RFCAN Hybrid
Home Automation System

Wired CAN (Controller Area Network)
Wireless RF (863, 902, 915MHz)

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1. Hybrid building automation system (BAS) with CAN & RF interfaces

RFCAN home automation controllers can control and integrate multiple devices of various types.

Controllers are (OEM variants – PCBs modules without covers) can be mounted directly in electric socket cans or third party devices:

- CAN – wired system (Controller Area Network Interface)
- RF – wireless network (RF Radio Frequency Sub-GHz: **863MHz, 902MHz** or **915MHz**)

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

RFCAN BAS works under the supervision of a PC or any microcomputer system based on "Lightweight" Linux operating system (eg: PC, Raspberry Pi, Raspberry Pi 2, Banana Pi / PRO, etc). Bundled Server software allows full control and system integration of RFCAN BAS with other communication variants RS-485, LAN, WIFI, PRO, CAN, RF and future products of our company.

Apache web server software with dedicated module enables Server integration which allows complete control, management, configuration 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.

Whole Building Management System (CAN, RF, RS-485, LAN, WIFI, BMS) is a modular, enabling optimal use of controllers, adjusting the installation to suit your needs and the planned budget. RFCAN BAS 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. RFCAN smart controllers have dimensions for mounting in the deep wall socket cans and is very easy to install. Plug in relay module exists which it contains up to 4 relays 230V/5A for direct switching of electrical appliances or power and four 12VDC/3A dimmers drivers.

Wired **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 big devastation.

RF controllers are wireless, using MiWi Pro architecture which makes it ideal for installation in old building without any devastation. It works in free RF base-band **863MHz**, **902MHz** or **915MHz** which depends on plugged in RF module to controller. Used base-bands are much less occupied than standard 2.4GHz (WiFi, BlueTooth, RF home automation systems, ZigBee, Wireless Remote Controllers, etc). It is also 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 mainly 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.

1.1. RFCAN BAS components

- Smart I/O controller CAN (Controller Area Network)
- RF Radio module (wireless network 863 or 902/915 MHz)
- RS232/RF gateway and main RF network coordinator
- Linux based microcomputer as RFCAN BAS Server

With whole BMS system it is possible to create any Hybrid installation using any of following system components

- LAN
- Centralized
- RS-485
- CAN
- RF
- WiFi

and integrate them via Linux server application. This gives possibility e.g. 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.

1.2. Features and capabilities of RFCAN BAS system

RFCAN BAS system is based on a small micro-controller device with **encrypted bootloader**.

This enables securely download new firmware or different variants of controllers.

RFCAN 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 the investor before plastering the building decided at the last minute for building automation
- 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 for sensors, remote switches, etc.

RFCAN Smart Controller has the following options/features:

- 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
- graphical visualization of events - individually created images of rooms and devices (web browser)
- 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 (e.g. motion detectors, gas, humidity, wet, fire, etc.)
- control system via a Web browser from any device and operating system
- remote control of the system with IR remote controllers
- text and graphical remote control and configuration via LAN, WiFi, Internet from Web browser

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

1.3. RFCAN BAS under PC supervision.

The PC is widely understood microcomputer running the “Lightweight” Linux operating system e.g.: Raspberry Pi 1 / 2 / 3, Banana Pi / Pro or other microcomputer board working with the SD card. Server 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.

Server software is written in low-level C language (not C++) and it can be compiled on any version of Linux and CPUs (x86, x64, ARM, Atom, etc.). The source code is highly scalable and can be compiled using different compilers or even OS.

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

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

1. RF Gateway/Coordinator for wireless network to manage all RF controllers and route all data between nodes and receive statuses. It contains RS-232 gateway for communication. This device have dedicated firmware of PAN Coordinator. **(Only ONE gateway/coordinator**

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:
   - Binary Inputs (ON/OFF) (*)
   - Measurement Inputs (*)
   - IR Receiver
   - LED PWM Dimmers
   - IR Transmitter
   - Binary Outputs (ON/OFF)

   which are fully supported by firmware algorithms. This device is powered and working all the time sending and receiving data to the RF network.
3. Repeaters/Coordinators (CO) for expanding range which can route data from FFD controllers.
4. Reduced Functionality Device (RFD) have equivalent hardware for input signals (*) as FFD but do not have outputs functionality support. This device can be 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.

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

** - hardware must be individually produced for required features.

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

- up to 100 / (8000 *** in theory) counting all together (RFD, CO, FFD) can be used.

- up to 10 of coordinators can be used.

Theoretical amounts (***) can be reached by ordering and load individual firmware & software.

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

Although all RF controllers operates locally and in RF network, independently from the PC, but its 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.

RFCAN BAS system uses following software:

- Linux server software
- Apache Web Server - for direct integration with a web browser
- Apache integration module - Apache web server communication module/gateway software for

integration with Linux Server

Integration and cooperation of these applications allows you to configure, 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.

1.4. CAN data + power bus.

All **CAN** Controllers work on a **Controller Area Network** bus. Only CAN BAS 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 (100m long @ 100kbps speed).

Bus wiring is placed in series, one segment after the other by combining the controllers. For total distances smaller than 100m it could be placed on Star topology (requires test on the building).

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. Installation must be tested before plastering the building.

CAN system allows the use of up to 100 devices on a single bus (without line amplifiers). Each one must have unique address. Each device has a 2-byte address consisting of two components ADRH and ADRL.

Each CAN device has ADRH = 127 (0x7F).

Each RF device has ADRH = 126 (0x7E).

Controllers must be connected one by one to CAN/RF Gateway in proper sequence (**“on the table”**). The ADRL number are incremented automatically.

Steps of Initialization of CAN/RF controllers into installation:

- Connect RFCAN gateway to UART port of computer and run console (115200 8N1) and assure proper power supply
- Connect new CAN controller to CAN data bus (observe console Window). Attach permanent sticker with ADRL number to the controller PCB.
- RF controller require only power supply for initialization. However it requires smaller distance than 0.5m from CAN/RF gateway for security during initialization (**If distance is too big controller will not initialize !!!**).

It automatically assigned addresses sequentially from one (1) upwards. Addresses 250.. 255 are reserved for special functions, including CAN/RF converter < -> RS232, gateways, line listener, etc.

CAN bus consists of two signal lines CAN+, CAN- (differential) to transmit data in both directions and 4 power lines 2*(0V) and 2*(12-24 VDC) 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..16, by which is much simpler to install the system. Power supply voltage (+12..24 VDC) must be secured by 2-5 amps fuse, depending on the number of connected controllers (counting min. 0.2A per 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 locations 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.).

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

CAN bus cable with the controller should be mounted in a separate electrical can (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 CAN controller). Relay module should be located in other socket can then electronic controller for safety.

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

1.5. RF wireless network.

RF BAS wireless home automation system works on network protocol based on license from **Microchip Cooperation**. RF uses best and highest quality RF modules for 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.

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

All RF BAS vital components (microcontroller, RF modules, MiWi Pro stack, compilers) comes from one manufacturer “Microchip” assuring most secure, stable and reliable work of RF wireless

network. User can chose one frequency band for his installation by changing RF module and change configuration of controller. Sub-GHz bands was chosen because its much less utilized, disrupt 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. Maximal range was tested: ~300 meters for open space and 60cm through of concrete without enabling additional LNA and at 0dBm transmit power.

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

RF limitations current (theoretical)

- Max number of Coordinators (CO): 4 (64)
- Max number of nodes (COs+RFDs+FFDs): 100 (8000)

Wise planning 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 RF BAS itself, switch to other channel in case of noise environment automatically, that's why all channels should be check. RF BAS however manage himself with colliding networks and ignore data other, but the less traffic in frequency band the better for stability, quality of signal, missing events, statuses, re-transmissions etc. In case of other RF networks on the same channel and battery powered controllers batteries is utilized much more time than on clear channels.
- 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 or Repeater on each elevation/floor above and below (more or less at the same place).
- Locate Coordinators or Repeaters in each corners of building. If the distance from PAN Coordinator to any Coordinator is greater than 10 meters 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 straight “path of view” each coordinators to PAN coordinator.
- On the other hands coordinators generate more traffic in radio signals comparing to FFDs because it broadcasts received information further and information is re-transmitted as many

times as many coordinators receive a broadcast.

2 RFCAN BAS Intelligent home electronic modules.

2.1. RFCAN Smart home system controller.

RFCAN smart controller is a "microcomputer", for control electrical appliances, electronic and electromechanical in its near location.

RFCAN 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 various sensors eg.: temperature, 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 lighting (without the built-in PWM output drivers – which are built in on external relay modules sufficient for driving 12VDC/3A LED strips)
- RS232-TTL port to install system extensions - future and dedicated applications
- built-in clock
- infrared receiver (IR) to control via the IR remote controller or panel (Sony – SIRC standard)
- infrared transmitter (IR) to control external audio/video devices, with learned remote control signal by sending them to devices
- the ability to connect max. 100 (without CAN bus amplifier) controllers for "**CAN**" and up to 100 (8000 in theory) for "**RF**". For higher amounts of automation points we suggest use different approaches of home automation based on (RS-485 or LAN controllers)

Any RFCAN smart home controller is configured and managed via PC (Linux) and Server application that allows you to program all the parameters of the module and to program the startup conditions of all signals (inputs/outputs of different types). Each signal has a number of events and options dependent on signal type and are discussed later in this document.

The signals are divided into input and output signals.

The input signals are:

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

The output signals are:

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

"**CAN"** and "**RF"** smart controllers may 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 from LAN the Internet (via Web Browser)
- playing acoustic communicates from the system
- monitoring operation of the system and information about errors and problems
- perform dedicated algorithms to expand whole 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 communication versions of the system: RS-485, LAN, PRO, RF, CAN

2.1.1. Description of Inputs/Outputs and configuration.

The names of the Inputs and outputs (controlled devices) are located on a single HTML form in a web browser at:

http://192.168.0.200/canrf/ for **RF/CAN** Devices

Configuration Example (Read Only) http://bms.forsale/canrf/

For local installation, address must be replaced by a local IP of Linux Server.

If you have hybrid (mixed CAN/RF installation) you can't assign the same ADDRL to different controllers because from the server side these controllers (eg. 7F03 & 7E03) are treated as one and differences only by communication medium (wired or wireless respectively).

At **http://bms.forsale/v/** link there is publicly available RFCAN system demo installation under Linux Server (Raspberry PI 3) (Read Only).

For **CAN** controller the address is stored in hex code, e.g. 7f0a - 10th **CAN** controller.

Address for CAN Controllers contains of 2 bytes.

1. Higher byte should remain always 0x7f (127) because our 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 **RF** controller the address is stored in hex code (7e03 - in this case - 3rd **RF** controller) e.g. 7e0a - 10th RF controller.

Total Address for RF Controllers in RF 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. Medium byte should remain always 0x7e (126) because our applications recognize controller type (transmission medium) by high address – in this case RF device. In case of larger installation then 250 RF controllers this address should go downwards (0x**7d**, 0x**7c**, 0x**7b**, etc.)
3. Lower byte should be in range 1..100 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 – installation

number) is omitted because only one installation is supported by one system instance. Only last two bytes are taken to construct address for events and status: e.g. 7E03 for third controller.

This convention enables distinguished communication mediums and transmit events to different installation types in hybrid version of BMS system (LAN, RS-485, CAN, RF, WiFi).

The whole logic of the forms configuration and change the names in the script is /**can/index.php**, **/canrf/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://192.168.0.200/style.css** which is much more safe than the modification of the configuration script which can damage controllers or make it non responsive.

2.1.2. Analog input (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 10 bits. They have defined and configured minimum and maximum thresholds at which events (commands) are lunched when measured value exceeds these levels.

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" fields there are only descriptions, which can be arbitrary and serve only to information description of event which has been entered in the "DIRECT EVENT" fields.

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.

Additional options for analog inputs:

- Invert (*) - the input is an negative scale mapping i.e. 100% - x
- Alarm Delay - delay of launch 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" field 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" field 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 “Admin flag” to modify this parameter.

Only floating (non external voltages) connection of sensors can be realized. Otherwise connecting external voltages may damage controller inputs or controller itself.

2.1.3. 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 set in configuration.

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 (floating connection - 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 (e.g. 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 controllers 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.

Input have programmed functionality and command (event) to be launched when switch is pressed. In addition to assigned event to input, 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 input, the time set in the "Alarm Delay" field 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

2.1.4. Binary outputs (on/off) with relays.

Binary outputs turn on/off electrical equipment – by shorting (1 - closing) and open (0) relay contacts. It can be run as event (command) 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 (e.g. low temperature, change input state, etc.). Relays are mounted on the controller board or external mini-relay module.

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 - 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 (single) 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 (pulse control - stop is initiated with activation both lines)
- 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 movement, 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”

2.1.5. PWM output (dimmers).

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

These outputs with external power drivers can fluently 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.

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.

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 (equivalent: 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

2.1.6. IR Control – (SONY Standard).

Any RFCAN intelligent controller can be controlled by IR remote control in Sony (SIRC standard) if infrared receiver is installed.

Remote control allows you to change the state of the digital outputs, programs, temperature / light level thresholds (min, max) of analog inputs (ADC), reboot the controller and run a specific event associated with remote control buttons. The default remote deployed to control RFCAN 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 with big amount of buttons to allow a greater range of infrared remote control. Other universal remote controller, supporting Sony standard may be used for control the system. Additionally touch panel with LCD display RC Controller or even SmartPhone with Infrared support may be used. 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 RFCAN system.

The use of IR remote control allows you to perform almost all operations by RC controller, even send configured event to another controller. All codes are sent via Linux 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.

In addition to built-in remote control discussed above, it can be assigned to any of the events processed by RFCAN Server application such as Audio/Video equipment control.

The following buttons are predefined (by default):

IR RC Buttons	Functions
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	Binary Output
Audio Monitor	Analog Input (thresholds)
Rec	reset the device (requires confirmation “OK” button)
OK	confirmation required for reset and program selection
Power	Switch/toggle (change signal state of the outputs)
Smart File	Program selection (preset max. 24)
Menu (*)	Control other CANRF controller (only turn on/off outputs)
Clear	Cancel
Pause	VideoLan (Play)
Sat	VideoLan (Stop)
Index Next	VideoLan (Next Track)
Index Prev	VideoLan (Previous Track)
SP/LP	VideoLan (Shuffle)
Wide	VideoLan (Repeat)
Vol +	VideoLan (Volume +)
Vol -	VideoLan (Volume -)

* Control another device: ["Menu" + ControllerNo + "OK" + "Input Select" + OutputNr on/off/toggle]

Remote control of RFCAN is as follows:

1 Selecting the operating mode:

- temperature
- lighting
- Digital Output
- Analog Input (ADC)
- profile (program)

2 Selecting a channel number.

3 Changing a parameter for the current channel:

- +
- -
- turn off
- turn on

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

Note: Controllers 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.

2.1.6.1. Change the status of the binary 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

2.1.6.2. 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

2.1.6.3. Moving thresholds of measurement inputs.

1. on the remote control, press the button (Audio Monitor)
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 deg)

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 +)

2.1.6.4. 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 e.g. 10s).... => (Stop) - start increasing the level of

light dimmer 1 and stopping the growth of the 10s

(Display) => (3) => (+) - 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) => (2) => (-) => (wait..) =>(Display) => (1) => (Stop) – the dimmer one stop in the desired position, the other stop when finished.

2.1.6.5. Controlling the output of another controller.

1. Press the button on the remote (Menu)
2. Select RFCAN controller number (Address Low)

3. confirm by pressing (OK)

4. proceed as in the case of local lighting control RFCAN controller (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

For Example:

(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

2.1.6.6. VideoLAN application control.

RFCAN system can cooperate with VideoLAN software and will be managed by the RC controller and any RFCAN controller, sending control codes to the computer where the RFCAN Server software together with VideoLAN application are located. This means that from any room, in which the RFCAN 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 Linux server together with RFCAN Server Software.

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

- Pause VideoLAN (Play) or repeated play of the current track
- SAT VideoLAN (Stop) fade out 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%

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

IR emitters can be mounted in RFCAN controllers to control external devices with the remote control signals.

Each RFCAN controller may control HiFi devices by emulating IR remote control signal (learned from original RC). 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 (e.g. TV, Video, HiFi) you should test the device compatibility and the remote control is working IR control with intelligent controller RFCAN). 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 controller.

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

2.1.7.1. Defining the RC Controller signals to control external devices.

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

1. capture the code using CAN/RF=>RS232 converter or other method
2. add to CANRF Linux Server as events

3. Configuration

3.1. Startup settings of RFCAN intelligent controller.

Startup settings of RFCAN controller include initial configuration of the controller. Setup is run as a standard system events (commands) after start up/reset the controller for all inputs, outputs, multiple outputs, individual dimmers, measurement inputs.

Configuration is done on the form (Read Only example http://bms.forsale/canrf/):

http://192.168.0.200/can/index.php?func=advancedsettings&address=7f03 for CAN devices.

http://192.168.0.200/canrf/index.php?func=advancedsettings&address=7e03 for RF devices.

For local installations, you must replace address with IP address of your own Linux Server 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.

3.2. Changing the configuration of RFCAN intelligent controller (ad-hoc).

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

For Local Installations:

http://192.168.0.200/can/ for CAN devices

http://192.168.0.200/canrf/ for RF devices

Read Only Example of Installation http://bms.forsale/canrf/

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 controllers, 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.

3.3. Pin description of RFCAN intelligent home controller.

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

All digital inputs are connected through resistors to +5 V 10K (Pull Up).

Switches or sensors connected between the **Input X** and the ground (**0V**) of the system (floating connection).

No	Designator	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	BK LED	Back Light panels for switches 1 LED with a current limiting resistor

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

Analog inputs carry out measurement of the input voltage relative to the GND (0V) of the system. Temperature sensors MCP 9700 can be connected between ground and the input.

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)

3.3.3. PWM Dimmers and Digital Outputs Connector - socket IDC-10 pin male (OUTPUTS) Rev. 1 (CAN Only with built in relays)

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.

No	Designator	Description
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 for 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.

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

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

No	Designator	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 Module

3.3.5. 4 pin connector (CAN & Power - Rev. 1)

No	Designator	Description
1	GND	Ground (0V)
2	CAN+	non inverting data bus line
3	CAN-	inverting data bus line

4	+12VDC	Power for Controller (+12..24VDC)

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

No	Designator	Description
1,2	GND	Ground (0V)
3	CAN+	non inverting data bus line
4	CAN-	inverting data bus line
5,6	+12VDC	Power for Controller (+12..24VDC)

CAN+ & CAN- Lines must be connected in series (for total cable length larger than 100m) at the beginning and end - terminators (120 ohm resistors) should be installed between (CAN+, CAN-) to reduce signal reflections and match impedance.

For smaller distances, star topology is better solution for service/maintenance and installation.

3.2. RFCAN converter/gateway (RS-232=>CAN/RF)

RFCAN converter is an adapter that allows CAN controllers connect to any PC or microprocessor board. It is also **PAN Coordinator** of all RF Wireless network to a PC or microprocessor board. It coordinate and manage all wireless network devices (CO, FFD, RFD Roles).

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

Basic features and capabilities:

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

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

No	Designator	Description
1,2	GND	Ground (0V)
3	CAN+	non inverting data bus line
4	CAN-	inverting data bus line
5,6	+12VDC	Power for Controller (+12..24VDC)

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

No	Designator	Description
1,2,3,4,5,8	N/A	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)
9	GND	0VDC (power supply)
10	VCC	Power for driver RS-232 TTL interface / RS-232C

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

RS232C – optionally installed IC MAX3232

4. RFCAN system software package

RFCAN software package consists of the following components:

- Linux x86, x64, Raspberry Pi, Banana Pi/PRO
- Apache web server and the communication module for CANRF
- CANRF server software for Linux
- PHP Scripts for configuration

4.1. Linux operating system.

RFCAN software runs on the lightweight Linux operating system and is available in binary form in several versions.

- x86 (32b)
- x64 (64b)
- ARM 6 (32b) such as Raspberry Pi 1, 2, 3

- ARM 7 (32b) 1,2,4 core CPU (Banana Pi, Pro, Raspberry PI 2)

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

Communication algorithms to CANRF server software is as Open Source for individual development. It also includes algorithms for all types of communication including CAN, RF, LAN, RS-485, PRO, WiFi controllers. This enables independent software development and compilation on any hardware platform and Linux version.

BAS Server software integrates multiple building automation systems (LAN, RS-485, CAN, RF, PRO, WiFi creating any hybrid combination of the system), and external intelligent equipment. Therefore, for maximum efficiency does not work on graphical environment.

Depending on whether BAS Server will operate only as building automation or Media Server or Player, you will also need to decide on the equipment at the specified performance of hardware. For simple building automation in any version, 1-2 core processor board can be used (e.g. 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 BAS Server host.

4.2. Apache Web Server Software with the RFCAN module.

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

Apache allows using its internal security SSL, certificates, user authentication and other mechanisms currently available and developed in the future.

Apache web server enables: control, configure, visualize, manage BAS system with web browser which has many benefits:

- does not depend on the hardware and software control panels, smartphones, PADs, smart TV and it's 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, etc.
- 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 RFCAN BAS Server, it requires the installation of a communication module, which is only a "gateway" between Apache and BAS Server application.

This module only sends information between them (act as proxy server), and does not contain any logic.

The module must be installed in CANRF server computer in the directory "/usr/local/canrf/" and properly add to Apache for execution.

4.3. CANRF BAS Software.

BAS/BMS Server software is constantly developed server application that serves whole BMS system. Its mission is to integrate all communication versions and third party products.

The system integrates with external systems, subsystems, equipment, Audio-Video, Media players and so on. 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 Apache WebServer 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 BAS/BMS Server:

- communication with the systems: RS-485, Ethernet, CAN, RF, WiFi, Central, BMS, Access control
- communication with the Apache Web Server (dedicated TCP/IP server). This server can also be used to integrate BAS/BMS Server to external applications and systems without going through Apache. Transmits coded status of all the controllers in text format. It contains a number of useful commands to control/manage controllers, software, hardware, reset etc.
- built-in TCP server compatible with Ethernet controllers servers, can serve as a "gateway" for external IP control panels (smartphones, PADs, PCs)
- supports hardware GSM/SMS (USB) gateway for SMS service messaging (notification and control)
- built-in "database" of statuses of all 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, Denon, Marantz allowing full control and online update of device status
- advanced handling and processing of the infrared signal (received by controllers) and assign system events
- Create automatic HTML panels for whole system visualization from a Web browser. Processing controller, system signals of BAS (RS-485, Ethernet, CAN, RF, WiFi, Central).
- The ability to create their own sophisticated algorithms in a separate module for dedicated services of smart home
- Modbus TCP/IP communication and control
- Cloud communication and control via Online MySQL Database (on Internet side)
- HTML Request for control of the system

BAS Server software is still updated with new algorithms based on current trends, standards available on the market.

BAS/BMS Server 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.

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

BAS/BMS configuration is automatically created "/usr/local/canrf/CanRf.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 CANRF Server, you should move the configuration file "/usr/local/canrf/CanRf.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.

Application generates 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 RS-485 controllers)
- RS-232/CAN converter (for CAN controllers)
- RS-232/CANRF gateway (for RFCAN controllers)

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.

5. References

RFCAN BAS Controller Connection: http://bms.forsale/docs/canrfsch.pdf

RFCAN Installation schematic: http://bms.forsale/docs/canrfinst.pdf

Read Only configuration & names: http://bms.forsale/canrf/

Read Only Installation http://bms.forsale/v/