



(51) International Patent Classification:

H04W 80/00 (2009.01) H04L 12/28 (2006.01)
H04W 4/00 (2009.01) H04L 29/06 (2006.01)

(21) International Application Number:

PCT/AU2013/000438

(22) International Filing Date:

30 April 2013 (30.04.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/641,166 1 May 2012 (01.05.2012) US
61/652,485 29 May 2012 (29.05.2012) US
61/678,020 31 July 2012 (31.07.2012) US
61/678,810 2 August 2012 (02.08.2012) US

(71) Applicant: XITEL PTY LIMITED [AU/AU]; 5436 Bay Hill Terrace, Sanctuary Cove, Queensland 4212 (AU).

(72) Inventors: DAVIS, Benjamin; 22 Elfreda Street, Alderley, Queensland 4051 (AU). DAVIS, Barrie; 5436 Bay Hill Terrace, Sanctuary Cove, Queensland 4212 (AU).

(74) Agent: CULLENS PATENT & TRADE MARK ATTORNEYS; Level 32, 239 George Street, Brisbane, Queensland 4000 (AU).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: WIRELESS POWER, LIGHT AND AUTOMATION CONTROL WITH AMBIENT LIGHT AND PROXIMITY DETECTION

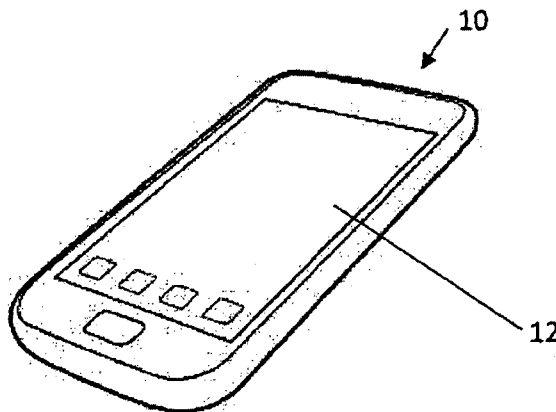


Fig. 1

(57) Abstract: A device and method for remotely controlling the supply of electricity to an electrical apparatus or system. The device (200) includes a wireless communications control module (202) configured for peer-to-peer communications, a microcontroller (208), and a sensor module (206) configured to detect at least one of light or proximity. The electrical supply is varied based on a command received through the wireless communications control module that may include specifying a threshold where data received from the sensor module that matches a predetermined threshold triggers a variance in the electrical supply.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). **Published:**

— with international search report (Art. 21(3))

WIRELESS POWER, LIGHT AND AUTOMATION CONTROL WITH AMBIENT LIGHT AND PROXIMITY DETECTION

Cross Reference to Related Applications

[0001] This application claims the benefit of U.S. Provisional Application Nos. 61/641,166, filed 1 May 2012; 61/652,485, filed 29 May 2012; 61/678,020, filed 31 July 2012; and 61/678,810, filed 2 August 2012. The entire contents of each of the above-identified applications is hereby incorporated by reference herein.

Field of Invention

[0002] The present invention generally relates to the control of mains power, lighting and automation in domestic and commercial devices by allowing a standard smartphone, tablet or similar item to act as a personal controller using a wireless peer-to-peer communications link.

Background of Invention

[0003] Many residential and commercial buildings have electrical power, lights, doors, gates, shutters, awnings and blind mechanisms that can be operated or programmed using buttons, switches or remote controls. In some instances these devices can perform tasks automatically based on the amount of ambient light detected.

[0004] In recent years, the proliferation of smartphones has placed powerful computing devices in the hands of the public. While these devices can generate and transmit wireless control commands, their generic wireless systems are not compatible with the standards currently used in domestic or commercial appliances and mechanisms, so they cannot natively communicate with such in order to transfer programming or control commands.

[0005] It can be appreciated that manufacturers of controllable power, light, door, gate, shutter, awning and blind mechanisms may find it highly advantageous for customers to program and control their products natively from a smartphone.

Summary

[0006] In one preferred embodiment, the present invention includes two parts: a power control unit with wireless communication capabilities and a sensor module; and a

battery powered personal controller able to communicate with a power control unit via a wireless peer-to-peer communications link.

[0007] The power control unit is preferably configured to operate as a Wi-Fi Direct access point/group participant using Wi-Fi Direct and/or network Wi-Fi technologies, and may include additional support for Bluetooth SIG class 2.1+EDR or later, and/or Near Field Communications (NFC). As used herein, "network Wi-Fi" refers to the Wi-Fi Alliance definition as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronic Engineers (IEEE) 802.11 standards" including any amendments, extensions or proprietary implementations. As used herein, the term "Wi-Fi Direct" refers to a device configured to support the Wi-Fi Alliance Wi-Fi Direct specification and amendments, extensions or proprietary implementations of Wi-Fi peer-to-peer technology.

[0008] Wi-Fi Direct and Bluetooth are peer-to-peer communication technologies. Peer-to-peer communication methods that may be incorporated into the power control unit are described in more detail in PCT Application No. PCT/AU2011/001666, filed December 29, 2011, titled "Wireless Power, Light and Automation Control," the entire disclosure of which is incorporated herein by reference.

[0009] The personal controller is preferably a commercially available cellular or mobile phone commonly known as a smartphone that supports at least network Wi-Fi and may also support Wi-Fi Direct and/or Bluetooth and/or Near Field Communications (NFC). Unless otherwise noted, the personal controller will be described in terms of a smartphone, though the invention is not so limited. For example only, the personal controller may be any portable device which can download or install by other means an App, have a suitable interface the user can interact with to control the App in order to execute required functions, and have the wireless communications capability to establish communications with a power control unit. Examples of personal controllers include smartphones, tablets, laptops, ultrabooks and notebook personal computers.

