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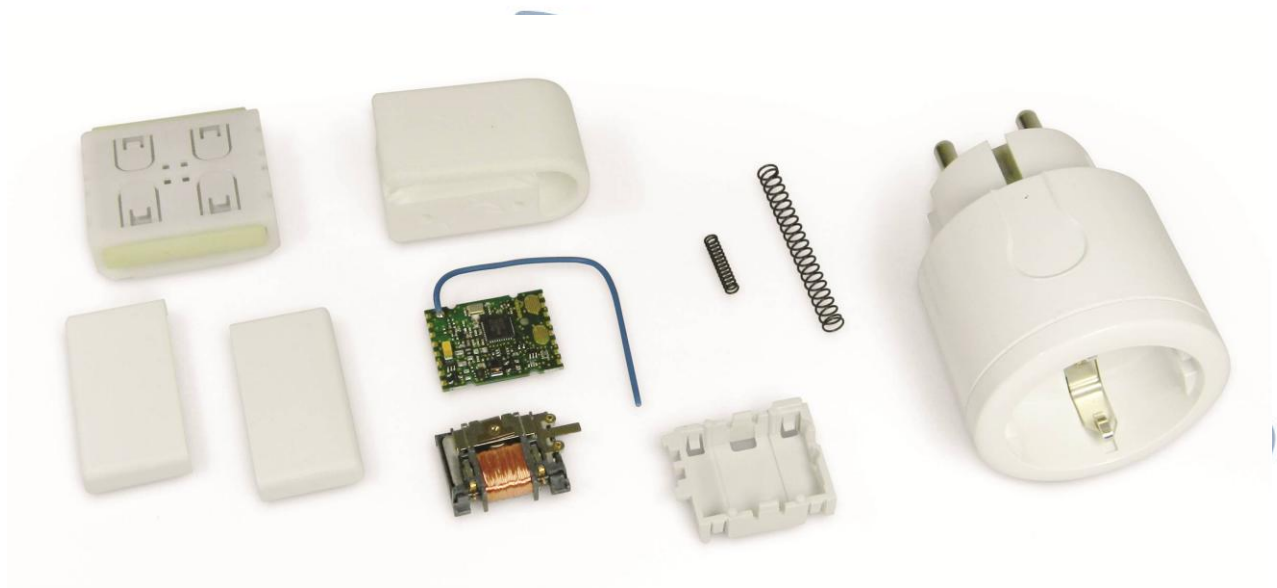
Customizable and 3D Printable Switch for self-powered IoT
ESDK - EnOcean Switch Design Kit

ESDK 868 - User Manual
June 3, 2016

⚠ WARNING This development kit is intended for use in Europe only. The provided power plug applies to Schuko socket system. In some European regions suitable socket adaptors must be used.

Observe precautions! Electrostatic sensitive devices!

Patent protected:
WO98/36395, DE 100 25 561, DE 101 50 128,
WO 2004/051591, DE 103 01 678 A1, DE 10309334,
WO 04/109236, WO 05/096482, WO 02/095707,
US 6,747,573, US 7,019,241

REVISION HISTORY

The following major modifications and improvements have been made to the first version of this document:

No	Major Changes
V1.0	Initial public document

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Important!

This information contained herein describes the functionality of the component and should not be perceived to provide assured characteristics. No responsibility is assumed for possible omissions or inaccuracies in print. Circuitry and specifications are subject to change without notice. Users are therefore referred to the latest product specifications, found at the EnOcean website: http://www.enocean.com.

As far as patents or other rights of third parties are concerned, liability is only assumed for modules, not for the described applications, processes and circuits.

EnOcean does not assume responsibility for use of modules described and limits its liability to the replacement of modules if determined defective due to workmanship. Devices or systems containing RF components must meet the essential requirements of the local legal authorities.

The modules must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can endanger people, animals or real value.

Components of the modules are considered and should be disposed of as hazardous waste. Local government regulations must be observed.

Packing: Please use the recycling operator's guidelines. By agreement, EnOcean will take packing material back if it is sorted. Sender must bear the costs of transport.

For packing material that is returned unsorted or that we are not obliged to accept, we shall invoice the sender for any costs incurred.

TABLE OF CONTENT

1   GENERAL DESCRIPTION

1.1   What Is This Kit For?

The "ESDK - EnOcean Switch Design Kit" enables you to realise a bespoke switch housing with 3D printing, based on given housing design data. Later in this User Manual you will find an overview of the designs of which the corresponding 3D design data are available as download.

Key Benefits:
1. Cutting edge: **Combines 3D Printing & IoT**
2. Plug & Play: All required parts included
3. Expandable: Instructions from simple switching application to whole IoT solution
4. Parts easy to reproduce: Printer data and spare parts list provided
5. Easy to customize: 3D plastic design data enclosed
6. Simple housing design: No battery compartment necessary
7. Maintenance free: Batteryless
8. Cool & Green: Self-powered by using kinetic energy

Switch Housing Design Process:
1.) Select your appropriate Switch Design from this User Manual
2.) Download the corresponding design data from www.enocean.com/design-data *)
3.) If needed, modify the 3D data with an IGS compatible CAD tool
4.) If you have an own 3D printer simply print the/your design. Alternatively there are a lot of low-cost printing services available on the internet. Examples you will find in Appendix A2.

*) Please note that an easy registration process is needed at the first visit of the design data page. After login please click the item "Design data for energy harvesting wireless switch applications".

Figure 1: Typical Wireless Application

Figure 2: Design of individual switch applications

1.2   How Does "Kinetic-powered" Device Work?

To transmit a radio signal to the receiver, a wireless switch needs an electric power supply. Instead of a conventional battery, the EnOcean wireless units are powered by the patented Electro-dynamic Energy Generator ECO 200.

Operating the generator by a kinetic motion moves a magnet within a coil. By changing the magnetic flux an electric tension is induced within the coil. Approximately 120uWs per press and per release actuation is generated to power the radio module. A generator size of 29.3 x 19.5 x 7.0 mm allows for small and flat switch designs
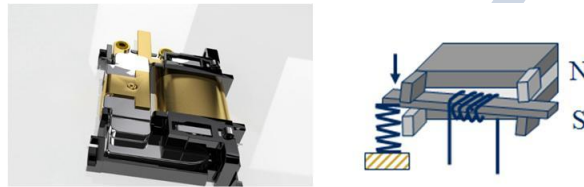
Figure 3: Electro-dynamic Energy Generator

1.3   Connecting to the IoT

The kit contains a socket power plug that can be directly controlled by switches. This is the basic approach to control a load directly, e.g. a lighting fixture.
Connecting switches and sensors to intelligent systems like Raspberry Pi enables innovative IoT solutions. In combination with 3D printing this enables total new options and new businesses. This connecting can be easily done via EnOcean TCM 310 module, EnOcean USB or EnOcean Pi extension. All three parts are described below and can be purchased separately.

