black) is connected to the underlay's *ground* (red/black) and to AC *earth* (green/yellow). The connection between the underlay's *plus* and the *plus* of the power supply (both red) is done by means of an ordinary connector (orange/grey).

To switch off the SensFloor (e.g. during floor cleaning) the power supply can be interrupted by means of a fuse. Alternatively, a key- or RFID-switch can be used to interrupt the DC connection between the power supply and the underlay

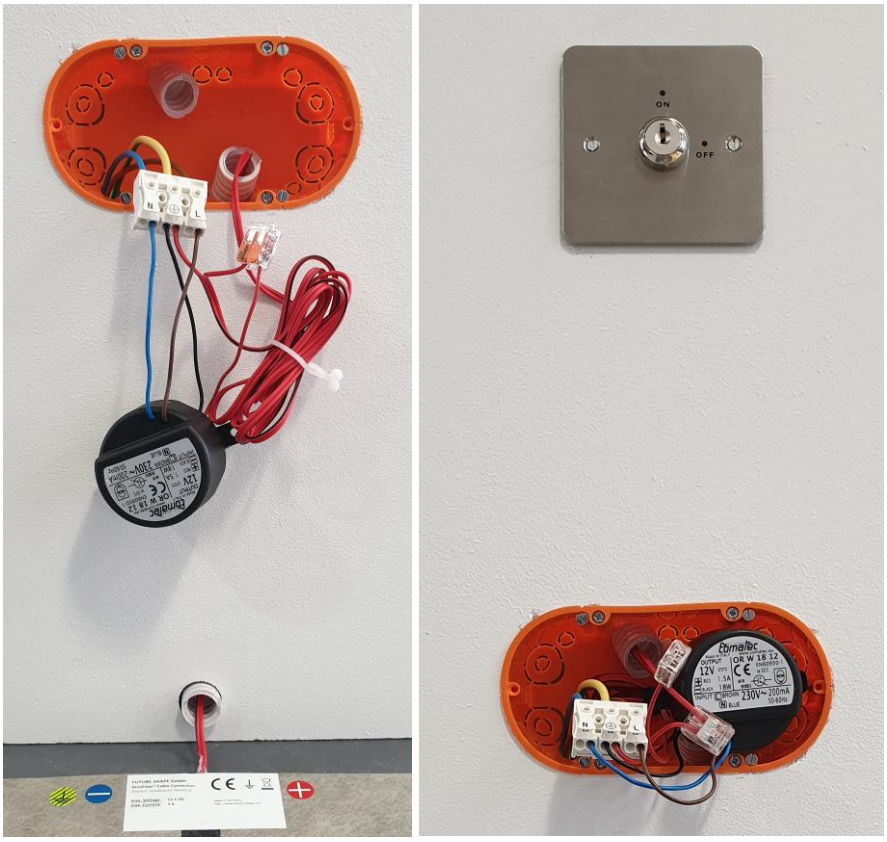



Fig. 29: Connection of the underlay (left) and a key switch (right).

This can be achieved by using a second connector to build the interrupter into the *plus* DC wire (Fig. 29 on the right).

If the underlay is powered by a DIN rail power supply (variant B), the DC cable from the underlay is connected in a flush mounted junction box to a DC cable leading to the electrical installation box (Fig. 5 and 28). There, the *plus* wire of the DC cable is connected to a 1-pole interrupter and then to the power supply. Also, in this variant, AC *earth* must be connected to DC *ground* as being displayed in the wiring diagram (Fig. 28).

On the same DIN-rail, the SE10 room terminal can be mounted as described in the next section.

# 5 Installing the SE10 Room Terminal

The sensor data is sent wirelessly to a receiver in the room's electrical installation box that is called *SE10 room termina*l (see Fig. 30). The SE10 is based on a Raspberry Pi® computer for which a 5VDC power supply is required that is also mounted on the DIN rail. As the radio range is around 15m, the SE10 should not be placed too far away from the SensFloor. Ensure that the radio frequency of the receiver fits to that one of the sensor modules (either 868.3 or 920 MHz, see label).
The SE10 serves for two purposes: a) first time configuration of the SensFloor and b) gateway to nurse call system, home automation or ward-terminal in everyday operation.
For a), the SE10 just requires power. For b), however, the SE10 must be connected to the LAN network using the RJ45 socket or to home-automation/nurse call system using the 8 potential-free relay outputs available as screw terminals on the upper side. As the label indicates, the potential-free relays have one common pole and shall not be loaded with more than 60VDC or 0.1A each.

Fig. 30: SE10 room terminal with 5V power supply.

The relay outputs can be configured as NOC (normally open) or NCC (normally closed contacts) to work just like ordinary push buttons when being used as automatic alarm devices in a nurse-call system. The wiring scheme is described in Fig. 27 and Fig. 28.

