IN THE HIGH COURT OF JUSTICE
CHANCERY DIVISION
PATENTS COURT

Claim No: HP-2016-000046

B E T W E E N:

(1) PHILIPS LIGHTING NORTH AMERICA CORPORATION
(a company incorporated under the laws of the USA)

(2) PHILIPS LIGHTING HOLDING B.V.
(a company incorporated under the laws of the Netherlands)

Claimants

-and-

(1) MEGAMAN (UK) LIMITED

(2) NEONLITE INTERNATIONAL LIMITED

(3) NEONLITE ELECTRONIC & LIGHTING (HK) LIMITED
(a company incorporated under the laws of Hong Kong)

Defendants

ANNEX B – SCHEDULE OF AMENDMENTS OF THE FIRST REQUEST

The proposed conditional amendments to European Patent (UK) No. 1 502 483 (the "**Patent**") of the First Request are as follows:-

Conditional Amendments to the Claims of the Patent		
Old Claim	**New Claim**	**Conditional Amendment**
1	1	An illumination apparatus (200), comprising: at least one LED (104); and at least one controller (204) coupled to the at least one LED (104) and configured to provide D.C. power to the at least one LED (104);~~,~~ wherein the controller is configured to receive, from an A.C. ~~power source~~dimmer circuit, an A.C. power-related signal being a dimmer

		output signal generated by the dimmer circuit based on a standard A.C. line voltage but having higher frequency components than ~~a~~the standard A.C. line voltage; ~~and~~ wherein the controller is configured to provide said D.C. power based on the A.C. power-related signal~~,~~; characterized in that the at least one controller (204) is configured to filter out ~~the~~said higher frequency components.
~~2~~		~~The apparatus of claim 1, wherein the A.C. power source is an (A.C.) dimmer circuit.~~
~~3~~	2	The apparatus of claim ~~2~~1, wherein the A. C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the at least one controller is configured to provide an essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface.
~~4~~	3	The apparatus of claim ~~3~~2, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one controller (204) is configured to provide the essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface notwithstanding variations in the duty cycle of the power-related signal.
~~5~~	4	The apparatus of claim ~~3~~2, wherein the at least one controller (204) comprises: a rectifier (404) to receive the power-related signal and provide a rectified power-related signal; a low pass filter (408) to filter the rectified power-related signal; and a DC converter (402) to provide the essentially non-varying power based on the filtered rectified power-related signal.
~~6~~	5	The apparatus of claim ~~3~~2, further comprising: a screw-type power connector configured to engage mechanically and electrically with a conventional incandescent light socket so as to couple the apparatus to the A.C. dimmer circuit.
~~7~~	6	The apparatus of claim ~~6~~5, further comprising:

		a housing, coupled to the screw-type power connector, to enclose the at least one LED and the at least one controller, the housing being structurally configured to resemble an incandescent light bulb.
~~8~~	7	The apparatus of claim ~~7~~6, wherein the at least one LED (104) includes a plurality of differently colored LEDs.
~~9~~	8	The apparatus of claim ~~2~~1, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the at least one controller is configured to variably control at least one parameter of light generated by the at least one LED (104) in response to operation of the user interface.
~~10~~	9	The apparatus of claim ~~9~~8, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one controller (204) is configured to variably control the at least one parameter of the light based at least on the variable duty cycle of the power-related signal.
~~11~~	10	The apparatus of claim ~~9~~8 wherein the at least one parameter of the light that is variably controlled by the at least one controller (204) in response to operation of the user interface includes at least one of an intensity of the light, a color of the light, a color temperature of the light, and a temporal characteristic of the light.
~~12~~	11	The apparatus of claim ~~9~~8, wherein the at least one controller (204) is configured to variably control at least two different parameters of the light generated by the at least one LED (104) in response to operation of the user interface.
~~13~~	12	The apparatus of claim ~~12~~11, wherein the at least one controller (204) is configured to variably control at least an intensity and a color of the light simultaneously in response to operation of the user interface.
~~14~~	13	The apparatus of claim ~~12~~11, wherein the at least one LED (204) is configured to generate an essentially white light, and wherein the at least one controller (204) is configured to variably control at least an intensity and a color temperature of the white light simultaneously in response to operation of the user interface.