[0010] The power control unit can preferably form a peer-to-peer communications link with a smartphone using Wi-Fi Direct by simulating a Wi-Fi access point or negotiating a Wi-Fi Direct connection. It can be appreciated that a power control unit operating as a Wi-Fi Direct access point/group participant can communicate directly with a smartphone without the requirement of a WLAN. A power control unit preferably appears as a Wi-Fi access point or SoftAP if the smartphone is not Wi-Fi Direct

enabled, allowing the smartphone to connect peer-to-peer to a power control unit in the same way it would otherwise connect to a standard Wi-Fi access point. Where the smartphone is Wi-Fi Direct enabled, the power control unit and smartphone preferably negotiate which will assume the Wi-Fi Direct group owner role and establish a Wi-Fi Direct peer-to-peer connection. Once a connection has been established, the user is able to send commands directly to the selected power control unit without the need for any other device, intermediary or network.

[0011] The present invention in one preferred embodiment provides a power control unit with wireless communication capabilities derived from any number of radios, transceivers and controllers that provide a Wi-Fi Direct connection with the ability to optionally support Bluetooth and/or NFC. Depending on cost and desired outcome, the wireless communication capabilities may be achieved by using: any number of discrete radios, aerials, transceivers and controllers either individually, collectively, or as a system in package (SiP) or as a system on chip (SoC); a combination or "combo" chip that aggregates the functionality of a number of discrete transceivers and controllers of different standards as a SiP or SoC; or using a combination of combo chip/s, SiP/s, SoC/s and/or discrete radios, aerials, transceivers and controllers. The power control unit may utilize single or multiple wireless bands, physical channels, virtual channels, modes or other coexistence technologies and algorithms, the methods of which are already known to those skilled in the art and are not described herein. Depending on the chosen hardware components, the power control unit may also include shared antenna support and shared signal receiving paths to eliminate the need for an external splitter.

[0012] A smartphone App is preferably used to configure any operational aspects and control the functional capabilities of the power control unit. Once a link has been established, the user is preferably able to activate a smartphone App which can use the data path between the smartphone and power control unit. Using a smartphone App, a user can preferably set the operational parameters of a power control unit such as name the device, set an encryption key, enter a password, configure any Wi-Fi Direct specific parameters or configure any other parameters that may be required or desirable. When this procedure has been completed, the user can preferably command the power control unit to "restart", at which time it will configure itself according to the parameters which have been specified. The power control unit would then only establish a communications link with smartphones that can fully comply with its connection

requirements. This may include security measures in addition to any native security measures of Wi-Fi Direct or Wi-Fi Protected Access.

[0013] In addition to configuring the operational aspects of the power control unit, a smartphone App would also preferably be used to control and program various automation functions of the power control unit. In one preferred embodiment this could include the ability to set a specific response to an ambient light threshold determined from an embedded ambient light sensor in the power control unit. In another preferred embodiment, this could include the ability to set a specific response in relation to a proximity event determined from an embedded proximity detector in the power control unit.

[0014] In one preferred embodiment, a Bluetooth peer-to-peer connection between a smartphone and power control unit may be used to enter the information for configuration of the power control unit as a Wi-Fi Direct access point/group participant.

[0015] The power control unit may have an exposed human interface in the form of a mechanical switch, switches, or buttons, or a capacitive/proximity touch pad or pads. In one preferred embodiment, it may be desirable to have no exposed human interface in order to reduce the incidence of vandalism or create a highly weather resistant unit.

[0016] It can be appreciated that the power control unit can be incorporated into many forms of power, light and automation control systems and applications where power switches, power boards, light switches, light dimmers, wall switches are some more common examples.

[0017] In another preferred aspect, the present invention provides a power control device for controlling an electrical apparatus or system through a peer-to-peer wireless communications link with a personal controller so as to control a supply of electricity to the electrical apparatus or system, the personal controller having a processor, a memory, a user interface, and a wireless communications transceiver. The device includes a wireless communications control module operable for wireless communication with the personal controller, the wireless communications control module including an aerial and a radio transceiver, the radio transceiver being configured to communicate with the personal controller using a peer-to-peer communications standard. The device also includes a sensor module configured to sense at least one of light and proximity, and a microcontroller configured to control the

electrical apparatus or system based at least in part on instructions communicated from the personal controller through the wireless control module, and based at least in part on a signal sent to the microcontroller by the sensor module, the signal from the sensor module being used by the microcontroller to determine the occurrence of a predetermined trigger event. The device further includes a power control circuit configured to implement a command from the microcontroller to vary the supply of electricity to the electrical apparatus or system.

[0018] In another preferred aspect, the present invention provides for a method for remotely controlling an electrical apparatus or system to control a supply of electricity to the electrical apparatus or system. The method includes: sensing, with a sensor module, presence in proximity to a power control device, the power control device controlling the supply of electricity to the electrical apparatus or system, the power control device having a wireless communications control module operable for wireless peer-to-peer communications with a personal controller; determining whether the presence matches a predetermined threshold; powering the wireless communications control module from a sleep state to an active state after determining the presence sensed matches the predetermined threshold;

[0019] opening a wireless peer-to-peer communications link between the personal controller and the power control device; receiving at the power control device through the communications link a communication from the personal controller containing at least one command for varying the supply of electricity to the electrical apparatus or system; and varying the supply of electricity to the electrical apparatus or system in accordance with the command.

[0020] In another preferred aspect, the present invention provides for a method for remotely controlling an electrical apparatus or system to control a supply of electricity to the electrical apparatus or system. The method includes: opening a two-way, peer-to-peer wireless communications link between a personal controller and a power control device, the power control device controlling the supply of electricity to the electrical apparatus or system; receiving at the power control device through the communications link a communication from the personal controller containing at least one command for varying the supply of electricity to the electrical apparatus or system; sensing, with a sensor module, at least one of light and/or proximity to the power control device; determining whether the light and/or proximity matches a predetermined threshold; and

varying the supply of electricity to the electrical apparatus or system if the light and/or proximity sensed by the sensor module matches the predetermined threshold, otherwise varying the supply of electricity to the electrical apparatus or system in accordance with the command received from the personal controller.

