Smart Home, Building, Flat

eHouse CAN (Controller Area Network) wired

eHouse RF MESH (868, 902, 915MHz) wireless

Home Automation Systems

Table of contents

1.Introduction.

"Smart home" term means all sort of home, building automation systems for controlling, driving of independent systems and installations incorporated in the building. Home automation systems can manage many different building types: house, flat, offices, hotels, etc.

Home automation systems currently are most important system for tuning and equipping of the house.
Along with more and more expensive energy prices, ecology restrictions for new buildings, adjusting to investment expectations these system are practically inestimable.
Flexibility of some home automation systems allow to reconfigure it together with changes of expectations during usage of the building, without necessity of changing traditional electric installations together with drastic renovation of the house.
Home automation systems allow increase comfort of living, security, economy, save energy, reduce price of living in the house or flat.

1.1. Convenience, comfort , automation.

Usage of eHouse system enables complex, local and remote control of light, temperature, electric and electronic devices in the house, flat, office, hotel, etc. It creates possibility of controlling Audio - Video, HiFi systems by emulating infrared remote controller signals which can be learn and executed by eHouse system. There is possibility of managing very advanced boiler room installation: heating, cooling, recuperation, ventilation, solar, boiler, heat water tank, bonfire with water jacket and hot air distribution system.

eHouse enables controlling system by common switches, IR remote controller, Smartphone, Pod, GSM mobile phone, PC, graphic touch panels working on Windows, Android, Linux and in web browser.

PC support enables creating own software which works together with eHouse package, performing logs and run advanced users algorithms which can be necessary or appear in the future.

1.2. Security.

Home is a place exposed to various dangers only because of the distance from the neighbors and a much larger number of weak points: the possibility of intrusion, theft, flood, fire, and sabotage. In the absence of a good security system and alarm sensors monitoring of all events, it isn't sufficient to rely on “good” neighbors who live several dozen meters away.

eHouse Application system significantly increases the safety of the house and adjacent buildings because it has an integrated security system with GSM/SMS notification. It allows you to connect any alarm sensors available on the market , eg. motion detectors, glass break, reed confirming the closing/opening windows, doors , shutters , water, fire . Security system can be activated outside a protected zone, not giving intruders the time for action.

eHouse system also enables multi-channel control of blinds, awnings , gates and garage doors. Security system can be used not only as an installation to protect against burglary, but also random events such as fire, flood, too low/high temperature, too high wind speed, etc. eHouse system enables automatic execution of programmed operations resulting from an alarm signal.

The system allows to imitate the presence of family members, for example by turning on lights or turn on/change the TV or radio programs. This seriously discourage potential intruders watching the house from

getting into the house.

1.3. Cost-effective , energy saving.

The use of eHouse smart home system provides significant savings of energy used to heat your home.

The use of low-cost energy sources (sun, solid fuels, wood), the accumulation of heat energy in the buffer and optimal control them, guarantees a savings of several hundred percent.

Additionally multi-point individual heating management in the rooms, gives effective control, ensures the required temperature in all areas and 100% of energy use for heating. In this case, each room temperature is maintained at the required ranges, regardless of:

- time of day
- time of year
- outside temperature
- solar heating
- wind direction and strength
- other climatic and atmospheric conditions that affect directly and independently to each room.

This normally effect in large temperature differences in the rooms , depending on the time of day , year and weather conditions in case of central heating. In the case of multi-point heating control does not overheat one room, in order to obtain the desired temperature in the other.

This does not cause a large loss of energy, as in the case of the use of central heating , and allows a further reduction in heating costs by tens of percent.

Additional energy savings can be achieved by automatically switching off lights in rooms where nobody is present , eg. by control lights from motion detector or turn on only for a short programmed period of time.

These capabilities allow eHouse home automation system to refund itself within 1-3 years, depending on the used energy sources.

Integrated alarm system with GSM notification enables effective home security and property against intruders. The use of an extended and large capacity scheduler allows the programming of repetitive tasks to perform automatically. Continuous development, expansion and the ability to connect a variety of devices and sensors available on the market companies can implement very complex projects and control virtually everything that can be controlled electronically.

eHouse system can be controlled via IR remote control , PC , Pod, smartphone , graphic panels, standard electrical switches , web browser , etc. The control can be done by any of communication media: Infrared , Ethernet (LAN), WiFi, SMS , Internet.

eHouse system uses standard electric actuators , switches , pumps available on the market that do not have built-in logic and does not require the use of expensive, dedicated devices. PC cooperation enables easy control of eHouse system, create own applications on the system or advanced control algorithms . All versions of eHouse cooperate with each other via the eHouse4cServer software installed on Linux and therefore can create any hybrid of eHouse system configuration depending on the needs of the investor or the installer, optimality and cost of the version.

Provides automatic and optimal control of parameters such as lighting, temperature, heating , leading to a reduction in energy consumption and ensure refund of the costs of the system within 1-3 years.

The system can operate in a residential flats, offices, hotels , public buildings , and access control and permissions.

Installation can be economical, comfortable or maximalist .

2. eHouse CAN / RF.

Ehouse CAN/RF system is an advanced solution of smart/electronic home, allows you to control and integrate multiple devices of various types.

Ehouse CAN/RF can be mounted directly in electric sockets / cans:

- eHouse CAN – wired system (Controller Area Network)
- eHouse RF – wireless MESH PRO infrastructure (RF Radio Frequency Sub-GHz **848MHz, 902MHz** or **915MHz**)

based on the same PCB core. For wireless radio operations it requires only plug in RF module on desired band. **Not all bands are legal for some countries and jurisdictions.**

eHouse CAN / RF works under the supervision of a PC or any microcomputer system based on Linux (eg Raspberry Pi, Raspberry Pi 2, Banana Pi / PRO) operating system. Bundled software eHouse4cServer (partially Open Source) allows full control and system integration of eHouse CAN/RF with other versions of eHouse system eHouse : RS-485, LAN, PRO, CAN, RF and future products.

Apache web server software with eHouse4Apache module enables integration eHouse4CServer, eHouse.PRO which allows complete control, management, configure from a Web browser. This way, the user has full choice of control panels, smartphones, Pads, Pods, Smart TV or even to the preferences of your web browser.

eHouse System is a modular , enabling optimal use of controllers , adjusting the installation to suit your needs and the planned budget. eHouse CAN/RF system is made in a decentralized wide area network architecture, allowing local control of individual points and minimizing electrical 230V wire length several times and repeatedly reduces the financial outlay for the installation compared to centralized systems. Ehouse CAN/RF smart controllers have dimensions for mounting in the deep wall socket and is very easy to install. On the controller board or additional relay module it contains up to 4 relays 230V/5A for direct switching of electrical appliances or power.

"**Ehouse CAN**" controllers are connected to each other with flat tape 6 -10 pin or UTP-8 twisted pair for computer networks, which allows you to install the system even during the renovation of the house, without too much devastation.

"**eHouse RF**" controllers are wireless, using MESH MiWi Pro architecture which makes it ideal for installation in old building without any devastation. It works in free RF baseband **868MHz**, **902MHz** or **915MHz** depending of plugged in RF module to controller. Used basebands are much less occupied than standard 2.4GHz (WiFi, BlueTooth, RF home automation systems, ZigBee, Wireless Remote Controllers, etc). It is also very suitable for outside installations (sensors, outputs) where putting wires would be very difficult, impossible and expensive.

Additionally it have much better propagation of RF waves and range comparing to 2.4GHz networks (3-5 times).

It especially concern going through the walls, chimneys, metal shields, concrete etc.

MESH network term means that in case of no direct link to main host, other devices on the range can route data indirectly.

2.1. eHouse smart home modules.

- Room controller - RoomManager (RM) { eHouse 1 - RS-485}
- Rollers, gateways, gates controller - ExternalManager (EM) {eHouse 1 - RS-485}
- Flat controller - LevelManager (CM / LM) { Ethernet eHouse (LAN)}
- Boiler Room, ventilation, recuperation controller - HeatManager (HM) {eHouse 1 - RS-485}
- Rollers, gateways, gates controller with Ethernet, GSM and integrated security system - CommManager (CM) {Ethernet eHouse (LAN)}
- Smart I/O controller CAN (Controller Area Network) { eHouse CAN }
- Smart I/O controller RF (MESH wireless network 868 or 915 MHz) { eHouse RF }
- RS232/RS485 Converter {eHouse 1 - RS-485}
- RS232/CAN gateway { eHouse CAN }
- RS232/RF gateway and PAN RF network coordinator { eHouse RF }

The modular nature of the eHouse system installation allows you to select individual variant of installation , which will be suitable for every investor such persons installing the system in homes that do not require shutters security system controller , driver, or CO boiler installations intelligent building. These people can simply opt out of these modules , and install only the modules RoomManager or LevelManager to control lighting , heating multipoint , equipment, Audio / Video, etc.

Alternatively, a smaller modules Intelligent home eHouse CAN/RF can be used for electric cans / socket montage whenever we need.

It is possible to create any hybrid installation using one of following eHouse system components

- LAN
- PRO
- RS-485
- CAN
- RF

and integrate them in one eHouse system with eHouse.PRO server application for Linux. This gives possibility eg. to use wired LAN controllers (in the rooms) and RF controllers outside or far from building where it is not economical or easy to put cables. RF controllers additionally gives workaround to add anything to the system, if we missed something on stage of creating wired installation.

2.2. Features and capabilities of eHouse CAN/RF system.

Ehouse CAN/RF system is based on a small electronic controller, which also has a much greater variety of system events and its spectrum, in principle, cover all functions of drivers eHouse 1 and Ethernet eHouse controllers. This architecture is particularly advantageous in the case of:

- low-budget installation - a small amount of controlled points
- highly dispersed controlled points in installation
- installations performed during the renovation (not in the raw state of the building)
- installations where previously laid cables 230V and the investor before plastering the building decided at the last minute for building automation
- very small amount of roller shutters, doors , awnings , and other drives and unprofitable driver installation blinds CommManager
- there is no need to use advanced boiler control HeatManager
- trying to replace old building automation installations made on the same scheme: in the wall sockets with a communication cable (for CAN bus) + power
- wireless radio home automation (RF) version

eHouse CAN/RF Smart Controller has the following options:

- Complete control of electrical equipment , electromechanical , electronic (on/off)
- Control Audio - Video equipment (learning and emulation of IR RC signals)
- Measurement and control of light level
- Measurement and control of heating - temperature
- Multi-point, hybrid control of heating - individual heating by various sources in the rooms
- control of boiler and central heating
- ventilation control, recuperation, intakes, heat exchangers
- boiler control
- control of the fireplace with a water jacket and/or the distribution of hot air
- control of solar systems
- control of a heat buffer - tank and DHW
- graphical visualization of events - individually created images of rooms and devices (web browser , Java or Android)
- control system, roller shutters, awnings , gates , windows, servos and other drives in many standards
- creation of logs in the system (PC)
- the use of third-party actuators, components and systems (such as water valves , electronic

locks, driveway gates , electronic controlled awnings and blinds , etc.)

- the use of analog and digital sensors , third-party devices (eg motion detectors, gas , humidity, wet, fire, etc.)
- control system via a Web browser from any device and operating system
- remote control of the system via the IR remote controllers (Sony standard)
- text and graphical remote control and configuration via LAN , WiFi , Internet from Web browser
- graphical remote control by mobile phone PDA, smartphones, Pods, Smart TV or other device with a touch panel (Android application WiFi, SMS or eMail, JAVA, Web browser)
- notification of alarms via SMS and change zones (to preset groups of people) (eHouse4cServer, eHouse.PRO)

eHouse system has built-in self-monitoring and the creation of logs , which ensure reliable operation of the system and allows rapid recovery in the event of problems

2.3. Versions of eHouse home automation system .

Due to the network infrastructure eHouse system , it can operate in five basic versions:

- eHouse 1 - working on the RS485 bus under PC or CommManager supervision
- eHouse LAN (Ethernet eHouse) - working directly in an Ethernet (LAN) network topology
- eHouse CAN - working on a Controller Area Network serial bus under the supervision of Linux computer or microcomputer. Installable in electric cans / socket
- eHouse RF – wireless radio based on radio MESH network working in one of bands Sub-GHz (868MHz, 902MHz or 915MHz) under Linux computer supervision. Installable in electric cans socket
- eHouse.PRO – Centralized version for Main Switch-Board for elevation or whole building. It also enables integration of any hybrid configuration of all currently available eHouse versions.