If lamps or other appliances should be operated directly by the SE10, additional external relays are required that are controlled by the potential-free relays and can switch higher currents.

Optionally, the SE10 can be equipped with a potential-free *input* that is available as free-wire-end cable fed out of the SE10's compartment. This can be used with potential-free push buttons or key switches e.g. as acknowledgement signal for a nurse reacting to an alarm case or for additional sensor inputs (e.g. from a PIR sensor) that are interpreted by the SensFloor Care software running on the SE10 or the ward terminal (see below).

Once the SE10 is powered, it takes about two minutes to boot up its Linux based operating system, a web server and a Wi-Fi access point. Through the latter, the installer can connect to the device by means of any Wi-Fi-enabled client (mobile phone, tablet, PC or MAC). SSID and password are indicated on the SE10's label.

Once connected, the installer should at first start a web browser on the client and enter the following URL: https://192.168.5.5:9000 (in some cases a certificate-message must be acknowledged). This brings the user to the interface GUI (*Graphical User Interface*) for configuring the freshly installed SensFloor. If the SE10 is already connected to a working LAN, the SE10 can be accessed through this connection too. In this case, the installer must find out the IP address that the SE10 has acquired from the DHCP server and use this one in the URL above.

As the same SE10 receiver is used to initially configure the SensFloor installation of a room and later to analyse and transmit the sensor data of that room, it must be ensured not to interchange SE10s of different rooms. Parts of the configuration require to walk across the freshly installed underlay. During this process, protective overshoes must be used to save the underlay or the sensor modules from damages.

**The initial mapping of the SensFloor underlay and the configuration of its functions is described in the manual "SE10 Room Terminal" available from Future-Shape.**

# 6 Test and documentation of the installation

After the SensFloor has been mapped by means of the configuration GUI (graphical user interface) of the room terminal, it must be tested for correct function. To this end, every sensor field must be activated by stepping on it (overshoes required!). Simultaneously, the sensor activity can be observed on the same client device (e.g. a tablet as in Fig. 31) that has been used for the mapping and the configuration of the SensFloor functions. During this test, sensor fields can be detected that cannot be activated or those that show spontaneous activity without being activated. These locations must be checked for conductive objects, dirt or moisture.

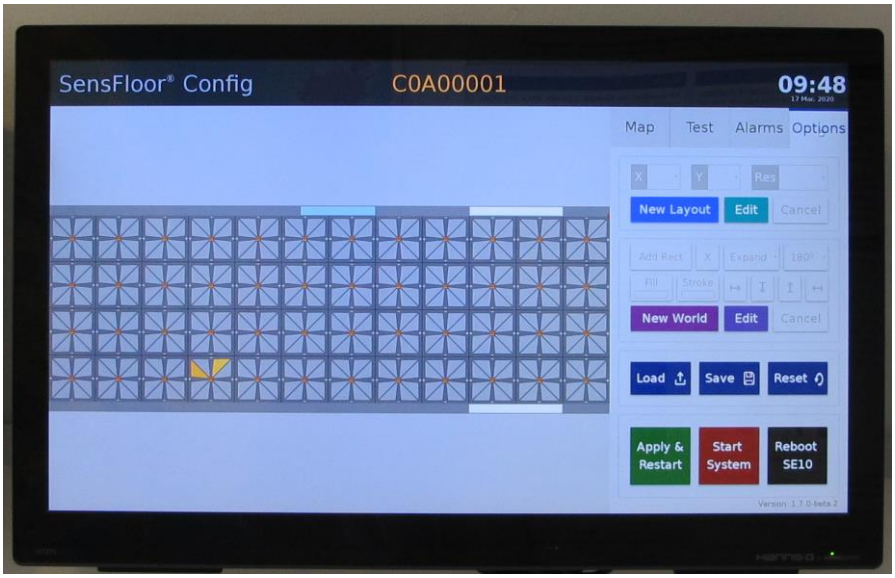



Fig. 31^: Controlling the SensFloor by walking on it

If these malfunctions cannot be rectified by recalibration or adjustment of the sensors' sensitivity, the corresponding patches must be replaced. For replacement, the conductive stripes must be cut, and the patch must be removed. To attach the replacement patch, a new piece of double-sided adhesive foil must be laid. After successful replacement, new conductive stripes must be attached, and the new electronics modules must be mapped within the configuration GUI.

Before the floor covering can be installed, the exact location of the SensFloor patches the power connections and the power pads must be documented for future maintenance works as these may differ from the original ground plans. This report must be stored in the electronic project documentation directory.