Brief Description of the Figures

[0021] Fig. 1 is a perspective view of a smartphone for use in one preferred embodiment of the present invention.

[0022] Fig. 2 is a block diagram of the functional elements of a power control unit in accordance with one preferred embodiment of the present invention.

Detailed Description of the Drawings

[0023] Alternative embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the claims which follow.

[0024] Fig. 1 is a perspective representation of a smartphone 10 which uses a wireless link to communicate with a power control unit (described in more detail below). Smartphone 10 is preferably a commercially available, conventional smartphone. Some of the basic functions the smartphone preferably includes are: a touch sensitive graphical screen interface 12; a compatible radio transceiver; and the ability to run an application program (App) specific to the individual smartphone that provides a control interface for the power control unit. In the examples that follow, specific coding for each App has been omitted for simplicity as a person of ordinary skill in the art would be able to understand and reproduce the functionality of the described embodiments without the need for a discussion on particular coding.

[0025] Smartphone 10 is preferably configured to operate across a range of wireless communications technologies, including the technology to communicate via at least network Wi-Fi. Smartphone 10 may additionally include support for Wi-Fi Direct and/or Bluetooth and/or NFC. While preferred embodiments of the present invention use a smartphone as its controller, and specifically a smartphone incorporating at least

network Wi-Fi, other wireless communications methods and systems could be used depending on the specific requirements of the application of the invention.

[0026] Referring now to Fig. 2, a power control unit 200 is shown in accordance with a preferred embodiment of the present invention. Power control unit 200 has wireless communications 202, perpetual clock calendar 204, sensor module 206, system microcontroller 208 with embedded memory, an aerial 210, power control circuit 212 and power measurement 214. In some preferred embodiments, it may be preferable for system microcontroller 208 to support external memory in addition to, or instead of, embedded memory.

[0027] Perpetual clock calendar 204 preferably includes a power backup by the way of a battery or supercapacitor enabling real time to be accurately maintained in instances where a mains power outage occurs. In some preferred embodiments, perpetual clock calendar 204 may be omitted where power control unit 200 does not perform any clock or date dependant operations.

[0028] The commands and responses between system microcontroller 208 and smartphone 10 are communicated through a radio frequency wireless link supported by wireless communications 202 and aerial 210. Wireless communications 202 preferably includes any number of radios, transceivers and controllers that provide a Wi-Fi Direct connection with the ability to optionally support Bluetooth. Examples of wireless communications are described in PCT Application No. PCT/AU2012/000959, filed August 15, 2012, the entire contents of which is incorporated by reference herein. Depending on cost and the desired operational functions, wireless communications 202 may include only a Wi-Fi radio, a combination of Wi-Fi radios, or any combination of: Wi-Fi Radio/s; wireless radio/s and a Bluetooth radio. The wireless communication capabilities may be achieved by using: any number of discrete radios, aerials, transceivers and controllers either individually, collectively or as a SiP or SoC; a combination or "combo" chip that aggregates the functionality of a number of discrete transceivers and controllers of different standards as a SiP or SoC; or using a combination of combo chip/s, SiP/s, SoC/s and/or discrete radios, aerials, transceivers and controllers. The power control unit may utilize single or multiple wireless bands, physical channels, virtual channels, modes or other coexistence technologies and algorithms, the methods of which would be understood by those skilled in the art and are not described herein. Depending on the chosen hardware components, the power

control unit may also include shared antenna support and shared signal receiving paths to eliminate the need for an external splitter.

[0029] When wireless communications 202 operates according to the Wi-Fi Direct specification, it can communicate with devices that support network Wi-Fi or Wi-Fi Direct on a peer-to-peer basis without the need for any intermediary hardware. Wireless communications 202 is preferably configured to operate according to the Wi-Fi Direct specification as both a Wi-Fi Direct group participant and Wi-Fi Direct access point or SoftAP, allowing the power control unit to appear to network Wi-Fi devices during discovery as a Wi-Fi access point. After being discovered as a Wi-Fi Direct access point, a Wi-Fi Direct device is able to communicate peer-to-peer with network Wi-Fi devices that support the IEEE 802.11 specification as amended from time to time. In this instance, a network Wi-Fi device will receive a device discovery message from the power control unit as if from a Wi-Fi access point and be able to establish a peer-to-peer communications link with the power control unit as though it were connecting to a standard Wi-Fi access point. The procedure of establishing a communications link between a Wi-Fi Direct device and network Wi-Fi devices are defined in the Wi-Fi Alliance specifications and would be understood by practitioners skilled in communications systems protocols.

[0030] Wi-Fi Direct has a number of advantages which simplify communications between a power control unit and a smartphone operating as a controller. Significant advantages include mobility and portability, where a smartphone and power control unit only need to be within radio range of each other to establish a wireless communications link. Wi-Fi Direct offers secure communications through means such as Wi-Fi Protected Access protocols and encryption for transported messages, ensuring the system remains secure to qualified devices. Most importantly, Wi-Fi Direct allows a smartphone with only network Wi-Fi to engage in peer-to-peer data exchange with a power control unit even though the smartphone network Wi-Fi was never intended to support on-demand, peer-to-peer communications.

[0031] As smartphones continue to evolve, new models are starting to include support for Wi-Fi Direct in addition to network Wi-Fi. In one preferred embodiment, where a power control unit receives a Wi-Fi Direct response to a device discovery message, the smartphone and power control unit will negotiate which device will assume the role of group owner in accordance with the Wi-Fi Alliance Wi-Fi Direct

specification, and a 1:1 or peer-to-peer Wi-Fi Direct communication link will be established. The Wi-Fi Direct specification allows any Wi-Fi Direct device to be a group owner, and depending on the capabilities of the device, the negotiation procedure determines the most suitable device to perform this role.

