European Copper Institute
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Leonardo ENERGY

APPLICATION NOTE

BEST PRACTICES FOR A FLEXIBLE AND FUNCTIONAL RESIDENTIAL ELECTRICAL INSTALLATION

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18/03/2015

ECI Publication No. Cu0219

Available from www.leonardo-energy.org

Document Issue Control Sheet

Document Title:	Application Note – Best Practices for a Flexible and Functional Residential Electrical Installation
Publication No.:	Cu0219
Issue:	01
Release:	Public
Author(s):	Guy Kasier
Reviewer(s):	Diedert Debusscher

Document History

Issue	Date	Purpose
1	18/03/2015	Initial public release
2		

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CONTENTS

1. Introduction **1**

2. About flexibility **2**

3. About functionalities **5**

4. About numbers and locations **6**

5. About techniques **8**

6. About integration and integrated controls **9**

7. About user-friendliness **11**

8. About structural improvements and optimizing work **12**

9. About the installation dossier **14**

10. About the relationship with the architect **15**

11. About the relationship with the principal/residents **16**

12. About the installer **17**

1. INTRODUCTION

Over the years, the demand for flexible and functional electrical installations for houses and apartments has grown on a daily basis. Changing living conditions and habits, evolving housing needs, the availability of new technologies and the awareness of the importance of efficient energy use provide the impetus for an in-depth analysis of the electrical installation.

Classic electrical installations are no longer the world standard. They no longer provide a satisfactory answer to the multitude of demands from end users for flexibility and functionality. An installation that can adapt at any time to the changing needs of the residents, expanded with customized functions that can lead to, among other things, lower energy consumption and greater ease of use, safety and care components, is now the obvious choice.

Housing construction experienced a similar revolution several decades ago with the switch from individual coal or gas heaters to central heating. Today, a central heating system is the accepted standard for a house or apartment. New and renovated homes deserve a similar switch for the electrical installation. Integrated installations with greater flexibility and functionality must now become the norm to ensure that installations do not become obsolete within a few years.

This Application Note with Good Practices does not provide you as an installer with practical tips on how to lay conduits, install distribution boards, make connections or program an integrated system. We assume you are sufficiently well versed in the technical field. It does, however, point the way towards installations with added value; installations where the customer is both the focal point and the starting point. Reflecting on what an installation should be capable of for a particular building and its residents is the central theme in the text that follows. Installing high-tech material that only offers functions that are comparable to those of a classic installation is no longer desirable. We have to adopt a more rational approach to the use of many modern technical possibilities and involve the user appropriately in this process.

This document aims for Good Practices in an ideal situation and for an ideal installation. In daily practice, it will not always be easy or even possible to follow all of the suggestions included here. We do, however, hope that the installer will follow and implement as much of the advice and suggestions as possible. This will satisfy the customer, the architect and the installer.

This Application Note is based on several interviews with installers within the housing construction industry, interviews with representatives of manufacturers, and five workshops on flexibility and functionality in the home. The workshops, organized and run by the European Copper Institute (ECI), were attended by manufacturers (ABB, Abitana, Legrand Group, Niko, Siemens) and several organizations active within the housing construction industry or the installation world (Tecnolec, Enter v.z.w., CeDuBo). We would like to thank all these people, organizations and manufacturers for their cooperation.

2. ABOUT FLEXIBILITY

There are a great many reasons for ensuring that a contemporary electrical residential installation possesses sufficient flexibility. Examples include changing living conditions and requirements. A young family with small children has different needs than those of a family with children who are studying or an elderly couple without children. A single-parent family likewise has different needs, as does a single elderly person who requires a little care to be able to live independently in their own home for longer.

In addition, various rooms in the home may be assigned different uses over the years. A bedroom becomes a study for the teleworker who wants to avoid the daily traffic jams. Another room becomes a temporary or permanent living and sleeping area for grandmother, who moves in because she's having trouble walking, needs temporary care, or is becoming too lonely.