After the floor covering is installed, the QR codes will not be visible anymore so that a new mapping will become difficult. Therefore, a backup copy of the configuration file that has been generated on the options-page during the configuration process (see Fig. 31) must be stored in the project directory as well.

# 7 Installing Height Levelling Material and Intermediate Layers

After the room terminal has been installed and configured and the underlay has been successfully mapped and tested, the room's floor can be finalized. The first step is to fill up the areas in the room that have not been equipped with SensFloor underlay, with height levelling material. This is required to produce an even surface for the upper layers of the floor construction.
As height levelling material, a roll of polyester fleece is delivered (Fig. 32). The material is laid out along the edge of the SensFloor underlay (i.e. the power spine) and cut along the wall with a hooked knife. As there should not exist a distance of more than 20-30cm to the wall, the width of the height levelling material should be sufficient. The height levelling material is glued to the floor in the same way as the SensFloor patches. Due to the capillary properties of the material, care should be taken not to insert it into drains in the floor (Fig. 33) as this can lead to an intake of water later on.
**If moisture has accidently entered the underlay during installation, its power supply must be immediately switched off to avoid galvanic corrosion. Only after completely drying out the underlay can be tested and floor cover can be installed!**

Fig. 32: Fleece for height compensation

Fig. 33: Openings for drains in the floor.

Any material that is applied on top of the SensFloor underlay (glues, foils, reinforcement layers, floor coverings, …) must be certified or authorized by Future-Shape. This is important as any conductive ingredients will impair the capacitive measurement. In addition, long-term chemical or physical interaction with the sensor underlay needs to remain under control. Depending on the selected floor layer construction (refer to the document "**Floor Construction**" from Future-Shape), an authorized intermediate layer is laid out on the SensFloor. This can be done either floating or glued given the glue is authorized as well.

Fig. 34: Floating parquet on SensFloor with PE foil as moisture barrier in between

For parquet or laminate floors, an impermeable PE foil prevents moisture (e.g. from floor cleaning) from entering the SensFloor underlay (Fig. 34).
For soft floor coverings such as carpets, PVC etc. the intermediate stabilizing layer Mondo Everlay® (Fig. 35) is laid out loosely on top of the SensFloor underlay. On top of that layer the final floor covering is glued either with a certified glue (UZIN KE68). It is important to lay out the sheets of the top flooring perpendicularly to the laying direction of the stabilizing layer.

Fig. 35: Stabilizing intermediate layer laid out floating on the SensFloor underlay

# 8 Final Test and Configuration

After the floor covering is installed, all the functions that have been configured according to the manual **SE10 Room Terminal** must be verified. This final test consists of several phases:

## 8.1 Function of the sensor fields

Like inevitable pixel errors even in new monitors, there exists a probability that some of the multitude of independent sensor fields in the SensFloor underlay can show malfunction without impairing the overall function of the system. This probability is usually below 1%. However, these sensor fields should be identified and permanently deactivated before handing over the system to the customer. To achieve this, the same test procedure must be run that was performed directly after the installation of the underlay: every part of the floor is visited while simultaneously observing the fields' activations on the client device. If all sensor fields can be activated and no field becomes active without stepping on it, everything is ok. Are there locations where this is not the case, the floor covering must first be controlled for dirt or moisture at these positions.

If the issues cannot be resolved through recalibration or adjusting the sensor's sensitivity, the corresponding sensor fields must be selected and deactivated using the "Disable Filed" tab on the configuration GUI (see Fig. 36). Please refer also to the manual **SE10 Room Terminal**.

If there are larger areas that do not work, this may be due to an interruption of the power supply to the corresponding electronic modules.

If many sensor fields show permanent activity, this can be due to moisture that went into the underlay during the installation process of the floor covering. In both cases, the power supply to the SensFloor underlay must be interrupted and the floor covering must be opened for further inspection, replacement or drying of the underlay.