[0032] System microcontroller 208 preferably incorporates a firmware program which defines the operation and functions of power control unit 200 and assumes responsibility for running all program code and system elements, including specifying and controlling the operation of wireless communications 202, interrogation of the perpetual clock calendar 204, control and management of the sensor module 206, interrogation and management of power measurement 214, and operation of power control circuit 212. System microcontroller 208 preferably includes a non-volatile memory to store any program data received from an App. In some preferred embodiments, perpetual clock calendar 204 may be an embedded function of system microcontroller 208. In some preferred embodiments, non-volatile memory may be external to system microcontroller 208. In some preferred embodiments, more than one microcontroller may be used.

[0033] When power control unit 200 is manufactured, system microcontroller 208 preferably holds the firmware to operate power control unit as a Wi-Fi Direct access point/group participant. When power is applied to power control unit for the first time, system microcontroller 208 preferably starts wireless communications and control module 202 in Wi-Fi Direct access point/group participant mode and begins transmitting discovery messages or "pings" that can be detected by a smartphone within wireless range.

[0034] It can be appreciated that a power control unit operating as a Wi-Fi Direct access point/group participant can communicate directly with a smartphone without needing a Wi-Fi WLAN. Power control unit 200 either appears as a Wi-Fi access point if smartphone 10 is not using Wi-Fi Direct; or negotiates with smartphone 10 as to which device will assume a Wi-Fi Direct group owner role if smartphone 10 supports Wi-Fi Direct. The user is then able to establish a peer-to-peer communications link and send commands directly to the selected power control unit without the need for any other device.

[0035] A preferred method for controlling a power control unit is through a related Product App. Installation instructions for the Product App are preferably included with

the power control unit. The Product App preferably adopts the same centralized app store installation methods common to all smartphone platforms.

[0036] The Product App communicates with any mix of wireless elements and radio technologies to seamlessly provide the best communications link. In one preferred embodiment, Product App preferably controls smartphone 10 wireless communications in order to initiate, search and establish a wireless communications link with a power control unit. Product App preferably displays preconfigured and new power control units via graphical elements on smartphone touch screen 12.

[0037] When the Product App starts, it preferably scans for power control units and identifies any new power control units that need to be initially configured. At this point the Product App preferably allows the user to establish a peer-to-peer connection with a new power control unit. The Product App then leads the user through a series of data inputs preferably using the smartphone's touch screen 12 as a human interface. The Product App communicates with system microcontroller 208 and replaces the general parameters used for the initial connection to specific parameters which define the power control unit as a unique Wi-Fi Direct product. These may include: setting a unique encryption key so all data transfers between power control unit and the smartphone are protected; setting the power control unit name to a unique, easily recognisable identifier, e.g., from a product name such as "Power Control Unit" to "Garden Lights"; setting the power control unit's unique Wi-Fi address ID so that it becomes an individual device in its own right; and setting a password in the power control unit used to establish a secure link with a smartphone.

[0038] The Product App preferably maintains a record of these specific parameters in the smartphone memory for future identification of, and connection to, the new power control unit.

[0039] Once the setup procedure is complete, the Product App preferably commands the power control unit firmware to "restart". When the applications firmware restarts, the power control unit will use the user loaded data to populate and create its own unique Wi-Fi Direct identity. The smartphone which was used to set this identity will be able to automatically connect to that power control unit because the new specific parameters are known. The Product App can then be used to preferably automatically establish a communications link with the power control unit each time the user selects that particular device.

[0040] Once a power control unit has been configured, any other smartphone can only connect if the user knows the specific parameters that are now unique to that particular power control unit. If a second smartphone searches for Wi-Fi access points or Wi-Fi Direct devices, it will see the power control unit identified as, for example, "Garden Lights" with the characteristic that it is "secure". To connect to it, the user will have to know the specific password allocated to that power control unit, otherwise it will not be able to establish a communications link. If the password is known and entered into the smartphone when requested, a communication link between the second smartphone and the power control unit will be established. The Product App is still preferably required to control the power control unit and may have additional security requirements depending on the nature of the application.

[0041] The operating parameters for power control unit are preferably retained by system microcontroller 208 in the event power is disconnected or lost. When power is restored, system microcontroller 208 powers up with all of the operating parameters and programming as previously operating before power was removed, restoring the appropriate operating parameters from non-volatile memory.

[0042] The Product App is preferably able to communicate with a power control unit and command it to re-initialise to the factory default configuration. In this case, all user-defined parameters that were loaded into the power control unit are lost and it is returned to its factory default state, ready to receive new user-defined parameters.

[0043] The power control unit may incorporate a mechanical means such as a button or switch which the user could activate to cause the power control unit to re-initialise to the factory default configuration without the use of a smartphone or Product App.

[0044] In one preferred embodiment, wireless communications control module 202 may include Bluetooth communication capabilities in addition to Wi-Fi Direct access point/group participant capabilities. A peer-to-peer Bluetooth communication link between smartphone 10 and power control unit 200 may be used by the Product App to enter parameters for establishing a Wi-Fi Direct access point/group participant communications link, or may in its own right operate as a peer-to-peer communications link for transfer of control commands between Product App and power control unit. Similarly, NFC can be included and used where desirable.

[0045] In one preferred embodiment, the power control unit may incorporate a means such as a button, switch, capacitive pad, or proximity sensor that may facilitate the secure initialization of a peer-to-peer connection.

[0046] In one preferred embodiment, the power control unit may include an NFC tag that the Product App could use when first communicating with a new power control unit to automatically establish a Wi-Fi Direct access point/group participant peer-to-peer communications link on smartphones that support NFC. This process is commonly referred to as "bootstrapping" and is an established method for initializing communications known by those skilled in the art.

[0047] It will be appreciated that the steps described above may be performed in a different order, varied, or certain steps added or omitted entirely without departing from the scope of the present invention. By way of example only, where the smartphone operating system does not allow the Product App to control the smartphone wireless communications in order to establish a peer-to-peer link with a power control unit, the user may use any mechanism provided by the smartphone operating system to establish a peer-to-peer communication link with a power control unit prior to starting the Product App.