1.3.1 EnOcean TCM 310 transceiver module

The TCM 310 is a small SMD mountable module that enables the design of radio gateways by providing a bi-directional EnOcean radio interface at one end and a bi-directional serial Microcontroller interface at the other end.
Further details about TCM 310 can be found at the link listed in chapter 6.

1.3.2 EnOcean USB transceiver

USB 300 is a USB stick which connects PC's and smart home servers to the world of EnOcean based radio products. USB 300 is equipped with the TCM 310 transceiver gateway module. It provides bi-directional EnOcean radio and bi-directional serial interface via USB. Radio messages are sent and received via a connected USB host.
Further details about USB 300 can be found at the link listed in chapter 6.

1.3.3 EnOcean Pi extension

The ENOCEAN PI is a plug-in radio transceiver module for Raspberry Pi single board computers enabling the design of very compact IoT system solutions combined with wireless sensors and actuators.

The **User Manual of the ENOCEAN SENSOR KIT from Element14 shows a good detailed example on how to build-up a home automation system around wireless units. This system can form the basis of your individual IoT project**. The described reference design uses FHEM for the server software, but other open systems are also possible, such as openHAB.
The link to the User Manual of the EnOcean Sensor Kit and the link to further details about EnOcean Pi are listed in chapter 6.

Figure 4: Hardware for a compact IoT Solution

1.4   Typical Applications – Create Your Own Ideas!

Target customers for this kit are designers, innovators, inventors, design houses, OEMs and the Wireless community. Typical application areas are wireless and batteryless control and automation of consumer equipment, professional equipment, household appliances, buildings, industrial manufacturing and processes, medical equipment and other innovative set-ups for the "IoT":

Building	Industry	Environment	Consumer
Wall Switch	Bus Stop	Level Monitoring	Appliances (Vacuum Cleaner, High Pressure Cleaner, …)
Remote Ctrl.	Seat Belt	Antitheft Systems (e.g. Container)	
Key Fob	Air Plane Flaps	Dust Bin Monitoring	
Smart Chair / Mattress	Pressure Pad	Mouse Trap	Remote Pad (e.g. coffee machine)
Smart Furniture	Cable Assembly	Etc…	
Toilet Flush	Kanban Systems		Remote Sensor (Water, etc…)
Smart Fridge	Foot Switch (e.g. medical)		
Servant Call	Animal Farming		Etc…
Etc…	Etc…		

Table 1: Typical Application Areas for Wireless Switches

Figure 5: Examples of Kinetic-powered Switch Products
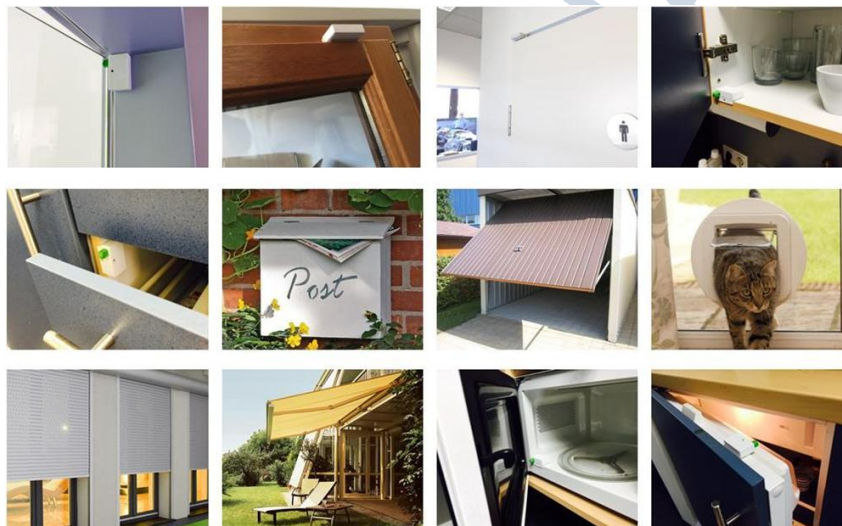
Figure 6: Examples of Applications for Batteryless Contact Switches

1.5   Technical Data for Enclosed Radio Modules

The radio modules enclosed in this kit are using the EnOcean 868 MHz radio protocol:

Physical / Application Layer	ISO/IEC 14543-3-10 (EnOcean Radio) / EEP (EnOcean Alliance)
Frequency / Transmission power	868.3 MHz / max. 10 mW EIRP
Data rate / Channel bandwidth / Modulation type	125 kbps / 280 kHz / ASK
Transmission range	300m free field, typ. 30m indoor

1.6   Frequencies 868/902/928/2400 MHz – Module Replacements

This kit can easily be used for designing kinetic-powered applications for different radio frequencies: Simply replace the enclosed radio modules as follows (available from Farnell and other outlets).

	868 MHz (Europe)	902 MHz (USA/CAN)	928 MHz (Japan)	2.4 GHz (global)
	PTM 330 enclosed	PTM 330U	PTM 430J	PTM 535Z
	PTM 210 enclosed	PTM 210U	PTM 210J	PTM 215ZE

Table 2: EnOcean Modules Overview for different Radio Frequencies

1.7   Kit Operating Conditions

This kit is intended for laboratory and indoor use only!

Temperature	+5 up to +40°C
Humidity	0-80% r.h., no condensation
Power Plug, AC Supply Voltage / Frequency	207 - 253 V / 43 - 67 Hz (EU/EFTA)
Power Plug, Load Power	Max. 2500 W continuous (Tungsten)

2   KIT CONTENT

2.1   Overview

The Kit contains the following:

- **WIRELESS MODULES** (kinetic-powered)
- **SWITCH HARDWARE** (Clamp Switch + Rocker Switch)
- **PLUG RECEIVER** (Plug & Play)
- **DESIGN DATA** (links)

1. Clamp Switch   2. Rocker Switch   3. Pushbutton Switch   4. Mini Button   5. Contact Switch   6. Rolling Wheel

Figure 7: Enclosed DESIGN DATA (1+2 enclosed as switch hardware)

2.2   Parts List

#	Function	Type	Picture	Spare Part
1	EnOcean Module	ECO 200 Energy Generator		Available from distributors, e.g. www.farnell.com
2	EnOcean Module	PTM 330 Radio Transmitter PCB		Available from distributors, e.g. www.farnell.com
3	EnOcean Module	PTM 210 Switch Module		Available from distributors, e.g. www.farnell.com

4	Switch Hardware	Clamp Switch Housing		3D printable. Examples of suitable service provider can be found in Chapter A2.
5	Switch Hardware	Switch Rocker (2x)		3D printable. Examples of suitable service provider can be found in Chapter A2.
6	Switch Hardware	ECO Fixation Housing		Email info@enocean.com
7	Switch Hardware	Restoring Spring for Clamp Switch		Type D-057C available from www.federnshop.de
8	Switch Hardware	Restoring Spring for Contact Switch		Type VD-047G available from www.federnshop.de
9	Switch Receiver	Power Plug PSC 234		Available from www.greenelectric.eu
10	Power Adapter (UK only)	Power Adaptors (male and female)		Available from electronics retail outlets
10	Paper Insert	Quick Start (links to further Documentation) + Safety Instructions		n.a.