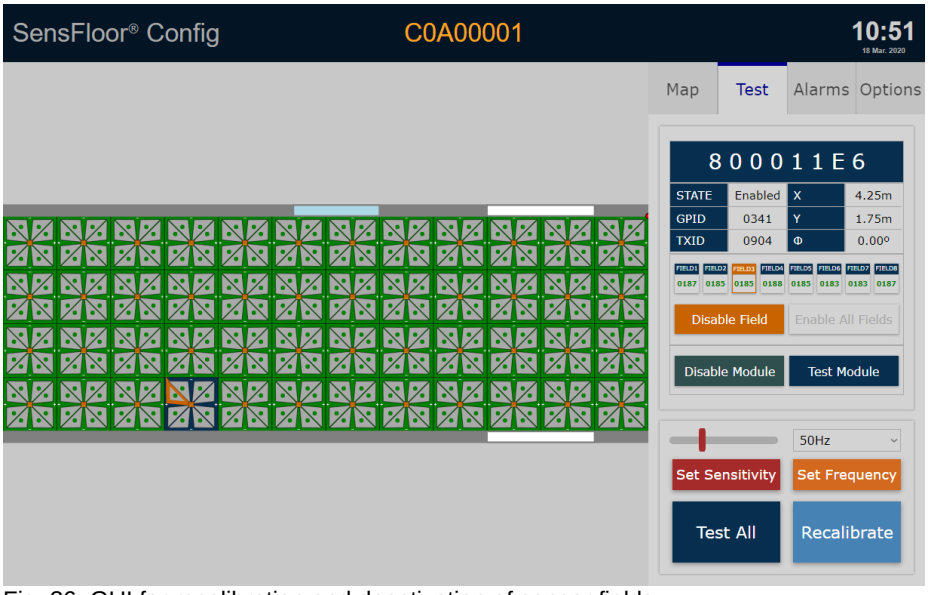



Fig. 36: GUI for recalibration and deactivation of sensor fields.

## 8.2 Testing fall detection and other functions

One of the main functions of the SensFloor system is the detection of a situation in which a person lies on the floor, e.g. because of a fall. Therefore, the corresponding alarm function is preconfigured as default in the room terminal for the entire area of a SensFloor installation. The proper function of this alarm must be tested after a new SensFloor installation and also during service and maintenance visits later on.
The test is conducted by using a so-called **fall dummy**, that can be purchased from Future-Shape. At various locations in the room, this dummy must be put on the floor with the black side facing upwards.
The grey conductive underside of the fall dummy produces a similar sensor activity as a person lying on the floor.
If this fall situation is shown on the activity display of the SE10 room terminal (Port 8000) and the alarm is transmitted to the indoor call system (if connected) the test is successful.
Otherwise, the sensitivity of the SensFloor must be adjusted and the connection to the indoor call system must be checked.
In the same way, all other configured functions such as presence detection, entering/leaving bed/bathroom/apartment or the function of connected orientation lights must be tested and adapted before handing over the system to the customer. In particular the areas (door area, bed etc), for which certain functions are defined must be controlled for proper location and size. Refer to the manual **SE10 Room Terminal** for further information.

Fig. 37: Testing the fall detection function

# 9 Installing and Configuring the Ward Terminal

## 9.1 Connection

The ward terminal, which is based on the Raspberry Pi®-platform, is connected to the SE10 room terminals in the shared LAN network. A touch monitor, which is connected to the ward terminal through HDMI and USB, clearly shows the current state of all rooms that are equipped with SensFloor (Fig. 38). Also refer to the **manual of the ward terminal** that is available from Future-Shape.
Please note that not all touch monitors are compatible with the ward terminal. A list of tested brands is available from Future-Shape too.

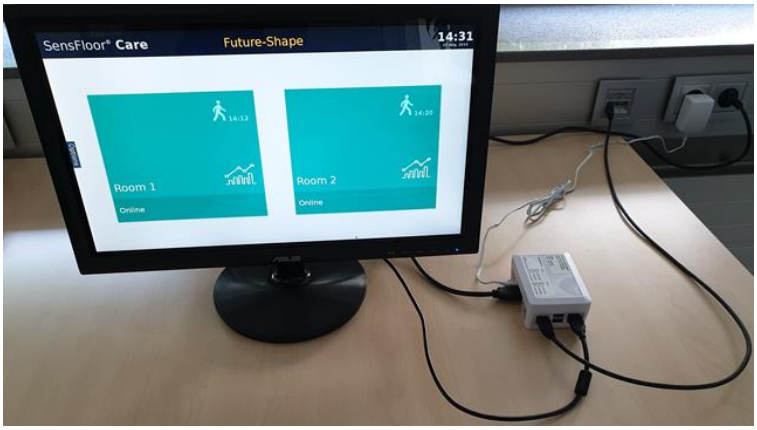



Fig 38: Ward terminal with touch monitor: wired but not yet fully installed.

