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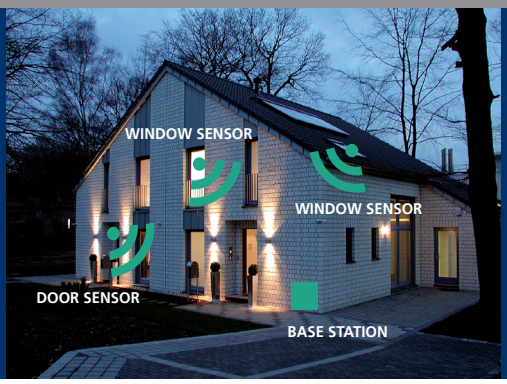

1 *HomeGuardian Application Scenario.*
2 *The Visible Part of the Window Sensor: Solar Cell between the Panes of the Insulating Glass Unit.*

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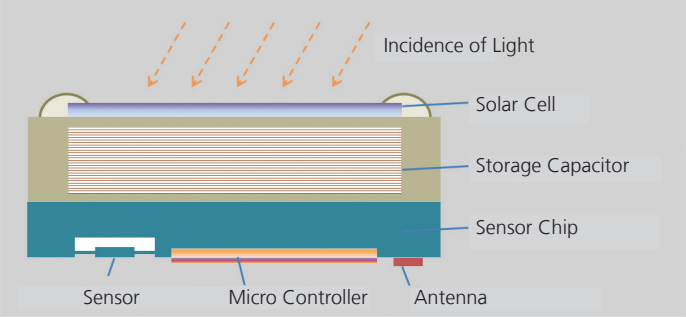
HOMEGUARDIAN – ENERGY-SELF-SUFFICIENT SENSORS MONITORING THE HOUSE

In the majority of cases it is desirable or even necessary to be permanently aware of the status of a window or a door. Not only to assist the inhabitants in ventilating the room, but also to secure the window against burglaries, an electronic surveillance of windows and doors is useful. As statistics show, concerning single-family-homes as well as terraced houses, burglars prefer non-observable windows and patio doors to enter the house. Thus, an early and reliable detection of the act of housebreaking is required, preferably even before the door or windows yields to the house-breaking tools. Until now, the recording of the status usually took place by means of window contacts. There are two different versions of window contacts available: tethered and wireless. Tethered window contacts have been introduced on the market some time ago and are tried and trusted. However, their major disadvantage is the great effort that is necessary to equip, in particular, buildings with a large number of windows. In most cases a refit of already existing buildings does not pay off since retrofitted cabling is extremely effortful. In recent years, wireless window contacts became available for that very reason. Most are powered by batteries recognizing the status of the window via simple magnetic contacts, and transport the collected data by radio to the home automation. One major disadvantage is that batteries need to be replaced at regular intervals. Unfortunately, this maintenance is often omitted with the result that the window contact becomes inoperative. A solar cell might solve this problem, but in that case a concealed installation of the contact is rendered impossible, which in many cases is required due to various aesthetical and practical reasons.



HomeGuardian Window Sensor

This is why the energy-self-sufficient window sensor »HomeGuardian«, which operates without being dependent on batteries, has been developed at the Fraunhofer Institute for Microelectronic Circuits and Systems in Duisburg. In addition it identifies the three window positions without the need of magnetic contacts. Apart from that, a micromechanical sensor is integrated within the window sensor, which recognizes any kind of vibration – for instance in the event of a burglary.

The window sensor derives all of its energy from a solar cell and hence is independent from cables as wells as high-maintenance batteries. By that any kind of additional effort in terms of installation and operation rendered superfluous/redundant. This unique solar cell has been conjointly developed by Fraunhofer IMS and in cooperation with the company SOLCHIP. The solar cell is produced directly on the surface of a CMOS micro-chip and by that it can be applied cost-effectively during the manufacturing process of the micro-chips.

What is special is the position of the sensor and its solar cell: The gap between the two panes of an insulated glass unit provides optimal luminous efficiency. The sensor is mounted on the lower part of the spacer between the two panes of insulating glass. Since in most cases windows are cleaned well-enough, even in winter the charging of the energy storage is sufficient for the operation during night time.

The window contact identifies via its electronics each of the window positions and either the diagnosed status or else the alarm is send to a base station.

HomeGuardian Basis Station

The base station is the interface of the home automation. It is installed in a suitable spot, e.g. on the ceiling or inside an electric socket. Apart from a large number of window contacts the base station is able to register additional wireless sensors. For instance motion sensors, smoke detectors, light intensity sensors for shading control, temperature sensors for climate control, or heat quantity meters for consumption control. Depending on the configuration of the system the sensors are scanned at either minute or second intervals and the established data is forwarded to the home automation. In the case of short intervals it is makes sense to connect the base station to a 230 V power supply system.

In the case of longer intervals it is possible to run the base station on batteries. A third alternative is »power over Ethernet« or the supply via home bus system. This option enables on the one hand smart power supply and on the other hand a simultaneous interconnection of one base station with other base stations and the central home automation. Apart from that radio networking of all base stations is possible. In that case all base stations are network nodes within a wireless sensor network; however the real sensors are mounted inside the windows.

Advantages of the System

Compared to other existing systems, this realization has significant advantages:

- Suitable for both new and existing buildings
- Discreet and unobtrusive mounting spot
- Window contacts cause no additional maintenance expenses
- No failure due to dead batteries, therefore, a high availability of the entire system can be ensured
- High security and reliability of the system with low maintenance effort
- The integration of additional sensors, e.g. light intensity sensors, temperature sensors, or heat quantity meters is feasible

The HomeGuardian System is currently beeing developed at Fraunhofer IMS. Cooperation partners for further development and marketing are looked for.

Project partner in the development of solar cells:

SOLCHIP
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3 *Cross section of the window sensor micro system.*