Table 3: Parts List of Kinetic Design Kit

2.3   Switch Receiver

2.3.1 Overview Power Plug PSC 234

The PSC 234 is a wireless controlled socket plug switch with metering, near-to-zero-volt switching and overload protection.

The plug supports the following Functions / Operation Modes:

1. **ROCKER SWITCH** (PTM 210 only)
2. **TOGGLE SWITCH** (Output state changes on each press/release action)
3. **BUTTON-FOLLOWER SWITCH** (Output is on as long button is pressed)

With a touch button (TB) the user can configure the device and manually switch the load. An LED is used as an indicator during 'learn-in' of devices. Details about learn-in of wireless devices and mode of configuration can be found in the PSC 234 User Manual, link listed in chapter 6.

position of
touch button

position of
signal LED
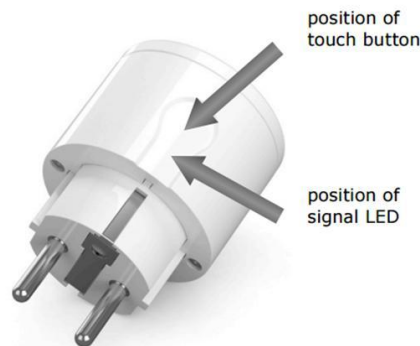
Figure 8: Socket Plug Receiver PSC 234

2.3.2 Compatibility of European Power Plug Systems

The **male side** of the power plug PSC 234 is of CEE-7/7 system, which combines the two plug systems of Type-F (SCHUKO system) and Type-E (FRENCH system).

This plug has lateral contact surfaces for the earth contacts of Type-F sockets and a contact hole for the ground pin of Type-E sockets. The PSC 234 male side is compatible to power sockets in Germany, Sweden, Norway, Benelux, Spain, Italy, Greece, etc… (see countries marked BLUE in the following table "Colour Guide Map"), and is also compatible to power sockets in France, Spain, Poland, etc… (see countries marked RED in table "Colour Guide Map").

Power Plug System	Color Guide Map
Schuko (Type F) French (Type E) British (Type G) Swizz (Type J) Danish (Type K) Italian (Type L)	

Figure 9: Compatibility Map of Power Plug Systems (Source: Wikipedia)

The **female side** of PSC 234 is of Type-F (SCHUKO). Pure French Type-E power plugs have become rare, since they are increasingly being replaced by CEE-7/7 power plug that can be used with the female side of the PSC 234 (see Figure 10).
Alternatively a flat Euro plug (without ground pin) can be used on the female side of PSC 234. The flat Euro connector is common in European countries.

Figure 10: CEE-7/7 power plug (compatible to Type F and Type-E sockets)

2.3.3 Suitable Plug Adapters for PSC 234

Great Britain, Denmark, Switzerland and parts of Italy need suitable power plug adapters. The UK version of the kit includes suitable adaptors. In the other countries those power adaptors are easily available as accessories in electronics retail outlets. On the female side flat Euro plug can be used (e.g. a night light with such connector).

3   QUICK START GUIDE

3.1   ROCKER SWITCH Application

The Plug Receiver is controlled by the Rocker Switch:

	Step	Details
1	Assemble Rocker Switch	Clip the two rockers onto the grey PTM 210 module
2	Connect Plug Receiver	■ If needed connect country specific socket adaptors ■ Connect Plug Receiver to power socket & load (lamp) ■ Press TB to switch on/off
3	Reset Plug *(only needed if Plug Mode was changed)*	■ Press TB for >20s until RED LED lights-up permanent ■ Press TB again for >2s until GRN LED FLASHES for a short duration
4	Teach Rocker Switch into Plug Receiver	■ Press TB for 5 seconds: RED LED BLINKS ■ Operate one of the rockers: GRN LED BLINKS = Ready-to-go!

Note: TB = Touch Button of Plug Receiver

Table 4: Quick Start of Rocker Switch

3.2   CLAMP SWITCH Application

The Plug Receiver is controlled by the Clamp Switch:

	Step	Details
1	Assemble Clamp Switch	■ Insert restoring spring ■ Insert transmitter PCB ■ Insert ECO generator (if needed, see "Clamp Switch, Assembly")
2	Connect Plug Receiver	see 3.1.2
3	Reset Plug *(needed for change Plug Mode)*	■ Press TB for >20s until RED LED lights-up permanent ■ Press TB again for >2s: GRN LED FLASHES for a short duration
4	Change plug operation to **Button-Follower Mode**	■ Press TB ≈15s until RED LED FLASHES cyclic (after blinking 9x) ■ Press TB ≈0.2s: RED LED FLASHES 2x cyclic ■ Press TB ≈0.2s: RED LED FLASHES 3x cyclic *) ■ Press TB again for >5s: GRN LED BLINKS 5x
5	Teach Clamp Switch into Plug Receiver	■ Press the TB for ≈5 seconds: RED LED BLINKS ■ Operate Clamp Switch: GRN LED BLINKS = Ready-to-go!

*) **Toggle Mode:** Press TB a third time ≈0.2s (RED LED FLASHES 4x cyclic). You can repeat short TB pressing as many times, the number of flashes indicates the selected Mode (1x = Rocker, 2x = Rocker, 3x = Toggle, 4x = Button-Follower).
For more details about changing Plug Modes look-up in the PSC 234 User Manual (link in chapter 6)

Table 5: Quick Start of Clamp Switch

3.3   Assembly / Disassembly

3.3.1 Rocker Switch

Simply plug the two rockers on the PTM 210 module.
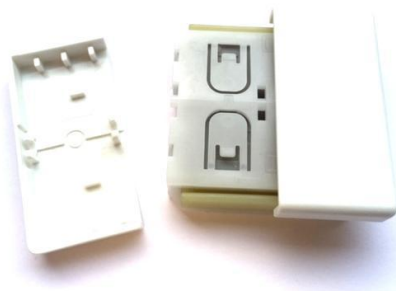
Clip both rockers onto the PTM module

Figure 10: Rocker Switch – Assembly/Disassembly

3.3.2 Clamp Switch

1. Insert Restore Spring   2. Insert Transmitter Module   3. Insert Energy Generator
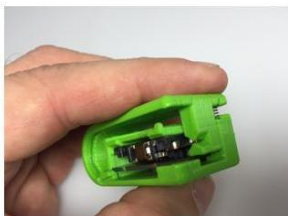
4. Ready To Use   5. Disassembly

Figure 11: Clamp Switch – Assembly/Disassembly

Notes: Contact springs of ECO energy generator have to contact the unpopulated PCB side (white ECO rubber mat on the opposite). When inserting the generator move its black plastic nose around the PCB antenna soldering point. The housing inside has a small antenna slot in which the module antenna can be pressed in with a screwdriver and thus fixed.