[0048] With continued reference to Fig. 2, the user can, using the Product App in its simplest form, command system microcontroller 208 to actuate power control circuits 212 to supply electrical power to an attached device or disconnect electrical power to an attached device. The Product App is also preferably configured to program power control unit 200 with more complex functions and scheduling. Programmed, time dependant operations are preferably executed by system microcontroller 208 as a timed sequence from a trigger event, such as a countdown timer, or as a specified task at a predetermined date and/or time of day for a continual or defined period. Single or multiple daily start and stop times, selected day timers, repetition timers, weekly timers, combinational timers, specific date timers and many other functions are all possible and contemplated within the scope of the present invention.

[0049] In one preferred embodiment, the absolute time and date parameters of perpetual clock calendar 204 are preferably synchronized with smartphone 10 when a communications link is established.

[0050] Power control unit 200 preferably includes sensor module 206. As shown in Fig. 2, sensor module 206 preferably includes an ambient light sensor and a proximity detector. Unless otherwise mentioned, sensor module 206 will be described as if including an ambient light sensor and a proximity detector, though the invention is not so limited. It can be appreciated that the automation of a range of tasks can be greatly facilitated by the accurate measurement of ambient light and the setting of thresholds that system microcontroller 208 can use to determine if a trigger event has occurred in order to actuate power control circuit 212. By way of example only, this could be setting an ambient light level as a threshold for turning lights or other devices connected to power control circuit 212 on and off at dusk and/or dawn. By way of another example, this could be setting an ambient light level as a threshold for lowering or raising a mechanised blind or awning.

[0051] In one preferred embodiment, a user through the Product App is preferably able to set an ambient light threshold that system microcontroller 208 can use as a trigger for executing an associated task. The ambient light threshold may be pre-stored in the Product App, or the Product App through a wireless communications link with power control unit 200 may take an immediate ambient light measurement from sensor module 206 to use as a threshold. Any ambient light levels set in the Product App as a threshold are preferably stored in the non-volatile memory of power control unit 200 and can be used by system microcontroller 208 to actuate power control circuit 212 when system microcontroller 208 determines that sensor module 206 is reporting the conditions matching a threshold for a trigger event.

[0052] System microcontroller 208 is preferably able to process multiple different thresholds, triggers, and sequencing which may be combined with time based modifiers; filters; and/or processes designed to reduce the likelihood of false positive conditions. By way of example only, system microcontroller 208 may be programmed by the Product App to actuate power control circuit 212 at a specified ambient light threshold. System microcontroller 208 preferably analyses measurements from sensor module 206 over a period of time to ensure the ambient light threshold has been met and is not being caused by an intermediate condition such as something temporarily covering sensor module 206. By way of another example, system microcontroller 208 may be programmed by the Product App to only use a threshold as a trigger event after a particular time of day. In that way, a user could set a power control unit to only use ambient light measurements after say 5pm. By way of another example, where sensor

module 206 includes spectral analysis capabilities, a threshold may be specified based on spectral analysis of an ambient light measurement. This is a form of filtering known by those skilled in the art that allows an ambient light threshold to be determined from the level of natural light without interference from artificial lighting. By way of another example, system microcontroller 208 may be programmed to turn power control circuit 212 on at a specified ambient light threshold and off at a different ambient light threshold using a time based modifier. This could be by way of setting an actual time of day at which measurement for different thresholds occur, or a specifying a period of time after one threshold event that system microcontroller 208 starts scanning for the next threshold event.

[0053] The management of power, light and automation it is often part of a broader energy conservation strategy. For that reason it may be desirable for power control unit 200 to only activate its wireless communications when a user wishes to establish a wireless communications link rather than have it run continuously drawing power. In one preferred embodiment, a user via the Product App may specify that the wireless communications and control module 202 only activate on the detection of a proximity event by sensor module 206. The proximity detector capability of sensor module 206 is preferably used to detect a user's hand in front of, and/or near and/or touching power control unit 200 and send a control signal to system microcontroller 208 that a proximity event has occurred. System microcontroller 208 on determining that a proximity event has occurred would preferably initialize wireless communications 202 to allow smartphone 10 to establish a wireless communications link. System microcontroller 208 would preferably only run wireless communications for a pre-defined active period after a proximity event and return wireless communications to a passive sleep state if a wireless communications link was not established during that period. If a wireless communications link was established during the pre-defined active period, system microcontroller 208 would preferably keep wireless communications active while the communications link was active, and return to a sleep state a short time after the communications link was terminated.

[0054] In one preferred embodiment the sensor module is preferably a single integrated component, however in some embodiments it may be preferable to use a discrete ambient light sensor and/or a discrete proximity sensor. In some preferred embodiments, the proximity detector may be omitted and replaced with a button, switch,

or capacitive pad. In some preferred embodiments, the ambient light sensor may be omitted.

[0055] In one preferred embodiment, while sensor module 206 is used to activate wireless communications, it is not so limited and may also initiate any task that may otherwise be performed by a mechanical switch. By way of example only, a power control unit 200 may have a group of lights attached to power control circuit 212 and be programmed by the Product App with a low light ambient light threshold that system microcontroller 208 uses as a trigger to begin monitoring the proximity detector in sensor module 206 for a proximity event such as a user's hand approaching and/or touching power control unit 200. A proximity event may be the detection of proximity less than a predetermined proximity threshold (e.g., proximity within predetermined distance from the proximity detector). The predetermined distance may be configured as, for example only, anywhere within in a single room, hallway, corridor or open area within a building, and/or an area outside of a building. The predetermined distance may be specifically calibrated for a range from the proximity detector, for example only, between 0cm to 3m, more preferably 1cm to 1m. On detection of a proximity event, system microcontroller 208 may actuate power control circuit 212 to supply power to attached lights for a user defined period of say 3 mins. In that way a power control unit could be used in a building to only activate a group of lights at night for a set period of time when a user touches or is detected by the power control unit, thereby saving considerable power by not running the lighting continuously or not allowing the lighting to be used during the day when there is sufficient natural light.