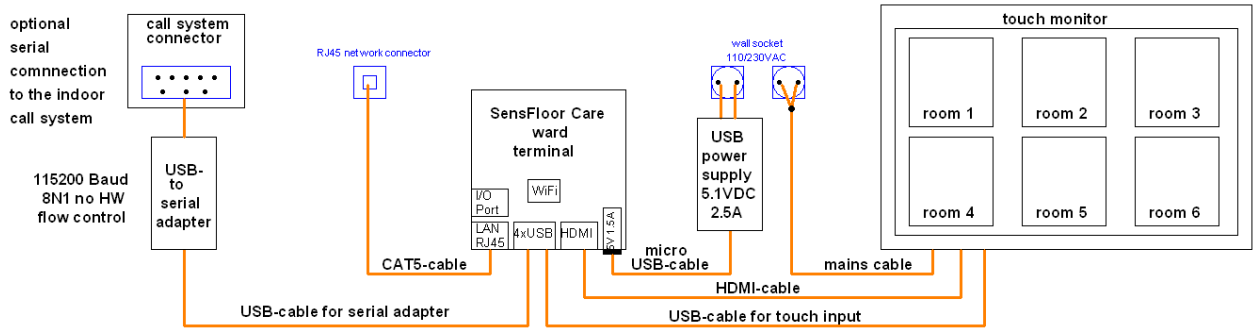



Fig. 39: Wiring diagram for connecting the ward terminal

To connect the ward terminal according to Fig. 38 and 39, please proceed in the following order:

- First, connect the HDMI cable between monitor and Ward terminal.
- To use the touch function, the USB cable must be connected between the ward terminal and the monitor.
- Next, the ward terminal must be connected to LAN using a patch cable with RJ45 plug.
- The monitor must be connected to mains and switched on.
- After this, the ward terminal is powered using the 5.1V power supply.
- Finally, the ward terminal can be mounted to the back of the monitor using a VESA mount.

When the ward terminal is powered, ist Linux-based operating system starts up and searches for Room Terminals in the same network. It takes about 2 minutes until all the connected rooms are displayed on the monitor.

Optionally, the ward terminal can operate without touch monitor too. In any case it is possible to start up a web browser on any tablet or mobile phone in the same LAN and to call the address http://<IP-ADDRESS>:10000 to obtain the visualization of the rooms. Here, <IP-ADDRESS> must be replaced by the IP-address of the ward terminal that it had received from the network's DHCP server on the first connection. Please consult the network's administrator to obtain this address.

As described in the section about the Room Terminal, usually the connection to an indoor call system is achieved by making use of the potential-free relays of the SE10s in the rooms. However, it is also possible to connect to the indoor call system at the central point where the ward terminal is installed. Depending on the actual type of indoor call system, the connection can be achieved either through the TCP/IP network or through a serial USB adapter. All configured alarms and events that are transmitted through this interface, are text messages equipped with a time stamp and the corresponding room number. Please clarify with the manufacturer of the indoor call system how these messages can be accepted and processed by the indoor call system. A detailed description of the message protocol is contained in the document **SensFloor_Care_API**, that is available from Future-Shape.

For configuring and operating the ward terminal, please refer to the **maual of the ward terminal,** that is available from Future-Shape.

## 9.2 Functional Test

Before the ward terminal can be handed over to the customer, all of its functions must be tested. For this, a mobile device such as a tablet can be used, which is connected through Wi-Fi with the customer's network. Another possibility is the connection to the Wi-Fi access point of the ward terminal (credentials are indicated on the device's label and the IP address is http://192.168.5.5:10000.
All defined functions should be tested in the same way as described earlier in the section of the Room Terminal.
A **test protocol** which contains the procedure and outcome of the tests must be added to the electronic project directory. A template of this protocol can be obtained from Future-Shape.
If all alarms and events were correctly transmitted and displayed on the ward terminal the overall system can be handed over to the customer.

Fig. 40: Mobile device for testing the functions of all rooms on the ward terminal.

# 10 Handover and Acceptance

When all functions of the Room Terminals, the ward terminals, and the connected devices (indoor call system, building automation, lamps, external sensors) have been tested successfully, the overall system can be handed over to the customer. For this process, the packing list is required, and a **Handover Protocol** must be filled in. A template of this protocol can be obtained from Future-Shape.

For large projects with multiple installation phases partial acceptances may be required, each of which refers to those parts of the system that have been installed until then. The complete handover process consists of the following steps:

- Based on the packing list, all the components and their correct installation is shown to the customer.
- All functions are demonstrated in the same way as during the final test after installation. In large projects with many rooms, the customer may agree to a demonstration in one room and at the ward terminal only. In this case, the correct function of all other rooms can be proved by handing over the protocol of the final test.
- All deviations such as works that could not be finalized, missing preparations of the customer or necessary additional work that turned out during the installation must be noted in the handover protocol.
- The handover protocol must be signed by the customer and by the SensFloor installer.
- All documents that are meant for the customer are handed over in an appropriate form. These are:
    - Packing list
    - The customer's copy of the handover protocol
    - Protocol of the final test
    - Plan of the SensFloor's layout
    - Photos of the installation of SensFloor and the electrical connection
    - Maintenance contract
    - Manuals and short manuals required for the operation of the ward terminal and the room terminals (available from Future-Shape).
- A training session for the end users (e.g. the nursing home managers) should be planned.