New techniques and technologies are emerging and we want to integrate these into existing homes. Examples abound. Perhaps it is an extension of the existing structure because one of the residents wants to start a private practice as a physiotherapist or medical chiropodist. The list is virtually endless.

Below, we examine the ways in which a home's flexibility can be increased from the installer's perspective.

- A classic electrical residential installation has extremely limited possibilities for added flexibility. Once installed, it is difficult, if not impossible, to make changes without extensive renovation. The classic installation is no longer able to cope with the often rapidly changing needs of residents and the new techniques and technologies that are available.
- What is needed is an installation in which integration and flexibility are possible. We are helped in this by all manner of management, automation and integration systems. An installation with an Integrated Home System (IHS) must be the basis and standard for any new home or major renovation. If this is not the case, the home will be outdated and not adaptable within a few years.
- When fitting manually operated shutters, the installer should also immediately provide cabling to the distribution board. At a later phase in the building's life, electrical shutters that can be controlled by the IHS can then still be fitted.
- Provide cabling for a sun blind and for the weather station. The IHS can then control the sun blind automatically according to ambient light and darkness, time of day, windy conditions, rain and indoor temperature.
- For larger homes, consider installing several distribution boards. Suggestions here include one distribution board per floor and for any free-standing garage and the garden shed. An extra distribution board also has its place in the kitchen. When fitting a new kitchen, laying wiring for the appliances will have less of an impact on the rest of the home.

Figure 1: Multiple distribution boards increase flexibility. (Image: Fotolia)

- Also consider providing sockets in the living rooms and bedrooms that can be switched on or off by the IHS. Floor lamps and other free-standing fixtures with plugs can then easily be controlled within lighting atmospheres.
- Within socket circuits, four or five wires can be used instead of the usual 3G2.5 mm². A socket that was previously live can be switched off at any time using these additional wires. Use only deep flush-mounted boxes when making the connections possible.

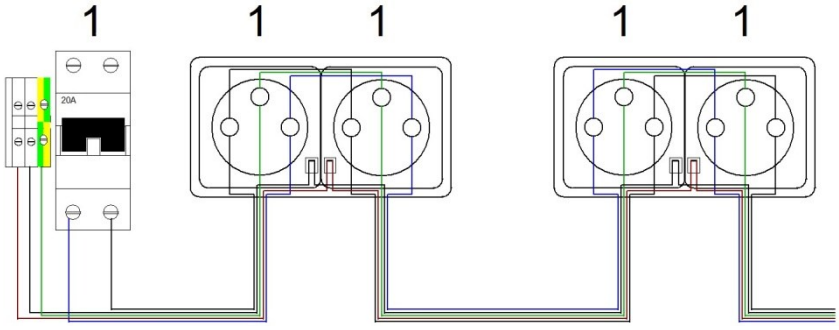

Figure 2: Additional wires in the conduits for sockets enable additional switching or dimming of those sockets at a later date. (Image: E&D Systems)

- If PV panels have not yet been installed on the roof, provide the cabling or a shaft to the attic to allow this to be done later.
- A multifunctional, structured cabling concept, combined with a patch box for data, telephony, radio and TV, significantly increases flexibility. Depending upon the residents' needs, each outlet can then be configured for a particular function (telephony, data, TV, etc.).