3.3.3 ECO Fixation Housing
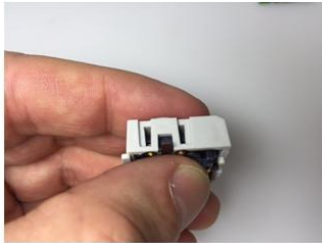
1. Insert Energy Generator   2. Insert Transmitter Module
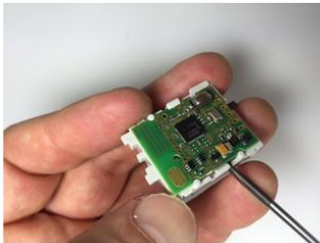
1. Release PCB Holder Flap   2. Release ECO holder front mounting bracket while pushing ECO spring   3. Release rear mounting bracket
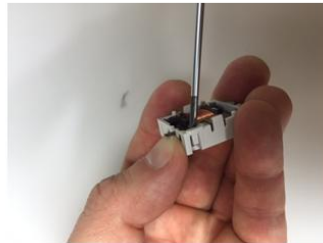
Figure 12: ECO Fixation Housing – Assembly/Disassembly

Note: Contact springs of ECO energy generator have to touch the contacts on the unpopu-lated PCB side (direct the ECO side with white rubber mat onto the bottom of the housing).

4   DESIGNING & PRINTING 3D PARTS

4.1   Realization Options

The trade-off of parts cost versus surface tolerances of the parts can be found in the following Figure. 3D printing is a technology that enables quick and low-cost creation of single mechanical parts, but with limitations on tolerances.

Characteristics	Tooling	Rapid Prototyping	3D Printing
Fix Cost (NRE)	high	medium	low
Variable Cost (Parts)	low	medium	high
Part Tolerances	low	medium	high
Key Application	**High volume production**	**Low to mid volume**	**Single parts, "Maker"**

Table 6: Realization Options of 3D Parts

Most reference designs provided with this kit will allow for 3D printing, however the Mini Button, is intended for tool manufacturing with low part tolerances.

4.2   3D Printing

3D printing is a prototyping process whereby a real object is created from a 3D design. The digital 3D-model is generated with a suitable CAD software and saved in STL format before sending to a 3D printer. The 3D printer then prints the design layer by layer and forms a real object. 3D printing makes it possible to create a part from scratch in just hours.

4.2.1 Printing Technologies

3D printers are a simple version of rapid prototyping machines but they are lower cost and less capable. There are several different 3D printing technologies. The main differences are how printing layers are built to create parts. Generally, the main considerations for 3D printing are surface smoothness, part complexity and size, cost of the printed prototype, cost of the 3D printer, choice and cost of materials and printing speed.

a) **Fused Deposition Modelling (FDM)** is an additive manufacturing technology commonly used for modelling, prototyping, and production applications. It is one of the techniques used for 3D printing. FDM works on an "additive" principle by laying down material in layers; a plastic filament or metal wire is unwound from a coil and supplies material to produce a part.

b) **Fused Filament Fabrication (FFF)** is a 3D printing process that uses a continuous filament of a thermoplastic material. This is fed from a large coil, through a moving, heated printer extruder head. Molten material is forced out of the print head's nozzle and is deposited on the growing workpiece. The head is moved, under computer control, to define the printed shape. Usually the head moves in layers, moving in two dimensions to deposit one horizontal plane at a time, before moving slightly upwards to begin a new slice. The speed of the extruder head may also be controlled, to stop and start deposition and form an interrupted plane without stringing or dribbling between sections.

c) **Selective laser sintering** (**SLS**) is an additive manufacturing technique that uses a laser as the power source to sinter powdered material (typically metal), aiming the laser automatically at points in space defined by a 3D model, binding the material together to create a solid structure. SLS is a relatively new technology that so far has mainly been used for rapid prototyping and for low-volume production of component parts.

Fused filament printing is now the most popular process (by number of machines) for hobbyist-grade 3D printing. Other techniques, such a photo-polymerisation and powder sintering, may offer better results (at greater cost), but FFF still dominates commercial printing.

4.2.2 3D Copy Shops

3D copy shops are (on-line) established and cost-effective. Several on-line shops offer selection between different materials and suppliers. After transferring the relevant design-data they even supply part quotes on-line. Some examples are listed in Chapter A2.

4.2.3 3D Printer

3D printers (not included in this kit) are available in all performance levels from low-cost up to professional equipment.

4.3   CAD Software

CAD Software (not included in this kit) has to be IGS compatible. Such design software is widely used in the market and available in all performance levels from freeware up to professional construction and simulation tools.

4.4   More Information about creating 3D Printing Parts

3D printing parts can be made either on an own printer, or can be ordered at a service provider for a few Euro. Many of these providers also offer an on-line parts price comparison. Some exemplary on-line shops can be found listed in section A2.

A lot of more detailed information about creating 3D printing parts can be found in the internet, see www.element14.com/community/groups/3d-printing, for example.