[0056] It can be appreciated that a number of sophisticated and complex automation and control schemes can be programmed into power control unit 200 by combining the processing capabilities of system microcontroller 208 with the timing capabilities of perpetual clock calendar 204 and sensing capabilities of sensor module 206.

[0057] In one preferred embodiment, power control circuits 212 may include a single relay configured to vary the supply of power to attached devices in a simple on/off fashion. In another preferred embodiment, power control circuits 212 may include a number of relays configured to vary the supply of power to different devices separately or grouped, such as lights or banks of lights, in a simple on/off fashion. In another preferred embodiment, power control circuits 212 may include a dimmer control. A dimmer control is used to vary the amount of power transferred to attached lights which

have the appropriate characteristics to allow the light output to be varied anywhere from fully on to fully off as directed by system microcontroller 208. Using a dimmer in power control circuits 212 under the control of system microcontroller 208, the amount of electrical power transferred to the attached light can be regulated. Because the electrical load presented to the dimmer control can be resistive, inductive or capacitive depending on the light type and arrangement, the dimmer unit can provide leading edge, trailing edge, pulse width modulation or other suitable methods of variable power control.

[0058] In one preferred embodiment, power control unit 200 may not contain any embedded power control circuits 212 and interface entirely with external power control circuits allowing for a custom number of circuits to meet the particular requirements of the application at hand.

[0059] Where power control unit 200 controls external power control circuits, it may do so through a physical connection (for example only, a wired connection) or may alternately use a wireless link such as sub-1GHz radio. The use of a wireless extension may require the addition of a supporting radio that may be a transmitter only, or a transmitter and receiver, depending on the requirements of the external power control circuits. The supporting radio may be configured by system microcontroller 208 to operate at a number of different carrier frequencies. Data could be modulated onto those carrier frequencies such that the encoded data could be received, decoded and acted upon by a compatible radio receiver in a remote power control circuit to operate lights or a device such as, for example only, a door lock, alarm system, boom gate and/or blind system.

[0060] The supporting radio may be capable of FSK, GFSK, MSK, OOK or other modulation methods and be able to operate over a wide frequency range including the license free Industrial Scientific and Medical (ISM) frequencies, or may support specific proprietary standards such as Zigbee, Z-wave or equivalent standards. While these specifications are applicable to most wireless sensor networks, home and building automation, alarm and security systems and industrial monitoring and control, there may be applications where a system compatible transceiver with specific frequency and modulation specifications is required. In these situations, a specific supporting radio could be provided within the embodiment described herein.

[0061] It will be appreciated that the power control circuit 212 described above can be extended in many ways without departing from the scope of the present invention. Power control circuit 212 may be configured to control an external device such as a blind, shutter, gate, door and lights, allowing power control unit 200 to manage a range of external devices according to programmed schedules and ambient light conditions.

[0062] In one preferred embodiment, power measurement 214 allows the electrical parameters of the electricity transferred through power control circuit 212 to be measured. These parameters are available to system microcontroller 208 and may include instantaneous voltage, current and power, Irms and Vrms, average real and apparent power and energy-to-pulse conversion. Some or all of the measured electrical parameters could be sent to smartphone 10 via the communications link where the Product App would be able to perform additional calculations or conversions if required and display the results in a graphical format on the smartphone's touch sensitive screen for the user to view. Suitable processing of these parameters allows information such as the instantaneous power being used by an attached device or appliance to be displayed. Power usage over time, total power used and trend analysis are also some of the useful representations of the basic electrical data that are preferably measured and could be displayed to the user. By using the smartphone's Internet capability, the Product App could access a power company's rates and charges, and provide the user with usage and cost comparisons.

[0063] The inclusion of power measurement 214 allows more advanced functionality other than simple metering to be offered by power control unit 200. In one preferred embodiment, system microcontroller 208 may continuously measure various electrical parameters through power measurement 214 allowing system microcontroller 208 to detect possible error conditions in order to cause power control circuit 212 to reduce or cut power to an attached device to protect both power control unit 200 and the attached device. In another preferred embodiment, system microcontroller 208 through power measurement 214 may take a measurement of power control circuit 212 under operational load to establish a normal operating threshold. System microcontroller 208 could periodically or continuously monitor power measurement 214 and report to the Product App any deviation from the operating threshold. By way of example only, this could be used to measure the operating load of a group of lights connected to power control circuit 212 and allow a user through the Product App to determine if any lights

had blown based on the change in power being consumed rather than having to inspect each luminaire.

[0064] It will be appreciated by those skilled in the art that the system described above can be varied in many ways without departing from the scope of the present invention. By way of example only, elements of wireless communications 202, system microcontroller 208, perpetual clock calendar 204 may be aggregated into a single or various SoCs or SiPs. Sensor module 206 may be wired to power control device 200, or wirelessly connected. For example, a sensor module may be located in one portion of a room while the power control device is at another portion of the room. More than one sensor may be utilised. For example, ambient light sensors may be positioned in multiple rooms throughout a structure or building. Sensors other than light or proximity may be used. For example, motion, temperature and/or sound sensors may be utilised if desired. The sensor module may include any combination of light, proximity, motion, temperature and/or sound sensors.

[0065] Aspects of the present invention may be used in a variety of environments. For example only, the invention can be adapted for use with lighting, gates, blinds, garage doors, fans, pools, timers, power outlets, consumer electronics, computers, vehicles, power meters, and air conditioning systems.