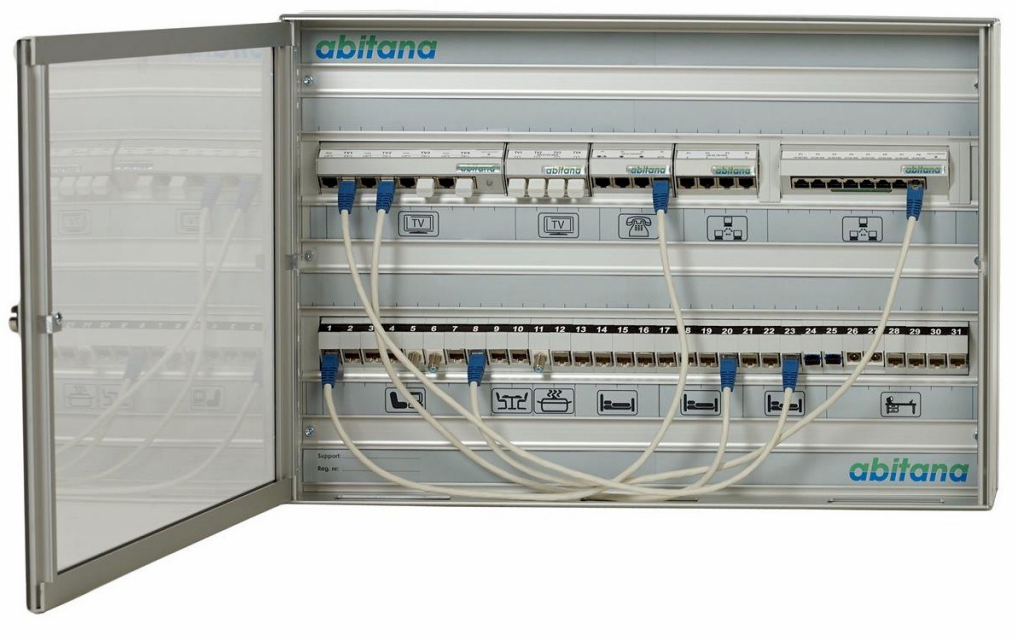

Figure 3: For each RJ45 outlet, the residents can choose the function that best meets their needs. (Image: Abitana)

3. ABOUT FUNCTIONALITIES

Happily, the time when you could only operate a single light with one switch is now past. With the advent of integrated systems, basic functionality has become much greater. With one push of a button, we can call up an entire atmosphere that not only takes the lighting to a certain level, but also operates the shutters and heating if required. Besides atmosphere buttons, we also have group controls (shutters), the all off button, the sleep button and, if desired, buttons to control audio and video.

The functionality someone needs depends upon various factors, including the size of the home, the composition of the family, the degree of comfort desired, the necessary level of security and communication, and the way the residents live and work. The choice of functionalities to be implemented must be tailored to all of these factors. Obviously, people should not be given functions they will never use, but rather those functions they will make use of on a regular basis.

- Experience has shown that many builders/renovators and architects have insufficient knowledge of the current possibilities. The installer, together with the principal and/or architect, should therefore carry out a small study to determine the needs of the residents and select the appropriate functionalities.
- The realization of needs and functionalities can take place in various ways. First, there is the discussion between installer and principal. Identify the needs and propose functionalities based on these findings. Make a clear note of these. They will help form the basis for preparing a quote.
- A second, less time-consuming method of accomplishing this consists of using a design tool or checklist. The principal can start on this before the discussion with the installer begins. On the one hand, he is presented with functions with which he may presently be unfamiliar, and on the other can tick those functions he currently wants, would like later or does not logically anticipate ever needing. All this can be clarified in the discussion with the installer. A good example of such a design tool is the Design Guide for Integrated Home Systems. Chapter 3 of this guide addresses the most common functionalities. Read this chapter carefully before entering into discussions with the client.

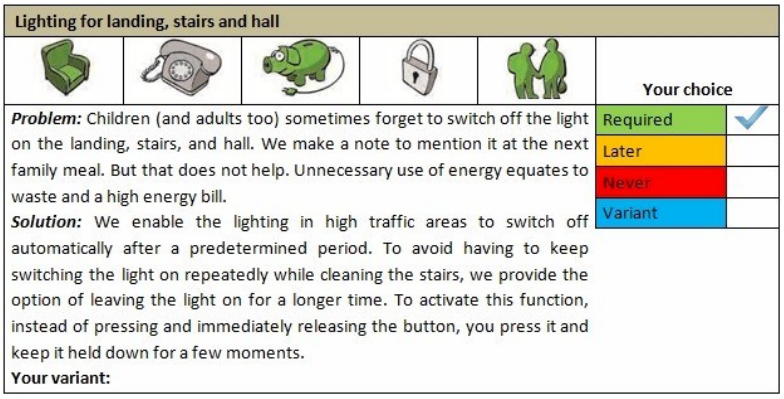

Figure 4: In the Design Guide, the end user can choose his desired functionalities himself. (Image: ECI)

- A visit to a showroom or to a home with an IHS installation can also clarify many things. In the latter case, encourage the residents of an installed home to provide the explanation, thus highlighting first-hand the benefits for users.

