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Datasheet for the decision of 4 April 2011

Case Number: T 1519/07 - 3.5.02

Application Number: 98948456.3

Publication Number: 1018208

IPC: H02M 5/257

Language of the proceedings: EN

Title of invention:
Phase controlled dimming system with active filter for preventing flickering and undesired intensity changes

Patentee:
Lutron Electronics Co., Inc.

Opponent:
AEG Power Solutions GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step - no"

Decisions cited:
-

Catchword:
-

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Case Number: T 1519/07 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 4 April 2011

Appellant: (Patent Proprietor)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 11 July 2007 revoking European patent No. 1018208 pursuant to Article 102(1) EPC 1973.

Composition of the Board:

Chairman: M. Ruggiu
Members: G. Flyng
E. Lachacinski

Summary of Facts and Submissions

I. European patent no. EP 1 018 208 B1 was granted on the basis of European patent application number 98 948 456.3 to Lutron Electronics Co., Inc. (the proprietor).

An opposition was filed against the grant of the patent by AEG SVS Power Supply Systems GmbH (the opponent).

The opposition division issued a decision posted 11 July 2007 revoking the patent. That decision is the subject of the present appeal by the proprietor.

II. During the appeal procedure, the Board summoned the parties to oral proceedings.

In an annex to the summons the Board set out its preliminary observations, referring *inter alia* to the following documents, which remain pertinent to this decision:

E11: "The Art Of Electronics", P. Horowitz and W. Hill, first edition (1980), Chapter 4: Active Filters and Oscillators, Cambridge University Press, pages 148 to 162

E16: JP 57-206 932 and translation thereof filed by the appellant with the letter of 16 November 2007.

III. The appellant (proprietor) replied to the summons with a letter dated 4 March 2011. In the letter it was stated that a new set of claims as a main request and a new set of claims as auxiliary request 1 were enclosed.

The EPO received the letter by fax on 4 March 2011 and a confirmation copy thereof by post on 14 March 2011. The fax included two sets of the claims of the main request but no set of claims of the auxiliary request 1. Furthermore, only a set of the claims of the main request was enclosed with the postal confirmation.

IV. Oral proceedings were held before the Board on 4 April 2011.

The representative of the respondent (opponent) advised that the opponent had changed to AEG Power Solutions GmbH. He presented a letter that was filed by fax during the course of the oral proceedings and enclosed evidence of the change of opponent to AEG Power Solutions GmbH and an authorisation signed in that name.

The appellant presented a new set of claims as auxiliary request 1.

Finally, the appellant requested that the decision under appeal be set aside and the patent be maintained in amended form on the basis of claims 1 to 16 of the main request filed with the letter dated 4 March 2011, or if that was not possible, on the basis of claims 1 to 15 of the auxiliary request 1 received in the oral proceedings.

The respondent requested that the appeal be dismissed.

V. Independent claim 1 of the main request reads:

"1. A phase controlled lighting control system to control the dimming level of a lighting load by controlling the delivery of power from an AC line to the lighting load, wherein the AC line has a fundamental component with a fundamental frequency, the system comprising:-

a filter (30, 30') having a frequency characteristic such that high frequencies relative to said fundamental frequency are substantially attenuated;

a zero cross detector (28) coupled to receive an output of the filter and providing an indication of zero crossings thereof;

a controllably conductive device (22) connected in series to the AC line and the load; and

a control circuit (26) generating trigger signals in response to the indications provided by the zero cross detector (28) for rendering the controllably conductive device (22) conductive for at least a portion of a cycle of the said waveform;

characterised in that said filter (30, 30') comprises a low-pass active filter with a frequency characteristic such that substantially a selected one of the fundamental frequency of said waveform or the second harmonic thereof is passed and such that the third order and greater harmonics of the fundamental frequency are substantially attenuated, and which interposes a substantially linear phase delay relative to the said waveform on the AC line of less than one-half of a period of the fundamental frequency."