[0066] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A power control device for controlling an electrical apparatus or system through a peer-to-peer wireless communications link with a personal controller so as to control a supply of electricity to the electrical apparatus or system, the personal controller having a processor, a memory, a user interface, and a wireless communications transceiver, said device comprising:
 - a wireless communications control module operable for wireless communication with the personal controller, said wireless communications control module including an aerial and a radio transceiver, said radio transceiver being configured to communicate with the personal controller using a peer-to-peer communications standard;
 - a sensor module configured to sense at least one of light and proximity;
 - a microcontroller configured to control the electrical apparatus or system based at least in part on instructions communicated from the personal controller through said wireless control module, and based at least in part on a signal sent to said microcontroller by said sensor module, the signal from said sensor module being used by said microcontroller to determine the occurrence of a predetermined trigger event; and
 - a power control circuit configured to implement a command from said microcontroller to vary the supply of electricity to the electrical apparatus or system.
2. The device of claim 1, wherein said sensor module includes an ambient light sensor.
3. The device of claim 2, wherein the trigger event is based at least in part on a predetermined threshold of light sensed by said ambient light sensor.
4. The device of claim 1, wherein said sensor module includes a proximity detector configured to detect presence
5. The device of claim 4, wherein the trigger event is based at least in part on the detection of presence at a predetermined distance from said proximity detector.

6. The device of claim 1, wherein said sensor module includes at least one ambient light sensor and at least one proximity detector.
7. The device of claim 6, wherein the trigger event is the detection of an ambient light threshold being sensed by said ambient light sensor, said microcontroller being configured to use the trigger event to begin monitoring said proximity detector.
8. The device of any one of the above claims, wherein at least a portion of said sensor module is in wireless communication with said microcontroller.
9. The device of any one of the above claims, further comprising a timer for measuring a predetermined period of time for assessing whether the trigger event has occurred.
10. The device of claim 9, wherein said timer forms a portion of said microcontroller.
11. The power control device of any one of the above claims, further comprising a power measurement module for measuring electrical parameters of electricity transferred through said power control circuit.
12. The device of claim 11, wherein said power measurement module operates continuously.
13. The device of either claim 11 or 12, wherein said microcontroller is configured to compare data provided by said power measurement module with a predetermined operating threshold associated with the electrical apparatus or system.
14. The device of claim 13, wherein said microcontroller is configured to issue a notification if the data measured by said power measurement module varies from the predetermined operating threshold.
15. The device of claim 14, wherein the notification includes an alert concerning a burnt-out luminaire.
16. The device of any one of the above claims, wherein said power control circuit is wired to said microcontroller.

17. The device of any one of claims 1 to 15, wherein said power control circuit is wired to the electrical apparatus.
18. The device of any one of the above claims, wherein said microcontroller is configured to open a peer-to-peer wireless communications link with the personal controller by either:
 - simulating a Wi-Fi access point if the personal controller is a network Wi-Fi device; or
 - negotiating with the personal controller as to which of said microcontroller or the personal controller will assume a group owner role if the personal controller is a Wi-Fi Direct device.
19. The device of any one of claims 1 to 17, wherein the peer-to-peer communications standard is Wi-Fi Direct.
20. A method for remotely controlling an electrical apparatus or system to control a supply of electricity to the electrical apparatus or system, the method comprising:
 - sensing, with a sensor module, presence in proximity to a power control device, the power control device controlling the supply of electricity to the electrical apparatus or system, the power control device having a wireless communications control module operable for wireless peer-to-peer communications with a personal controller;
 - determining whether the presence matches a predetermined threshold;
 - powering the wireless communications control module from a sleep state to an active state after determining the presence sensed matches the predetermined threshold;
 - opening a wireless peer-to-peer communications link between the personal controller and the power control device;
 - receiving at the power control device through the communications link a communication from the personal controller containing at least one command for varying the supply of electricity to the electrical apparatus or system; and

varying the supply of electricity to the electrical apparatus or system in accordance with the command.

21. The method of claim 20, wherein the predetermined threshold for presence is based on detection of presence within a predetermined distance from the sensor module.
22. The method of either claim 20 or 21, wherein the predetermined threshold is adjustable via commands sent to the power control device from the personal controller over the communications link.
23. The method of any one of claims 20 to 22, further comprising measuring a period of time during which it is determined whether the presence matches the predetermined threshold.
24. The method of any one of claims 20 to 23, further comprising measuring electrical parameters of the electricity supplied to the electrical apparatus or system.
25. The method of claim 24, further comprising comparing the measured parameters to a predetermined operating threshold associated with the electrical apparatus or system.
26. The method of claim 25, further comprising issuing an alert if the measured parameters vary from the predetermined operating threshold.
27. The method of claim 26, wherein the alert concerns a burnt-out luminaire.
28. The method of claim 20, wherein the opening of the peer-to-peer wireless communications link between the power control device and the personal controller, includes:

simulating a Wi-Fi access point if the personal controller is not utilising Wi-Fi Direct to communicate with the power control device; or

if the personal controller is utilising Wi-Fi Direct to communicate, negotiating between the power control device and the personal controller which of the power control device and the personal controller will assume a Wi-Fi Direct group owner role.

29. The method of claim 20, wherein the opening of the peer-to-peer wireless communications link includes opening a Wi-Fi Direct communications link.
30. A method for remotely controlling an electrical apparatus or system to control a supply of electricity to the electrical apparatus or system, the method comprising:
- opening a two-way, peer-to-peer wireless communications link between a personal controller and a power control device, the power control device controlling the supply of electricity to the electrical apparatus or system;
 - receiving at the power control device through the communications link a communication from the personal controller containing at least one command for varying the supply of electricity to the electrical apparatus or system;
 - sensing, with a sensor module, at least one of light and/or proximity to the power control device;
 - determining whether the light and/or proximity matches a predetermined threshold; and
 - varying the supply of electricity to the electrical apparatus or system if the light and/or proximity sensed by the sensor module matches the predetermined threshold, otherwise varying the supply of electricity to the electrical apparatus or system in accordance with the command received from the personal controller.
31. The method of claim 30, wherein the sensing includes sensing ambient light.
32. The method of claim 31, wherein the predetermined threshold for light is based on detection of the ambient light falling below or above normal daylight.
33. The method of claim 30, wherein the sensing includes sensing proximity.
34. The method of claim 33, wherein the predetermined threshold for proximity is based on detection of presence within a predetermined distance from the sensor module.
35. The method of claim 30, wherein the sensing includes sensing light, further including sensing for proximity after determining that the light sensed matches the predetermined threshold.