The lasts steps are the generation and transmission of the final invoice, the completion of the electronic project directory with the documents signed by the customer and the marking of the maintenance appointments in the calendar.

# 11 Training

To maximize the benefit provided by the SensFloor Care system the end users must know about the correct operation and its features. Therefore, a training session should be planned after handing over the system to the customer. Participants in this session are ideally members of the nursing home's management who can train all other staff members later.

As accompanying materials, the short and long forms of the user manuals of the ward terminal and the Room Terminals should be handed out to the participants. The web site of Future-Shape offers further materials to refer to during the training session.

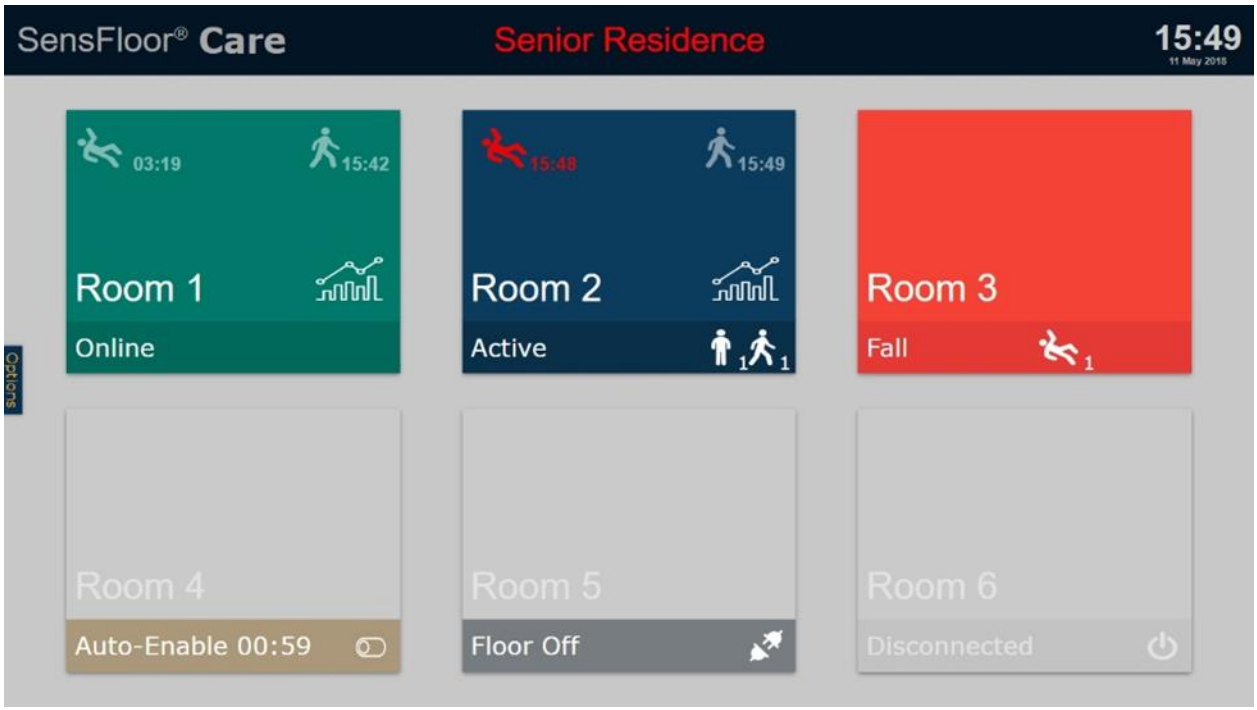



Fig. 41: Ward terminal with the display of alarms and events based on colours and icons

For the training, the ward terminal and a room equipped with SensFloor must be accessible.

The following topics are subject of the training:

- Capacitive measurement principle of SensFloor
- Meaning of the colours and icons in the room overview of the ward terminal
- Display of activity and fall alarms on the ward terminal
- Display of other alarms and events
- Live view of the room and its options
- Long-term analysis and statistics using the history-function
- Influence of objects and liquids on the floor (e.g. during cleaning)
- Recalibrating and switching off the SensFloor
- Maintenance contract and support in case of malfunctions.