Independent claim 1 of auxiliary request 1 reads:

"1. A load control system, connectable to an AC line (16) and a load (14), for controlling the power delivered from the AC line to the load, wherein the AC line has a fundamental component with a fundamental frequency, the system comprising:-

a filter (30, 30') having a frequency characteristic such that high frequencies relative to said fundamental frequency are substantially attenuated;

a zero cross detector (28) coupled to receive an output of the filter and providing an indication of zero crossings thereof;

a controllably conductive device (22) connected in series to the AC line and the load; and

a control circuit (26) generating trigger signals in response to the indications provided by the zero cross detector (28) for rendering the controllably conductive device (22) conductive for at least a portion of a cycle of the said waveform;

characterised in that said filter (30, 30') comprises a low-pass active filter with a frequency characteristic such that substantially a selected one of the fundamental frequency of said waveform or the second harmonic thereof is passed and such that the third order and greater harmonics of the fundamental frequency are substantially attenuated, and which interposes a substantially linear phase delay relative to the said waveform on the AC line of less than one-half of a period of the fundamental frequency;

wherein the system comprises one of a two wire wall mountable dimmer switch, a three wire wall mountable dimming switch, and a dimming panel."

VI. The appellant's arguments relevant to the present decision may be summarised as follows:

Claim 1 of the main request is directed to a phase controlled dimming system. As set out in the patent (see EP 1 018 208 B1, paragraphs [0003] and [0004]), in such a system, at low levels of delivered power, even a small variation in the conduction angle represents a relatively large variation in the percentage of the total delivered RMS power. This can cause intensity changes, including visible flickering of the light source. Since the conduction angle is dependent on the detection of the zero crossing, it is crucial that zero cross detection be accurate and reliable.

Document E16 is the closest prior art as it attempts to treat this problem in the context of lighting dimming.

The patent sets out four different types of disturbance that may be present, simultaneously and/or alternately, in the waveform on the AC line and may cause a shift in the zero crossing (see paragraphs [0005], [0007], [0009] and [0010]), namely:

- Spikes;
- Bumpy/wavy AC waveform;
- Frequency variations; and
- Changes in the RMS voltage.

In the prior art these disturbances were treated in different ways, i.e. using filtering, phase-locked loops and window detection.

Document E16 fails to appreciate these disturbances and the fact that they may interact. E16 also fails to

appreciate that errors in zero crossing detection have a greater effect on light intensity when small conduction angles are used to dim to a low lighting level.

The technical problem as formulated by the opposition division in the contested decision is incorrect: it is too limited (it makes no reference to the four disturbances mentioned above); it ignores the effects achieved by the characterising features; and it contains a pointer to the solution of improved filtering.

Starting from E16, the objective technical problem is to give improved stability of the lighting level at low lighting levels, so that a person is unlikely to perceive any fluctuation thereof.

The opposition division's argument that the skilled person would conduct routine experimentation to find a suitable filter ignores the fact that, in the prior art discussed in the patent, solutions other than filtering were used to treat some of the disturbances on the AC line (i.e. phase-locked loops and window sampling). The skilled person has no objective reason to choose to look specifically at the filtering solution and no reasonable expectation of success in doing so. Only with hindsight would the skilled person look more closely at the filtering aspect. The fact that the filter characteristic set out in claim 1 provides a solution for all of the identified disturbances on the AC line is evidence of a surprising effect.

There is no indication in E16 that the filter has a linear phase delay relative to the AC waveform. Furthermore, as there is no noticeable phase delay according to figure 6 of E16, this would mean that the low pass filter of E16 must have its corner frequency substantially far away from the base frequency of the AC line and would thus be ineffective at removing frequencies near the first few harmonics of the base frequency. According to claim 1, however, third order and greater harmonics are "substantially attenuated", which means greatly attenuated.

Claim 1 of auxiliary request 1 is further restricted to a wall mountable dimmer switch or a dimming panel. This restriction in the location of the dimming system is not evident from document E16 or document E11. The use of a transformer in E16 would suggest that it was not suitable for use in a wall mounted switch.