~~15~~	14	The apparatus of claim ~~14~~13, wherein the at least one controller (204) is configured to variably control at least the intensity and the color temperature of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source.
~~16~~	15	The apparatus of claim ~~15~~14, wherein the at least one controller (204) is configured to variably control the color temperature of the essentially white light over a range from approximately 2000 degrees K at a minimum intensity to 3200 degrees K at a maximum intensity.
~~17~~	16	The apparatus of claim ~~15~~14, further comprising: a screw-type power connector (202) configured to engage mechanically and electrically with a conventional incandescent light socket so as to couple the apparatus to the A.C. dimmer circuit.
~~18~~	17	The apparatus of claim ~~17~~16, further comprising: a housing, coupled to the screw-type power connector, to enclose the at least one LED (104) and the at least one controller (204), the housing being structurally configured to resemble an incandescent light bulb.
~~19~~	18	The apparatus of claim ~~15~~14, wherein the at least one LED includes a plurality of differently colored LEDs.
~~20~~	19	The apparatus of claim ~~9~~8, wherein the at least one controller includes: an adjustment circuit (208) to variably control the at least one parameter of light based on the varying power-related signal; and power circuitry to provide at least the power to the at least one LED (104) based on the varying power-related signal.
~~21~~	20	The apparatus of claim ~~20~~19, wherein the power circuitry includes: a rectifier (404) to receive the power-related signal and provide a rectified power related signal; a low pass filter to filter (408) the rectified power-related signal; and a DC converter (404) to provide the power to at least the at least one LED (104) based on the filtered rectified power-related signal.

~~22~~	21	The apparatus of claim ~~21~~20, wherein the adjustment circuit is coupled to the DC converter and is configured to variably control the at least one LED (104) based on the filtered rectified power-related signal.
~~23~~	22	The apparatus of claim ~~21~~20, wherein the adjustment circuit includes at least one processor (102) configured to monitor at least one of the power-related signal, the rectified power-related signal, and the filtered rectified power-related signal so as to variably control the at least one LED (104).
~~24~~	23	The apparatus of claim ~~21~~20, wherein the power circuitry is configured to provide at least the power to the at least one LED (104) and power to the at least one processor (102) based on the varying power-related signal.
~~25~~	24	The apparatus of claim ~~21~~20, wherein the at least one processor (102) is configured to sample the varying power-related signal and determine at least one varying characteristic of the varying power-related signal.
~~26~~	25	The apparatus of claim ~~21~~20, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one processor (102) is configured to variably control the at least one parameter of the light based at least on the varying duty cycle of the power-related signal.
~~27~~	26	The apparatus of claim ~~26~~25, wherein the at least one LED (104) includes a plurality of differently colored LEDs.
~~28~~	27	The apparatus of claim ~~27~~26, wherein: the plurality of differently colored LEDs includes: at least one first LED (104A, 104B, 104C) adapted to output at least first radiation having a first spectrum; and at least one second LED (104A, 104B, 104C) adapted to output second radiation having a second spectrum different than the first spectrum; and the at least one processor (102) is configured to independently control at least a first intensity of the first radiation and a second intensity of the second radiation in response to operation of the user interface.
~~29~~	28	The apparatus of claim ~~28~~27, wherein the at least one processor (102) is programmed to implement a pulse width modulation (PWM) technique

		to control at least the first intensity of the first radiation and the second intensity of the second radiation.
~~30~~	29	The apparatus of claim ~~29~~28, wherein the at least one processor (102) further is programmed to: generate at least a first PWM signal to control the first intensity of the first radiation and a second PWM signal to control the second intensity of the second radiation; and determine duty cycles of the respective first and second PWM signals based at least in part on variations in the power-related signal due to operation of the user interface.
~~31~~	30	The apparatus of claim ~~20~~19 wherein the adjustment circuit includes drive circuitry (109) including at least one voltage-to-current converter to provide at least one drive current to the at least one LED so as to control the at least one parameter of the generated light.
~~32~~	31	The apparatus of claim ~~31~~30, wherein the at least one voltage-to-current converter includes an operational amplifier (UIA) configured so as to have a predetermined error voltage applied across its non-inverting and inverting inputs during operation to essentially reduce to zero a current output of the at least one voltage-to-current converter when a voltage applied to the at least one voltage-to-current converter is essentially zero.
~~33~~	32	An illumination method, comprising an act of: A) providing D.C. power to at least one LED (104) based on a power-related signal being a dimmer output signal provided by an A.C. ~~power source~~ dimmer circuit based on a standard A.C. line voltage but having higher frequency components than ~~a~~the standard A.C. line voltage~~,~~; characterized in that ~~the~~said higher frequency components are filtered out of the power-related signal prior to providing D.C. power to the at least one LED (104).
~~34~~		~~The illumination method of claim 33, wherein the act A) includes an act of:~~ ~~providing the D.C. power to the at least one LED (101) based on a power-related signal from an alternating current (A.C.) dimmer circuit.~~