## 12 Troubleshooting

The following list contains possible errors that can occur during the installation of the SensFloor Care system. If problems cannot be solved, please contact the Future-Shape support.

| Symptom | Possible reason | Correction |
|---|---|---|
| double-sided adhesive foil does not stick to the ground | subfloor is not even and dust-free | prepare the subfloor according to the document „Preliminaries by the customer “ |
| underlay shows a short circuit after installation | - connection stripes wrongly applied<br>- aluminium foil is connected to “plus”<br>- a patch’s orientation is wrong<br>- electrical connection wrong<br>- conductive object (e.g. a screw) on the SensFloor | - check all connection stripes<br>- check the patches‘ edges for aluminium foil<br>- check orientation of all patches<br>- disassemble and rework electrical connection according to manual<br>- remove all objects |
| many modules cannot be mapped | - underlay is not powered<br>- radio frequency of the SE10 does not fit to the modules | - power the underlay<br>- check connection stripes<br>- compare frequencies on the labels |
| a single module cannot be mapped | QR-code label dirty | enter the module’s ID manually |
| during test the sensor fields seem to be rotated in the configuration GUI of the room terminal | - patches are not equally oriented<br>- during mapping, x and y were swapped | - check orientation of all patches<br>- when selecting the layout, place yourself such that the patches‘ labels are in the upper right corner. Then x is from left to right and y is from bottom to top<br>- rotate the overall layout in the configuration tab “map” |
| single sensor fields blink or do not react | - dirt or moisture<br>- objects on the underlay<br>- modules broken | refer to sections „test“ and “final test” |
| many sensor fields blink | reference potential is missing | Connect DC-ground to mains ground (PE) according to Fig. 28 and 29 |
| during final test SensFloor shows large areas of permanent activity | - wrong adhesive for floor covering<br>- floor covering is conductive<br>- underlay got wet | - new installation of intermediate layer and floor covering required<br>- cut underlay from power and call support |
| fall detection does not work or produces false alarms | - sensitivity level wrong<br>- dirt or moisture on the floor | - adapt sensitivity in config. interface<br>- recalibrate at ward terminal<br>- clean and dry the floor |
| alarms are not transmitted to indoor call system | - wrong configuration of relays<br>- relays not properly connected<br>- indoor call system wrongly configured | - check relay configuration on the room terminal’s config GUI<br>- check relays using a voltmeter<br>- inform indoor call system manufacturer |
| rooms do not appear on the ward terminal | - IP-address or subnet mask wrong<br>- wrong network configuration | - restart ward terminal<br>- contact local network administrator |
| no picture on Ward terminal monitor | - HDMI-kernel module not loaded<br>- Standby/Source config. wrong | - connect HDMI before powering<br>- check the monitor’s configuration |

## 13 Request for Quotation

The following form can be used to request a quotation for SensFloor components from Future-Shape. Which of the listed third-party products is necessary, depends on the selected floor construction. As a plausibility check, the fourth column contains the estimated amount typically needed for a care home ward (C) with ten rooms with PVC flooring of 20m² each. The fifth column contains the estimated amounts typically required for an 80m² four-room sample apartment (A) with floating laminate flooring.

How many patches of the types A,B and C are required, depends on the specific ground plan and results from the planning process. For some components, a reserve quantity of 10% was added. Some components come in fixed amounts or lengths such that the amount to order needs to be rounded up to the next full package.

Working time, software license, shipping, consumables, floor covering, skirting etc. are not listed. The article number for SensFloor and the SE10s contain the required radio frequency 920MHz or 868MHz. As described in section 4, the frequency 920MHz is for projects in USA, Canada, or Australia whereas the frequency 868MHz is for projects in Europe. Of course, the frequency of the SE10 room terminals must fit to the frequency of the floor.

The list does not contain any prices. A price list with full information about rebates for distributors and/or larger volumes and with more SensFloor products for special projects is available from Future-Shape.