5 REFERENCE DESIGNS & APPLICATIONS

5.1 CLAMP SWITCH

The enclosed clamp switch housing consists of only one plastic part and a restoring spring. By that it is the simplest way to realize a remote pushbutton. You can simply print more of those or make your own application based ideas from the provided design data and an IGS compatible CAD program.
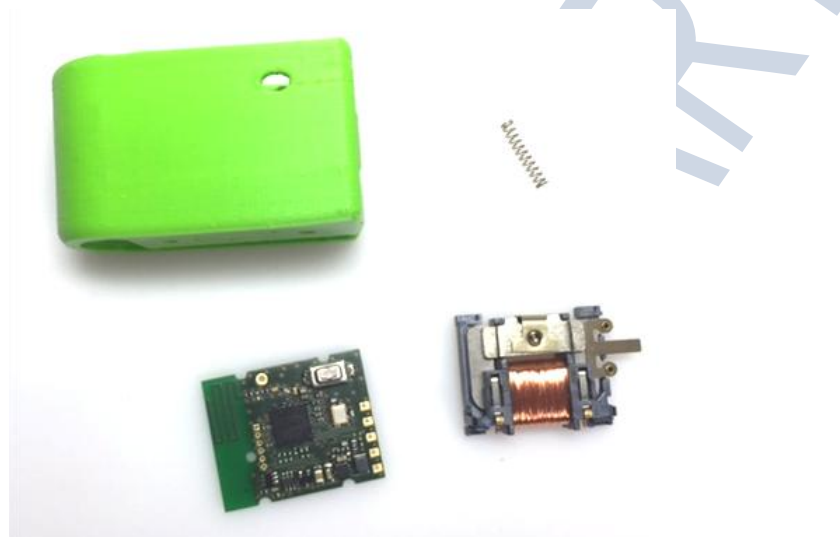
Figure 13: CLAMP SWITCH Reference Design

5.1.1 Kit Content
The Kit contains:
- Clamp housing
- Small restoring spring
- Transmitter module PTM 330
- Energy generator ECO 200

5.1.2 Design Data Provided
The following Design Data is provided as download (link see chapter 6):
- Design Data of the basic Clamp Housing (IGS, 3D printable)
- Mounting Instructions and 3D shape data for ECO and PTM module

5.1.3 Typical Applications
- Wireless control of a single receiver (e.g. the enclosed plug switch)
- In combination with a control system (e.g. Raspberry Pi) such remote controls enables 100s of mobile applications in multi-room environment:
    - o Person Dependent Impact (individualised switches)
    - o Colour/Shape Dependent Impact (use different colours/shapes)

o   Location Dependent Impact (Different switches at different places/rooms and/or App figures out which receiver gets strongest signal)

5.1.4 Tips for Part Printing

a) FDM / FFF process:

To get best results in function and surface smoothness the model must be oriented with the side surface (where the dolphin logo is) touching the build plate. The part then gets build up with minimum material for support structure and gets the most stable mechanical performance.

Based on tolerance requirements given by the Energy Generator the recommended print parameters are:

- Material recommendation: PLA
- Layer thickness is 0,1mm
- At least two lines as shell wall
- Print speed with <50mm/s
- Infill 25%
- x-y-tolerance <=0,1mm
- Avoid over extrusion

Rework after printing:

- All support structure must be removed completely before use of the parts, most important: remove all support in the area of the returning spring holes in a proper way
- When using EnOcean electronics with whip antenna, be sure that the given slot in the printed part is free of support or particles

b) SLS process:

No special tips needed. The design is perfectly suited to be manufactured in SLS process. The enclosed clamp switch sample is produced by SLS process and ready to use. The used material for the enclosed samples is PA2200.

5.2   ROCKER SWITCH

The PTM 210 module together with the two rockers enclosed in this kit allows for plug & play assembly of a 4 channel remote switch by simply plugging the rockers onto the PTM module.

You can easily design a basic housing and/or your own handheld remote or a wall switch by using an IGS compatible CAD program and the provided design data of the PTM 210 module shape.
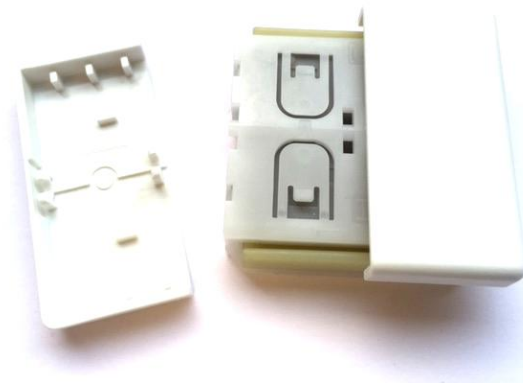
Figure 14: ROCKER SWITCH Reference Design

5.2.1 Kit Content

The kit contains a complete radio remote
- Switch module PTM 210
- 2 switch rocker

5.2.2 Design Data Provided

The following Design Data are provided as download (link see chapter 6):
- 3D design data of model rocker (IGS)
- 2D tolerance data of model rocker (PDF)
  Note: The model differs from the parts contained in the kit!
- Design data of PTM 210 module shape (3D and 2D)

5.2.3 Typical Applications

- Handheld Remotes (up to 4 channels)
- Wall Switches (1 or 2 rocker with medial position)

5.2.4 Tips for Part Printing

a) FDM / FFF process:
Based on the high mechanical stress in both snap-in pins when mounting the rocker onto the PTM module, the model must be oriented with a side surface touching the build plate. In this orientation the snap-in pins are shaped with each layer and get best stability. This orientation requires additional support structure in the area of the snap-in hooks.
Based on tolerance requirements given by the PTM module the recommended print parameters are:
  - Material recommendation: PLA
  - Layer thickness is 0,1mm to 0,2mm according to wanted surface smoothness
  - At least two lines as shell wall
  - Print speed with <50mm/s
  - Infill 25%
  - x-y-tolerance <=0,1mm

Rework after printing:
- All support structure must be removed completely before use of the parts
- To get best fitting to the PTM module both snap-in hooks must have an inner diameter of 2,6±0,03mm according to the drawing provided with the part

b) SLS process:
No special tips needed. The design is also suited to be manufactured in SLS process. As for the material it is recommended to use PA2200.

5.3   PUSHBUTTON SWITCH

This is the kit's easiest design for a pushbutton switch. Using the PTM 210 module and simply printing the provided design data of the two plastic parts (Base Plate and Pushbutton Cover) a final pushbutton switch can be easily assembled. Examples for on-line 3D printing shops see list in chapter A2. In addition you can also give the pushbutton your own personal shape by modifying the design data before printing by using an IGS compatible CAD program.
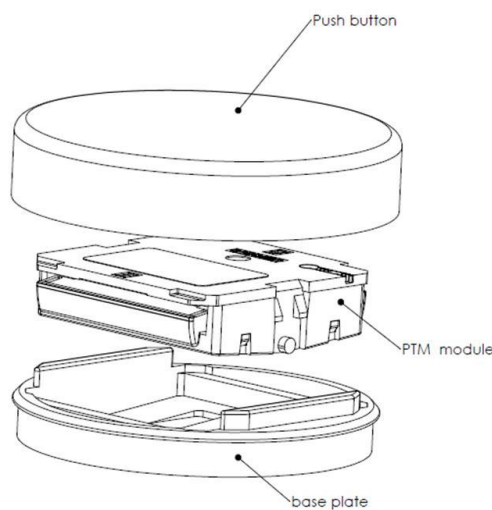

Figure 15: PUSHBUTTON Reference Design

5.3.1 Kit Content
Switch module PTM 210

5.3.2 Design Data Provided
The following Design Data are provided as download (link see chapter 6):
- Simple 3D design data of Base Plate (IGS)
- Simple 3D design data of Pushbutton Cover (IGS)

5.3.3 Typical Applications

Personalized wireless 1-channel remote controls (handheld remote, foot-switch, wall pushbutton etc...)