~~35~~	33	The method of claim ~~34~~32, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the act A) comprises an act of: B) providing an essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface.
~~36~~	34	The method of claim ~~35~~33, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act B) includes an act of providing the essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface notwithstanding variations in the duty cycle of the power-related signal.
~~37~~	35	The method of claim ~~35~~33, wherein the act B) includes acts of: rectifying the power-related signal to provide a rectified power-related signal; filtering the rectified power-related signal; and providing the essentially non-varying power based on the filtered rectified power related signal.
~~38~~	36	The method of claim ~~35~~33, wherein the at least one LED includes a plurality of differently colored LEDs.
~~39~~	37	The method of claim ~~34~~32, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the act A) includes an act of: C) variably controlling at least one parameter of light generated by the at least one LED (104) in response to operation of the user interface.
~~40~~	38	The method of claim ~~39~~37, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act C) includes an act of: D) variably controlling the at least one parameter of the light based at least on the variable duty cycle of the power-related signal.
~~41~~	39	The method of claim ~~39~~37 wherein the act D) includes an act of:

		variably controlling at least one of an intensity of the light, a color of the light, a color temperature of the light, and a temporal characteristic of the light in response to operation of the user interface.
~~42~~	40	The method of claim ~~39~~37, wherein the act D) includes an act of: E) variably controlling at least two different parameters of the light generated by the at least one LED in response to operation of the user interface.
~~43~~	41	The method of claim ~~42~~40, wherein the act E) includes an act of: variably controlling at least an intensity and a color of the light simultaneously in response to operation of the user interface.
~~44~~	42	The method of claim ~~42~~40, wherein the at least one LED (104) is configured to generate an essentially white light, and wherein the act E) includes an act of: F) variably controlling at least an intensity and a color temperature of the white light simultaneously in response to operation of the user interface.
~~45~~	43	The method of claim ~~44~~42 wherein the act F) includes an act of: G) variably controlling at least the intensity and the color temperature of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source.
~~46~~	44	The method of claim ~~45~~43, wherein the act G) includes an act of: variably controlling the color temperature of the essentially white light over a range from approximately 2000 degrees K at a minimum intensity to 3200 degrees K at a maximum intensity.
~~47~~	45	The method of claim ~~46~~44 wherein the at least one LED includes a plurality of differently colored LEDs.
~~48~~	46	The method of claim ~~39~~37, wherein the act C) includes an act of H) digitally sampling the varying power-related signal and determine at least one varying characteristic of the varying power-related signal.
~~49~~	47	The method of claim ~~48~~46 wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act H)

		includes an act of variably controlling the at least one parameter of the light based at least on the varying duty cycle of the sampled power-related signal.
~~50~~	48	The method of claim ~~39~~37, wherein: the at least one LED (104) includes; at least one first LED (104A, 104B, 104C) adapted to output at least first radiation having a first spectrum; and at least one second LED (104A,104B,104C) adapted to output second radiation having a second spectrum different than the first spectrum; and the act C) includes an act of: I) independently controlling at least a first intensity of the first radiation and a second intensity of the second radiation in response to operation of the user interface.
~~51~~	49	The method of claim ~~50~~48, wherein the act 1) includes an act of: J) implementing a pulse width modulation (PWM) technique to control at least the first intensity of the first radiation and the second ~~intensilty~~intensity of the second radiation.
~~52~~	50	The method of claim ~~51~~49, wherein the act J) includes acts of: generating at least a first PWM signal to control the first intensity of the first radiation and a second PWM signal to control the second intensity of the second radiation; and determining duty cycles of the respective first and second PWM signals based at least in part on variations in the power-related signal due to operation of the user interface.

Conditional Amendments to the Description of the Patent		
Old Page	**New Page**	**Conditional Amendment**
3	3	this type of operation, as they produce light when there is current flowing through a filament in either direction; as the average voltage of an A.C. signal applied to the source(s) is adjusted (e.g., either by an adjustment of

voltage amplitude or duty cycle), the current (and hence the power) delivered to the light source also is changed and the corresponding light output changes. With respect to the duty cycle technique, the filament of an incandescent source has thermal inertia and does not stop emitting light completely during short periods of voltage interruption. Accordingly, the generated light as perceived by the human eye does not appear to flicker when the voltage is "chopped," but rather appears to gradually change.

US-6,127,783 discloses a white light emitting luminaire including a plurality of LEDs in each of the colors red, green, and blue have a separate current regulator which receives current outputs from an A.C. converter.

US-6,369,525 discloses a white LED array driver circuit with a multiple output flyback converter with output current mode control. The circuit comprises a power supply source, a transformer, and a controller arranged to control the flow of current to the primary winding of the transformer.

US-A-2002/0048169 discloses the general concept of converting A.C. power signals from a dimmer circuit into D.C. power for an LED. However, it does not disclose that higher frequency components present in a chopped signal from a dimmer circuit can cause fatal damage to LED light sources in certain circumstances. It is an aim of the present invention to address this problem.