2.3.1. eHouse CAN/RF under PC supervision.

The PC is widely understood microcomputer running the Linux operating system. This could be, for example, the Raspberry Pi, Raspberry Pi 2, Banana Pi/Pro, microcomputer board working with the SD card. Ehouse4cServer, eHouse.PRO software on Linux without a graphical environment provides very efficient operation of the system, much more stable and more economic than Windows applications and other systems, operating in graphical environment .

eHouse4cServer software is written in low-level C language (not C++) so that it can practically be compiled on any version of Linux and CPU (x86 , x64 , ARM, Atom , etc.). The source code is highly scalable and can be compiled using compilers, even for the simplest 8bit microcontrollers.

All smart eHouse CAN controllers have equal rights and communicate with each other directly without a PC. They are configured remotely from a PC with the software installed eHouse4cServer directly from a Web browser. eHouse CAN controllers network are connected to PC via CAN-RS232 smart converter (gateway).

"**Ehouse RF**" smart controllers have 4 types of roles to manage and maintain proper communication link together with eHouse Home automation algorithms and services:

1. PAN Coordinator for wireless network to manage all other controllers and route all data between nodes. It gather status information Additionally It contains RS-232 gateway to PC for communication. It do not contains any eHouse inputs, outputs and eHouse algorithms and only acts as communication interface and data grabber. This is dedicated device with dedicated firmware of PAN Coordinator. **(ONLY ONE DEVICE CAN BE INSTALLED for single network)**
2. Fully Functional Device (FFD) are end nodes controllers, which can't route information and can connect only to Coordinators or PAN Coordinator. It contains:
   - Inputs ON/OFF (*)
   - Measurement Inputs (*)
   - IR Receiver
   - LED PWM Dimmers
   - IR Transmitter
   - Digital Outputs

   which are fully supported by eHouse firmware algorithms. This device is powered and working all the time sending and receiving data to the MESH network. Can be managed by PAN coordinator or one of coordinators. (**)
3. Additional Coordinators (CO) for expanding range which can route data as well and are managed by PAN Coordinator or other Coordinator. This device contains the same eHouse functionality, hardware and algorithms as FFD device, however it utilize more network traffic then FFD. (**) (***)
4. Reduced Functionality Device (RFD) have equivalent hardware for input signals (*) as FFD but do not have outputs functionality support. This device is battery powered and "sleeping" most of the time and "wake" sequentially or on button pressed. Its sends its status (inputs or measurement) to coordinator. Limited functionality minimize battery utilization and live time of the controller work. (**)

FFD (2) and CO (3) have the same hardware however other firmware for other roles support. eHouse system Algorithms and functionality are the same.

RFD (4) can have different hardware and different firmware from FFD, maximally limiting battery utilization.

Controllers roles are initially programmed and must be properly located during installation.

(**) - up to 250 / (8000 in theory) counting all together (RFD, CO, FFD) can be used.

(***) - up to 64 of coordinators can be used.

Theoretical amounts can be reached by ordering and load individual firmware & software,

however it could use much more resources which will limit some eHouse functionality.

"**eHouse RF**" controllers are configured remotely from a PC via eHouse.PRO, eHouse4cServer software, directly from a Web browser. Ehouse RF controllers network are connected to PC via: **RF PAN Coordinator & Gateway MESH / RS232 (1)**.

Although all eHouse RF controllers operates locally and in RF network, independently from the PC , but its greatly extends the capabilities of whole system. It is not necessary the use of a typical desktop computer, it may be for example, low cost microcomputer board. Your computer needs to work on Linux.

Ehouse CAN/RF system uses following software :

- eHouse4cServer, eHouse.PRO - eHouse server software (All in One)
- Apache Web Server - for direct integration with a web browser
- eHouse4Apache - Apache web server communication module/gateway software for integration with eHouse4cServer

Integration and cooperation of these applications allows you to configure , full control , text and graphical visualization from Web browsers. As a result, there are no restrictions on the controls, graphic panels , smartphones, Pads , Smart TV or even Web Browser type. Currently it only depends on user preferences or accessed device at the moment.

2.3.2. eHouse CAN data + power bus.

All **eHouse CAN** system devices work on a CAN bus (Controller Area Network). Only eHouse CAN smart controllers can work on CAN bus. This bus is connected to the converter (CAN - RS232C / USB) or interface board for Raspberry Pi, Banana Pi / Pro. RS232C-CAN Converter translates control commands to the differential CAN bus (and vice versa), which provides data security, trouble-free transmission with high speed transfer over long distances (hundreds of meters long and 100kbps) .

Bus wiring is placed in series, one segment after the other by combining the controllers.

At the ends of pairs of lines terminators are used - 120 oms resistors. We suggest connect additional power lines in parallel to serial cable to protect against voltage drop in the cables every several controllers in series.

For smaller homes you can lead wires in a star topology, which allows a much simpler installation, service, test and measurement.

In any case, it is necessary to fully test the system and the wiring before plastering, because later repair of faulty wiring is very tedious, time-consuming, expensive and requires major construction work like chiselling and repair .

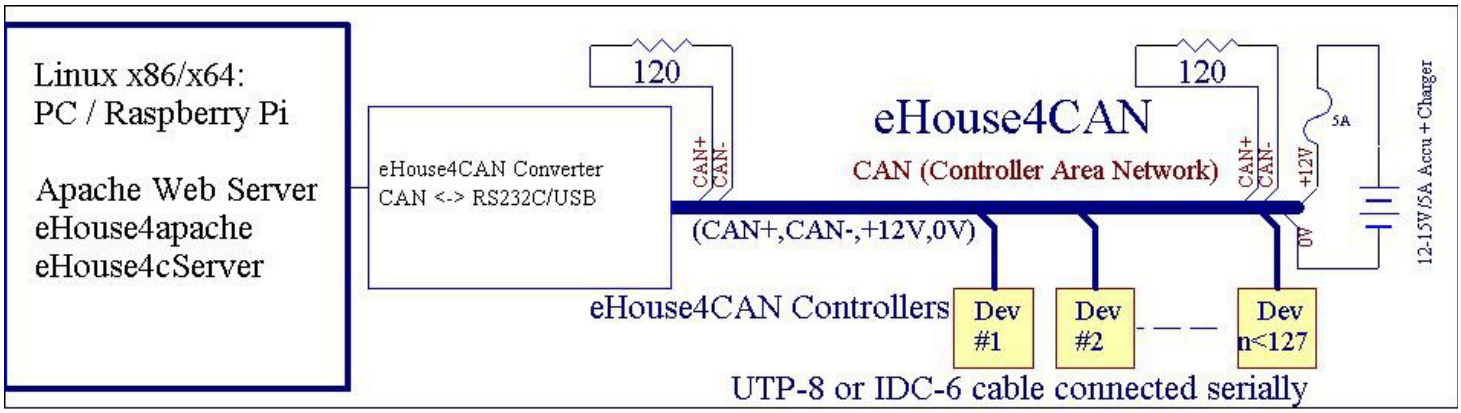

Figure 1 Schematic of eHouse CAN smart home installation.

Ehouse CAN system allows the use of up to 100 devices on a single bus (without line amplifiers). Each one must have unique addresses. Each device has a 2-byte address consisting of two components ADRH and ADRL . Each eHouse CAN device has ADRH = 127 (0x7F). New controller must be attached to the bus and immediately changing the default address to another (only ADRL component to not overlapped) . Addresses need to be assigned sequentially from one (1) upwards. Addresses 250 .. 255 are reserved for special functions , including CAN converter < -> RS232, gateways, line listener, etc .

eHouse4CAN bus consists of two signal lines CAN+, CAN- (differential) to transmit data in both directions and 4 power lines 2*GND and 2*12V power supply and relay drivers. The cable used to distribute controllers among all the bus is a standard computer cable UTP-8 (8 wires). In the case of UTP-8, be sure that signal pair (CAN+, CAN-) was on the same twisted pair, in order to minimize noise picked up by the cable length of up to several hundred meters.

Alternatively, up to 100m total length, you can use a flat cable IDC-6, by which is much simpler to install the system. Power supply voltage (GND , +12 V) must be secured by 2-10 amps fuse, depending on the number of connected controllers (counting 0.2A per eHouse CAN Controller).

If you need to distribute the cable outdoors or in damp areas we recommend to use the casing pipe diameter PE selected so as to put the cord through it.

Before starting the installation and configuration it is the best to develop the project or draft

containing the location of the different devices (alarms sensors, controllers , sensors , and give them unique names, short and clear) and project deployment cabling to facilitate repair possible in the case of later problems with the system (drilling of cables, adding some controllers, etc.) .

eHouse CAN bus cable should be placed in crude residential building for plastering and taking maximalist version, which will enable the incorporation new controllers when user wants add new devices after finishing and equipping home.

Ehouse CAN bus cable with the controller is mounted in a separate electrical box (deep) to protect against accidents and stray voltage .

To neighboring socket cans in the common terminal must lead wire to the inclusion of external voltage controlled devices (up to 4 on one eHouse CAN controller) . Relay module should be located in other socket can then electronic controller for safety.

To power eHouse CAN system we recommend using the accumulator and 12V-14V charger providing continuous power to the controllers , alarm sensors and a microcomputer host.

2.3.2. eHouse RF MESH wireless network.

Ehouse RF wireless home automation system is based on “**MiWi PRO**“ **MESH** network protocol based on license from **Microchip Cooperation**. Ehouse RF uses best and highest quality RF modules for **MiWi PRO MESH** network for **868MHz, 902MHz** or **915MHz** bands manufactured by Microchip Cooperation.

Modules meet all compatibility and restrictions compatibility with any FFC, EU, CE norms regarding to radio frequency transmitters, EMI emissions etc. assured by its manufacturer “**Microchip**”.

It should be taken into account that not all frequency band may be allowable at some countries and jurisdiction.

All eHouse RF vital components (microcontroller, RF modules, MiWi Pro stack, compilers) comes from one manufacturer “Microchip” assuring most secure, stable and reliable work of MESH wireless network. User can chose one frequency band for installation by changing RF module and change configuration of eHouse RF controller. Sub-GHz bands was chosen because its much less utilized, disrupt, loaded then common 2.4GHz band (used by WiFi, BlueTooth, ZigBee, RF Remote controllers, etc.).

Much smaller frequency assures better radio waves propagation and range (3 times) then 2.4GHz band.

There is also much better propagation through barrier materials as concrete, walls, ceiling, chimney, ground, metal shield, etc. Range was tested: several hundred meters for open space and through 60cm of concrete without enabling additional LNA and at 0dBm transmit power.

Besides MESH topology assures routing data for out of range nodes via coordinators (CO) serially. In case of distort channels devices can switch to another (0-26).

Ehouse RF limitations current (theoretical)

- Max number of Coordinators (CO): 64
- Max number of nodes (COs+RFDs+FFDs): 250 (8000)

Wise planing and placing of **coordinators** and **PAN coordinator**, choosing unused band and channels, assures stable and good quality communication in rectangle 1000m*1000m of open area or 100m*100m building - build from common materials.

The easiest way to plan coverage of band over the building and premises is as follow:

- Before decided which frequency band of 868MHz, 902MHz or 915MHz to use, test all of them at each channel at the edges of premises, if there are other wireless installations in the neighborhood. It could take hours to scan all channels but if there would be colliding networks in range the effort will pay off. Chose the less occupied band considering all channels. You should have in mind that wireless intelligent home automation controllers as eHouse RF itself, switch to other channel in case of noise environment automatically, that's why all channels should be check. Ehouse RF however manage himself with colliding networks and ignore data, but the less traffic in frequency band the better for stability, quality of signal, missing events, statuses, re-transmissions etc.
- Count and buy required number of controllers CO, FFD, RFD for required frequency band.
- Locate Wireless network PAN Coordinator/gateway together with PC circle about in the middle of building
- Locate one Coordinator on each elevation/floor above and below (more or less at the same place)
- Locate Coordinators in each corners of building on each floor. If the distance from PAN Coordinator to any Coordinator is greater then 10 metters you should test RSSI level (signal strength indicator) with „Zena Wireless Network Analyzer", level should be greater than 30. Otherwise you can add another coordinator in the middle of length of this segment or change location to obtain better path (propagation) of radio waves. Avoid concrete walls, chimneys, metal shield in stright path of view each coordinators to PAN coordinator.
- Coordinators (CO) are fully functional „eHouse RF" devices so you can install up to 64 of them spread them over the house and permises instead of Fully Functional Devices (FFD). Hovewer best way is to keep some of them for „plan B" if we have communication problems after plastering walls, finishing building, final installation of the system, sockets and other equipment. On the other hands coordinators generate more traffic in radio signals comparing to FFDs because it broadcasts received information further and information is retransmited as many times as many coordinators receive a broadcast.

3 eHouse CAN/RF Intelligent home electronic modules .

3.1. Smart home eHouse CAN/RF system controller .

Ehouse CAN/RF smart controller is a "micro computer ", for control electrical appliances, electronic and electromechanical in its near location.

Ehouse CAN/RF smart controller has the following hardware resources:

- 4 programmable relay outputs (230V/5A AC/DC) to turn on/off devices (resistive load) – relays depends on version of hardware (optionally on mini-relay module)
- 4 programmable inputs (on/off) switch, which can be connected to external sensors, switches or mechanical switches for information of opening doors, windows, etc. These inputs, depending on the state, can be assigned to specific events, triggered on change of state
- 2 analog inputs - measurement with programmable thresholds (min, max) , which can be assigned to specific events (when crossing the threshold). ADC input can be connected to the temperature sensors, lighting, wind strength, humidity, etc. You can connect any 5V powered sensors with low supply current (10mA max). It is also possible to measure the voltage on these inputs.
- 4 programmable dimmers PWM / DC (Pulse Width Modulation) low-power, regulating the level of indoor lighting (without the built-in PWM output drivers – which are build in on external relay modules sufficient for driving 12VDC LED strips)
- RS232-TTL port to install system extensions - future and dedicated applications
- built-in clock
- infrared receiver (IR) to control via the remote control panel (standard Sony – SIRC)
- infrared transmitter (IR) to control external audio/video devices, with learned remote control signal by sending the device
- the ability to connect max. 100 (250 – with CAN bus amplifier) controllers for "**eHouse CAN**" and up to 250 (8000 in theory) for "**eHouse RF**".

Any eHouse CAN/RF smart home controller is configured and managed via PC (Linux) and eHouse4cServer, eHouse.PRO server application that allows you to program all the parameters of the module and to program the startup conditions of all signals. Each signal has a number of events and options dependent on signal type and are discussed later in this document.

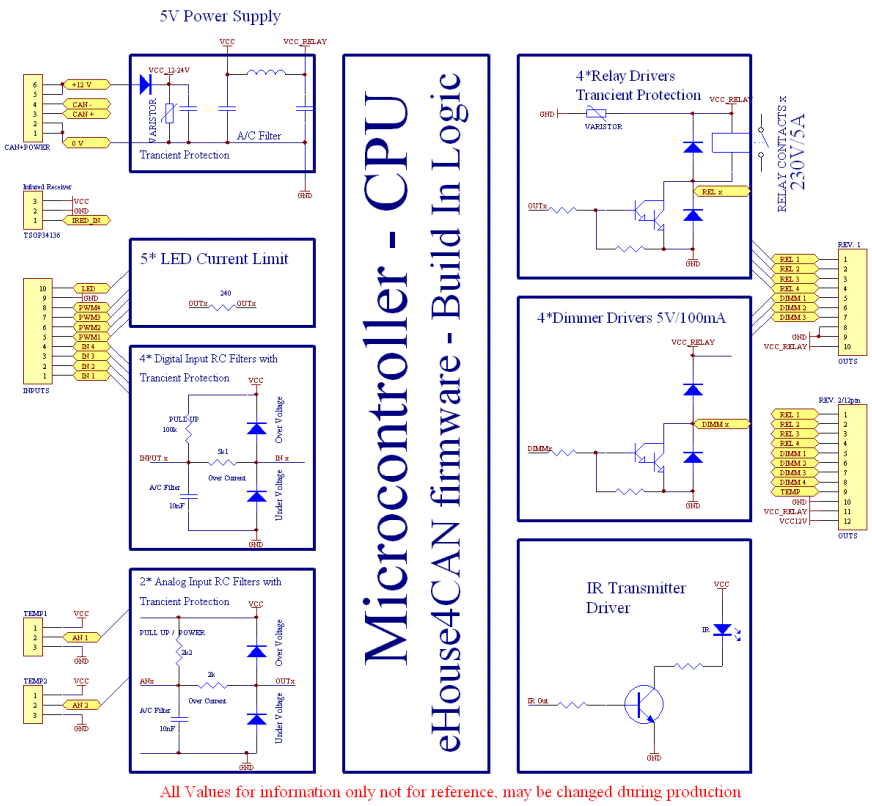

Figure 2 Functional diagram of the smart eHouse CAN/RF controller .

The signals are divided into input and output signals.

The input signals are:

- All analog inputs (measuring)
- all inputs (on/off)
- infrared (IR)

The output signals are:

- digital outputs
- dimmers (PWM output)
- transmitter infrared (IR)

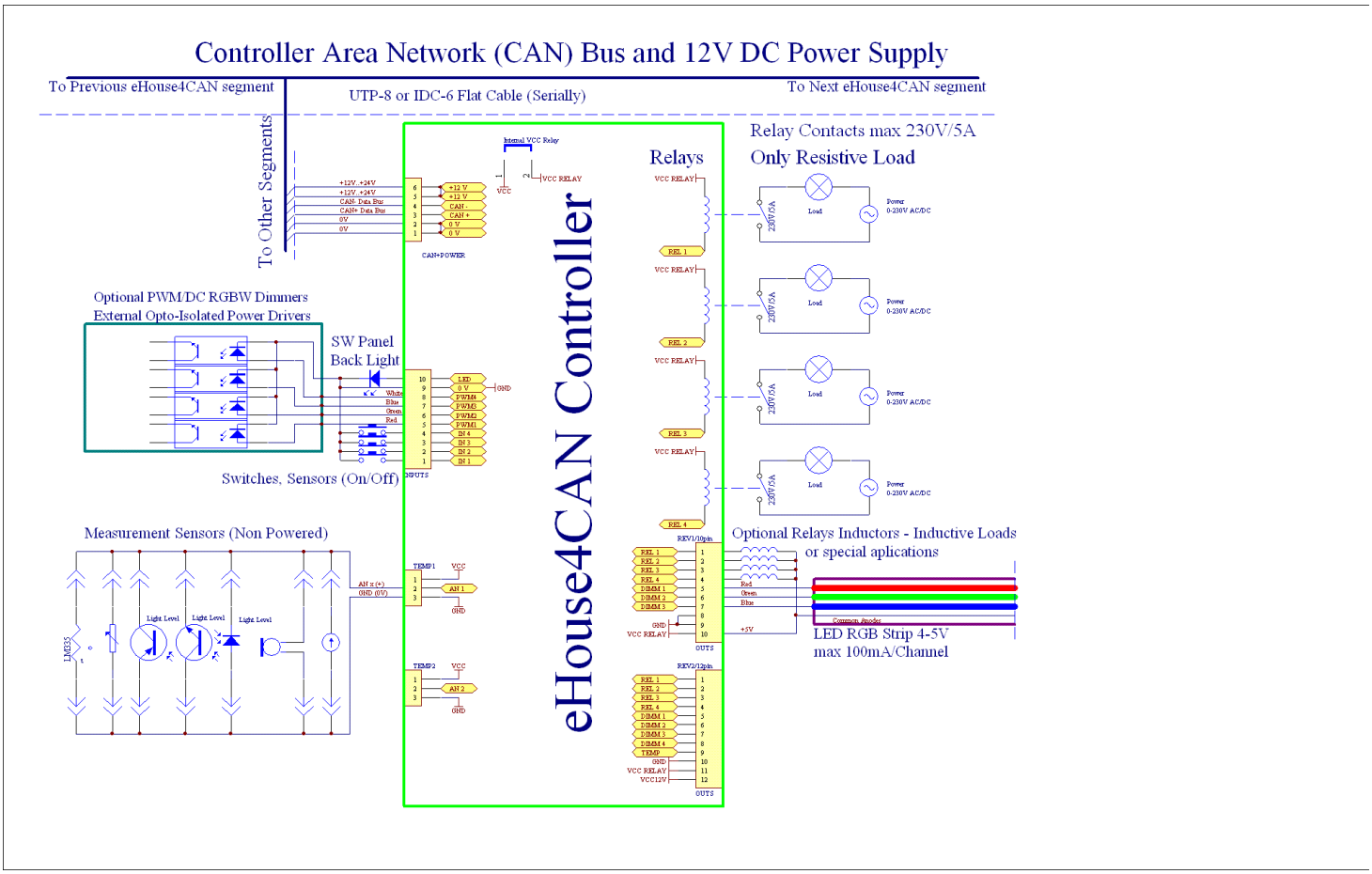

Figure 3 Wiring diagram of smart controller "**eHouse CAN/RF**" installation of building automation

Although smart "**eHouse CAN"** and **"eHouse RF"** can work locally and respectively in **CAN** or **RF** network independently from the PC (acting all programmed functions and control other units in the CAN/RF network).

The PC also allows you to:

- the creation of logs in the system
- receiving control commands from the Internet
- receiving control commands via TCP/IP
- receiving control commands via SMS
- send SMS alerts through GSM modem
- future receive control commands from other media of communication
- visualization control of your PC and the Internet
- playing acoustic communications system
- monitoring operation of the system and information about errors and problems

- perform dedicated algorithms to expand eHouse system functionality
- increase its functionality (with the user's own algorithms)
- multimedia features – VideoLAN
- integration with external systems , Audio -Video , TV
- control and configuration from a web browser
- advanced support for IR and related events
- graphical visualization and control from Web browser
- transmission of data and events to other versions of eHouse system : RS-485, LAN, PRO, RF, CAN

3.1.1. Description signals and configuration.

The names of the signals and controls are located on a single HTML form in a web browser at:

http://inteligentny-budynek.eHouse.pro/ehouse4can/index.php?func=changename&address=7f03 for **eHouse CAN**

http://inteligentny-budynek.eHouse.pro/ehouse4rf/index.php?func=changename&address=7e03

for **eHouse RF**

The configuration of the controller is performed on a HTML form in a web browser at: http://inteligentny-budynek.eHouse.pro/ehouse4can/index.php?func=advancedsettings&address=7f03 for **eHouse CAN**

http://inteligentny-budynek.eHouse.pro/ehouse4rf/index.php?func=advancedsettings&address=7e03 for **eHouse RF**

At http://inteligentny-budynek.eHouse.pro/ is publicly available demo system installation **eHouse RS-485**, **eHouse.PRO** and **eHouse CAN** under eHouse.PRO server based on Raspberry Pi.

For local installation address must be replaced by a local IP of eHouse4cServer, eHouse.PRO.

For **eHouse CAN** controller the address is stored in hex code (in this case - 3rd controller **eHouse CAN**) eg 7f0a - 10th **eHouse CAN** controller.

Address for CAN Controllers contains of 2 bytes.

1. Higher byte should remain always 0x7f (127) because eHouse applications recognize controller type by high address.
2. Lower byte should be in range 1..127 for intelligent home controllers. For larger installations 1..250. Higher addresses are reserved for special function devices (CAN gateway, CAN analyzer etc.). Controllers should be addressed sequentially 1,2,3....

For **eHouse RF** controller the address is stored in hex code (0xfe03 - in this case - 3rd controller **eHouse CAN**) eg 7e0a - 10th **eHouse CAN** controller.

Address for RF Controllers in RF MESH network contains of 3 bytes.

1. Most significant byte of address is Installation address 1..255 in RF range. Installer should test near neighborhood for other installation and set unused address the same for each controller in the installation. Other installations (addresses) are ignored if working on the same frequency band and channel, however best way is to avoid such a collisions and additional traffic for stability of the system.
2. Higher byte should remain always 0x7e (126) because eHouse applications recognize controller type by high address – in this case RF device. In case of larger installation then 250 RF controllers this address should go downwards (0x7d, 0x7c, 0x7b, etc.)
3. Lower byte should be in range 1..120 for intelligent home controllers. For larger installations 1..250. Higher addresses are reserved for special function devices (RF gateway/PAN Coordinator, RF analyzers etc.). Controllers should be addressed sequentially 1,2,3....

After passing RF data from **RF gateway/PAN Coordinator** to PC, first byte (MSB) is omitted because only one installation is supported by one system instance. Only last two bytes are taken to construct eHouse address for events and status: eg. 0x7e03 for third controller.

This convention enables distinguished and transmit events to different installation types in hybrid version of eHouse system.

The whole logic of the forms configuration and change the names in the script is **ehouse4can/index.php** ,**ehouse4rf/index.php** which can independently change for its own purposes (field names , language , etc.) and its own responsibility (improper configuration change can cause blockage or damage to the controller) .

The style of the form can be changed in the file http://www.inteligentny-budynek.eHouse.pro/style_eHouse.css which is much more secure than the modification of the configuration script which can damage controllers or make it non responsive.

3.1.1.1. Analog input converter (ADC).

Each analog input has a measuring range <0 , Vcc> where Vcc is power supply of processor in the controller. All controllers have Vcc=5V except (RFD – which is battery powered (3.3;3.7V) and power supply Vcc is equal to battery/accumulator voltage). Resolution of measurement is 12 bits. They have declared minimum and maximum thresholds at which events are run exceeded previously assigned.

Depending on the input voltage Ux are 3 cases :

- Ux < Umin when crossing threshold the event is triggered, programmed in the form in the "LOW Direct" field
- Umin = < Ux < = Umax when crossing one of thresholds the event is triggered, programmed in the form in the " OK Direct" field
- Ux > Umax when crossing threshold the event is triggered, programmed in the form in the " HIGH Direct" field

It should be noted that these are event codes "Direct Event" that you can copy from the settings by

selecting a signal event for the driver and output, and the "Copy". This allows you to use the full spectrum and far more advanced than the standard events only "on/off".

In "LOW Event" , "OK Event" , "HIGH Event" are only descriptions, which can be arbitrary and serve only to information description of event which has been entered in the "DIRECT EVENT".

For example: turn On of Output 4 (for 1 hour) at the same controller:

in paragraph: Single Output Settings [On/Off]

in box 4) set to On , Repeats : 0, Time On example : 1h 0m 0s (one hour) , Time Off : 0 choose "Copy" for the same field.

Then, as appears copy of the created event "Direct" , press the key combination "Ctr - C" or simply copy, depending on the operating system and press Enter or click "OK" .

Later, in one of the fields "LOW Direct" , "OK Direct" , "HIGH Direct" paste the event and in the box "LOW Event" , "OK Event" , "HIGH Event" to create short and an intuitive description.

Another point is the threshold of the minimum and maximum measurement inputs in the fields : "Low Level" and "High Level". If you cross the value of these thresholds by the sensors will be running events associated with them respectively.

These inputs in relation to eHouse RS-485 or eHouse LAN controllers have a much more features and functionality.

Additional options for analog inputs:

- Invert (*) - the input is an negative scale mapping ie. 100%-x
- Alarm Delay - delay issue alarm by the programmed time. This feature is very helpful for example when we measure a parameter, and run the event "to control" parameter. After the time of alarm delay if the value is not corrected (regulated) by the actuator the alarm is issued.
- Alarm LOW - activating an alarm in the event of dropping measured value below the lower threshold. The alarm is activated with delay set in the "Alarm Delay" if the value is not corrected (regulated) before this time
- Alarm HIGH - activate the alarm in case of increase measured value above the upper threshold. The alarm is activated with delay set in the "Alarm Delay" if the value is not corrected (regulated) before this time
- Disable Event - blocking action thresholds related to events such as: if it is winter it is not necessary to control the solar collectors etc.
- Admin (*) - administrative settings. Some parameters can be changed only after setting “Admin” flag to protect against accidental erroneous controller configurations such as changing the flag "Invert"

(*) - Requires setting a flag Admin to modify this parameter.

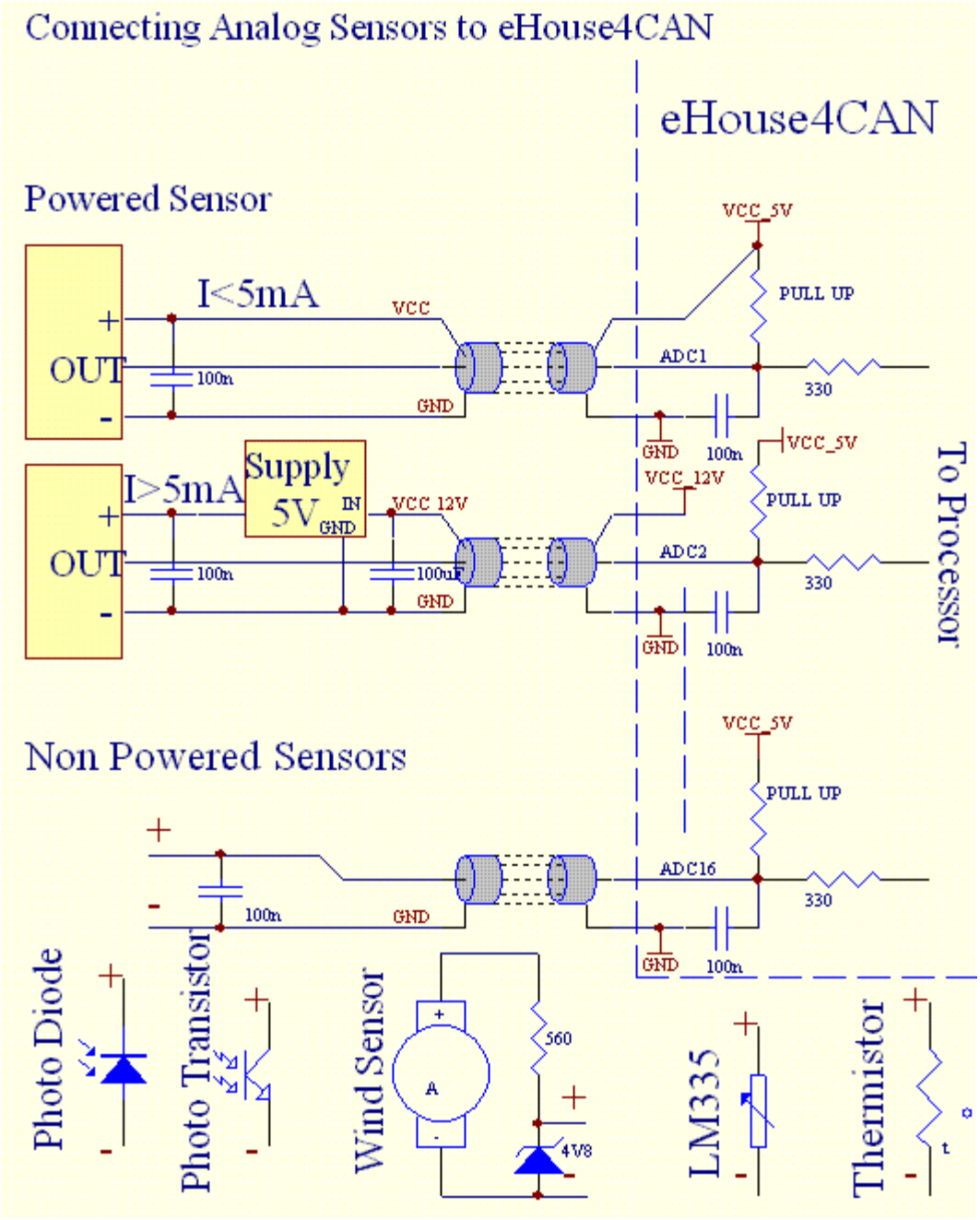

Figure 4 . Measurement inputs circuit diagram .

The values of the elements can be changed during production stage.

3.1.1.2. Digital inputs (on/off) .

They are responsive to input 2 logical states : low (0) U<0.4V and high (1) U>1.5V . With the change of state from low to high run event is programmed in the "Event (1)" for the appropriate input programmed in eHouse application .

Each input is connected through a resistor to +5V, so it is always in a state of logical one.

To change input state it should be shorted to ground (0V) through switches, sensors, etc.

There must be potential free contactor (without the applied external voltage), otherwise the voltage differences between grounds of the two systems or sensor damage, may result in exceeding the permissible parameters of the system and damage the controller or make it unstable (eg. Reset without reason).

With the change of state from high to low to execute event programmed in "Direct Event" filed for the appropriate input set in the web browser on the form of the controller configuration. This should be performed as discussed in the section on measurement inputs. Each input has an inertia of the order of 0.5s to protect from responding to electromagnetic, electrostatic interference. It is therefore necessary for the holding time of the switch , has been programmed to run event. The same applies to the contact release . Repeated short-circuiting and disconnection of contacts requires a pause between switching on and off about 0.5s , otherwise the drivers treat the pulses as interference and ignore them. This protects the output devices controlled by inputs from repeated turn on/off of the supply voltage (for example, children playing) , thereby reducing the risk of damage to the device connected to the system.

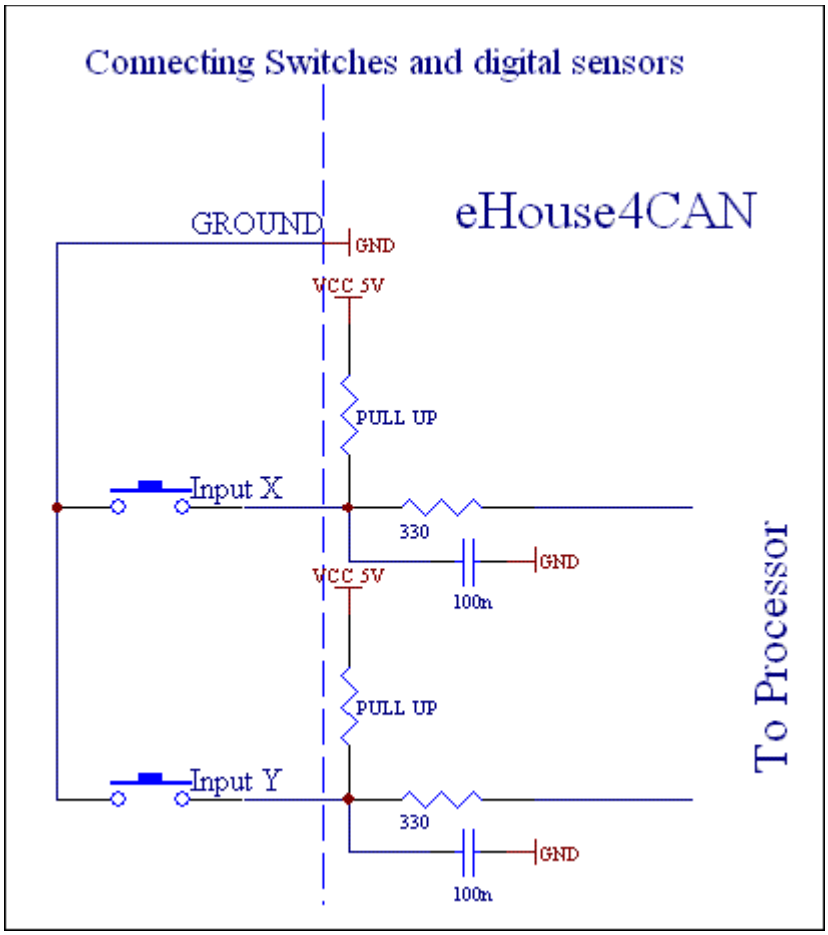

Figure 5 Simplified diagram of the controller inputs eHouse CAN compatible with eHouse 1 controllers.

The values of the elements can vary during production.

The digital inputs are also much more functional in relation to eHouse RS-485 & LAN controllers inputs. In addition to the event are assigned to run a number of parameters associated with the events which are used for the advanced configuration:

- Invert - negated input event is triggered when you release the switch , if you use contactors normally closed (eg. alarm detectors , reed confirming the closing of windows, doors, gates, etc.)
- Alarm - flag is set to raise an alarm associated with the entry, the time set in the "Alarm Delay" if the input is still active after this time
- "Alarm Delay" - delay of the alarm for a programmed time. This parameter is especially valuable when you want to run the event, along with the inclusion of the switch or sensor which removing the cause of alarm inside alarm delay time. An example might be a situation when we apply sensor water level in the drainage wells to dry the building associated with the event inclusion drain pump wells. In normal situations, when the pump will empty wells before the expiration of the "Alarm Delay" time, the alarm will not be triggered. However, in case of failure , power failure or pump failure we will obtain alarm.
- "Remember State" - time of memorize the state of input, not to overlook the state change, as long as we are dealing with an important input or sensor

3.1.1.3. The digital outputs with relays.

Digital outputs turn on/off electrical equipment – by shorting (1 - closing) and open (0) relay contacts . It can be run as event automatically, manually from the control panel , assigned to the inputs (on/off), IR remote control, or as a consequence of the particular state of the system (eg low temperature, change input state, etc.). Digital outputs scheme is analogous to the eHouse RS-484 & LAN controllers, except that implementing relays are mounted on the controller board or external mini-relay module.

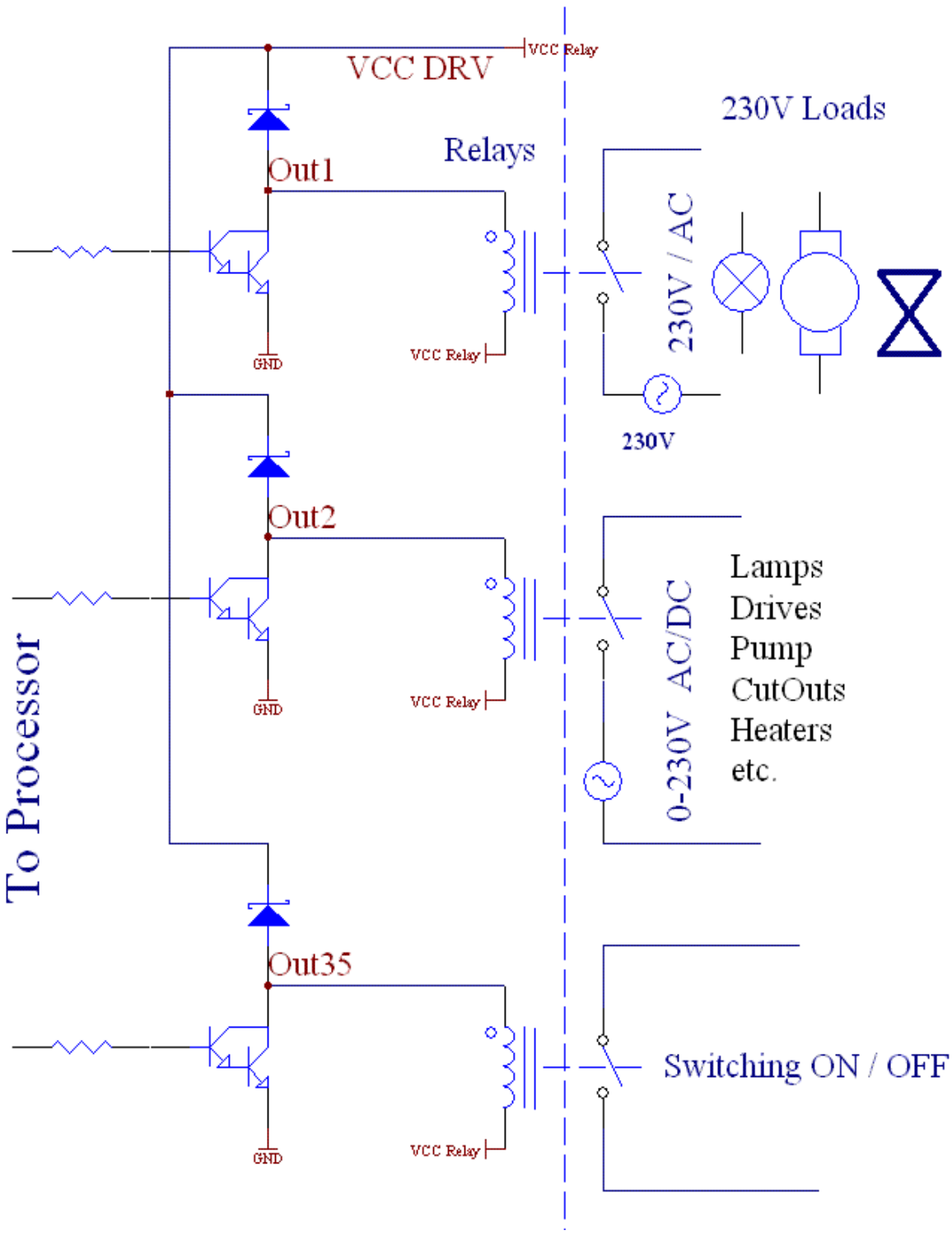

Figure 6 Simplified diagram of output drivers, and connecting external devices .

Digital outputs have much more functionality than eHouse RS-485 or Ethernet controllers and have integrated functions available in all types of drivers (RoomManager , CommManager , HeatManager , ExternalManager).

Digital outputs switch on/off - can operate in the following modes:

- individual outputs (switching standard electrical devices on/off)
- dual outputs (actuators control shutters, doors , awnings , windows, solenoids , actuators adjustable in both directions)
- quad outputs - all outputs working together, such as power control vents, heat recovery ventilators , fans, etc.

In addition, the settings are implemented functions :

- cyclic repetition of events
- count of repetitions
- on time
- off time
- control output in the operating mode (single, double , quadruple)

Modes are set independently.

Single output mode :

- Disable (*) - blocking the output in single mode , if you use another operating mode for outputs. All events related to the individual outputs are ignored
- Admin - Administrative flag unlocks advanced features for the security and safety configuration of external devices
- State - The state of the output (Off/On/Toggle)
- Repeats - number of repetitions of the event beyond the initial start-up
- Time On – keeping output on for this time, after the expiration, the output will turn off automatically
- Time Off - output off time. This parameter is relevant if the "Repeats" is greater than 0, the output will be turned on again after the expiry of the above time

Dual outputs mode (one output direction Down (-) , the other UP (+)) :

- Disable (*) - blocking the outputs pairs working in dual mode , if you use another operating mode outputs. All events related to the dual outputs are ignored
- Admin - Administrative flag unlocks advanced features for security and safety configuration of external devices
- Somfy (*) - set "Somfy" standard mode

- State - The state of the output (N/A , Down, Up, Stop) for Somfy . (Stop , Down , Up , Stop) for all other drives
- Time On - Time To stop the Up / Down , after the expiration of the output will turn off automatically
- Time Off - output off time Up / Down. If it is greater than 2 this time is treated as a " Disable Time"
- Disable Time (*) - the time for locking outputs when changing the direction of movement of the drive. Protection against drive damage as a result of too rapid changes in direction or attempt to run simultaneously in both directions. The driver waits before turning on any output this time causing delay in change of state. If the "Time Off" is greater than 2 - "Disable Time" is ignored -> Driver is not expected before the change of status but when the drive stops
- Repeats - number of repetitions of the event beyond the initial start-up

(*) - Parameter change requires setting a flag “Admin”

3.1.1.4. PWM output (dimmers)

PWM outputs are DC dimmers , in which the duty ratio is controlled square wave with a resolution of 8 bits.

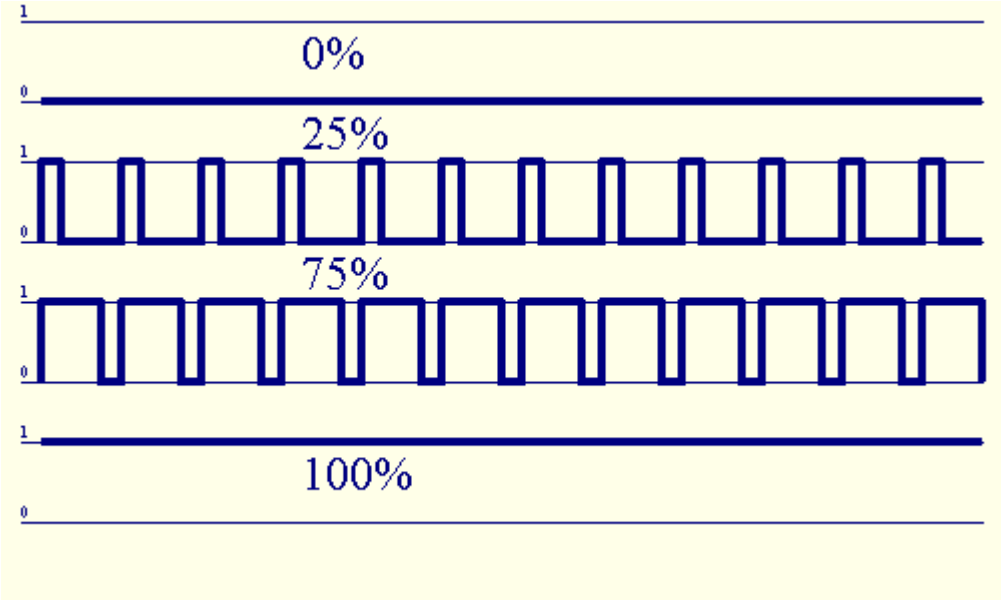

Figure 7 Pulse width modulation (PWM Pulse With Modulation).

These outputs with external power drivers can smoothly adjust the LED lighting, LED RGB (W). It is necessary to connect external power drivers available on relay modules to LED/RGB stripes , etc.

The entrance of such a driver must be equipped with galvanic isolation (optocoupler) to protect

against damage due to damage of the drivers.

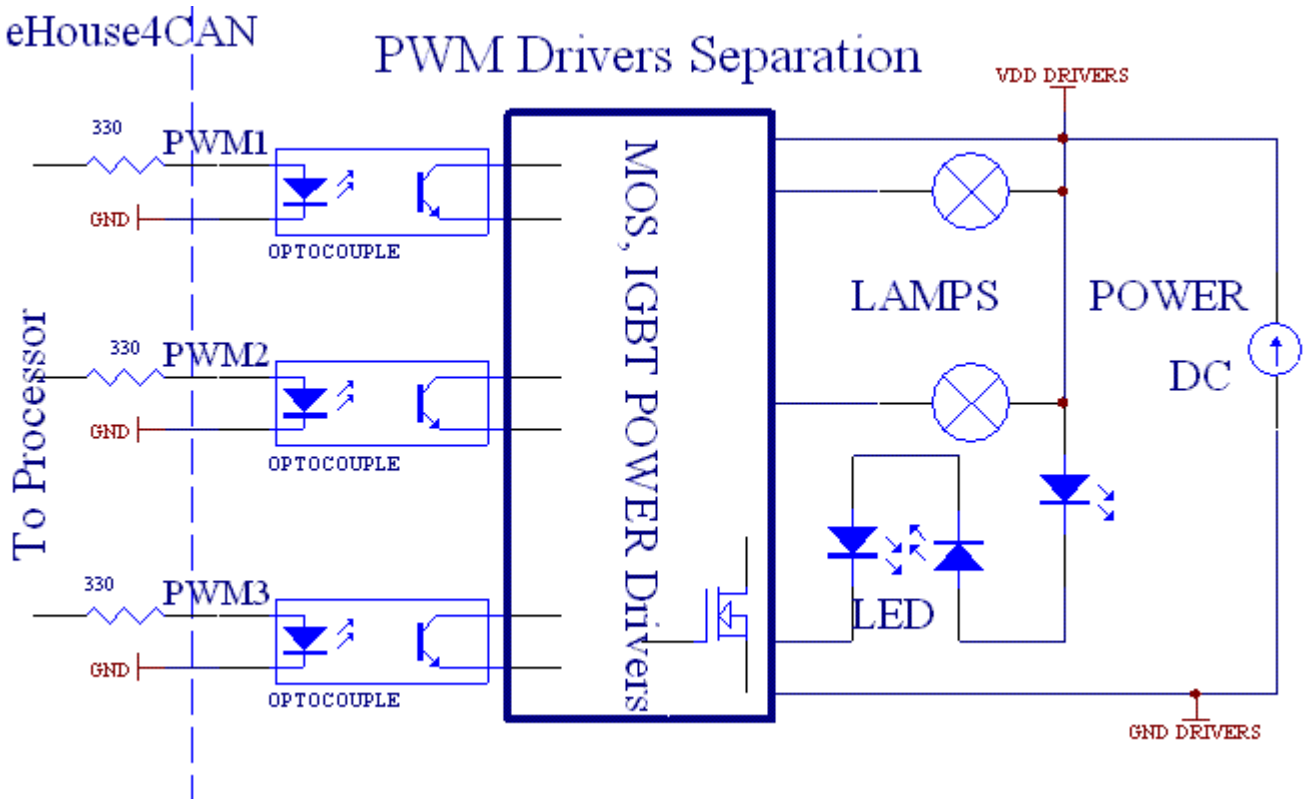

Figure 8 Example of connecting an external power driver to eHouse system controller. Optoisolator diode are directly connected to INPUTS connector.

Dimmer outputs (RGB) are also routed to OUTPUTS connector by low power drivers (100mA/5V). You can connect the 5V RGB LED strip. Tape length should be limited so as not to exceed the current for one channel above 100mA. Larger current may cause damage to the fuse which protects the controller or power supply.

Dimmers can work individually (four) or together as one RGBW (Red, Green , Blue , White) dimmer. Dimmers are much more functional than in eHouse RS-485, Ethernet controllers.

There are events and configuration control for individual dimmer and dimmer RGB + W together.

Individual dimmers have the following operating parameters:

- Value - the lighting level 0 .. 255

- Value Min (*) - the minimum recommended lighting levels 0 - permanently OFF
- Value Max (*) - the maximum recommended level of illumination 255 - permanently ON
- Mode - Mode (N/A, Stop, +, -, Set)
- Step - change step for +, -
- Admin - administration flag to activate the advanced settings
- Disable (*) - blocking dimmer. Events for the dimmer are ignored
- Invert (*) - inverts output dimmer - the lighting level is inverted (255-x). This setting depends on the connected external driver or dimmer has an input inverting or not.

(*) Change option requires setting "Admin" flag

Multiple dimmer 4 working parameters:

- Settings Value Min, Value Max, Step, Invert, Disable, Value are taken from the individual settings of individual dimmers
- Mode - (N/A, Stop, +, -, Set) for all (unblocked channels) channel dimmers at once
- Continuous dimmer 1 (Red) - the value of the light level changes between (min, max) with a programmed step for the dimmer - decorative lighting
- Continuous dimmer 2 (Green) - the value of the light level changes between (min, max) with a programmed step for the dimmer - decorative lighting
- Continuous dimmer 3 (Blue) - the value of the light level changes between (min, max) with a programmed step for the dimmer - decorative lighting
- Continuous dimmer 4 (White) - the value of the light level changes between (min, max) with a programmed step for the dimmer - decorative lighting

3.1.1.5. IR Control – (SONY Standard).

Any eHouse CAN/RF intelligent controller can be controlled by IR remote control as standard Sony (SIRC) if infrared receiver is installed .

Remote control allows you to change the state of the digital outputs, programs, temperature, light level thresholds (min, max) analog inputs (ADC), reboot the controller and run a specific event associated with remote control buttons. The default remote deployed to control eHouse CAN/RF intelligent home controller is Sony (VIDEO 2), for example, RMT-V260 (equipped with a switch to select the VCR number). Due to the large number of functions in the system, it is recommended to use the remote control to maximize the number of buttons to allow a greater range of infrared remote control.

The following buttons are predefined (by default):

RC button	Function
Clear	cancel
0-9	0-9 channel selection, the number of inputs, outputs
Play	turn on
Stop	turn off
+	Scroll wheel (clockwise) increase
-	Scroll Wheel (counter clockwise) decrease
TV/Video	temperature (shift thresholds)
Display	lighting (level)
Input Select	Digital Output
Audio Monitor	Analog Input (thresholds)
Rec	reset the device (requires confirmation “OK” button)
OK	confirmation required for reset and program selection
Power	switch (change in signal state of the outputs)
Smart File	program selection (preset max. 24)
Menu	control other driver (only turn on/off outputs)

["Menu" + ControllerNo + "OK" + "Input Select " + OutputNr on/off/toggle]

Pause	VideoLan (Play)
SAT	VideoLan (Stop)
Index Next	VideoLan (Next Track)
Index Prev	VideoLan (Prev Track)
SP/LP	VideoLan (Shuffle)
Wide	VideoLan (Repeat)
Vol +	VideoLan (Volume +)
Vol-	VideoLan (Volume -)

The use of infrared remote control allows you to perform almost all operations by RC controller, even send configured event to another controller. All codes are sent to eHouse4cServer, eHouse.PRO server software where they can be linked to any external events. They can be independently defined for the remote control code, and for each individual controller.

Remote control is as follows:

1 Selecting the operating mode:

- temperature
- lighting
- digital Output
- Analog Input (ADC)
- profile

2 Selecting a channel number.

3 Changing a parameter for the current channel :

- +
- -
- turn off
- turn on

(eg lighting, channel 1, +, +, +)

Note: Drivers ignore long press the button, and detects them as a single signal. It requires repeatedly press the +, - to change the value to the required level.

You can purchase a universal remote (programmable - that support SONY SIRC), touch panel LCD display RC Controller or even SmartPhone with Infrared support. Remote Control of this type allow you to program descriptions for the buttons on the remote control , the corresponding control codes and controller settings, so that we get wireless touch panel control of eHouse system.

In addition to built-in remote control discussed above , it can be assigned to any of the events processed by eHouse4cServer, eHouse.PRO such as hardware control Audio/Video.

3.1.1.5.1. Change the status of the digital output (relay controlled device).

1. on the remote control, press the button (Input Select)
2. the number of output
3. press one of the buttons:

- (POWER) to change the state (ON->OFF or OFF->ON)
- (Play) - on
- (Stop) - off

Examples:

(Input Select) -> (3) - > (Play) = turn on output 3

(Input Select) - > (2) -> (Stop) = turn off output 2

(Input Select) -> (1) -> (Power) = change (toggle) output 1

3.1.1.5.2 . Change user profile (program).

1. on the remote control , press the button (Smart File)
2. No program
3. (OK).

Examples:

(Smart File) -> (1) -> (OK) = program “1” selection

(Smart File) -> (7) - > (OK) = Select the program 7

3.1.1.5.3. Moving thresholds of measurement inputs.

1. on the remote control , press the button (Monitor Audio)
2. analog input number
3. scroll wheel clockwise (+) opposite (-) (one pulse = shift by (5V * 1/1024) of full scale measuring about 5 mV voltage, temperature about 0.5 st)

For example, an increase of 1.5 degrees of heating , controlled by a temperature sensor connected to the input of the ADC 2.

(Audio Monitor) -> (2) -> (Scroll Wheel +) -> (Scroll Wheel +) -> (Scroll Wheel +)

3.1.1.5.4. Control the level of lighting.

1. Press the button (Display)

2. Dimmer dial - command:

- 1-4 -> for the dimmer number (1..4) PWM
- 9 -> all PWM dimmers
- 0 -> to on/off the following digital outputs (lighting groups)

3. Select one of the control functions, turn off (Stop) , turn on (Play) , toggle (Power) , "+" (turn the knob in order to increase), "-" (turn the knob counter to reduce the level of light)

4. (turn off) - command

for the dimmer number :

- 1-4 - > For PWM dimmers (to stop the increase or decrease) when the dimmer is currently changing its settings. If the dimmer does not change the settings, you can press this button initiates dimming
- 9 -> if you change the setting stops dimmers change all dimmers .

If you do not change the settings (to single dimmer) dimmers dimming initiates all dimmers.

4 (toggle) - command

for the dimmer number :

1-4 -> if the dimmer level is zero initiates lighting up the dimmer

Otherwise, it initiates dimming

4 (ON) - command

for the dimmer number :

- 1-4 -> initiates an increase in the level of light on the dimmer (for maximal lightening or manual stop)
- 9 -> initiates an increase in the level of all dimmers (the total lighten or manual stop)
- 4 (-)

for the dimmer number :

- 0 => off last switched output (lighting group)
- 1-4 => initiates reducing the level of the dimmer (completely extinguish or manual stop)
- 9 => initiates a reduction in the light of all the dimmers (completely extinguish or manual stop)
- 4 (+)

for the dimmer number:

- 0 => activates the next output (lighting group)
- 1-4 => initiates increasing the level of the dimmer (for total lightening or manual stop)
- 9 => initiates increasing the level of all dimmers (the total lightening or manual stop)

For example,

(Display) => (1) -> (+) => ..... (waiting eg 10s) .... => (Stop) - start increasing the level of

light dimmer 1 and stopping the growth of the 10s

(Display) => (9) => (+) - start brightening all dimmers (until you press

Stop button or reach the maximum level of illumination)

(Display) => (+) - enable the next group of lighting (recent dimmer)

(Display) => (-) - disable current lighting group (the recent off)

(Display) => (9) => (-) => (wait..) =>(Display) => (1) => (Stop) – the dimmer one stop in the desired position, the other

Dimmers will be extinguished after a certain time

3.1.1.5.5. Controlling the output of another controller.

1. Press the button on the remote (Menu)

2. Select eHouse CAN controller number (Address Low)

3. confirm by pressing (OK)

4. proceed as in the case of local lighting control driver eHouse CAN (Input Select) -> (output number) => (Power / Play / Stop - buttons)

5. Support for local controller will be restored automatically after 2 minutes of inactivity, the remote control or select the device number (controller address) 0

eg.:

(Menu) => (2) => (OK) selecting a second controller(base address = (127,2) => 0x7f02)

(Input Select) => (2) => (Power) change state of output 2 on the selected driver

(Input Select) => (1) => (Play) output 1 turn on the selected driver

(Input Select) => (4) => (Stop) turn off output 4 on the selected driver

(Menu) => (OK) to select the current Controller

3.1.1.5.6. VideoLAN application control.

Ehouse CAN/RF system can cooperate with the software VideoLAN and will be managed by the RC controller and any eHouse CAN/RF controller, sending control codes to the computer where the eHouse4cServer, eHouse.PRO together with VideoLAN application are located. This means that from any room, in which the eHouse CAN controller (with activated VideoLAN control codes), you can control your music from your PC.

At the moment, you can run the following VideoLAN functions (play, stop, next track, previous track, repeat , shuffle, volume +, volume -, <<, >>).

VideoLAN application must be installed and running on eHouse.PRO server computer system.

Pre-defined buttons for applications VideoLAN and the corresponding functions:

- Pause VideoLAN (Play) or repeated reproduction of the current track
- SAT VideoLAN (Stop) mute and stop the current track
- Index Next VideoLAN (Next Track) next track
- Index Prev VideoLAN (Previous Track) previous track
- >> VideoLAN (FF) fast forward a few seconds
- << VideoLAN (Rew) rewinds a few seconds
- SP/LP VideoLAN (Shuffle) on/off random playback tracks

- Wide VideoLAN (Repeat) enable/disable repeat playback of the track list
- Vol+ VideoLAN (Volume+) to increase the volume by 1%
- Vol- VideoLAN (Volume-) decrease the volume by 1%

3.1.2. Control of external Audio-Video devices by emulating RC control signals in various standards.

IR emitters can be mounted in eHouse CAN/RF controllers to control external devices with the remote control signals.

Each eHouse CAN/RF controller can control HiFi devices by emulating remote control infrared signal (learned before sending the signal from the remote control) . It is possible to scan, up to 248 signal codes (buttons) of RC controllers of different devices types (tens standard of infrared remotes). Before buying an electronic device (eg TV , Video , HiFi) you should test the device compatibility and the remote control is working IR control with intelligent controller eHouse CAN/RF). We didn't found of any problems in controlling selected devices manufacturers such as . Sony , Mitsubishi, Aiwa , Samsung, Daewoo , Panasonic, Matsushita , LG . However the safest method is to apply the principle of choosing one company such as Sony, and is definitely not recommended to use devices and exotic little-known companies, which may have their own standards for infrared control, unacceptable by the driver.

Controllers have implemented events for running IR transmissions containing the manufacturer code and command code.

3.1.2.1. Defining the RC Controller signals, control external devices.

To add a remote control signal to control external devices (TV, HiFi, Video, DVD, etc.) under the control of the driver, you must:

1. capture the code using the converter CAN/RF=>RS232 or other method
2. add to the applications eHouse4cServer, eHouse.PRO as events

3.1.3. Expansion modules of eHouse CAN/RF intelligent controller .

eHouse CAN/RF controllers have implemented RS-232 TTL, which can be connected to a dedicated computer peripherals. For larger projects, it is possible to implement a firmware which supports external devices .

3.1.4. Startup settings of eHouse CAN/RF intelligent controller .

Startup settings of eHouse CAN/RF controller include initial configuration of the controller. Setup is

run as a standard eHouse system event after the start/reset the controller for all inputs, outputs, multiple outputs, individual dimmers , multiple measurement transducers.

Configuration is done on the form:

http://inteligentny-budynek.eHouse.pro/ehouse4can/index.php?func=advancedsettings&address=7f03 for eHouse CAN devices.

http://inteligentny-budynek.eHouse.pro/ehouse4rf/index.php?func=advancedsettings&address=7e03 for eHouse RF devices.

For local installations, you must replace our address with IP address of your own eHouse4cServer, eHouse.PRO machine.

It should be set to the required value of the parameters of all elements :

- parameters for all digital inputs
- parameters for all measuring inputs
- options and states of all digital outputs
- options and levels of all individual dimmers
- RGBW dimmer options

Then press the "Save" button to save the configuration of the controller.

At the end, press the "Update" button to send the configuration to the controller.

3.1.5. Changing the configuration (ad-hoc) of eHouse CAN/RF intelligent controller.

Configuration of smart home eHouse CAN/RF is carried out in the form of standard events eHouse and can be started at any time by sending an advanced events from the form

http://inteligentny-budynek.eHouse.pro/ehouse4can/index.php?func=advancedsettings&address=7f03 for eHouse CAN devices

http://inteligentny-budynek.eHouse.pro/ehouse4rf/index.php?func=advancedsettings&address=7e03 for eHouse RF devices

Changing certain parameters is possible only when the “admin” flag is on. In another case, part of the parameters may be ignored. Be particularly careful if you change the settings of outputs connected to drives, solenoid valves, gates, etc. as incorrect configuration can cause damage of them.

The configuration can be changed by re-sending the event changing the signal option again. Configuration also returns to the startup settings (default) after the reset controller.

3.1.6. Pin description of eHouse CAN/RF intelligent home controller.

3.1.6.1. Digital inputs (on/off) - socket IDC- 10 pin (INPUTS).

All digital inputs are connected through resistors to +5 V 100k (Pull Up) .

Switches or sensors connected between the input X and the ground (0V) of the system.

No..	Pin.	INPUTS	Description
1	IN 1	Input 1	(digital input) (square soldering pad and the arrow on the socket)
2	IN 2	Input 2	(digital input)
3	IN 3	Input 3	(digital input)
4	IN 4	Input 4	(digital input)
5	PWM 1	dimmer 1	(Red) output for direct connection to an optocoupler or one LED includes a current limiting resistor
6	PWM 2	Dimmer 2	(Green) output for direct connection to an optocoupler or one LED includes a current limiting resistor
7	PWM 3	dimmer 3	(Blue) output for direct connection to an optocoupler or one LED includes a current limiting resistor
8	PWM 4	dimmer 4	(White) output for direct connection to an optocoupler or one LED includes a current limiting resistor
9	GND	(0V)	
10	Back Light LED - backlight panels for switches 1 LED with a current limiting resistor		

3.1.6.2. Connectors sensors - 3-pin SIP socket (TEMP x) .

The analog inputs are connected through resistors to +5 V 1K (Pull Up) . PULL UP resistors are used to power sensors such as temperature.

Analog inputs carry out measurement of the input voltage relative to the ground (0V) of the system. LM335 temperature sensors connected between ground and the input. The third pin ADJ (adjust) the unused must be removed.

No. .	**Pin .**	**TEMP x Description**
1	VCC	(+5 V regulated output from the controller) for possible power sensors powered , do not connect without the consultation. For (RFD devices battery powered could be other value in range 3.3V-3.7V depending on power supply value)
2	AN x	analog input x

3	GND	0V (common for analog sensors - temperature and lighting)

3.1.6.3. PWM Dimmers and Digital Outputs Connector - socket IDC- 10 pin male (OUTPUTS) Rev . 1

All OUTx and PWMDRVx are Open Collector (OC) the maximum recommended output current 100mA, do not connect external voltages due to protection diodes to VCC.

Signal No. Designation No. of relay driver

1	OUT1	Digital Output 1 connected in parallel to relay 1
2	OUT2	Digital Output 2 connected in parallel to relay 2
3	OUT3	Digital Output 3 connected in parallel to relay 3
4	OUT4	Digital Output 4 connected in parallel to relay 4
5	PWMDRV1	PWM dimmer Driver 1 (Red) max 100mA/5V
6	PWMDRV2	PWM dimmer Driver 2 (Green) max 100mA/5V
7	PWMDRV3	PWM dimmer Driver 3 (Blue) max 100mA/5V
8	GND	(0V)
9	GND	(0V)

10 VCC_RELAY voltage relays (+5 V supply voltage shorted). DO NOT CONNECT TO EXTERNAL VOLTAGE – RISK of DAMAGE CONTROLLER. Common anode for dimmers PWMDRVx for RGB LED strip.

3.1.6.4 . PWM Dimmers and Digital Outputs Connector - socket IDC- 12 pin (OUTPUTS) Rev. 2

All OUTx and PWMDRVx are Open Collector (OC) the maximum recommended output current 100mA - do not connect external voltages .

Pin No. Signal Description

1	OUT1	Digital Output 1	Relay output 1
2	OUT2	Digital Output 2	Relay output 2
3	OUT3	Digital Output 3	Relay output 3

4	OUT4	Digital Output 4	Relay output 4
5	PWMDRV1	dimmer Driver 1	(Red) max 100mA/5V
6	PWMDRV2	dimmer Driver 2	(Green) max 100mA/5V
7	PWMDRV3	dimmer Driver 3	(Blue) max 100mA/5V
8	PWMDRV4	dimmer Driver 4	(White) max 100mA/5V
9	TEMP	T3	temperature sensor input
10	GND	(0V)	

11 VCC_RELAY voltage relays (+5 V supply voltage shorted) . DO NOT CONNECT TO EXTERNAL VOLTAGE – RISK of DAMAGE CONTROLLER. Common anode for dimmers PWMDRVx for RGB LED strip.

12	VCC_12V	+12 .. +24 V	power supply of controller from Dimmers

3.1.6.5. 4 pin connector (CAN & Power - Rev. 1)

1	GND	Ground (0V)
2	CAN+	non inverting data bus line
3	CAN-	inverting data bus line
4	+12V	Power for Controller

3.1.6.6. IDC-6 (CAN & Power - Rev. 2).

1, 2	GND	(0V)
3	CAN+	non inverting data bus line
4	CAN-	inverting data bus line
5,6	+12V	Power for Controller

Lines CAN+ , CAN- must be connected in series (not a star or a closed loop topology) at the beginning and end - terminators (120 ohm resistors) should be installed between (CAN+ , CAN-) to reduce signal reflections and match impedance.

3.2. eHouse CAN converter/gateway (RS-232/CAN)

Ehouse CAN converter is an adapter that allows eHouse CAN controllers to connect to a PC or microprocessor board. It can be installed on expansion board for Raspberry Pi, Raspberry Pi 2, Banana Pi / PRO. For universal serial RS-232 port is used to connect to any computer hardware, microprocessor equipped with RS-232 or USB port. If you connect the USB need to connect the USB<=>RS-232 adapter. Converter is not only a passive adapter, but has a number of logical

functions to increase the functionality of the entire eHouse CAN smart home system.

Basic features and capabilities:

- transparent mode RS232/CAN for upload new firmware to the controllers or configuration
- receives and stores the status of all eHouse CAN controllers
- sequentially synchronizes time for eHouse CAN controllers
- sequentially transmits the status of all eHouse CAN controllers to a PC for eHouse4cServer, eHouse.PRO server application
- Has mounted IR receiver to learn the codes of external devices (HiFi Equipment , Electronics , Audio -Video)

3.2.1. eHouse CAN converter/gateway connectors.

3.2.1.1. IDC-6 (CAN & Power - Rev. 2).

No..	Pin.	Outputs Description
1,2	GND	(0V)
3	CAN+	non inverting data bus line
4	CAN-	inverting data bus line
5,6	+12 V	Power for Controller

3.2.1.2. RS-232C/TTL Connector* - connector IDC- 10 pin male (INPUTS)

No..	Pin.	Outputs Description
1	-	do not connect
2	-	do not connect
3	-	do not connect
4	-	do not connect
5	-	do not connect
6	TX1OUT	RS-232C/TTL TX * - transmission line (to the receiving line of PC)
7	RX1IN	RS-232C/TTL RX * - receiver line (to the transmitting line of PC)
8	PWM 4	do not connect
9	GND	(0V)
10	Back Light	power driver RS-232 TTL interface / RS-232C

* TTL (0-VCC) - RS-232 TTL 0..5 V or 0 ..3V3 system without MAX3232 IC

RS232C – optionally installed MAX3232 IC

3.3. eHouse RF gateway & Wireless Network PAN Coordinator connectors.

Ehouse RF gateway and Wireless Network PAN Coordinator is an adapter that allows connection of eHouse RF Wireless network to a PC or microprocessor board. It additionally coordinate and manage all wireless network devices (CO, FFD, RFD Roles).

Universal serial RS-232 port is used to connect to any computer hardware, or microprocessor equipped with RS-232 or USB port. If you connect the USB, you need to connect the USB<=>RS-232 adapter. Converter is not only a passive adapter, but has a number of logical functions to increase the functionality of the entire eHouse RF smart home system.

Basic features and capabilities:

- receives and transmit status of all the wireless eHouse RF controllers to the PC
- sequentially synchronizes time of all eHouse RF controllers
- sequentially transmits the status of all eHouse RF controllers to a PC for eHouse4cServer, eHouse.PRO server application
- Manage and Coordinate all RF wireless network devices (Coordinators, Full Functional Devices, Reduced Function Devices)
- Transfer data and events between RF devices
- Connect eHouse RF to PC and external word
- Has mounted IR receiver to learn the codes of external devices (HiFi Equipment , Electronics , Audio -Video)

3.3.1. eHouse RF gateway & Wireless Network PAN Coordinator connectors.

3.3.1.1. IDC-6 (CAN & Power - Rev. 2).

No..	Pin.	Outputs Description
1,2	GND	(0V)
3	CAN+	do not connect
4	CAN-	do not connect
5,6	+12 V	Power for Controller

3.3.1.2. RS-232C/TTL Connector* - connector IDC- 10 pin male (INPUTS)

No..	Pin.	Outputs Description
1	-	do not connect

2	-	do not connect
3	-	do not connect
4	-	do not connect
5	-	do not connect
6	TX1OUT	RS-232C/TTL TX* - transmission line (to the receiving line of PC)
7	RX1IN	RS-232C/TTL RX* - reception line (to the transmitting line of PC)
8	PWM 4	do not connect
9	GND	(0V)
10	Back Light	power driver RS-232 TTL interface/RS- 232C

* TTL (0-VCC) - RS232 TTL 0..5 V or 0 ..3V3 system without MAX3232 IC
  RS232C – optionally installed MAX3232 IC

4. eHouse CAN/RF system software package.

Ehouse CAN & eHouse RF software package consists of the following components:

- Linux x86 , x64, Raspberry Pi, Banana Pi/PRO
- Apache web server and the communication module eHouse4Apache
- eHouse4cServer, eHouse.PRO - software drivers eHouse management and smart home features eHouse

4.1. The Linux operating system.

Ehouse CAN/RF software runs on the Linux operating system and is available in binary form in several versions.

- x86 (32b)
- x64 (64b)
- ARM 6 (32b) such as Raspberry Pi
- ARM 7 (32b) 1,2,4 core CPU (Banana Pi, Pro, Raspberry PI 2)

It can be build on other hardware platforms based on demand, development and market availability.

Part of the software eHouse4cServer is available as Open Source for individual development. It includes algorithms for all types of communication including eHouse CAN, eHouse RF controllers. This enables independent software development and compilation on any hardware platform and Linux version.

Ehouse4cServer, eHouse.PRO software work as a server integrating multiple building automation systems (eHouse LAN, RS-485, CAN, RF, PRO creating any hybrid combination of the system), and external intelligent equipment . Therefore, for maximum efficiency does not work in a graphical environment.

Depending on whether eHouse4cServer, eHouse.PRO will operate only as building automation or Media Server or Player will also need to decide on the equipment at the specified performance of hardware. For simple building automation in any version, 1 core processor board can be used (eg. Raspberry PI). For playing audio files the best low cost solution Banana PRO (2 core CPU) with HDD connected to internal SATA for media storage is the best issue. If you need the best performance with decent price, some 4 core CPU board can be used which implement SATA and HDD.

Without any compromise Standard PC x86, x64 can be used as eHouse4cServer host. Unfortunately eHouse.PRO algorithms (for central switch board installation I/Os) is not supported on PC hardware due to lack of I2C, SPI interfaces and I/O.

4.2. Apache Web Server Software with the eHouse4Apache module.

Apache web server software is free and is the standard when it comes to advanced and secure Web server .

Allows the use of internal security Apache SSL, certificates, user authentication and other mechanisms currently available and developed in the future.

With the Apache web server can be implemented to control, configure, visualize, manage eHouse system with web browser .

This solution has several advantages :

- does not depend on the hardware and software control panels , smartphones, PADs , smart TV – very scalable
- configuration is in one place - on the server (no need to update the configuration to panels , smartphones, PADs, computers, etc.)
- we have the possibility of central management , administration , users, access rights
- graphical visualization and control looks pretty much the same regardless of the hardware and operating system control panels
- there is no need to write individual software for each operating system and the type of control device
- have a single unified tool for everything "All In One"

For Apache Web Server works properly with eHouse4cServer, it requires the installation of a communication module, which is only a "gateway" between Apache and eHouse server application.

This module only sends information between them, and does not contain any logic.

The module must be installed with eHouse4cServer in the directory " /usr/local/ehouse/" .

In order to enable it in the Apache configuration file " /etc/apache2/apache2.conf " add two lines :

LoadModule eh /usr/local/ehouse/ehouse4apache.so

AddHandler eh .x

In newer versions of Apache, you must create two files in the directories "/etc/apache2/mods-enabled/" and "/etc/apache2/mods-available/":

"eh.conf" - contains one line "AddHandler eh .x"

"eh.load" - contains 2 lines:

- LoadModule eh /usr/local/eHouse/eHouse4apache.so
- AddHandler eh .x

Then restart the Apache service : "service apache2 restart" .

To the directory "/var/www/" , upload all eHouse the files. In the operating system website and give

them necessary rights including subdirectories to eHouse4cServer application can save data .

Apache module "/usr/local/ehouse/ehouse4apache.so" should have the right X - execute .

4.3. eHouse4cServer, eHouse.PRO Software.

eHouse4cServer software is constantly developed server application that serves eHouse system. Its mission is to integrate all versions of eHouse: eHouse 1 , Ethernet eHouse , eHouse CAN, eHouse RF .

In addition, the system integrates eHouse with external systems , subsystems , equipment , Audio -Video Media palayers. It has the task of logical control and management in the form of smart home "All in One" - from a single point . Working together with WebServer Apache module eHouse4apache.so responding to his requests and sending data so that all system functions can be controlled , managed and configured from a web browser on any operating hardware, operating system.

the main features and capabilities eHouse4cServer :

- communication with the system eHouse 1 (RS-485) - USB / RS-232 (reception status of controllers, transfer events, transparent mode for update configuration and firmware)
- communication to system eHouse Ethernet (LAN) TCP/UDP (receive controllers status and transfer events)
- communication to eHouse CAN system - USB / RS-232 (reception status of controllers , transfer events , configuration, update the firmware, complete management and control)
- communication to eHouse RF system - USB / RS-232 (reception status of drivers , transmission events , configuration, complete management and control)
- communication with the Apache Web Server (dedicated TCP/IP server). This server can also be used to integrate eHouse4cServer external applications and systems without going through Apache . Transmits coded status of all the drivers in text format. It contains a number of useful commands to control how the message of the event eHouse, reset software, etc.
- built-in TCP server compatible with servers eHouse Ethernet controllers, can serve as a "gateway" for external control panels (smartphones, PADs, PCs)
- supports hardware GSM/SMS (USB) gateway for SMS service messaging (notification and control)
- built-in support for SMS messaging for Polish operators Orange, Plus , T-Mobile via web gateways
- built-in "database" of statuses of all eHouse Controllers and continuous online update
- the ability to process status, measurements and the creation of dedicated algorithms
- TCP client to send "HTML Requests" to control external applications, hardware, electronics, software, Audio-Video systems, Media Players , etc.

- multi-threaded TCP client to control Audio -Video, HiFi Onkyo equipment allowing full control and online update of device status
- multi-threaded TCP client to operate the equipment Audio -Video, HiFi Denon allowing full control and online update of device status
- multi-threaded TCP client to operate the equipment Audio -Video , HiFi Marantz allowing full control and online update of device status
- advanced handling and processing of the infrared signal (received by controllers) and assign eHouse system event
- Create automatic HTML panels for eHouse system visualization from a Web browser. Processing controller, system signals of eHouse RS-485 , LAN, CAN, RF.
- The ability to create their own sophisticated algorithms in a separate module for dedicated services of smart home

Software eHouse4cServer is still updated with new algorithms based on current trends, standards available on the market .

Software " eHouse4c " should be uploaded into the directory "/usr/local/ehouse/" giving as the highest access rights to the directory:

- "/usr/local/ehouse/" - software directory of eHouse4cServer
- "/usr/local/e-house/" - data directory , system configuration eHouse CAN , eHouse RS-485 , eHouse LAN, eHouse RF
- "/var/www/" - web directory for Apache webserver , which automatically creates documentation eHouse4cServer

File "ehouse4c" and “ehousepro” must be set to the attribute X - "execute" .

It is important to select the user that is running the software eHouse4cServer because the application can run external applications and control them. If the permissions are too low to run and manage applications, eHouse4cServer may not work properly .

eHouse4cServer application should work on the user "root" - full ownership.

This also applies to drivers USB/RS -232 MEM (DMA) that are created by default with low rights for users. If you work on a different user than root , it is necessary each time change access rights RW for all users. In case of problems with USB/RS-232 driver and trying to restart the application or system of these rights disappear.

eHouse4cServer application should be run after Linux startup scripts when you boot the appropriate "text" mode . It does not require a graphics mode and the system is many times more efficient and faster at the server versions of Linux.

eHouse4cServer configuration is automatically created "/usr/local/eHouse/eHouseServerC.cfg " and should be edited first time when you start the software to improve typing the appropriate values. Configuration values are separated by a tab from the descriptions that intuitively explain the meaning of the individual parameters and options. The application is in constant development time does not discuss these parameters here.

When uploading a new version of the software before running eHouse4cServer, you should move the configuration file "/usr/local/ehouse/eHouseServerC.cfg " to another location and run the server software that will create the file with all the current and default settings.

Then compare with the old configuration file and correct all the old settings and enter the correct new settings.

Starting the application first time after the update manually with the parameter " eHouse4c -docs " will generate documentation and help in the directory "/var/www/docs/", so you know what new features are in the server software.

For external serial interfaces connected to the USB ports , such as:

- SMS gateway hardware (GSM)
- RS-232/485 converter (for eHouse RS-485)
- RS-232/CAN converter (for eHouse CAN)
- RS-232/RF gateway (for eHouse RF)

It is the best way to choose producer driver name instead of port (“/dev/ttyUSBx”) because devices connected to USB ports can change number during discovering on system start.

eHouse.PRO server software is a variant of eHouse4cServer application which support additionally local I/O of eHouse.PRO Hardware (only for Raspberry Pi, Banana PRO and future PC boards – limited by appropriate hardware resources).

Requires additional hardware:

- Interface board with RS-485, CAN, 2*SPI, 2*I2C ports
- Input expansion modules (up to 256) implementing also alarm relay outputs (Silent, warning, monitoring, horn, early warning)
- Output expansion modules(up to 256)
- power supply (only for raspberry Pi and eHouse.PRO I/O hardware)

5. References:

English:

Most current version is located (EN): http://isys.pl/download/eHouseCANRFEN.pdf

Do It Yourself information (EN): http://smart.eHouse.Pro/

Producer Web Page (EN): http://home-automation.isys.pl/

Producer Internet Shop (EN): http://ehouse.biz/

Polish:

Najnowsza wersja tego dokumentu (PL): http://isys.pl/download/eHouseCANRFPL.pdf

Informacje do samodzielnego montażu (PL): http://inteligentny-dom.eHouse.Pro/

Strona producenta (PL): http://www.isys.pl/