5.3.4 Tips for Part Printing

Tolerance and clearance of both parts are designed for being built with the FDM process.
a)   FDM / FFF process:
The provided 3D model of the Pushbutton may be printed in the same orientation as used in the application. The top surface will get the best resolution and quality. This orientation will require additional support structure.
Based on tolerance requirements given by the PTM module the recommended print parameters are:

- Material recommendation: PLA
- Layer thickness is 0,1mm to 0,2mm according to wanted surface smoothness
- At least two lines as shell wall
- Print speed with <50mm/s
- Infill 25%
- x-y-tolerance <=0,1mm
- Avoid over extrusion

Rework after printing:

- All support structure must be removed completely before use of the parts
- Both parts and the PTM module must move freely in assembly. When print is slightly over extruded excess material must be removed.

b)   SLS process: When using the SLS process, adapt clearance to the given process parameters. As material it is recommended to use PA2200.

5.4   MINI BUTTON

Providing the same functionality as PUSHBUTTON, the MINI BUTTON is based on discrete ECO 200 and PTM 330 components. This allows lower unit cost for volume production. This MINI BUTTON design is really set-up for tool making, 3D printing of the parts is not practical as it's not possible to achieve the surface quality needed for the internal mechanics.
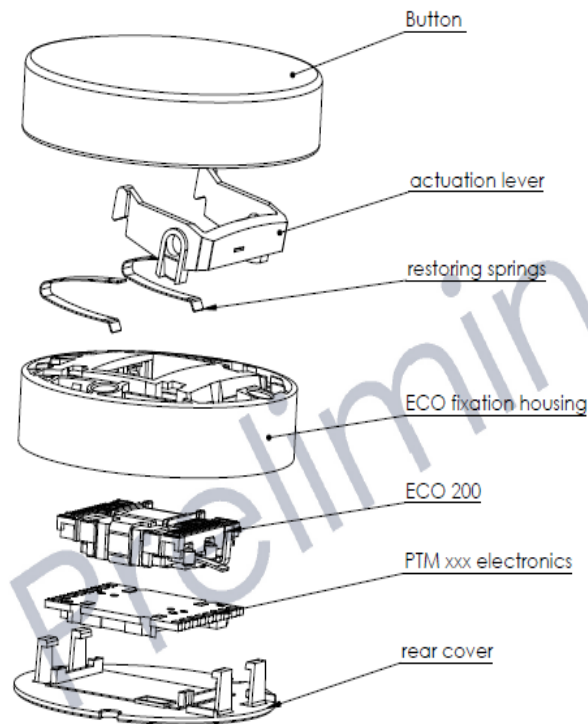
Figure 16: MINI BUTTON Reference Design

5.4.1 Kit Content
- Transmitter module PTM 330
- Energy generator ECO 200

5.4.2 Design Data Provided
The following Design Data are provided as download (link see chapter 6):
- All plastic parts & restoring spring: 3D tooling data (IGS) + 2D tolerance data (PDF)

5.4.3 Typical Applications
Nice looking wireless 1-channel remote controls (handheld remote, foot-switch, wall pushbutton etc...).

5.4.4 Tips for Part Printing
The provided data is for tool making and not for 3D printing. The data set does not contain any cavity angle for deforming. An additional adaption loop would be needed to get all interacting surfaces of button and ECO fixation housing into a nice and smooth function. Currently the data set contains a large clearance for further individual adoption.
It would be possible for a designer to work on the outer design shape in order to achieve their own individual button format.

Due to the very small geometry in the parts, the FDM process is not applicable.

By using the SLS process, the function of all parts can be achieved but there is a risk that the tolerances get too big. Mostly the sliding surfaces of the button and housing part may not be suitable for a smooth interaction. As for the material it is recommended to use PA 2200.

5.5   CONTACT SWITCH

The provided data set contain two versions of Contact Switch. One represents 3D data pre-pared for tool making and not directly for 3D printing. The second version is a simplified data set with less details and low cost printing process. You can easily modify the outer mechanical design interface to your individual application / requirements. The given data set for tool making does not contain any cavity angle for deforming and must be finalised before tool manufacturing.
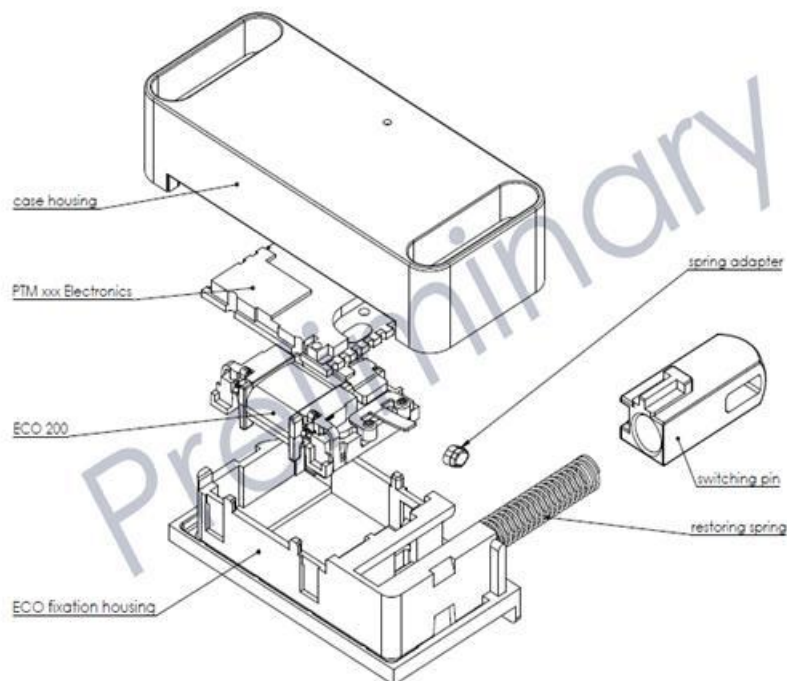

Figure 17: CONTACT SWITCH Reference Design (tooling version)

5.5.1 Kit Content

The kit contains:
- Energy generator ECO 200
- Transmitter module PTM 330
- Large restoring spring

5.5.2 Design Data Provided

The following Design Data are provided as a download (link see chapter 6):
- Plastics 3D tooling data (IGS)
- Plastics 2D tolerance data (PDF)
- Plastics 3D simplified printer data (IGS)

5.5.3 Typical Applications

Position Monitoring of windows, doors, drawers, cabinet doors, blinds, awnings, garage doors, mailboxes, cat flaps, etc… (see Figure 6: Examples of Applications for Contact Switch).