Summary

There is provided according to the present invention an illumination apparatus, comprising: at least one LED; and at least one controller coupled to the at least one LED and configured to provide D.C. power to the at least one LED~~,~~; wherein the controller is configured to receive, from an A.C. ~~power source~~dimmer circuit, an A.C. power-related signal being a dimmer output signal generated by the dimmer circuit based on a standard A.C. line voltage but having higher frequency components than ~~a~~the standard A.C. line voltage; and wherein the controller is configured to provide said D.C. power

	3a	based on the A.C. power-related signal;, characterized in that the at least one controller is configured to filter out thesaid higher frequency components. According to a second aspect of the present invention there is provided an illumination method, comprising an act of: A) providing D.C. power to at least one LED based on a power-related signal provided by an A.C. power sourcedimmer circuit having higher frequency components than a standard A.C. line voltage, characterized in that the higher frequency components are filtered out of the power-related signal prior to providing D.C. power to the at least one LED. In one embodiment, methods and apparatus of the invention particularly facilitate the use of LED-based light sources on A.C. power circuits that are controlled by conventional dimmers (i.e. "A.C. dimmer circuits"). In one aspect, methods and apparatus of the present invention facilitate convenient substitution of LED-based light sources in lighting environments employing A.C. dimming devices and conventional light sources. In yet other aspects, methods and apparatus according to the present invention facilitate the control of one or more parameters relating to the light generated by LED-based light sources (e.g., intensity, color, color temperature, temporal characteristics, etc.) via operation of a conventional A.C. dimmer and/or other signals present on the A.C. power circuit. More generally, one embodiment of the invention is directed to an illumination apparatus, comprising at least one LED and at least one controller coupled to the at least one LED. The controller is configured to receive a power related signal from an A.C. power source that provides signals other than a standard A.C, line voltage. The controller further is configured to provide power to the at least one LED based on the power related signal.
4	4	Another embodiment of the invention is directed to an illumination method, comprising an act of providing power to at least one

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~~LED based on a power related signal from an A.C. power source that provides signals other than a standard A.C. line, voltage.~~

~~Another embodiment of the invention is directed to an illumination apparatus, comprising at least one LED, and at least one controller coupled to the at least one LED and configured to receive a power related signal from an alternating current (A.C.) dimmer circuit and provide power to the at least one LED based on the power related signal.~~

~~Another embodiment of the invention is directed to an illumination method, comprising an act of providing power to at least one LED based on a power related signal from an alternating current (A.C.) dimmer circuit.~~

Another embodiment of the invention is directed to an illumination apparatus, comprising at least one LED adapted to generate an essentially white light, and at least one controller coupled to the at least one LED and configured to receive a ~~power related~~dimmer output signal from an alternating current (A.C.) dimmer circuit and provide power to the at least one LED based on the power-related signal. The A.C. dimmer circuit is controller by a user interface to vary the ~~power related~~dimmer signal. The controller is configured to variably control at least one parameter of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source.

Another embodiment of the invention is directed to a lighting system, comprising at least one LED, a power connector, and a power converter associated with the power connector and adapted to convert A.C. dimmer circuit power received by the power connector to form a converted power. The system also includes an adjustment circuit associated with the power converter adapted to adjust power delivered to the at least one LED. Another embodiment of the invention is directed to a method of providing illumination, comprising the steps of providing an A.C. dimmer circuit, connecting an LED lighting system to the AC dimmer circuit, generating light from the LED lighting system by

		energizing the A.C. dimmer circuit, and adjusting the light generated by the LED lighting system by adjusting the AC dimmer circuit.

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(2) NEONLITE INTERNATIONAL LIMITED

(3) NEONLITE ELECTRONIC & LIGHTING (HK) LIMITED
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Defendants

ANNEX C – SCHEDULE OF AMENDMENTS OF THE SECOND REQUEST

The proposed conditional amendments to European Patent (UK) No. 1 502 483 (the "**Patent**") of the Second Request are as follows:-

Conditional Amendments to the Claims of the Patent		
Old Claim	**New Claim**	**Conditional Amendment**
1	1	An illumination apparatus (200), comprising: at least one LED (104); and at least one controller (204) coupled to the at least one LED (104) and configured to provide D.C. power to the at least one LED (104), wherein the controller is configured to receive, from an A.C. ~~power source~~dimmer circuit, an A.C. power-related signal being a dimmer signal