4. About numbers and locations

There is nothing so tedious and annoying as finding that, as a resident of a newly built or renovated house or apartment, you have too few sockets, data, telephone and TV connections, and that likely as not, they are in the wrong place. To avoid the residents using extension cables or giving in to their DIY spirit (with possible repercussions for the safety of the installation), it is advisable to make a considered choice of the number of sockets, data, telephone and TV connections and their locations within the home. The same applies to controls such as buttons and switches. There are no hard and fast rules here, but a number of tips and the use of a checklist may help.

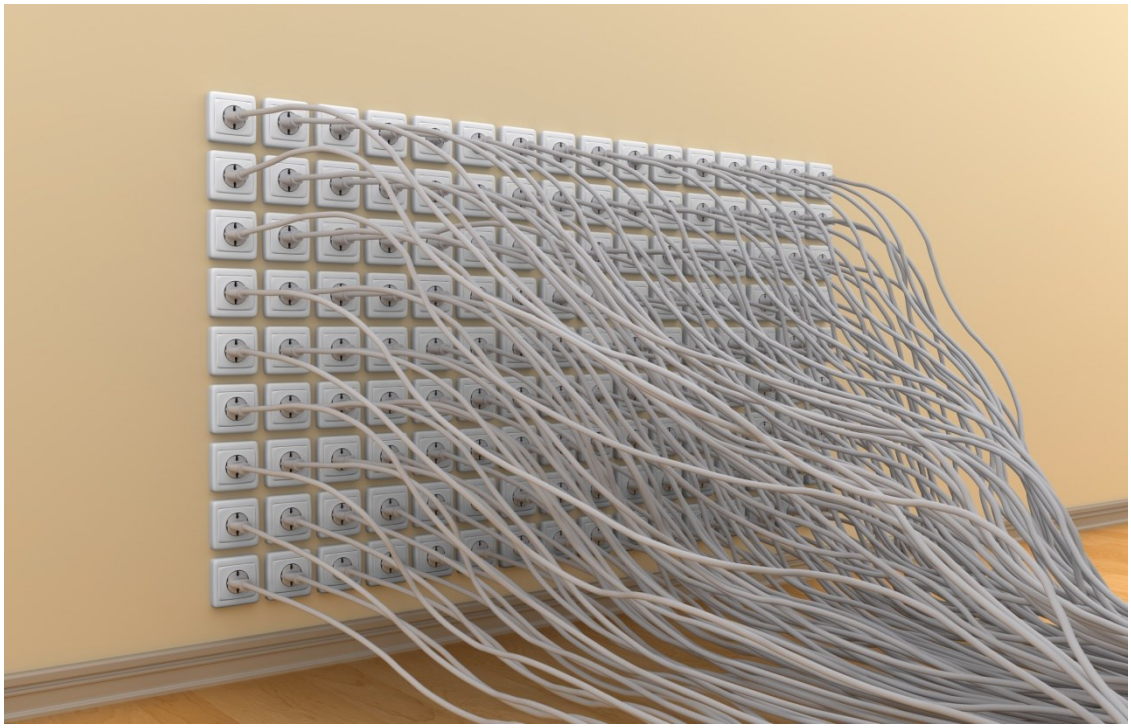

Figure 5: This is definitely too much of a good thing, but sufficient sockets, data, telephone, radio and TV connections are extremely important in the home. (Image: Fotolia)

Checklists provide examples of what type and how many connections are generally provided in each room.

- Many switch manufacturers provide their own checklist on their website.
- The European Copper Institute (ECI) has produced its own, brand-independent checklist (Checklist for the electrical installation in the home). It is also possible to enter figures in a spreadsheet for each room of both a house and an apartment. Points of attention are given for each room in relation to the possible appliances for each room.

Some tips:

- Place sockets in each corner of living rooms and bedrooms.
- Ideally, provide at least two sockets in every other area. This means the resident does not need to unplug a fixed appliance to temporarily plug in another. This is less important for sockets beneath a switch.
- Provide sockets at regular intervals on long walls.
- More sockets must be installed for TVs and computers. After all, several appliances are likely to be connected here.
- There will obviously be a TV connection in places where there is currently a TV. Provide another TV connection at another point in the same room (opposite wall). This lets residents enjoy the flexibility of moving their TV.

- Since a wired data connection is much faster, safer and more stable, sufficient data connections must be provided. Living rooms and bedrooms should get at least one double RJ45 socket.
- Consider installing multimedia cabling or a structured cabling network with RJ45 sockets and a patch box. Thanks to the active components in a patch box, the residents can choose which socket is used for telephony, data or TV at any time. In certain cases, separate coaxial cabling is required for the television.
- Data connections also need to be provided behind the television and the audio chain for the smart TV, the digital TV box of the provider and for internet radio.
- It may be advisable to install one or more motion detectors in passageways.
- Buttons and other controls for operating lighting, shutters, heating, etc. also have a role to play. Provide at least one control point for one or more buttons at each entrance to a room. Buttons can also be provided in the kitchen and study for lighting the respective work surfaces.
- We discuss how many buttons should be installed in a particular location in the section entitled *About integration and integrated controls*.

5. ABOUT TECHNIQUES

Choices also have to be made in terms of techniques in the design phase. Does the principal want a classic doorbell, an intercom or a videophone?

- We refer here to Chapter 4 of the above-mentioned Design Guide for Integrated Home Systems. The most commonly used techniques are briefly discussed here. The principal and/or architect can tick the desired techniques.

6. About integration and integrated controls

To promote flexibility and functionality, we must work on integration. In addition to the installation for lighting and sockets, a home consists of all types of subsystems such as shutters, sun blinds, heating, cooling, ventilation, the LAN network, telephony, video telephony, audio and video streaming, etc. In some cases we can talk of integration even within a single subsystem. One example of this is lighting. A lighting atmosphere, activated by a single button, whereby we dim several separately controllable lights to different levels, is an example of integration within the lighting subsystem. It is advisable to integrate multiple subsystems as effectively as possible for several reasons. It can increase comfort and the possibilities for communication. Integration with heating, cooling and ventilation in turn saves energy.

On the one hand, integration is a technical aspect of the installation. It raises questions such as what technical means can we use to interlink subsystems? In practice, there are usually sufficient solutions available from manufacturers. The end result of this technical integration is the possibility of performing actions with the various subsystems via the IHS, automatically or by means of control modules (buttons, keypads, smartphone, etc.).

On the other hand, integration also comprises a non-technical process of reflection. How can we bring integration to the user? In practice, things often go wrong in this area. An example:

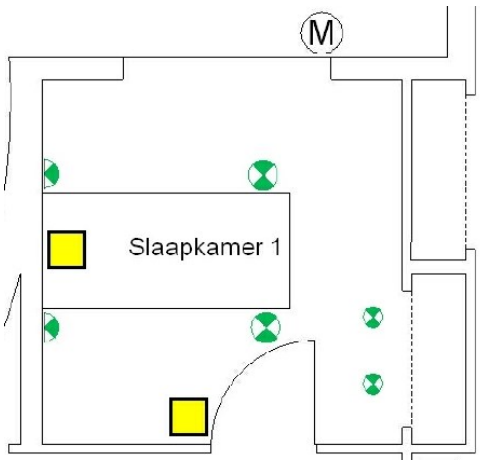

Figure 6: How many buttons should you install in this bedroom? (Image: E&D Systems)

- There are three separate lights, and also one shutter, in a bedroom. The installer places five buttons next to the entrance to this room. The first three control the separate lights. The last two buttons are used to open and close the shutter.
- In the above example, we assume that technical integration has taken place. Both the lights and the shutter are controlled by the IHS. The problem in this example is that they are never controlled by the same command. So there is no added value for the user compared with a classic electrical installation. He can only do the same as with a classic installation. Technical integration is present, but nothing is being done with it.
- In addition to several necessary one-to-one buttons, it is preferable to integrate the functions in this case. A so-called *I'm going to sleep* button by the door could be used when someone enters the bedroom. This would switch the lights on and close the shutter. A *I'm leaving the bedroom* button could also be provided. The lights that are on could also be dimmed to zero over a period of one minute, the light on the landing could come on if it is too dark, and the shutter could be opened after two minutes, for example.

What can we do to bring about user integration?

- Take into account the function of the room. Different integrated functions will be required in a bedroom, a study or a living room.
- Take into account the number of users of a room. A room where several people are usually present will require different functions than a room that is only used by one person.
- Take into account the number of entrances to a room. We may also have to integrate the entrance hall lighting by the door of the living room into the hall. We can use a similar system at the entrance to the kitchen from the living room.
- When people enter a particular room, they have a particular intention: sleeping, reading a book, playing with the children, cleaning, etc. Take this into account to determine what integrated functions are needed at a particular control point and provide a control button there.
- Avoid one-to-one controls on push-buttons in the wall. If these are unavoidable, place them on an IR remote control or a smartphone app if possible.

7. ABOUT USER-FRIENDLINESS

An integrated system may be able to perform many functions, but it should be a system that is easy for the residents to operate. The judicious assignment of functions to certain buttons is therefore extremely important.

- Design a usage system for the placing of functions on buttons and use this in each room of the home. Example:
  - In each room where several buttons are installed alongside and below each other at the entrance to the room, the general lighting for the room can be assigned to the top-left button.
  - When leaving a room, the all off function can be triggered for that room by pressing and holding down the bottom-right button.
  - Shutter controls can always be placed on the right, for example.
  - The possibilities are endless.
- Only install modules on which every button performs a function. Modules on which one or more buttons perform no function should be avoided. They only cause confusion for the user ("What's this button for?").
- If possible, choose buttons with lettering. Text or symbols can be applied to them that indicate to the user what function will be performed if the button is pressed.
- To limit the number of buttons, we mainly program intention functions on the buttons in the wall (receive visit, read book, go to sleep, get up, etc.). Any one-to-one controls do not need to be placed on buttons in the wall, but can be moved to an IR hand-held remote control, a tablet or a smartphone.
- However, for functions that have to be activated or deactivated in real time (such as audio, for example), directly accessible buttons have to be provided. Running through a menu structure on a smartphone or tablet to activate the mute function when the phone rings is too inconvenient and time-consuming at that moment. Such functions must be able to be operated instantly.
- For dimmed lights, it is advisable, if possible, to set a minimum dimming level at which the user can still see that the light is on. This is important for dimmers with a memory mode. If the light can be dimmed below the point at which the user can still see that the light is on, the user is no longer in control. With an off function, the light will in fact be off. With a subsequent on function, the dimmer will return to this much too low light level. At that point, however, the user cannot see a difference, and thinks the bulb has gone or the system has stopped responding. A call to the installer will soon follow.

8. About structural improvements and optimizing work

We are largely dependent on the architect and his design for structural improvements, and often also for optimizing the work on the site. Below, we discuss several points that could increase flexibility and optimize the work on the site, thus cutting building costs. Some of these will have to be proposed to the architect and meet with his approval.