5.5.4 Tips for Part Printing

The mechanical design of both sets of the Contact Switch ensures that the ECO 200 is activated in a safe way, the restoring spring as well as the ECO 200 spring travel is slightly over dimensioned. Based on the 3D printing tolerance limits it's possible for parts get stuck in the application or sliding parts have extremely high friction. This may stop the proper function of the prototype.

a)   FDM / FFF process:

When applying the FDM/FFF process use the simplified data set of the Contact Switch to build prototypes. This data set does not contain filigree structure for ECO fixation or activation. Based on tolerance requirements given by the ECO 200 module the recommended print parameters are:
- Material recommendation: PLA
- Layer thickness is 0,1mm
- At least two lines as shell wall
- Print speed with <50mm/s
- Infill 25%
- x-y-tolerance <=0,1mm
- Avoid over extrusion

Rework after printing:
- All support structure must be removed completely before use of the parts, remove sharp edges in the printed parts, remove over extrusion
- All sliding surfaces may be optimised for low friction and nice sliding.
- All parts must move freely in the application.
- For simplified data set:
  - To provide an adequate guidance for restoring spring it is recommended to insert a dowel pin in dimension D4x13mm (max.) into the ECO fixation housing. Therefore it may be necessary to rework the hole in the ECO fixation housing for proper fitting.
  - The ECO 200 module is not fixed properly in that assembly. Be sure that the PTM 3xx electronic module fits to the housing and is able to hold down the ECO 200 module. The case housing part is additionally pressing down the PTM 3xx module. If necessary use some droplets of glue to fix the PTM 3xx module.

b) SLS process:
The SLS process can be applied to build both versions of the Contact Switch.

By using the SLS process there is a risk that the tolerances get too big. Also the sliding surfaces of the button and housing part may not be suitable for a smooth interaction. As for the material it is recommended to use PA2200.

When using the tooling data set, the most critical part for 3D printing will be the small "spring adapter" part. For small number of units this part should be built out of brass with adequate processes.

5.6   ECO FIXATION HOUSING

Based on the ECO/PTM Fixation Housing, an IGS compatible CAD program and a 3D printer, you can realize your totally new application idea. As a ready to go reference application please see the ROLLING WHEEL.
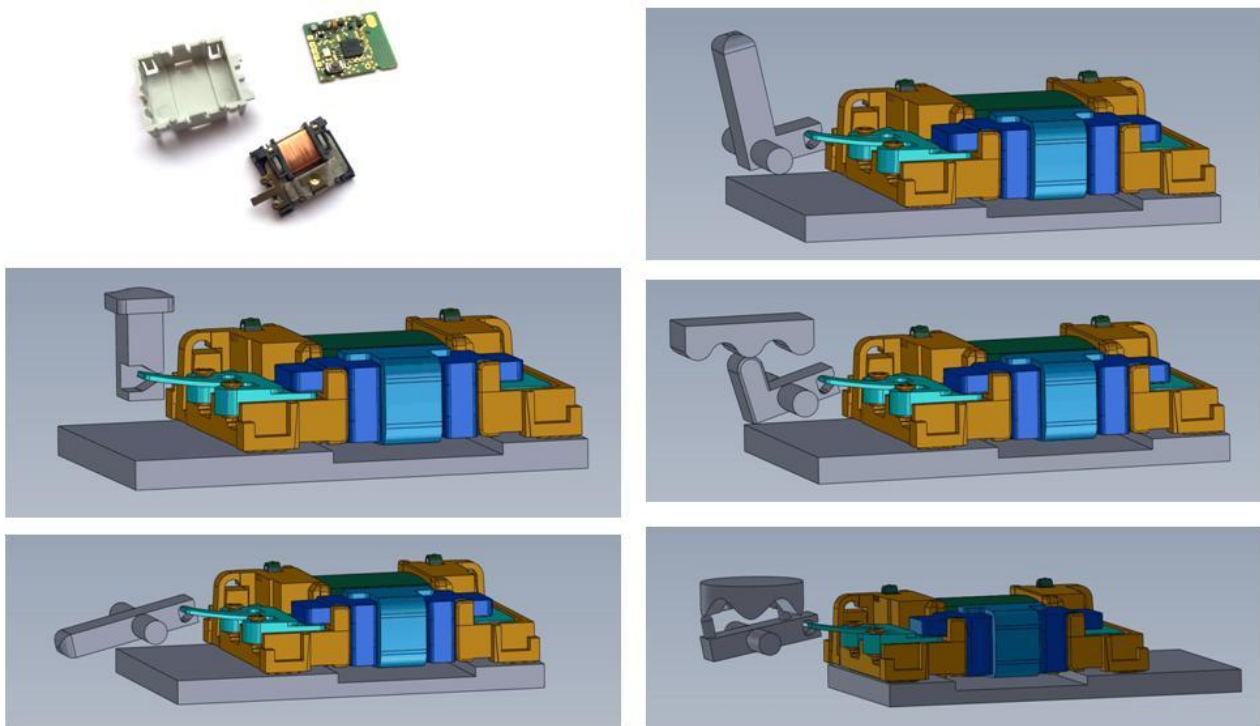

Figure 18: ECO FIXATION HOUSING Reference Designs

5.6.1 Kit Content
- ECO fixation housing
- Small and large restoring springs
- Energy generator ECO 200
- Transmitter module PTM 330

5.6.2 Design Data Provided

ECO FIXATION HOUSING offers perfect positioning of the ECO Generator and the PTM Radio PCB. The housing is intended to allow quick realisation of new ideas by providing easy mechanical interface to the ECO, so your application can be 3D printable

5.6.3 Typical Applications

This is a great space for innovation. Functional principles shown in the above figure are:
- Standard Pushbutton
- Lever Linear
- Lever Orthogonal
- Cam Linear
- Cam Rotary

5.6.4 Tips for Part Printing

- **NOTE: 3D printing of the fixation housing itself is not recommended due to printing tolerances and therefore 3D design data is not provided.**
- The ECO fixation housing is available in low volumes as spare part. For volume applications you have to design a dedicated tooling by considering the ECO mounting instructions and the 3D data of the PTM board that are both provided.