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		output by the dimmer circuit, having portions chopped out of A.C. voltage cycles of a standard A.C. line voltage, and having higher frequency components than the~~a~~ standard A.C. line voltage due to the chopping; and wherein the controller is configured to provide said D.C. power based on the A.C. power-related signal~~,~~; characterized in that the at least one controller (204) is configured to filter out said~~the~~ higher frequency components.
~~2~~		~~The apparatus of claim 1, wherein the A.C. power source is an (A.C.) dimmer circuit.~~
~~3~~	2	The apparatus of claim ~~2~~1, wherein the A. C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the at least one controller is configured to provide an essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface.
~~4~~	3	The apparatus of claim ~~3~~2, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one controller (204) is configured to provide the essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface notwithstanding variations in the duty cycle of the power-related signal.
~~5~~	4	The apparatus of claim ~~3~~2, wherein the at least one controller (204) comprises: a rectifier (404) to receive the power-related signal and provide a rectified power-related signal; a low pass filter (408) to filter the rectified power-related signal; and a DC converter (402) to provide the essentially non-varying power based on the filtered rectified power-related signal.
~~6~~	5	The apparatus of claim ~~3~~2, further comprising: a screw-type power connector configured to engage mechanically and electrically with a conventional incandescent light socket so as to couple the apparatus to the A.C. dimmer circuit.
~~7~~	6	The apparatus of claim ~~6~~5, further comprising:

		a housing, coupled to the screw-type power connector, to enclose the at least one LED and the at least one controller, the housing being structurally configured to resemble an incandescent light bulb.
~~8~~	7	The apparatus of claim ~~7~~6, wherein the at least one LED (104) includes a plurality of differently colored LEDs.
~~9~~	8	The apparatus of claim ~~2~~1, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the at least one controller is configured to variably control at least one parameter of light generated by the at least one LED (104) in response to operation of the user interface.
~~10~~	9	The apparatus of claim ~~9~~8, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one controller (204) is configured to variably control the at least one parameter of the light based at least on the variable duty cycle of the power-related signal.
~~11~~	10	The apparatus of claim ~~9~~8 wherein the at least one parameter of the light that is variably controlled by the at least one controller (204) in response to operation of the user interface includes at least one of an intensity of the light, a color of the light, a color temperature of the light, and a temporal characteristic of the light.
~~12~~	11	The apparatus of claim ~~9~~8, wherein the at least one controller (204) is configured to variably control at least two different parameters of the light generated by the at least one LED (104) in response to operation of the user interface.
~~13~~	12	The apparatus of claim ~~12~~11, wherein the at least one controller (204) is configured to variably control at least an intensity and a color of the light simultaneously in response to operation of the user interface.
~~14~~	13	The apparatus of claim ~~12~~11, wherein the at least one LED (204) is configured to generate an essentially white light, and wherein the at least one controller (204) is configured to variably control at least an intensity and a color temperature of the white light simultaneously in response to operation of the user interface.

~~15~~	14	The apparatus of claim ~~14~~13, wherein the at least one controller (204) is configured to variably control at least the intensity and the color temperature of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source.
~~16~~	15	The apparatus of claim ~~15~~14, wherein the at least one controller (204) is configured to variably control the color temperature of the essentially white light over a range from approximately 2000 degrees K at a minimum intensity to 3200 degrees K at a maximum intensity.
~~17~~	16	The apparatus of claim ~~15~~14, further comprising: a screw-type power connector (202) configured to engage mechanically and electrically with a conventional incandescent light socket so as to couple the apparatus to the A.C. dimmer circuit.
~~18~~	17	The apparatus of claim ~~17~~16, further comprising: a housing, coupled to the screw-type power connector, to enclose the at least one LED (104) and the at least one controller (204), the housing being structurally configured to resemble an incandescent light bulb.
~~19~~	18	The apparatus of claim ~~15~~14, wherein the at least one LED includes a plurality of differently colored LEDs.
~~20~~	19	The apparatus of claim ~~9~~8, wherein the at least one controller includes: an adjustment circuit (208) to variably control the at least one parameter of light based on the varying power-related signal; and power circuitry to provide at least the power to the at least one LED (104) based on the varying power-related signal.
~~21~~	20	The apparatus of claim ~~20~~19, wherein the power circuitry includes: a rectifier (404) to receive the power-related signal and provide a rectified power related signal; a low pass filter to filter (408) the rectified power-related signal; and a DC converter (404) to provide the power to at least the at least one LED (104) based on the filtered rectified power-related signal.