- Together with the architect and the principal, explore the possibilities of providing one or more vertical shafts in the home. These can be used at a later stage to install additional cabling to the various floors. This could be important, for example, if the older resident(s) want to split the much too large house into apartments, or if solar panels are only fitted at a later stage.
- If possible, provisions must also be made to be able to extend horizontally. This could be a horizontal shaft to the garden (via the cellar or crawl space). In this way, several cables can be installed for garden lighting and sockets, for the garden shed, the terrace, the free-standing garage or carport.
- False ceilings are also an excellent way of extending horizontally. Obviously these are modular false ceilings, parts of which can be removed temporarily to install additional cabling. This could be done in a hallway, for example. In this way, cabling can be installed between different rooms situated alongside the hallway. Permanent false ceilings in living rooms also offer the possibility of integrating light fittings without any problem.
- The screed is normally only laid once all the tubes and conduits have been installed and when the plasterer has completed his work. This state of affairs has drawbacks. The plasterer can damage tubes and conduits in the course of his work. Plastering is also much easier on a level floor (on the screed) then on an uneven base. We therefore advocate laying the screed once all the tubes and conduits have been installed (and hence protected), before carrying out the plastering. The plasterers then only need to place a plastic sheet over the screed to avoid dirtying it. Any additional costs for this way of working are much less than any interventions that must be performed if a conduit or tube proves to be damaged after the screed and tiles have been laid. After all, digging everything up is the only option at this point.
- A great many cables or tubes generally have to find their way through the ceiling above distribution boards. Openings have to be cut or drilled in the concrete slabs for this. The size of these openings can compromise the stability of arches. One solution consists of having the architect provide the necessary openings above distribution boards at an early stage. He can ensure adequate support for the various concrete slab elements without jeopardizing stability.
- Since we want to integrate several subsystems with the IHS, the necessary agreements will have to be made with the installers of the other techniques. Site meetings with all installers, together with the architect, can be used as a tool in this regard.
    - Which subsystems must be linked and controlled by the IHS?
    - Which contacts, connections and cabling are required for this?
    - Who delivers what and who installs what?
    - Who takes charge of coordinating the integration (installer/integrator/architect)?
    - Make firm agreements at the site meeting. The architect notes these down and sends them to all technicians as a report of the meeting.

Figure 7: Technicians must work together and make clear agreements to achieve a well-integrated installation of all subsystems in the home. (Image: Fotolia)

9. About the installation dossier

An installation is only fully complete once a high-quality, usable installation dossier has been produced. A good installation dossier for a domestic installation contains the legally required documents (such as the single-wire diagram, the situation diagram and the agreed report for the installation inspection certificate) as well as the following components:

- The as-built plan of the conduits.
- A ground plan with the location of all sensors operating on SELV and any actuators (buttons, touch panels, motion detectors, temperature sensors, light sensors, interfaces, etc.).
- A list of consumers in which it is noted to which output of the output module each consumer is connected, with their address where appropriate.
- A list with the connection of the sensors to the input modules and the address for programming.
- A list or software file in which it can be verified which sensor will perform which function.
- A layout of the distribution boards.
- If software is used for the configuration, this software and the installation file in electronic form must make up a part of the dossier.

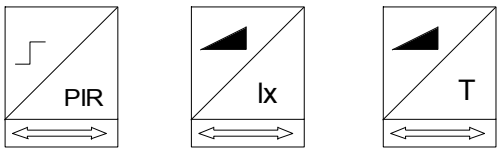

Figure 8: The use of the correct symbols is vital for a good dossier. (Image: E&D Systems)

Several copies of the complete dossier should be produced.

- Three copies are normally produced as standard.
  - One copy (with the legally required documents) goes to the inspection body at the time of the inspection. There is no need to attach the other components of the dossier discussed in this case.
  - A second copy (legal documents plus all additional components, including software and installation file) is handed to the owner/resident at the time of the inspection. This dossier must remain with the installation at all times.
  - A third complete dossier is for the installer's records. It can be used for after-sales service.
- If desired, the architect also receives a copy of the dossier (including software and installation file).
- The procedure for compiling a complete dossier is explained in Chapter 3 of the e-Book: Integrated Home Systems - Chapter 3 - The System File. This also contains examples of symbols to be used for IHS installations.

The installation dossier is not only important for the after-sales service.