VII. The respondent's arguments relevant to the present decision may be summarised as follows:

In the state of the art, it is known (in particular from document E16) to use a low pass filter (LPF) to produce a clean AC signal (V_F) from the voltage (V_C) on the AC line and to use the clean AC signal to detect the zero crossings. This arrangement prevents high frequency components (V_H) that are superimposed on the basic AC frequency (V_B) from causing a shift in the zero crossing point, thereby preventing fluctuations in the output power and flickering.

In E16, the desired frequency characteristic of the filter is shown in figure 5 and its input and output

waveforms are shown in figure 6, see waveforms (b) and (d). There is no phase delay between the input and output waveforms shown in figure 6.

Starting from E16 and seeking to provide a clean AC signal, the skilled person, a filter specialist, has at his disposal a toolbox of known filter arrangements. It would be obvious to choose from among these a known low pass filter that has a cut-off frequency close to the AC fundamental frequency and little phase delay.

Document E11 describes and compares the characteristics of various known active filters. The characteristics and advantages of the Bessel filter are set out on pages 155 and 156. It is evident to the skilled person from E11 that the Bessel filter has the desired characteristics of sharp cut-off and low phase delay. Hence it would be obvious for the skilled person to use a Bessel low pass filter for the dimmer system of E16.

At the time when document E16 was drafted, active filters were relatively complex and expensive. Since then, and before the priority date of the contested patent, integrated circuit active filters became simple and cheap and, with their evident advantages, it was obvious to use them.

As to the different types of AC line disturbance set out by the appellant, it is not evident that the dimming system of claim 1 is able to deal with phase variations. Furthermore, for E16 and for the contested patent the cause of the high frequency disturbance is unimportant. Regardless of the cause, the high frequency components are attenuated by the low pass

filter to clean up the AC signal, so that the zero crossing can be accurately detected.

The feature of claim 1 that third order and greater harmonics are "substantially attenuated" does not clearly define the extent to which the harmonics are attenuated. Figures 11a and 11b of the patent show some third harmonic still present after filtering. There is no clear distinction with respect to document E16.

Regarding the auxiliary request, it is well known to mount dimmers in wall mounted switches and in panels. It is a trivial matter for the skilled person to mount the dimmer of E16 in such a generally known manner.

Reasons for the Decision

1. The appeal is admissible.

2. Main request

2.1 The subject-matter of document E16 was conceived for the same purpose as the claimed invention, namely lighting dimming. Furthermore, it aims at the same objective, namely preventing fluctuations in output power and hence flickering of the light (see translation, second page, lines 14 to 16).

E16 aims at preventing "fluctuations in the output power by detecting the zero cross signal from the output of the filter which disconnects the high frequencies included in the alternating current power supply voltage" (see translation, second page, lines 19

to 21). This filter is a low pass filter (4) (see second page, line 35) which "is constructed such that the basic frequency of the alternating current power supply voltage is passed through it" and whose output "is inputted into the zero cross detection circuit" so that "there is no fluctuation of the zero cross point" (see third page of the translation, lines 6 to 17).

In other words, E16 uses the same approach as the contested patent - filtering the waveform of the AC line with a low pass filter to enable better detection of the zero crossing points of the fundamental waveform.

For these reasons the Board shares the appellant's view that document E16 may be taken as the closest prior art for the purposes of assessing inventive step.

2.2 Document E16 discloses a phase controlled dimming system having all the features recited in the pre-characterising portion of claim 1.

More specifically, E16 discloses (see translation):

– a phase control circuit (see title of the invention) to control the dimming level of a lighting load (see second page, lines 14 to 16) by controlling the delivery of power from an AC line to the lighting load (see paragraph spanning the first and second pages),

– wherein the AC line has a fundamental component with a fundamental frequency (basic frequency V_B, see second page, lines 2 to 6),

the system comprising:

– a filter (LPF, 4) having a frequency characteristic such that high frequencies relative to said fundamental frequency are "disconnected" (see second page, lines 23 to 31);

– a zero cross detector (5) coupled to receive the output of the filter and providing an indication of zero crossings thereof (see second page, lines 28 and 29);

– a controllably conductive device (1) connected in series to the AC line and the load (see paragraph spanning the first and second pages);

– and a control circuit (6) generating trigger signals in response to the indications provided by the zero cross detector (5) for rendering the controllably conductive device (1) conductive for at least a portion of a cycle of the said waveform (see paragraph spanning the first and second pages and second page, lines 9 to 11 and 29 to 31).

2.3 As to the features of the characterising part of claim 1, the Board notes the following.

E16 discloses that the filter is a low-pass filter, but does not disclose that it is an active low-pass filter.

Claim 1 specifies that the frequency characteristic of the filter is such that "third order and greater harmonics of the fundamental frequency are

substantially attenuated" (emphasis added). In general, the word "substantially" may be interpreted in two rather different senses. On the one hand it may be interpreted in the sense "*to a great or significant extent*". On the other hand it may also be interpreted in a blurring sense, such as "*for the most part; essentially; to all intents and purposes; more or less; near enough*". The appellant argues that the former interpretation is the correct one for the feature "substantially attenuated". The Board cannot, however, find any basis for this assumption and considers that the feature "substantially attenuated" could be read in either sense - i.e. as "attenuated to a great extent", or alternatively, "more or less attenuated". For this reason the Board considers that the feature "substantially attenuated" as set out in claim 1 does not impose a clear and unambiguous limitation on the extent to which the third order and greater harmonics of the fundamental frequency are attenuated.

According to E16, the filter disconnects "high frequencies" to the alternating supply (see translation, second page, lines 23 to 31). In the working example the low pass filter has a characteristic as shown in figure 5 (see second page, lines 31 to 34). The disconnection frequency f_0 of the filter, at which there is a -3dB attenuation, is set "somewhat higher" than the basic frequency f_B of the AC power supply (see second page, lines 34 to 37). The Board considers that if there is a -3dB attenuation at a frequency somewhat higher than the basic frequency f_B then there must be some attenuation of the third and higher harmonics of the basic frequency f_B. Furthermore, according to the sentence spanning the second and third

pages of E16, "when the filter (4) is used the input voltage V_F of the zero cross detection circuit (5) becomes an almost perfect sine wave". This is only possible if third and higher harmonics of the basic frequency have been attenuated. Hence, although E16 does not explicitly mention that third order and greater harmonics are attenuated, the Board considers that this is implicit from the above disclosures.

E16 does not make any explicit mention of the phase characteristic of the low-pass filter, but figure 6 shows the waveforms at various parts of the circuit and shows no phase delay between the input waveform (a) and the filtered waveform (d). From this, the Board concludes that E16 suggests the filter should not introduce any erratic phase delay that cannot easily be compensated, and certainly not anything like a phase delay of at least one half-period of the AC fundamental, which would be too long to permit the trigger to act in response to the actual zero crossing.

Summarising, the Board finds that the subject-matter of claim 1 differs from the disclosure of E16 in that the low-pass filter is an active low-pass filter.

Hence, the subject-matter of claim 1 is considered to be novel over the disclosure of E16, Article 54 EPC.

2.4 Using an active low pass filter apparently gives improved stability of the lighting level by improving the ability of the circuit to detect the zero-crossings of the AC fundamental waveform. Thus, starting from document E16, the problem to be solved may be objectively formulated as being to improve the ability

of the circuit to detect the zero-crossings of the AC fundamental waveform.

2.5 E16 already teaches to use a low-pass filter to enable reliable detection of the zero-crossings for this purpose, so it would be obvious for the skilled person, aiming to improve zero-crossing detection, to look more closely at that low-pass filtering. Whilst E16 teaches to use a low-pass filter, it does not give any suggestion as to what type of low-pass filter to use.