| Article Number | Component/Description | Unit | C | A | # |
|---|---|---|---|---|---|
| **Material to order from Future-Shape** | | | | | |
| SF LR A 868 | Low Resolution Underlay Patch Type A 100cm x 150cm, 868.3MHz | 5pcs. package=15m² | 11 | 5 | |
| SF LR B 868 | Low Resolution Underlay Patch Type B 100cm x 100cm, 868.3MHz | 5pcs. package=10m² | 6 | 2 | |
| SF LR C 868 | Low Resolution Underlay Patch Type C 100cm x 50cm, 868.3MHz | 5pcs. package= 5m² | 9 | 3 | |
| | | | | | |
| SF HR A 868 | High Resolution Underlay Patch Type A 100cm x 150cm, 868.3MHz | 5pcs. package=15m² | | | |
| SF HR B 868 | High Resolution Underlay Patch Type B 100cm x 100cm, 868.3MHz | 5pcs. package=10m² | | | |
| SF HR C 868 | High Resolution Underlay Patch Type C 100cm x 50cm, 868.3MHz | 5pcs. package= 5m² | | | |
| | | | | | |
| SF LR A 920 | Low Resolution Underlay Patch Type A 100cm x 150cm, 920MHz | 5pcs. package=15m² | | | |
| SF LR B 920 | Low Resolution Underlay Patch Type B 100cm x 100cm, 920MHz | 5pcs. package=10m² | | | |
| SF LR C 920 | Low Resolution Underlay Patch Type C 100cm x 50cm, 920MHz | 5pcs. package= 5m² | | | |
| | | | | | |
| SF HR A 920 | High Resolution Underlay Patch Type A 100cm x 150cm, 920MHz | 5pcs. package=15m² | | | |
| SF HR B 920 | High Resolution Underlay Patch Type B 100cm x 100cm, 920MHz | 5pcs. package=10m² | | | |
| SF HR C 920 | High Resolution Underlay Patch Type C 100cm x 50cm, 920MHz | 5pcs. package= 5m² | | | |
| | **resulting total area of SensFloor underlay** | **m²** | **135** | **55** | |
| SF HL 0.3x50 | Height Levelling Material, usually 1/3 of floor area | 50m * 0.3m roll=15m² | 5 | 2 | |
| SF PL 0.1x50 | Power Line 0.1m x 50m, installation material | 50m by 10cm roll | 4 | 2 | |
| SF PP | Power Pad for electrical connection, 1.5A (max. 120 modules) | pc. | 10 | 4 | |
| SF CS 2x12 | Connection Stripes, 2cm x 12cm, installation material | 50pcs. package | 8 | 3 | |
| SF CS 3x12 | Connection Stripes, 3cm x 12cm, installation material | 50pcs. package | 13 | 5 | |
| SF KS 3x6 | Kapton Stripes, 3cm x 6cm, installation material | 144pcs. package | 3 | 2 | |
| | | | | | |
| SF PS DR 4.50 | Power Supply for DIN rail, 12VDC, 4.5A (max.180 modules) | pc. | | 1 | |
| SF PS DR 1.25 | Power Supply for DIN rail, 12VDC, 1.25A (max 50 modules) | pc. | | | |
| SF PS FM 1.50 | Power Supply flush mounted, 12VDC, 1.5A (max. 60 modules) | pc. | 10 | | |
| SF SW DR | DC Switch for DIN rail, one per room | pc. | | 4 | |
| SF KS FM | DC Key switch flush mounted, one per room | pc. | 10 | | |
| | | | | | |
| SF SE10 F A/B 868 | Room terminal in flat compartment (no relay access), 868.3MHz one per room, A: comes with MicroUSB power supply | pc. | | | |
| SF SE10 H A/B 868 | Room terminal for DIN rail (relay access), 868.3MHz, one per room, A: comes with DIN rail power supply | pc. | 10 | 1 | |
| SF SE10 F A/B 920 | Room terminal in flat compartment (no relay access), 920MHz, one per room, A: comes with MicroUSB power supply | pc. | | | |
| SF SE10 H A/B 920 | Room terminal for DIN rail (relay access), 920MHz, one per room, A: comes with DIN rail power supply | pc. | | | |
| | | | | | |
| SF WT | Ward terminal, one per ward, comes with Micro USB power supply | pc. | 1 | | |
| SF WT TS 20 | 20” touch screen for ward terminal, one per ward, max. 20 rooms | pc. | 1 | | |
| | | | | | |
| **Third-party material to order from Future-Shape or directly from manufacturer** | | | | | |
| UZ PL 2.5 | UZIN Planus precoating 2.5kg for approx. 20m² | can | | | |
| UZ PL 10 | UZIN Planus precoating 10kg for approx. 80m² | can | | | |
| UZ SI 1 | UZIN Sigan 1 double-sided adhesive foil, roll with 25m² | roll | | | |
| DT R 10 | D-Tack REMOVE precoating 10l for approx. 100m² | can | 2 | 1 | |
| DT EL 25 | D-Tack EXTRA-LAY double-sided adhesive foil, roll with 25m² | roll | 9 | 3 | |
| DT DL 25 | D-Tack DUO-LAY double-sided adhesive foil to fit floor covering (textile, PVC), roll with 25m² | roll | 9 | | |
| MO E 100 | Mondo Everlay A stabilizing sheet membrane, roll with 100m² | roll | 3 | | |
| MDF 2.88 | MDF underfloor system, stabilizing layer for high point load, 600x1200x7mm +/-0.2mm, package with 2.88m² | package | | | |
| PE F 200 | PE foil moisture barrier for floating laminate/parquet, roll with 100m² | roll | | 1 | |
| UZ KE68 14 | UZIN adhesive (depends on selected floor construction), 14kg | can | | | |
| UZ KR430 8 | UZIN adhesive (depends on selected floor construction), 8kg | can | | | |
| UZ MK92s 10 | UZIN adhesive for parquet/laminate, 10kg | can | | | |
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