36. The method of any one of claims 30 to 35, wherein the predetermined threshold is adjustable via commands sent to the power control device from the personal controller over the communications link.
37. The method of any one of claims 30 to 36, further comprising measuring a period of time during which it is determined whether the light and/or presence is outside of the predetermined threshold.
38. The method of any one of claims 30 to 37, further comprising measuring electrical parameters of the electricity supplied to the electrical apparatus or system.
39. The method of claim 38, further comprising comparing the measured parameters to a predetermined operating threshold associated with the electrical apparatus or system.
40. The method of claim 39, further comprising issuing an alert if the measured parameters vary from the predetermined operating threshold.
41. The method of claim 40, wherein the alert concerns a burnt-out luminaire.
42. The method of claim 30, wherein the opening of the peer-to-peer wireless communications link between the power control device and the personal controller, includes:
 - simulating a Wi-Fi access point if the personal controller is not utilising Wi-Fi Direct to communicate with the power control device; or
 - if the personal controller is utilising Wi-Fi Direct to communicate, negotiating between the power control device and the personal controller which of the power control device and the personal controller will assume a Wi-Fi Direct group owner role.
43. The method of claim 30, wherein the opening of the peer-to-peer wireless communications link includes opening a Wi-Fi Direct communications link.

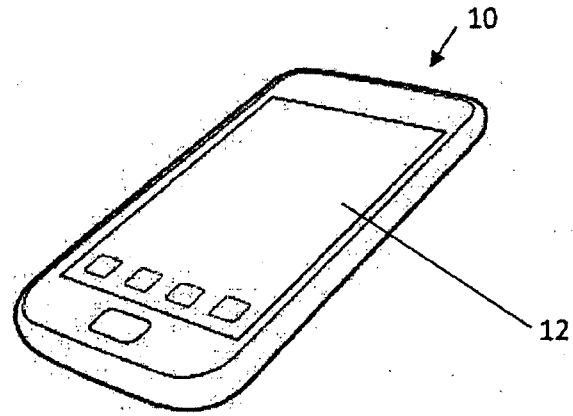


Fig. 1

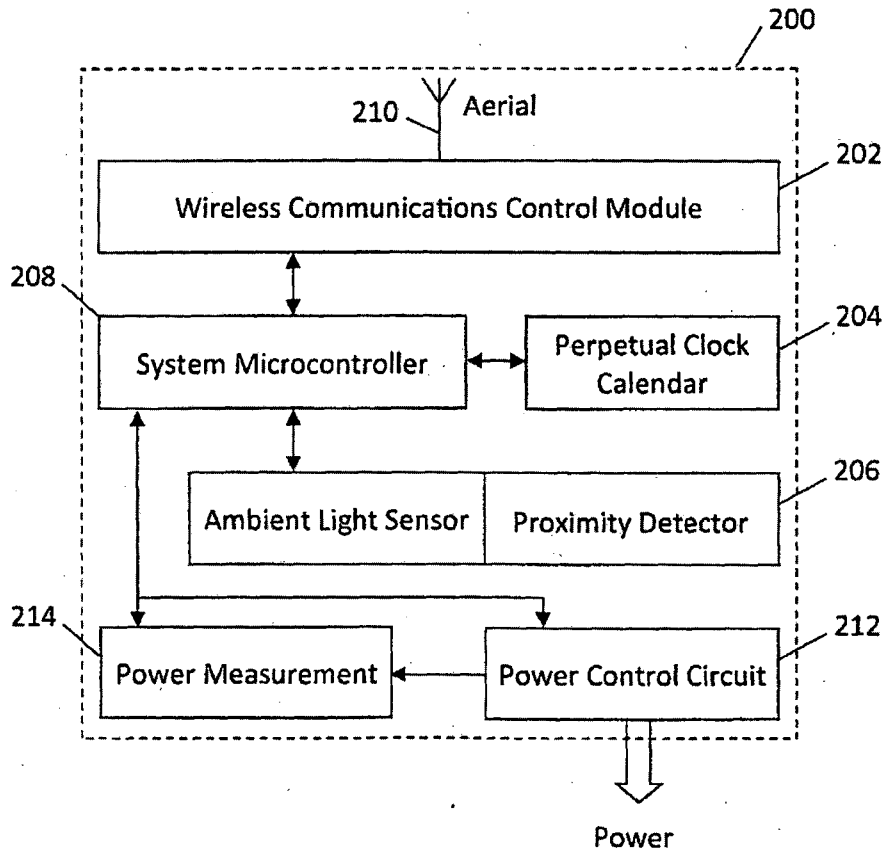


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/000438

A. CLASSIFICATION OF SUBJECT MATTER

H04W 80/00 (2009.01) H04W 4/00 (2009.01) H04L 12/28 (2006.01) H04L 29/06 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI (abstracts); GOOGLE keywords: PEER TO PEER, APPLIANCE, PERSONAL CONTROLLER, TRANSCEIVER, SENSOR, PROXIMITY and similar terms and phrases.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
29 May 2013Date of mailing of the international search report
29 May 2013

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au
Facsimile No.: +61 2 6283 7999

Authorised officer

Bayer Mitrovic
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262832164

INTERNATIONAL SEARCH REPORT

International application No.

C (Continuation).

DOCUMENTS CONSIDERED TO BE RELEVANT

PCT/AU2013/000438

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/0086563 A1 (ARLING ET AL) 12 April 2012 Whole document, especially abstract, Figs.1-4, paragraphs [0004], [0005], [0013]-[0018], [0022].	1-43
Y	US 6069896 A (BORGSTAHL ET AL) 30 May 2000 Whole document, especially abstract, Figs.1-6, column 1 lines 10-20, column 2 line 66 - column 5 line 51, column 8 lines 7-45, claims 7, 17-20.	1-43

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2013/000438

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
US 2012/0086563 A1	12 Apr 2012	None	
US 6069896 A	30 May 2000	None	

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

Form PCT/ISA/210 (Family Annex)(July 2009)