Seeking to select an appropriate low-pass filter it would be obvious for the skilled person to refer to a well-known textbook such as E11. In chapter 4, E11 teaches the advantages of active filters over RLC filters, stating in particular in section 4.03 that *active filters can be used to make low-pass, high-pass, bandpass and band-reject filters, with a choice of filter types according to the important features of the response, e.g. maximal flatness of passband, steepness of skirts or uniformity of time delay versus frequency*. Given the evident advantages of active filters, it would be obvious for the skilled person to use an active low-pass filter and to choose a type of active filter that has response characteristics that meet the requirements set out in document E16.

As set out above, the filter discussed in E16 has to pass the fundamental AC line frequency and block high frequencies so that the input voltage of the zero-cross detection circuit becomes an almost perfect sine wave. Furthermore, no phase delay has to be introduced by the filter (cf. figure 6 of E16). Document E11 discloses an active filter that meets these requirements, namely the

Bessel filter (see section 4.05, page 155, "Bessel filter"). There it is explained that:

– in situations where the shape of the waveform is paramount, a linear-phase filter (or constant-time-delay filter) is desirable;

– a filter whose phase shift varies linearly with frequency is equivalent to a constant time delay for signals within the passband, i.e. the waveform is not distorted; and

– the Bessel filter has maximally flat time delay within its passband.

Given these explanations it would be obvious to the skilled person that the Bessel active filter has the characteristics required for the low-pass filter of document E16. Thus, by using such a filter in E16, the skilled person would come to the subject-matter of claim 1 (main request) without involving an inventive step, Article 56 EPC.

2.6 The appellant has argued that document E16 fails to appreciate the different sources of AC line disturbance that are identified in the patent, and the fact that these may interact. Given that the patent uses essentially the same technique as E16 to deal with the AC line disturbances, i.e. low-pass filtering to clean up the AC line waveform before zero-crossing detection, the Board cannot see how the solution provided by the patent would be any more or less able to deal with line disturbances than the solution provided by E16, regardless of the cause of the line disturbance. Hence,

the Board finds that this argument does not have a bearing on the assessment of inventive step. The same applies to the appellant's argument that E16 fails to appreciate that errors in zero crossing detection have a greater effect on light intensity when small conduction angles are used to dim to a low lighting level.

3. First auxiliary request

3.1 According to claim 1 of the first auxiliary request, the system comprises one of a two wire wall mountable dimmer switch, a three wire wall mountable dimming switch, and a dimming panel. Document E16 does not concern itself with the manner in which the dimming system is mounted or accommodated. Hence, this feature has to be considered novel over E16.

3.2 Two wire wall mountable dimmer switches, three wire wall mountable dimming switches, and dimming panels are well known in the art. This is not contested by the appellant. In the Board's view it would be a trivial matter to mount the dimming system of E16 in such a well known manner. The Board can see no particular technical difficulty in doing so. In particular, the presence of a transformer in E16 would not preclude wall mounting, as such a transformer would only be small. Also, the Board can see no surprising effect in mounting the dimmer as claimed, and none has been alleged.

Furthermore, starting from E16, the Board cannot see any interrelationship or functional reciprocity between the effect achieved by using an active filter in the

dimmer (i.e. stable lighting level) and any effect that might conceivably be provided by mounting the dimmer in a two or three wire wall mountable dimmer switch or a dimming panel. Indeed the appellant has not put forward any evidence of such an interrelationship. Hence, the subject-matter of claim 1 (first auxiliary request) has to be considered as a mere aggregation of features, rather than a combination invention (cf. Case Law of the Boards of Appeal, 6th edition 2010, I.D.8.2, Combination invention).

For the above reasons, the Board concludes that it would also be an obvious matter for the skilled person to mount the dimmer of E16 in the manner set out in claim 1 (first auxiliary request). The subject-matter of claim 1 of the first auxiliary request thus lacks an inventive step, Article 56 EPC.

4. In view of the above, none of the appellant's requests provide a basis for maintenance of the patent in amended form. Hence, the appeal has to be dismissed.

Order

For the above reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Moser M. Ruggiu