- Look on a dossier as a tool.
- Being well-prepared is half the battle. Prepare the dossier before you begin installation on site. Designate it as a task to your employees. A well-prepared dossier saves a great deal of time on site.
- Programming the software is also easier and better in the calm environment of the planning office than the day before delivery on site.

10. About the relationship with the architect

The architect plays a vital role in the acceptance or rejection of new technologies and methods, and the resultant flexibility and functionality for a home. It is therefore extremely important to establish a good, sustainable and long-term professional relationship with the architect.

- Try and become involved in every project as early as possible. The opportunity to make modifications to the concept for the home is much greater if the work for the shell of the building has not yet started than if the conduits are about to be put in place.
- Always try and think along the same lines as the architect to propose customized solutions. He will thank you for it.
- Use your knowledge of materials, systems, techniques and the market situation to assist the architect.
- Don't suggest new technologies simply because they are new. Always frame the technologies to be used in terms of the benefits to the residents.
- Provide the architect with a check-list for determining functions and techniques. The Design Guide for Integrated Home Systems can be of use here.
- If necessary, make suggestions for a better workflow on the site. This includes, among other things, clear agreements about who installs what and when, and the organization of site meetings with the other technicians.

Figure 9: Architect and installer must work together on determining the best possible workflow and on all manner of aspects that could improve the flexibility and functionality of the installation. (Image: Fotolia)

11. About the relationship with the principal/residents

Obviously, the relationship with the principal/residents is also very important.

- Do not present yourself as a seller of techniques, but rather as a provider of tangible solutions that will make their daily activities and life in the home more comfortable, safer, easier, etc.
- Give them the Design Guide for Integrated Home Systems, and ask them to have a look through Chapter 3 (functionalities) and tick which functions may be important to them. If desired, they can also choose specific techniques in Chapter 4.
- Invite the principal to visit a completed installation, a showroom or a concept store. However, in the last two cases, take care that it is not just about appearance and design, but that functions can be demonstrated.
- Note down all chosen functions and techniques.
- On that basis, prepare a quotation which, except for the total price, provides the necessary concrete details. In this way, the principal knows what he will get for a particular price.
- If desired, split your quotation up into a basic section (lighting, sockets, heating control, data connections, etc.) and a section with options (shutter control, video telephony, multimedia connection points, etc.).
- At delivery, go around with the residents and demonstrate the various functions.
- At delivery, provide the principal with paper on which he can note any malfunctions or problems. Return within the first three months to make adjustments.
- Keep your customers of completed installations informed of new possibilities and products for their installation. If necessary, provide a demonstration in their home.
- For large, complex installations in particular, it is interesting to work with a maintenance contract after delivery. A yearly or two-yearly inspection of the installation can prevent problems. Certain functions can also be adjusted.

12. ABOUT THE INSTALLER

Over the past twenty years, so many new techniques have appeared in the housing construction industry that we understand it sometimes becomes difficult to keep track of everything, be aware of everything and be able to do everything. Every installer (or installation firm) should therefore carry out a small study of their own possibilities, skills and level of knowledge.

- Draw up a list for yourself of the things you are good at (specific techniques, installation, sales, etc.).
- Also draw up a list of the things at which you are less proficient.
- Check whether there are items in this last list that you can improve yourself, for example, by following a training course.
- Go to evening classes that explain the new technologies in real terms.
- Monitor new trends, techniques and materials through specialist magazines for the professional installer and by regularly visiting trade fairs, both at home and abroad.
- Consider joint ventures with various colleagues (audio, security, heating, integrator, programmer, etc.). A group with different skills can achieve more than an individual.
- Perhaps you are good at techniques, but your sales opportunities do not deliver the desired result. Join forces with someone who is happy to take charge of supporting the architect, principal and other techniques. Work together with an integrator.
- There is and will be an increasing demand for specialists in the current and future residential construction market. Invest in the necessary training. Over the years, the function of the electrical installer has changed. Where once you could offer everything, this is now becoming much more difficult. Make the right choices for your business.