~~22~~	21	The apparatus of claim ~~21~~20, wherein the adjustment circuit is coupled to the DC converter and is configured to variably control the at least one LED (104) based on the filtered rectified power-related signal.
~~23~~	22	The apparatus of claim ~~21~~20, wherein the adjustment circuit includes at least one processor (102) configured to monitor at least one of the power-related signal, the rectified power-related signal, and the filtered rectified power-related signal so as to variably control the at least one LED (104).
~~24~~	23	The apparatus of claim ~~21~~20, wherein the power circuitry is configured to provide at least the power to the at least one LED (104) and power to the at least one processor (102) based on the varying power-related signal.
~~25~~	24	The apparatus of claim ~~21~~20, wherein the at least one processor (102) is configured to sample the varying power-related signal and determine at least one varying characteristic of the varying power-related signal.
~~26~~	25	The apparatus of claim ~~21~~20, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the at least one processor (102) is configured to variably control the at least one parameter of the light based at least on the varying duty cycle of the power-related signal.
~~27~~	26	The apparatus of claim ~~26~~25, wherein the at least one LED (104) includes a plurality of differently colored LEDs.
~~28~~	27	The apparatus of claim ~~27~~26, wherein: the plurality of differently colored LEDs includes: at least one first LED (104A, 104B, 104C) adapted to output at least first radiation having a first spectrum; and at least one second LED (104A, 104B, 104C) adapted to output second radiation having a second spectrum different than the first spectrum; and the at least one processor (102) is configured to independently control at least a first intensity of the first radiation and a second intensity of the second radiation in response to operation of the user interface.
~~29~~	28	The apparatus of claim ~~28~~27, wherein the at least one processor (102) is programmed to implement a pulse width modulation (PWM) technique to

		control at least the first intensity of the first radiation and the second intensity of the second radiation.
~~30~~	29	The apparatus of claim ~~29~~28, wherein the at least one processor (102) further is programmed to: generate at least a first PWM signal to control the first intensity of the first radiation and a second PWM signal to control the second intensity of the second radiation; and determine duty cycles of the respective first and second PWM signals based at least in part on variations in the power-related signal due to operation of the user interface.
~~31~~	30	The apparatus of claim ~~20~~19 wherein the adjustment circuit includes drive circuitry (109) including at least one voltage-to-current converter to provide at least one drive current to the at least one LED so as to control the at least one parameter of the generated light.
~~32~~	31	The apparatus of claim ~~31~~30, wherein the at least one voltage-to-current converter includes an operational amplifier (UIA) configured so as to have a predetermined error voltage applied across its non-inverting and inverting inputs during operation to essentially reduce to zero a current output of the at least one voltage-to-current converter when a voltage applied to the at least one voltage-to-current converter is essentially zero.
~~33~~	32	An illumination method, comprising an act of: A) providing D.C. power to at least one LED (104) based on an A.C. power-related signal being a dimmer signal provided by an A.C. ~~power source~~dimmer circuit, having portions chopped out of A.C. voltage cycles of a standard A.C. line voltage, and having higher frequency components than the~~a~~ standard A.C. line voltage due to the chopping;~~,~~ characterized in that said~~the~~ higher frequency components are filtered out of the power-related signal prior to providing D.C. power to the at least one LED (104).
~~34~~		~~The illumination method of claim 33, wherein the act A) includes an act of:~~ ~~providing the D.C. power to the at least one LED (104) based on a power-related signal from an alternating current (A.C.) dimmer circuit.~~

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~~35~~	33	The method of claim ~~34~~32, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the act A) comprises an act of: B) providing an essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface.
~~36~~	34	The method of claim ~~35~~33, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act B) includes an act of providing the essentially non-varying power to the at least one LED (104) over a significant range of operation of the user interface notwithstanding variations in the duty cycle of the power-related signal.
~~37~~	35	The method of claim ~~35~~33, wherein the act B) includes acts of: rectifying the power-related signal to provide a rectified power-related signal; filtering the rectified power-related signal; and providing the essentially non-varying power based on the filtered rectified power related signal.
~~38~~	36	The method of claim ~~35~~33, wherein the at least one LED includes a plurality of differently colored LEDs.
~~39~~	37	The method of claim ~~34~~32, wherein the A.C. dimmer circuit is controlled by a user interface to vary the power-related signal, and wherein the act A) includes an act of: C) variably controlling at least one parameter of light generated by the at least one LED (104) in response to operation of the user interface.
~~40~~	38	The method of claim ~~39~~37, wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act C) includes an act of: D) variably controlling the at least one parameter of the light based at least on the variable duty cycle of the power-related signal.
~~41~~	39	The method of claim ~~39~~37 wherein the act D) includes an act of:

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		variably controlling at least one of an intensity of the light, a color of the light, a color temperature of the light, and a temporal characteristic of the light in response to operation of the user interface.
~~42~~	40	The method of claim ~~39~~37, wherein the act D) includes an act of: E) variably controlling at least two different parameters of the light generated by the at least one LED in response to operation of the user interface.
~~43~~	41	The method of claim ~~42~~40, wherein the act E) includes an act of: variably controlling at least an intensity and a color of the light simultaneously in response to operation of the user interface.
~~44~~	42	The method of claim ~~42~~40, wherein the at least one LED (104) is configured to generate an essentially white light, and wherein the act E) includes an act of: F) variably controlling at least an intensity and a color temperature of the white light simultaneously in response to operation of the user interface.
~~45~~	43	The method of claim ~~44~~42 wherein the act F) includes an act of: G) variably controlling at least the intensity and the color temperature of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source.
~~46~~	44	The method of claim ~~45~~43, wherein the act G) includes an act of: variably controlling the color temperature of the essentially white light over a range from approximately 2000 degrees K at a minimum intensity to 3200 degrees K at a maximum intensity.
~~47~~	45	The method of claim ~~46~~44 wherein the at least one LED includes a plurality of differently colored LEDs.
~~48~~	46	The method of claim ~~39~~37, wherein the act C) includes an act of H) digitally sampling the varying power-related signal and determine at least one varying characteristic of the varying power-related signal.
~~49~~	47	The method of claim ~~48~~46 wherein the operation of the user interface varies a duty cycle of the power-related signal, and wherein the act H)

		includes an act of variably controlling the at least one parameter of the light based at least on the varying duty cycle of the sampled power-related signal.
~~50~~	48	The method of claim ~~39~~37, wherein: the at least one LED (104) includes; at least one first LED (104A, 104B, 104C) adapted to output at least first radiation having a first spectrum; and at least one second LED (104A,104B,104C) adapted to output second radiation having a second spectrum different than the first spectrum; and the act C) includes an act of: I) independently controlling at least a first intensity of the first radiation and a second intensity of the second radiation in response to operation of the user interface.
~~51~~	49	The method of claim ~~50~~48, wherein the act 1) includes an act of: J) implementing a pulse width modulation (PWM) technique to control at least the first intensity of the first radiation and the second ~~intensilty~~intensity of the second radiation.
~~52~~	50	The method of claim ~~51~~49, wherein the act J) includes acts of: generating at least a first PWM signal to control the first intensity of the first radiation and a second PWM signal to control the second intensity of the second radiation; and determining duty cycles of the respective first and second PWM signals based at least in part on variations in the power-related signal due to operation of the user interface.

Conditional Amendments to the Description of the Patent		
Old Page	**New Page**	**Conditional Amendment**
3	3	this type of operation, as they produce light when there is current flowing through a filament in either direction; as the average voltage of an A.C. signal applied to the source(s) is adjusted (e.g., either by an adjustment of voltage amplitude or duty cycle), the current (and hence the power)

delivered to the light source also is changed and the corresponding light output changes. With respect to the duty cycle technique, the filament of an incandescent source has thermal inertia and does not stop emitting light completely during short periods of voltage interruption. Accordingly, the generated light as perceived by the human eye does not appear to flicker when the voltage is "chopped," but rather appears to gradually change.

US-6,127,783 discloses a white light emitting luminaire including a plurality of LEDs in each of the colors red, green, and blue have a separate current regulator which receives current outputs from an A.C. converter.

US-6,369,525 discloses a white LED array driver circuit with a multiple output flyback converter with output current mode control. The circuit comprises a power supply source, a transformer, and a controller arranged to control the flow of current to the primary winding of the transformer.

US-A-2002/0048169 discloses the general concept of converting A.C. power signals from a dimmer circuit into D.C. power for an LED. However, it does not disclose that higher frequency components present in a chopped signal from a dimmer circuit can cause fatal damage to LED light sources in certain circumstances. It is an aim of the present invention to address this problem.

Summary

There is provided according to the present invention an illumination apparatus, comprising: at least one LED; and at least one controller coupled to the at least one LED and configured to provide D.C. power to the at least one LED, wherein the controller is configured to receive from an A.C. ~~power source~~dimmer circuit an A.C. power-related signal being a dimmer signal output by the dimmer circuit, having portions chopped out of A.C. voltage cycles of a standard A.C. line voltage, and having higher frequency components than the~~a~~ standard A.C. line voltage due to the chopping; and wherein the controller is configured

		to provide said D.C. power based on the A.C. power-related signal, characterized in that the at least one controller is configured to filter out saidthe higher frequency components. According to a second aspect of the present invention there is provided an
	3a	illumination method, comprising an act of: A) providing D.C. power to at least one LED based on an A.C. power-related signal being a dimmer signal provided by an A.C. power sourcedimmer circuit, having portions chopped out of A.C. voltage cycles of a standard A.C. line voltage, and having higher frequency components than thea standard A.C. line voltage, characterized in that the higher frequency components are filtered out of saidthe power-related signal prior to providing D.C. power to the at least one LED. In one embodiment, methods and apparatus of the invention particularly facilitate the use of LED-based light sources on A.C. power circuits that are controlled by conventional dimmers (i.e. "A.C. dimmer circuits"). In one aspect, methods and apparatus of the present invention facilitate convenient substitution of LED-based light sources in lighting environments employing A.C. dimming devices and conventional light sources. In yet other aspects, methods and apparatus according to the present invention facilitate the control of one or more parameters relating to the light generated by LED-based light sources (e.g., intensity, color, color temperature, temporal characteristics, etc.) via operation of a conventional A.C. dimmer and/or other signals present on the A.C. power circuit. More generally, one embodiment of the invention is directed to an illumination apparatus, comprising at least one LED and at least one controller coupled to the at least one LED. The controller is configured to receive a power-related signal from an A.C. power source that provides signals other than a standard A.C. line voltage. The controller further is configured to provide power to the at least one LED based on the power-related signal.

4	4	~~Another embodiment of the invention is directed to an illumination method, comprising an act of providing power to at least one LED based on a power-related signal from an A.C. power source that provides signals other than a standard A.C. line, voltage.~~ ~~Another embodiment of the invention is directed to an illumination apparatus, comprising at least one LED, and at least one controller coupled to the at least one LED and configured to receive a power-related signal from an alternating current (A.C.) dimmer circuit and provide power to the at least one LED based on the power-related signal.~~ ~~Another embodiment of the invention is directed to an illumination method, comprising an act of providing power to at least one LED based on a power-related signal from an alternating current (A.C.) dimmer circuit.~~ Another embodiment of the invention is directed to an illumination apparatus, comprising at least one LED adapted to generate an essentially white light, and at least one controller coupled to the at least one LED and configured to receive a power-related signal from an alternating current (A.C.) dimmer circuit and provide power to the at least one LED based on the power-related signal. The A.C. dimmer circuit is controller by a user interface to vary the power-related signal. The controller is configured to variably control at least one parameter of the essentially white light in response to operation of the user interface so as to approximate light generation characteristics of an incandescent light source. Another embodiment of the invention is directed to a lighting system, comprising at least one LED, a power connector, and a power converter associated with the power connector and adapted to convert A.C. dimmer circuit power received by the power connector to form a converted power. The system also includes an adjustment circuit

		associated with the power converter adapted to adjust power delivered to the at least one LED. Another embodiment of the invention is directed to a method of providing illumination, comprising the steps of providing an AC dimmer circuit, connecting an LED lighting system to the AC dimmer circuit, generating light from the LED lighting system by energizing the AC dimmer circuit, and adjusting the light generated by the LED lighting system by adjusting the AC dimmer circuit.
13	13	present invention facilitate the control of one or more parameters relating to the light generated by LED-based light sources (e. g., intensity, color, color temperature, temporal characteristics, etc.) via operation of a conventional dimmer and/or other control signals that may be present in connection with an A.C. line voltage. Lighting units and systems employing various concepts according to the principles of the present invention may be used in a residential setting, commercial setting, industrial setting or any other setting where conventional A.C. dimmers are found or are desirable. Furthermore, the various concepts disclosed herein may be applied in lighting units according to the present invention to ensure compatibility of the lighting units with a variety of lighting control protocols that provide various control signals via an A.C. power circuit. ~~One example of such a control protocol is given by the X10 communications language, which allows X10-compatible products to communicate with each other via existing electrical wiring in a home (i.e., wiring that supplies a standard A.C. line voltage). In a typical X10 implementation, an appliance to be controlled (e.g., lights, thermostats, jacuzzi/hot tub, etc.) is plugged into an X10 receiver, which in turn plugs into a conventional wall socket coupled to the A.C. line voltage. The appliance to be controlled can be assigned with a particular address. An X10 transmitter/controller is plugged into another wall socket coupled to the line voltage, and communicates control commands (e.g., on, off, dim, bright, etc.), via the same wiring providing the line voltage, to one or more X10 receivers based at least in part on the assigned address(es) (further~~

		~~information regarding X10 implementations may be found at the website "www.smarthome.com"). According to one embodiment, methods and apparatus of the present invention facilitate compatibility of various LED-based light sources and lighting units with X10 and other communication protocols that communicate control information in connection with an A.C. line voltage.~~ In general, methods and apparatus according to the present invention allow a substantially complete retrofitting of a lighting environment with solid state LED-based light sources; in particular, pursuant to the present invention, the use of LED-based light sources as substitutes for incandescent light sources is not limited to only those A.C. power circuits that are supplied directly from a line voltage (e.g., via a switch); rather, methods and apparatus of the present invention allow LED-based light sources to be used