5.7   ROLLING WHEEL

Based on this Reference Design you can design your own Rolling Wheel application (IGS compatible CAD program and 3D printer needed).
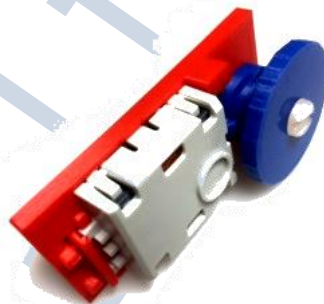

Figure 19: ECO FIXATION HOUSING Reference Designs

5.7.1 Kit Content

- Energy generator ECO 200
- Transmitter module PTM 330
- ECO fixation housing

5.7.2 Design Data Provided

The following Design Data are provided as download (link see chapter 6):
- Design data of plastic parts (3D IGS data), data of ECO fixation housing excluded (see chapter 5.6)

■ Mounting instructions and 3D shape data for ECO and PTM module

5.7.3 Typical Applications

Rotating Knob, Window/Door Handle, Sliding Doors, etc...

5.7.4 Tips for Part Printing

All parts are designed to be printed with FDM/FFF process. The design also integrates the ECO 200 housing for proper ECO 200 fixation. The ECO 200 housing is locked onto the base part with a locking block which should be fixed with some glue.

Based on tolerance requirements given by the PTM module the recommended print parameters are:

- Material recommendation: PLA
- Layer thickness is 0,1mm to 0,2mm according to wanted surface smoothness
- At least two lines as shell wall
- Print speed with <50mm/s
- Infill 25%
- x-y-tolerance <=0,1mm
- Avoid over extrusion

Rework after printing:

- All parts must move freely in the assembly. If the print is slightly over extruded, all excess material must be removed.
- In addition to the printed parts, the assembly uses a small M3 or M4 screw with washer to fix the wheel. The model is prepared to be reworked with a M3 or M4 thread in the wheel shaft area.

6   DOWNLOAD LINKS - Design Data and User Manuals

In the following please find the internet download links for Design Data and User Manuals:

6.1   DESIGN DATA for Reference Designs

The basic design data is available from: **www.enocean.com/design-data**

After registration please follow the link "Design data for energy harvesting wireless switch applications". The following page contains the housing design data and the relevant mounting data and outlines of the electronic modules.

#	Name	Based on	Description in
1	**CLAMP SWITCH**	ECO 200, PTM 330	Chapter 5.1
2	**ROCKER SWITCH**	PTM 210	Chapter 5.2
3	**PUSH-BUTTON SWITCH**	PTM 210	Chapter 5.3
4	**MINI BUTTON**	ECO 200, PTM 330	Chapter 5.4
5	**CONTACT SWITCH (3D printable)**	ECO 200, PTM 330	Chapter 5.5
6	**CONTACT SWITCH (tooling variant)**	ECO 200, PTM 330	Chapter 5.5
7	**ROLLING WHEEL SWITCH**	ECO 200, PTM 330	Chapter 5.6
8	**...**		Find more in future

Table 7: Overview of www.enocean.com/design-data

6.2   USER MANUALS for EnOcean Modules and System Components

The following table shows the internet links to the User Manuals of the enclosed socket plug PSC234 and of the enclosed electronic switch modules and components ECO 200, PTM 330 and PTM 210. This also shows links to the system components TCM 310, USB 300, EnOcean Pi and EnOcean Sensor Kit that are mentioned in Chapter 1.3 for connecting the switches to a radio receiver unit and the IoT.

#	Name	User Manual	Download from
1	ESDK - EnOcean Switch Design Kit	This Solution Guide	www.element14.com/EnOceanSwitchKit
2	PSC234	Plug Receiver	www.element14.com/community/docs/DOC-82028/l/smart-plug-psc234-datasheet
3	ECO 200	Energy Generator	www.enocean.com/en/enocean_modules/
4	PTM 330	Radio Transmitter Board	www.enocean.com/en/enocean_modules/
5	PTM 210	Radio Switch Module	www.enocean.com/en/enocean_modules/
6	TCM 310	Transceiver Radio Module	www.enocean.com/en/enocean_modules/
7	USB 300	Transceiver USB Stick	www.enocean.com/en/enocean_modules/
8	EnOcean Pi	Transceiver for Raspberry Pi	www.element14.com/enocean_pi
9	EnOcean Sensor Kit	Home Automation System based on Raspberry Pi	www.farnell.com/datasheets/1824742.pdf

Table 8: Links to relevant User Manuals

A   APPENDIX

A.1   Spare Parts Service

The parts provided within this Kit can be bought as spare parts as listed in Chapter 2, Table 3.

A.2   Design Service & Support

The following table has some useful links for design service & support:

#	Link	Service
1	www.farnell.com	Technical support
2	www.farnell.com	Distribution of EnOcean Modules (search for "EnOcean")
3	www.element14.com/community/ groups/3d-printing	3D Printing Community
4	www.3yourmind.com	3D Printing service & support
5	www.dimensionalley.com	3D Printing service & support
6	www.fablabairedale.org	3D Printing service & support
7	www.thingiverse.com	3D Data Base for consumer applications (search for "EnOcean")
8	www.semd.de	Volume design & development service
9	www.greenelectric.eu	Web-shop for finished EnOcean products (ready-to-go switches, sensors & actuators)
10	www.enocean.com	Module User Manuals, Kinetic Kit Design Data

Table 9: Useful Internet Links

A.3   Safety Information and Regulatory Compliance

⚠ WARNING: **This kit is intended for use in Europe. The provided power plug applies to Schuko socket system. In some European countries suitable socket adaptors must be used (see chapter 2.3)!**

NOTICE: **This development kit is intended for laboratory use only!**
Products realized with this kit require CE marking, which must be provided by the producer or distributor of the final product.

WARNINGS:

- Devices or modules containing RF components must meet the essential requirements of the local legal authorities.
- The modules must not be used in any relation with equipment that supports, directly or indirectly, any form of life critical applications or with applications that can endanger life or value.
- Any changes or modifications not expressly approved by the party responsible for compliance may 'void' the user's authority to operate this equipment.
- These modules must not be modified or used outside of their specification limits
- These modules may only be used to transfer digital or digitized data; Analogue speech and/or music is not permitted.
- The modules must not be used with gain antennas, otherwise resulting in exceeded ERP or spurious emission levels.

COMPLIANCE INFORMATION:

The EnOcean Switch Design Kit complies with the relevant provisions of the RoHS Directive for the European Union.

WEEE Directive Statement for the European Union:
- In common with all electronic and electrical products the kit should not be disposed of in household waste within the European Union.
- Components of the modules are considered and should be disposed of as hazardous waste.
- Alternative arrangements may apply to local jurisdictions.

European Union (EU) Electromagnetic Compatibility Directive Compliance Statement:
- This product is in conformity with the protection requirements of EU Council Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- This product has been tested and found to comply with the limits for Class B Information Technology Equipment according to the European Standards EN 55022 & EN 55024.

Compliant with: