A MODULAR CONTROL UNIT FOR CONTROLLING BUILDING FACILITIES

FIELD OF INVENTION

The present invention relates to a modular control unit for controlling building facilities and a data storage medium containing computer readable code means for instructing a programmable controller module of a modular control unit.

BACKGROUND

In modern buildings, facilities such as air conditioning, lightings, dimming of lights etc. are sometimes integrated and controlled by a control system.

One notable restriction of existing control systems for building facilities is that such systems are of a single Central Processing Unit (CPU) design. This means that only one controller is used and a single software application controls all the functions such as controlling the air conditioner reference temperature, on/off lightings etc.

In existing control systems, building facilities controls for different in-room layout typically require customization of the software of the control system before the control system can leave the manufacturer's site and be delivered to the installation site. In many instances, further modifications are still required after the system has been delivered. However, modification of the software cannot be made on site and can be changed only at the manufacturer's site. This creates a problem because the system has to be sent back to the manufacturer's site.

During customization of the software, if any changes are required for a particular function such as the addition of a control panel, the controller has to be reprogrammed and this may affect other functions also controlled by the software. Time spent to change the software and quality of work depends very much on the programming skill of the software programmer. Typically, the programming time is long and changes in the configuration cannot be immediate.

Furthermore, when tasks such as upgrading, maintenance and/or repairs to the system are required, they are time consuming and almost always require the technicians of the manufacturer of the system to carry out the tasks because the functions controlled by the system are in complex integration and is unfamiliar to other technicians.

Moreover, when there is new technology for a particular function of the system in the market, there is reluctance to upgrade the system due to the high cost to replace the entire controller and the inconvenience and risks of software errors in reprogramming the controller.

Another notable restriction of existing control systems is that they are too dependent on the Bus system, in particular, active Bus systems. The active Bus systems limit flexibility in addition of devices and changing of controls in Building facilities controls due to various software complications such as version conflicts, incompatibility of communication protocol and complexity in the procedures/programming involved to set up the device for use.

Passive bus usage on the other hand can provide more flexibility, however, individual devices in existing passive bus systems perform functions separately and are mostly hard wired to only perform the dedicated functions, e.g. lighting switches hard wired only for switching on/off lights, air conditioner panel hard wired to operate only the air-conditioner, etc. There is no interconnection between the various devices not to mention any scalability in system design for controlling all the building facilities.

A need therefore exists to provide a modular control unit for controlling building facilities that addresses at least one of the above-mentioned problems.

SUMMARY

In accordance with one aspect of the present invention, there is provided a modular control unit for controlling building facilities, the modular control unit comprising: a passive bus; a plurality of controller modules connected to the

passive bus, each controller module arranged for controlling at least one function associated with one or more of the building facilities; wherein each controller module comprises a data communication unit for broadcasting protocol packets over the passive bus, and a processor unit for processing protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said each controller module.

Each controller module may execute a delay mechanism prior to broadcasting protocol packets via the passive bus in response to protocol packets received by another controller module via the passive bus at a predetermined response time.

A delay time of the delay mechanism may be based on a type of each controller module.

Each controller module may execute an error checking mechanism on protocol packets received via the passive bus and if an error is detected, a retransmission request is broadcasted via the passive bus.

The error checking mechanism may comprise updating a counter for each retransmission request and only repeat broadcasting the retransmitted request until a preset counter value has been reached.

A new controller module connected to the passive bus may broadcast an initial message using a default address of origin.

The default address of origin may be changed by the new controller module in response to identifying a same existing address being used by another controller module.

Each controller module may be coupled to a power supply module via the passive bus.

The modular control unit may further comprise one or more control panels coupled to respective ones of the controller modules, for providing a user input to the controller modules.

Each controller modules may identify whether a user input received from the control panel coupled to said each controller module is destined to said each controller module or to another controller module, and said each controller module relays said user input via broadcasting over the passive bus if the user input is destined to another controller module.

One or more of the control panels may comprise a display element for displaying status information in response to the user input.

The modular control unit may further comprise one or more display panels coupled to respective ones of the controller modules, for displaying status information of the modular control unit.

One of the plurality of controller modules may be a Service Controller Module for controlling a privacy status and room service status of a room.

The modular control unit may further comprise a remote panel coupled to the Service Controller Module and for location outside the room for enabling sounding the doorbell based on a privacy status or a room service status of the room.

The remote panel may further display the privacy status or room service status based on the privacy status or room service status of the room.

The Service Controller Module may further control activation or deactivation of electrical utilities supplies in the room.

The modular control unit may further comprise one or more card readers coupled to respective ones of the controller modules for data input into the modular control unit.

The data input may be used for access control to functionalities of the modular control unit.

The one or more card readers may be coupled directly to respective controller modules or are coupled via the passive bus.

One of the controller modules may be an air-conditioner module for controlling an air-conditioner.

The modular control unit may further comprise a temperature sensor coupled to the air-conditioner module for sensing the room temperature.

One of the controller modules may be a relay module for controlling lights on/off.

One of the controller modules may be a dimmer module for controlling the brightness of lights.

The external devices may include a remote control device for user input into the modular control unit.

In accordance with another aspect of the present invention, there is provided a data storage device containing computer readable code means for instructing a programmable controller module of a modular control unit to execute a method for controlling building facilities, the method comprising: instructing controller modules to control at least one function associated with one or more of the building facilities, to broadcast protocol packets over a passive bus, and to process protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said controller module.

In accordance with yet another aspect of the present invention, there is provided a method for controlling building facilities, the method comprising: instructing controller modules to control at least one function associated with one or more of the building facilities, to broadcast protocol packets over a passive bus, and to process protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said controller module.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only and in conjunction with the drawings, in which:

Figure 1 is a diagram of the system architecture of an example embodiment of the present invention.

Figure 2 is a diagram of a Power Supply Module according to the example embodiment of the present invention.

Figure 3 is a diagram of a Service Controller Module according to the example embodiment of the present invention.

Figure 4 is a diagram of an Air-conditioner Controller Module according to the example embodiment of the present invention.

Figure 5 is a diagram of a Relay Controller Module according to the example embodiment of the present invention.

Figure 6 is a diagram of a Dimmer Controller Module according to the example embodiment of the present invention.

Figure 7 is a diagram of a Curtain Controller Module according to the example embodiment of the present invention.

Figure 8 is a diagram of a Key Card Holder according to the example embodiment of the present invention.

Figure 9 is a diagram of a Guest Service Panel according to the example embodiment of the present invention.

Figure 10 is a diagram of a Door Chime Panel according to the example embodiment of the present invention.

Figure 11 is a diagram of an Air-conditioner Control Panel according to the example embodiment of the present invention.

Figure 12 is a diagram of a Curtain Control Panel according to the example embodiment of the present invention.

Figure 13 is a diagram of a Light Switch Panel according to the example embodiment of the present invention.

Figure 14 shows examples of Light Switch Panels according to the example embodiment of the present invention.

Figure 15 is a diagram of a Light Dimmer Panel according to the example embodiment of the present invention.

Figure 16 illustrates a diagram of an arrangement of the example embodiment in a hotel.

Figure 17 is a flowchart illustrating the procedures for modules to communicate in their allocated time delays according to the example embodiment.

Figure 18 is a flowchart illustrating the procedures involved when a module of the system according to the example embodiment receives an erred data protocol packet.

Figure 19 is a flowchart illustrating the addressing procedures during addition of new modules to the system according to the example embodiment.

Figure 20 illustrates a controller module according to the example embodiment.

DETAILED DESCRIPTION

With reference to Figure 1, the control system 100 of the example embodiment comprises a Main Control Unit (MCU) 102 and numerous Auxiliary Panels (AUX)

120, 122, 124, 126, 130, 132 and 134. In the example embodiment, the MCU 102 and AUX 120, 122, 124, 126, 130, 132 and 134 are implemented in a hotel industry environment for controlling room facilities, such as air-conditioner, lighting, curtain, security etc. Every room in the hotel has a MCU 102 and all the AUX installed. It is appreciated that the control system 100 may be implemented in other environments such as home, commercial building, factory or the like.

Each module in the MCU 102 is functionally unique. A power supply module 104 powers the control system 100. Each module in the MCU 102 can be "plugged" into the control system 100 to provide the function associated with the MCU 102. New modules can be "plugged" into the control system 100 without any changes to the software structure of each module.

Each module is a separate firmware comprising on-board microprocessor(s) and the related peripherals for carrying out the function of the module and has unique data inputs and outputs that are attributed to the function of the particular module. Although some modules may be linked to each other in some function, each module can still function independently from one another. A passive bus 138 interconnects all the modules in the MCU 102.

A system network protocol (details will be provided later) governs how each module communicates with one another in the passive bus 138.

The system network protocol advantageously allows controls specifically for a particular module to be directed through other modules. That is, if a module is not capable of performing a function, the user commands to perform the function will be directed to the module capable of performing the function.

Furthermore, the system network protocol advantageously enables new modules and new control means (e.g. control panels, buttons, triggers, levers, etc.) to be added to the control system 100 without having to upgrade the entire operating software that governs the controls of all the modules and the auxiliary panels connected to the control system 100. This will allow technicians or engineers to make immediate on-site modifications to the control system without

having to send the system back to the manufacturer's site to make the modifications.

When a new module is added, the system network protocol provides a default device address to the new module on its connection to the passive bus. The address value is incremented until it no longer clashes with any addresses already allocated to the existing modules in the system. No software or hardware upgrades are necessary to activate the new module.

With regard to new control means, the system network protocol allows new control means for a particular function to be connected to the digital I/O of any existing module without regard to the function of the connected module. That is, the module connected to the new control means need not be capable of performing the function that the new control means are intended for. The link between the actual module(s) for performing the functions intended for by the new control means and the new control means can be established through on-site software programming using a programming device (not shown in Figure 1). The programming device stores the settings in a database maintained at each module. If the module connected to the new control means is not a module dedicated for performing the function the control means is intended for, the module will broadcast the commands originating from the control means in the passive bus 138. Upon receiving a broadcasted message in the passive bus 138, the modules connected to the passive bus 138 refer to the database to determine whether they are the modules intended for executing the commands. Only the modules programmed to perform the function will act accordingly.

The MCU 102 comprises a Power Supply Module (PSM) 104, a Service Controller Module (SCM) 106, an Air-conditioner Controller Module (ACM) 108, a Relay Controller Module (RCM) 110, a Dimmer Controller Module (DCM) 112, and a Curtain Controller Module (CCM) 114. The RCM 110 and DCM 112 are connected to lightings 136. The SCM 106 is connected to an external contactor relay 304. The ACM 108 is connected to an air conditioner unit (1804 in Figure 18) with an air conditioner motor (406 in Figure 4), water chiller valves (408 in Figure 4) and a temperature sensor (412 in Figure 4).

The AUX comprises a Key-Card Holder (KCH) 120, a Guest Service Panel (GSP) 122, a Door Chime Panel (DCP) 124, an Air-conditioner Control Panel (ACP) 126, a Curtain Control Panel (CCP) 130, a Light Switch Panel (LSP) 132 and a Light Dimmer Panel (LDP) 134.

Figure 16 shows an example arrangement of the MCU 102 and the AUX 120, 122, 124, 126, 130, 132 and 134 in a plan view of a hotel room 1800. The MCU 102 is located in a compartment 1802 in the room 1800.

The KCH 120 is located near the entrance 1810 inside the room 1800 and is connected to the SCM 106 through electrical cables (Not shown in Figure 16). The DCP 124 is located near the entrance 1810 outside the room 1800 and is connected to the SCM 106 through electrical cables (Not shown in Figure 16). The GSP 122 is located at a location inside the rest area 1816 of the room 1800 and is connected to the SCM 106 through electrical cables (Not shown in Figure 16).

The ACM 108 is connected to an air conditioner unit 1804 through electrical cables (Not shown in Figure 16). The ACP 126 is located near the air conditioner unit 1804 and is connected to the ACM 108 through electrical cables (Not shown in Figure 16).

With regard to the movement control of curtains 1808 by the window 1806, the CCP 130 is located near the curtains and is connected to the CCM 114 through electrical cables (Not shown in Figure 16).

As regard lightings 136, there are a few LSP 132, one near the entrance of the room 1800 for the guest to control the room lightings 136 upon entering the room 1800, one further inside the rest area 1816 of the room 1800 for controlling the room lightings 136 and one just outside the entrance of the washroom 1814 for controlling the lightings 136 in the washroom 1812. All the LSPs 132 may be connected to a single RCM 110 or some of which is separately connected to a secondary RCM that is also part of the MCU 102, which is solely used for washroom lightings control. The LSPs 132 are connected to the RCM 110 or RCMs through electrical cables (Not shown in Figure 16). The LDP 134 is located in the rest area 1816 of the room 1800 and is connected to the DCM 112 through electrical cables (Not shown in Figure 16).

It is appreciated that the MCU 102 may be integrated into the wall structures of the room 1800 or locked in a control panel box, preferably easily accessible by a technician wanting to upgrade, maintain or repair the MCU 102.

The detailed diagram of the PSM 104 is shown in Figure 2.

The function of the PSM 104 is to convert the high Alternating Current (AC) voltage of the mains to low Direct Current (DC) voltage so as to provide suitable and stable power supply to the control system 100 (Figure 1). The input voltage 202 from the mains to the PSM 104 in the example embodiment is ranged between 220 – 240VAC @50Hz and the PSM 104 is capable of delivering an output voltage 204 of 12VDC and +5VDC to the control system 100 (Figure 1).

The detailed diagram of the Service Controller Module (SCM) 106 is shown in Figure 3.

In the example embodiment, the hardware of the SCM 106 is connected to an external contactor relay 304, a DC power supply i.e. PSM 104 (Figure 1), and to door bell speakers (SPK) 310. The SCM 106 is also connected to the Guest Service Panel (GSP) 122 (Figure 1), the Key Card Holder (KCH) 120 (Figure 1) and the Door Chime Panel (DCP) 124 (Figure 1).

Data communication units 312, 314 and 316 are provided for connecting to the GSP 122, KCH 120 and DCP 124 respectively. The Data communication units 312, 314 and 316 may for example be RS485 serial interfaces, and also enable broadcasting of protocol packets from the SCM 106 to the passive bus 138 (Figure 1).

One function of the SCM 106 is to control the operation of door chimes or doorbell of guest rooms. The SCM 106 activates the operation of the doorbell speakers 310 according to user preference. The Guest Service Panel (GSP) 122 (Figure 1) allows visitors to activate or deactivate the doorbell speakers 310. The doorbell is rang by pressing a button (1108 in Figure 11) on the Door Chime Panel (DCP) 124.

A second function of the SCM 106 is to signal and display the room service status and privacy status of a room. The Guest Service Panel (GSP) 122 (Figure 1) allows

guests to signal a room service request or no objections to having room service performed, or a privacy indication indicating that room service is not to be performed for the room. The SCM 106 displays the room service status and privacy status on the DCP 124. The room service status and privacy status signals from the GSP 122 (Figure 1) are sent digitally to the SCM 106.

A third function of the SCM 106 is to activate electrical utilities supply to a guest room. When a guest enters the guest room and inserts a key card (910 in Figure 8) into the Key Card Holder (KCH) 120 (Figure 1), the KCH 120 (Figure 1), which has the function of a card reader, verifies whether the key card (910 in Figure 8) contains access rights to activate the electrical utilities supply to the guest room. It is appreciated that the key card (910 in Figure 8) may be digitally coded to prevent unauthorised access.

If the key card has access rights, a signal is sent digitally from the KCH 120 (Figure 1) to the SCM 106 to trigger an on-board relay 302, which triggers the external contactor relay 304 to enable electrical utilities supply to the guest room. Electrical utilities supply will continue to be supplied to the guest room as long as the key card is slotted in the KCH 120 (Figure 1). When the key-card is removed from the KCH 120 (Figure 1), a Light Emitting Diode (LED) indicator (906 in Figure 9) on the KCH 120 (Figure 1) will start flashing. After a preset period, for instance, a default setting of 30 seconds, the on-board relay 302 will be de-activated, thus controlling the external contactor relay 304 to disable electrical utilities supply to the guest room. The LED indicator (906 in Figure 9) on the KCH 120 (Figure 1) will continue to flash until a key-card (910 in Figure 9) is inserted again.

The detailed diagram of the Air-conditioner Controller Module (ACM) 108 is shown in Figure 4.

The ACM 108 has the following functions: -

- Air-con Fan Coil Motor speed control
- Water Chiller Valve On/Off Control (Two-pipe System)
- Room Temperature Reading
- Switching of reference temperature

In the example embodiment, the hardware of the ACM 108 comprises three fuse-protected interlocked relay outputs 402 (i.e. switches) for Air-con fan speed control. The three outputs 402 correspond to the low, medium and high fan speed respectively. At anytime, only one output will provide Alternating Current (AC) supply to the fan coil motor 406, hence the fan speed will only be running at low, medium or high speed.

A pair of dry contact 408 is provided for water chiller valve on/off control in a two-pipe air-conditioner system. For a four-pipe air-conditioner system, an additional Valve Control Module (VCM) 410 comprising another pair of dry contact 408 is required to control the additional valves in the four-pipe air conditioner system.

A temperature sensor 412 is connected to the ACM 108 for measuring the room temperature in each room.

The Air-conditioner Control Panel (ACP) 126 (Figure 1) is connected to the ACM 108. The main function of the ACP 126 (Figure 1) is to provide means for setting reference temperatures for the air conditioner (air-con) system and activating the air conditioner according to the settings.

The ACM 108 is also connected to the PSM 104 (Figure 1) for DC power supply.
The detailed diagram of the Relay Controller Module (RCM) 110 is shown in Figure 5.

Data communication units 404 and 414 are provided for connecting to the ACP 126. The Data communication units 404 and 414 may for example be RS485 serial interfaces, and also enable broadcasting of protocol packets from the ACM 108 to the passive bus 138 (Figure 1).

The function of the RCM 110 is for on/off lighting control. In the example embodiment, lighting or lights (136 in Figure 1) refer to fluorescent lamps, incandescent lamps or the like.

The RCM 110 has the following features: -

- Relay outputs 502 with common incoming line 504 for Alternating Current (AC) mains for on/off switching of lights at a location.
- Digital inputs 506 to be converted into analogue signals for activating the relay outputs to switch on/off lights according to the on/off data inputs received.

The number of inputs and outputs will depend on the amount of lighting being controlled at the location.

In the example embodiment, the hardware of the RCM 110 comprises four digital inputs 506 and four fuse-protected (e.g. 7.5A fuses) relay outputs 502, which controls the lighting in a guest room. The four digital inputs 506 correspond with the four on/off light switches 510 in the connected Light Switch Panel (LSP) 132 (Figure 1). Digital lighting on/off signals are sent from the LSP 132 (Figure 1) to the RCM 110. The RCM 110 is connected to the PSM 104 (Figure 1) for DC power supply.

It is appreciated that a secondary RCM 110 or more may be added to the system (100 in Figure 1) to control more lighting.

Data communication unit 508 is provided for connecting to the LSP 132. The Data communication unit 508 may for example be a RS485 serial interface, and also enables broadcasting of protocol packets from the RCM 110 to the passive bus 138 (Figure 1).

By virtue of its design, it is further appreciated that the RCM 110 can be used for controlling any other type of devices requiring on/off switching.

The detailed diagram of the Dimmer Controller Module (DCM) 112 is shown in Figure 6.

The function of the DCM 112 is for controlling the brightness of lights.

The DCM 112 has the following features: -

- Traic outputs 602 with common incoming line 606 for Alternating Current (AC) mains for dimming or brightening of lights at a location.

- Digital inputs 608 to be converted into analogue signals for activating the Traic outputs to dim or brighten lights according to received input data associated with brightness level.

The number of inputs and outputs will depend on the amount of lighting being controlled at the location.

In the example embodiment, the hardware of the DCM 112 comprises four digital inputs 608 and four fuse-protected (e.g. 7.5A fuse) Traic outputs 602 for dimming up/down the lighting and switching off the lights when tuned to the lowest brightness level. The four digital inputs 608 correspond with the four light dimmer switches 612 in the connected Light Dimmer Panel (LDP) 134 (Figure 1). Brightness level signals are sent from the LDP 134 (Figure 1) to the DCM. The DCM 112 is connected to the PSM 104 (Figure 1) for DC power supply

Data communication unit 610 is provided for connecting to the LDP 134. The Data communication unit 610 may for example be a RS485 serial interface, and also enables broadcasting of protocol packets from the DCM 112 to the passive bus 138 (Figure 1).

By virtue of its design, it is appreciated that the DCM 112 can be used for controlling any other type of devices requiring intensity setting.

The detailed diagram of the Curtain Controller Module (CCM) 114 is shown in Figure 7.

In the example embodiment, it is assumed that there are two sets of curtains by a window in a room, a thinner day curtain, which allows limited daylight through the thin layer, and a night curtain, which blocks out daylight completely. The function of the CCM 114 is to control the movement of the day and night curtains.

The CCM 114 has the following features: -

- Relay outputs 702 for day curtain motor control and night curtain motor control.
- Digital inputs 712 for both day and night curtain opening/closing control.

In the example embodiment, the hardware of the CCM 114 comprises four digital inputs 702 and four fuse-protected (7.5A fuse) interlocked relay outputs 712 for controlling two curtain motors 706, 708 for opening or closing the day curtain and/or the night curtain respectively. The four digital inputs 712 correspond with the four curtain movement switches 710 in the connected Curtain Control Panel (CCP) 130 (Figure 1). Curtain movement signals are sent from the CCP 130 (Figure 1) to the CCM 114. The CCM 114 is connected to the PSM 104 (Figure 1) for DC power supply.

Data communication unit 704 is provided for connecting to the CCP 130. The Data communication unit 704 may for example be a RS485 serial interface, and also enables broadcasting of protocol packets from the CCM 114 to the passive bus 138 (Figure 1).

By virtue of its design, it is appreciated that the CCM 114 can be used for controlling any other type of devices requiring continuous user activation for a period of time to perform a particular function.

The detailed diagram of the Key-Card Holder (KCH) 120 is shown in Figure 8.

The function of the KCH 120 is to verify the identity of a key card 910 utilizing Barcode, Radio Frequency IDentification (RFID) Technology or the like and determine whether the key card 910 is the authorized key card to enable electrical utilities supply to a guest room.

In the example embodiment, the hardware of the KCH 120 is made up of a printed circuit board (PCB) (Not shown in Figure 8) mounted behind a plastic cover 904. The key card 910 to be verified is slotted in a card slot 908 of the KCH 120. The PCB comprises a card reader for reading the data stored on the key card 910, a micro-switch for enabling/disabling electrical utilities supply and a Light Emitting Diode (LED) indicator 906, which flashes when no key card is inserted into the slot 908 and stops flashing when a key card is inserted into the slot 908. The KCH 120 controls the SCM 106 to perform electrical utilities on/off functions.

As the card reader may require much data processing power, the KCH 120 may comprise one or more on-board microprocessors to control the card reader. As such, the KCH 120 may be directly connected to the passive bus 138 in Figure 1 as a separate module to take away some data processing burden from the SCM 106.

The card reader of the KCH 120 is able to recognise different types of card inserted. Base on the recognition of the card type, the room facilities will be adapted accordingly to provide the room conditions pre-determined for the card type. Each pre-determined room condition for a type of card is hereinafter called a room mode.

The detailed diagram of the Guest Service Panel (GSP) 122 is shown in Figure 9.

The function of the GSP 122 is to indicate room service status and privacy status, in particular, to activate or deactivate a room privacy indicator or a room service indicator, which also activate or deactivate the doorbell speakers (310 in Figure 3) accordingly.

When the room privacy indicator is activated, it indicates that a guest in the room does not wish to be disturbed at that room and room service should not be provided for the room. The doorbell speakers (310 in Figure 3) will also be deactivated.

When the room service indicator is deactivated, it indicates that the guest wishes to have room service provided for the room. The doorbell speakers (310 in Figure 3) will be activated in this case. Due to the conflicting functions of the room privacy indicator and room service indicator, only one of the two indicators can be activated at anytime.

In the example embodiment, the hardware of the GSP 122 is made up of a printed circuit board (PCB) (Not shown in Figure 9) mounted behind a plastic assembly faceplate 1010, which comprises two buttons 1002, 1004 and two LED indicators 1006, 1008.

Button 1002 activates the room privacy indicator. The LED indicator 1006 is located above button 1002 and lights up only when button 1002 is pressed or when button

1004 is deactivated. A "PRIVACY PLEASE" 1012 label is adhered beneath button 1002 to indicate that button 1002 is for activating the room privacy indicator.

Button 1004 activates the room service indicator. The LED indicator 1008 is located above button 1004 and lights up only when button 1004 is pressed or when button 1002 is deactivated. A "MAKE UP ROOM" 1014 label is adhered beneath button 1004 to indicate that button 1004 is for activating the room service indicator.

Software interlocks are utilised to ensure that only one of the LED indicators 1006, 1008 is lighted up at anytime.

The GSP 122 controls the SCM 106 to perform doorbell activate/deactivate functions.

It is appreciated that the controls on the GSP 122 may be operated via remote control.

The detailed diagram of the Door Chime Panel (DCP) 124 is shown in Figure 10.

The function of the DCP 124 is to ring the doorbell if the doorbell speakers (310 in Figure 3) are activated and to display the privacy status selected by the GSP 122.

In the example embodiment, the DCP 124 is made up of a PCB mounted at the back of a plastic faceplate 1102. The DCP 124 comprises a "PRIVACY PLEASE" LED indicator 1104, a LED indicator 1106 for indicating room service request, and a door bell push button 1108 for allowing a visitor to ring the doorbell.

The DCP 124 is electronically wired to the GSP 122. When button (1002 in Figure 9) is pressed, the "PRIVACY PLEASE" LED indicator 1104 on the DCP 124 will light up and the LED indicator 1106 will be switched off. When button (1004 in Figure 9) is pressed, the LED indicator 1106 will light up and the "PRIVACY PLEASE" LED indicator 1104 will be switched off.

The DCP 124 controls the SCM 106 for door chime ringing based on the settings of the GSP 122. It is appreciated that the controls on the DCP 124 may be operated via remote control.

The detailed diagram of the Air-conditioner Control Panel (ACP) 126 is shown in Figure 11.

The function of the ACP 126 is to adjust and indicate air-con fan speed and temperature readings, and make temperature settings.

In the example embodiment, the ACP 126 is made up of a display control board (Not shown in Figure 11) and a switch-button board (Not shown in Figure 11) mounted together on the flip side of a plastic faceplate 1202.

Connected to the display control board are two digital 7-segment LED displays 1204, 1206 for showing temperature in °C 1210, and four LED indicators 1208 for indicating the air-con fan speed, which are located adjacent the corresponding fan speed labels 1212, HIGH, MED (Medium), LOW or OFF (switched off).

Three push buttons 1214, 1216, 1218 connected to the switch-button board are located adjacent corresponding switch-button labels TEMP UP (Temperature up) 1220, FAN 1222, TEMP DOWN (Temperature down) 1224. As indicated in the corresponding label, push button 1214 is for increasing the temperature stated on the two digital 7-segment LED displays 1204, 1206, push button 1218 is for decreasing the temperature and push button 1216 is for switching the air-con to fan mode.

There is a programming switch (Not shown in Figure 11) connected to the switch-button board to enable/disable the setting of the hotel preset temperature, fast cool/warm preset temperature, offset temperature and season setting.

The ACP 126 controls the ACM 108 to perform air-conditioner based functions. It is appreciated that the controls on the ACP 126 may be operated via remote control.

In the example embodiment, the ACP 126 has numerous buttons/displays to control i.e. two digital 7-segment LED displays 1204, 1206, a programming switch and three push buttons 1214, 1216, 1218 capable of numerous configurations of air-conditioner settings. As the many controls will require much data processing, the Air-Conditioner Control Panel 126 may comprise one or more on-board microprocessors. Hence, the ACP 126 may be directly connected to the passive bus 138 in Figure 1 as a separate Air-conditioner module for controlling the data inputs of the many buttons and data outputs to the displays, thereby taking away data processing burden from the ACM 108.

The detailed diagram of the Curtain Control Panel (CCP) 130 is shown in Figure 12.

The function of the CCP 130 is to control motor movement for opening or closing day and night curtains.

In the example embodiment, the hardware of CCP 130 is made up of a switch-button board (Not shown in Figure 12) mounted at the back of a plastic faceplate 1302. Four push buttons 1304, 1306, 1308, and 1310 are connected to the switch-button board. Button 1304 is for opening the day curtain, button 1306 is for closing the day curtain, button 1308 is for opening the night curtain and button 1310 is for closing the night curtain. Labels 1312 are adhered adjacent to the buttons to indicate the purpose of the button. The CCP 130 controls the CCM 114 to perform curtain movement functions. It is appreciated that the controls on the CCP 130 may be operated via remote control.

The detailed diagram of the Light Switch Panel (LSP) 132 is shown in Figure 13.

The function of the LSP 132 is to switch on or off the lights in a room or at any particular area.

In the example embodiment, the hardware of LSP 132 is made up of a switch-button board (Not shown in Figure 13) mounted at the back of a plastic faceplate 1402. Four push buttons 1404, 1406, 1408, and 1410 are connected to the switch-button board. Each button switches on lights at different location in the room or any particular area. Labels (Not shown in Figure 13) may be adhered adjacent to the buttons to indicate the location of the light being switched on/off by the button. The LSP 132 controls the RCM 110 to perform light on/off functions. It is appreciated that the controls on the LSP 132 may be operated via remote control.

In Figure 14 shows examples of Light Switch Panels with different number of switches for switching on/off lights at a particular area.

The detailed diagram of the Light Dimmer Panel (LDP) 134 is shown in Figure 15.

The function of the LDP 134 is to dim, brighten or switch off the lights in a room or at any particular area.

In the example embodiment, the hardware of LDP 134 is made up of a switch-button board (Not shown in Figure 15) mounted at the back of a plastic faceplate 1702. Four push buttons 1604, 1606, 1608, and 1610 are connected to the switch-button board. Each button is responsible for dimming or brightening lights at different location in the room or any particular area. Labels (Not shown in Figure 15) may be adhered adjacent to the buttons to indicate the dimming or brightening of lights when the button is pressed. The LDP 134 controls the DCM 112 to perform light dimming/brightening functions. It is appreciated that the buttons may be rotating switches, operated via a remote control or the like.

In the example embodiment, all the building facilities such as Lighting effect, air-conditioner settings, curtain movement etc. in each guest room are programmed using a programmer device. To program the controller modules, the programmer connects directly with any module via cables or through wireless means such as Bluetooth, infrared, HomeRF, Wireless LAN or the like. All the settings directed to a

particular module are stored in a database maintained at each module. It is appreciated that the programmer device may be a mobile device such as a Personal Digital Assistant (PDA), a Laptop computer or the like. Besides making settings, the programmer device can also act as a remote control for activating/deactivating the room facilities.

Examples of the features and programmable effects of the programmer device are as follow.

- Setting a Welcome Mode Lighting Pattern, e.g. a special lighting effect when a guest first enables electrical utilities supply to the room.
- Setting an Energy Saving Lighting Pattern, e.g. turning down the air-conditioner fan and dimming the intensity of the lights strategically to save energy and yet provide sufficient illumination to the room.
- Setting a Night Light feature Lighting Pattern, e.g. dimming the intensity of the lights and only switching on lights at a particular corner of the room, for instance, by the bed.
- Setting a Timer for Night Light feature, e.g. the time period of the day where the Night Light feature would be activated.
- Setting a Timer for Energy Saving feature e.g. the time period of the day where the Energy Saving Lighting feature would be activated.
- Adjusting a Real Time Clock so that the timing at each control module is synchronised with a central clock for timely execution of programmed functions.
- Assigning Lighting Pattern to switches, e.g. assigning a particular lighting switch near the entrance of the room to switch on only the lights located at the entrance of the room.
- Assigning type of control method to switches, i.e. assigning a way of how the switches can be used to control, e.g. setting a switch to increase the speed of drawing the curtains by continuously pressing the switch many times within a predetermined short period of time.
- Check statuses of all the modules in the MCU 102.
- Setting the room mode for the type of card detected by the KCH 120.

The system communication protocol of the example embodiment will now be described.

The communication protocol is based on a Multi-Master System. Transmissions from each module are broadcasted to all the other modules via the passive bus. Each module is capable of filtering unwanted transmissions and only responds upon receiving a transmission directed to it. In the example embodiment, a transmission refers to one or more protocol packets containing data such as command(s) to perform a particular function, update(s) of module statuses, programming settings, ... etc.

As each message is broadcasted to all the other modules, power wasting attributed to continuous polling of each individual module that does not have data to be communicated to other modules is advantageously avoided.

When the module needs to send data to one or more modules in the system, the module firstly checks whether the passive bus is idle or not. If the passive bus is not free because another module is broadcasting a transmission, the module will wait until the bus is idle before it broadcasts its transmission.

To avoid collision of data, all modules are given individual time delays to respond, so that no two modules will transmit at the same time. Table 1 below shows the time delays and the corresponding device addresses of modules in an example system setup.

Table 1:

Module Type	**Module Address in Hexadecimal numbers where X = 1, 2, 3, ... etc.**	**Time delay (Milliseconds = ms) (Microseconds = µs) 10ms +**
ACM (Air-con Controller Module)	2XH	
ACM1	20H	400µs
ACM2	21H	420µs
RCM (Relay Controller Module)	3XH	
RCM1	30H	600µs
RCM2	31H	620µs
KCH (Key Card Holder)	40H	800µs

ACP (Air-con Control Panel)	50H	1000μs
SCM (Service Controller Module)	60H	1200μs
DCM (Dimmer Controller Module)	70H	1400μs
CCM (Curtain Controller Module)	A0H	2000μs

There are two ACM, two RCM and one of each other modules in the example system setup. The number of bytes allocated for module addressing is one byte i.e. the system can take up to 256 modules. It is appreciated that more bytes can be used to increase the number of modules supported by the system.

In the example setup, each module type has a fixed range of addresses for addressing modules of the same type. For example, ACM type module has an address range of 20H – 2FH and RCM type module has an address range of 30H – 3FH. The first and second ACM, ACM1 and ACM2, have addresses 20H and 21H respectively. Similarly, the first and second RCM, RCM1 and RCM2, have addresses 20H and 21H respectively. The response time delay difference between modules of the same type is 20μs, whereas the time delay difference between the modules of different type is 200μs.

If a collision occurs between two or more modules transmitting a message at the same time, modules with a higher time delay can detect the collision and will wait for the passive bus to be idle again to attempt another transmission. The modules with lower delay will continue to send data as if no collision has occurred.

The data protocol packet of the example embodiment is shown in table 2 below. XXH and YYH indicate that the value of the packet field is variable and depends on the destination module and the length of the data content.

Table 2:

Description	**HEX**	**Remarks**
STX	02H	Start of Text, 1 Byte

DL	XXH	Data Length (Number of bytes from DA to ETX), 1 Byte
DA	XXH	Destination Device or Module Address, 1 Byte
Data Content	YYH	Command/Message, (Data Length - DA Length – ETX Length) Bytes
ETX	03H	End of Text, 1 Byte
CS	XXH	Check sum i.e. XOR (Exclusive OR) from STX to ETX, 1 Byte

The first field (STX) of the protocol packet in Table 2 is the Start of Text. The STX is one byte length with a specific value of 02H. Being the first byte to be received at the receiving modules, the STX is an indication to all the modules in the system that a transmission is taking place.

The second field (DL) of the protocol packet in Table 2 indicates the data length. The data length includes the number of bytes in the DA, the data contents and the ETX. In the example embodiment, one byte is used to indicate the value of the data length.

The third field (DA) of the protocol packet in Table 2 is the module address of the destination module. In the example embodiment, the DA is one byte length.

The fourth field (Data Content) of the protocol packet in Table 2 contains data. The length of this field is DL minus the length of DA and ETX. In the example embodiment, data content comprises command codes for flow control of the communication protocol, and function specific messages for controlling a curtain drawing motor, set the air-con temperature, switch on the lights, updating module status etc. Examples of Command codes for flow control are shown in table 3 below.

Table 3:

Command	**Command Code in Hexadecimal number**	**Description**
ACK	06H	Acknowledge the receipt of a previous data protocol packet
NACK	15H	Negative Acknowledge
PWR	99H	Power Up

ENQ	05H	Enquiry, i.e. a request to the transmitting module to resend previous data protocol packet(s)
ND	00H	New Device, i.e. a module is newly added and it sends this command code to request for the addresses of modules with the same address prefix.
ADCRA	25H	Indicates Address Crash between modules
ADSTAT	16H	Address Status
CMDSTAT	17H	Command Status

The fifth field (ETX) of the protocol packet in Table 2 is the End of Text. In the example embodiment, the ETX is one byte length with a specific value of 03H. The ETX is an indication to all the modules in the system that the commands and/or messages have ended.

The sixth field (CS) of the protocol packet in Table 2 is a check sum produced for cyclic redundancy check (CRC). The checksum is calculated based on the Data Content field of the protocol packet and appended to the protocol packet at the transmitting module. The Check Sum is one byte length and is used for verifying received data integrity at receiving modules.

Flowchart 1900 in Figure 17 illustrates the communication protocol of the example embodiment.

At step 1902, the system is initialised. All the modules connected to the system perform individual start-up initialization. The module address of each module is determined at this step. Details of module addresses determination for new modules up on initialisation will be described below. After initialisation, each module is ready to transmit and receive protocol packets from other modules, and from control panels or devices that are connected to the module.

Step 1904 is the procedure carried out by each module when a protocol packet is received from a broadcasted packet in the passive bus.

Figure 18 illustrates the procedure at step 1904.

At step 2002, the received protocol packet(s) is stored in a data buffer at each receiving module. The receiving module also starts a counter at three in the described example, which counts down the number of times the receiving module will request for resend of the protocol packet should the calculated checksum of the received packet be incorrect (see below).

Next, the receiving module checks the check sum calculation of the protocol packet at step 2004.

If the check sum is correct, the module checks whether the data content field of the protocol packet contains a message or command at step 2006.

If the data contents of the data protocol packet contain a message, the message is checked to see if it is required to update a task at step 2008. If the message is needed to update a task, the necessary data processing takes place and the task is performed by the module at step 2010. If it is not needed to update a task, the module continues its normal operation.

After step 2006, if the data content of the protocol packet is a command, the command is checked at step 2012 to see if it is an enquiry or acknowledgement.

At step 2014, the module takes action according to the command received.

If the check sum is not correct at step 2004, the counter is decremented by one at step 2016.

The counter is checked to see if its value has been decremented to zero at step 2018.

If the counter number is not zero, the module sends an ENQ command via the passive bus identifying the transmitting module from which the protocol packet was received and requesting for the re-transmission of the protocol packet at step 2020. After sending the ENQ command, the module waits for a response from the transmitting module at step 2024, and upon receipt of the re-transmission,

checksum processing at step 2004 is performed on the re-transmission protocol packet.

If the counter number is zero, no further action is taken and the module returns to a normal operation state. Stopping the sending of retransmission requests after three tries can avoid blocking the passive bus and free the passive bus for other communications.

Referring back to Figure 17 and with reference to the examples in Table 1, each module of a particular module type takes turns to transmit protocol packets within a pre-fixed delay time period at step 1906.

When the turn has arrived for a module to transmit protocol packets, the module checks whether it has to transmit any protocol packets at step 1908.

If the module has to transmit a protocol packet, a counter is started at step 1912.

The counter counts down the number of checks performed to see whether the passive bus is free for the module to transmit protocol packets at step 1914. In the example embodiment, the counter is set to three, i.e. the passive bus is checked only three times to see if it is free.

If the passive bus is free, the module proceeds to transmit the protocol packet(s) containing the data message or command at step 1916.

If the passive bus is not available, the counter of three is decremented by one at step 1918, hence indicating that one check has just been performed.

At step 1920, the module checks whether the counter is zero.

If the counter is zero, the module terminates the transmission.

If the counter is not zero, the module checks whether the passive bus is free again after a time delay at step 1922.

Next, the protocol for adding a new module with addressing scheme, 3XH with a prefix '3' and variable suffix 'X', is described below with reference to Figure 19.

At step 2102, the new module is connected to the passive bus and powered up.

At step 2104, the new module is set with a default address of 30H during this initialisation.

At step 2106, a new module message is broadcasted by the new module where the data content field of the protocol packet containing the new module message is 00H, which indicates new device (See Table 3).

At step 2108, modules of module types with DA having a prefix of '3' will respond to the new module message after their respective pre-fixed delay times to avoid collision.

Upon receiving responses from the respective modules of the same module type, the new module stores the received module addresses in a buffer at step 2110.

At step 2112, the new module compares its default address 30H with the received addresses in the buffer. If the address exists, the suffix of the default new module address 30H is incremented by one at step 2114 and compared with the next address in the buffer. If address 31H also exists, the suffix of the new module address increments once more, and the process goes on until all the received module addresses in the buffer have been compared.

Once no address in the buffer is the same address as the current address of the new module, the new module stores the current module address in its Flash memory for permanent storage at step 2116 until it is necessary to change the address again.

Examples of data content of protocol packets will now be described.

For example, the data content of the protocol packets of the Air-conditioner module can include ASCII code representing the status of the Air-conditioner module and its settings such as:

- Lowest, typical and highest Air–con Fast Cool/Warm Mode preset temperature;
- Lowest, typical and highest reference temperature for automatic temperature conditioning settings;
- Open and Close status of the air conditioner chiller valves;
- Open and Close status of the air conditioner heater valves;
- Lowest, typical and highest Guest preset temperature;
- Lowest, typical and highest Hotel preset temperature (default Hotel temperature) in the case of Hotel Industry;
- Lowest, typical and highest offset temperature setting for calibrating the temperature sensor;
- Fan Speed (OFF, LOW, MEDIUM and HIGH);
- Season setting for activating air-con to use 2-pipe or 4-pipe system for the various seasons; and
- Lowest, typical and highest Room temperature;

The data content of the protocol packets of the Service Controller Module can include ASCII code representing the status of the Service Controller Module and the connected panels such as:

- All services unavailable;
- "Do Not Disturb" privacy status;
- "Make Up Room" service status, e.g. for indicating to Hotel staff to make up the room;
- Service Request status; and
- Type of access card inserted into the Key Card Holder.

The data content of the protocol packets of the Relay Controller Module can include ASCII code representing the status of the Relay Controller Module such as the switching on/off of individual relays connected to the Relay Controller Module digitally or otherwise.

The data content of the protocol packets of the Dimmer Controller Module can include ASCII code representing the status of the Dimmer Controller Module such as the stepwise increment/decrement value of the dimmer setting.

The data content of the protocol packets of the Curtain Controller Module can include ASCII code representing the status of the Curtain Controller Module such as:
- All Curtain Motors deactivated;
- Daytime curtain opening mode;
- Daytime curtain closing mode;
- Night time curtain opening mode; and
- Night time curtain closing mode.

The data content of the protocol packets of all the controller modules can include ASCII code representing the status of the Real Time Clock running synchronously at each module.

The data content of the protocol packets of one of the controller modules can include ASCII code representing the status of an Alarm Clock feature such as:
- Alarm Status OFF;
- Alarm Status ON; and
- Alarm Status ON, Buzzer On.

Figure 20 shows a controller module 2030 in an example embodiment of the present invention. The controller module 2030 is one of a plurality of controller modules 2030 of a modular unit for controlling building facilities.

The controller module 2030 comprises a data communication unit 2032 and a processor unit 2034. The data communication unit 2032 connects the controller module 2030 to a passive bus 2038 and enables the controller module 2030 to broadcast protocol packets over the passive bus 2038. The data communication unit 2032 may be serial communication interfaces such as RS485, RS232 or the like. The data communication unit 2032 also connects the controller module 2030 to an external device 2036 for controlling at least one function associated with one or more building facilities. The data communication unit 2032 is coupled to the processor unit 2034, which processes protocol packets received via the passive bus

2038 to determine whether the received data contained in the protocol packets needs to be acted on by the controller module 2030. The controller module 2030 employs the communication protocol as previously described.

The algorithms for carrying out the communication protocol described can be implemented as software, such as a computer program being executed within the controller module 2030, and instructing the controller module 2030 to conduct the communication protocol of the example embodiment.

In addition to the data communication unit 2032 and a processor unit 2034, the controller module 2030 comprises a Random Access Memory (RAM) 2040 and Flash Memory 2042.

The application program is typically supplied to the user of the modular unit encoded on a data storage medium such as a CD-ROM or flash memory device and read utilising a corresponding data storage medium drive of a data storage device. The application program is read and controlled in its execution by the processor 2034. Intermediate storage of program data maybe accomplished using RAM 2040.

Example embodiments of the present invention may have the following features and advantages.

- Function locking capabilities, e.g. disabling bell buttons in guest rooms and private function rooms so that guests in the rooms and the private functions will not be disturbed if the guests choose not to be disturbed.
- Building or room facilities control, e.g. centralized air-conditioner control in a room or building, including control over fan speed as well as temperature, centralized lighting control for adjustment of dimness and brightness of lights in a room or building, ..., etc.
- Security capabilities, e.g. access key card for authorised initiation of the control system of the example embodiments via Barcode, Radio Frequency IDentification (RFID) Technologies or the like.
- Modular Scalability, modules(s) can be added on site and the buttons for the module(s) can be assigned for controlling any

function/devices/settings without any customization of the controlling software. Combinations of the modules to be added are expandable. The module(s) can be plugged and played without the need for any software configuration.

Many modifications and other embodiments can be made to the system and its methods by those skilled in the art having the understanding of the above described disclosure together with the drawings. Therefore, it is to be understood that the system and its utility is not to be limited to the above description contained herein only, and that possible modifications are to be included in the claims of the disclosure.

CLAIMS

1. A modular control unit for controlling building facilities, the modular control unit comprising:

a passive bus;

a plurality of controller modules connected to the passive bus, each controller module arranged for controlling at least one function associated with one or more of the building facilities;

wherein each controller module comprises a data communication unit for broadcasting protocol packets over the passive bus, and a processor unit for processing protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said each controller module.

2. The modular control unit as claimed in claim 1, wherein each controller module executes a delay mechanism prior to broadcasting protocol packets via the passive bus in response to protocol packets received by another controller module via the passive bus at a predetermined response time.

3. The modular control unit as claimed in claim 2, wherein a delay time of the delay mechanism is based on a type of each controller module.

4. The modular control unit as claimed in any one of the preceding claims, wherein each controller module executes an error checking mechanism on protocol packets received via the passive bus and if an error is detected, a retransmission request is broadcasted via the passive bus.

5. The modular control unit as claimed in claim 4, wherein the error checking mechanism comprises updating a counter for each retransmission request and only repeat broadcasting the retransmitted request until a preset counter value has been reached.

6. The modular control unit as claimed in any one of the preceding claims, wherein a new controller module connected to the passive bus broadcasts an initial message using a default address of origin.

7 The modular control unit as claimed in claim 6, wherein the default address of origin is changed by the new controller module in response to identifying a same existing address being used by another controller module.

8. The modular control unit as claimed in any one of the preceding claims wherein each controller module is coupled to a power supply module via the passive bus.

9. The modular control unit as claimed in any one of the preceding claims, the modular control unit further comprising:

one or more control panels coupled to respective ones of the controller modules, for providing a user input to the controller modules.

10. The modular control unit as claimed in claim 9, wherein each controller modules identifies whether a user input received from the control panel coupled to said each controller module is destined to said each controller module or to another controller module, and said each controller module relays said user input via broadcasting over the passive bus if the user input is destined to another controller module.

11. The modular control unit as claimed in claims 9 or 10, wherein one or more of the control panels comprise a display element for displaying status information in response to the user input.

12. The modular control unit as claimed in any one of the preceding claims, further comprising one or more display panels coupled to respective ones of the controller modules, for displaying status information of the modular control unit.

13. The modular control unit as claimed in any one of the preceding claims, wherein one of the plurality of controller modules is a Service Controller Module for controlling a privacy status and room service status of a room.

14. The modular control unit as claimed in claim 13, further comprising:

a remote panel coupled to the Service Controller Module and for location outside the room for enabling sounding the doorbell based on a privacy status or a room service status of the room.

15. The modular control unit as claimed in claim 14, wherein the remote panel further displays the privacy status or room service status based on the privacy status or room service status of the room.

16. The modular control unit as claimed in any one of claims 13 to 15, wherein the Service Controller Module further controls activation or deactivation of electrical utilities supplies in the room.

17. The modular control unit as claimed in any one of the preceding claims, further comprising:

one or more card readers coupled to respective ones of the controller modules for data input into the modular control unit.

18. The modular control unit as claimed in claim 17, wherein the data input is used for access control to functionalities of the modular control unit.

19. The modular control unit as claimed in claims 17 or 18, wherein the one or more card readers are coupled directly to respective controller modules or are coupled via the passive bus.

20. The modular control unit as claimed in any one of the preceding claims, wherein one of the controller modules is an air-conditioner module for controlling an air-conditioner.

21. The modular control unit as claimed in claim 20, the modular control unit further comprising:

a temperature sensor coupled to the air-conditioner module for sensing the room temperature.

22. The modular control unit as claimed in any one of the preceding claims, wherein one of the controller modules is a relay module for controlling lights on/off.

23. The modular control unit as claimed in any one of the preceding claims, wherein one of the controller modules is a dimmer module for controlling the brightness of lights.

24. The modular control unit as claimed in claim 23, wherein the external devices include a remote control device for user input into the modular control unit.

25. A data storage device containing computer readable code means for instructing a programmable controller module of a modular control unit to execute a method for controlling building facilities, the method comprising:

instructing controller modules to control at least one function associated with one or more of the building facilities, to broadcast protocol packets over a passive bus, and to process protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said controller module.

26. A method for controlling building facilities, the method comprising:

instructing controller modules to control at least one function associated with one or more of the building facilities, to broadcast protocol packets over a passive bus, and to process protocol packets received via the passive bus to determine whether the received protocol packets needs to be acted on at said controller module.