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**Datasheet for the decision
of 5 June 2024**

Case Number: T 0388/21 - 3.5.02

Application Number: 14730799.5

Publication Number: 3149848

IPC: H03B5/32, H03L3/00, H03L5/00

Language of the proceedings: EN

Title of invention:
Oscillator circuit with bias current generator

Applicant:
Telefonaktiebolaget LM Ericsson (publ)

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (yes)



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Case Number: T 0388/21 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 5 June 2024

Appellant: Telefonaktiebolaget LM Ericsson (publ)
(Applicant) 164 83 Stockholm (SE)

Representative: Ericsson
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted on 9 November 2020 refusing European patent application No. 14730799.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Flyng
Members: C.D. Vassoille
W. Ungler

Summary of Facts and Submissions

- I. The appeal of the applicant lies against the decision of the examining division with which European patent application no. 14 730 799.5 was refused.
- II. The following documents were cited in the first instance proceedings:
- D1: US 2012/068774 A1
 - D2: US 2012/154066 A1
 - D3: EP 2 634 914 A1
 - D4: US 6 798 301 B1
 - D5: EP 0 724 331 A1
 - D6: US 2007/096841 A1
 - D7: JP 2006 121477 A
 - D8: WO 89/03617 A1
 - D9: US 2012/161889 A1
 - D10: US 2011/074499 A1
 - D11: US 2009/079510 A1
 - D12: EP 1 791 252 A1
 - D13: US 2012/098609 A1
 - D14: US 7 486 153 B2
- III. In the contested decision, the examining division concluded, *inter alia*, that the subject-matter of claims 1 and 11 of the main request did not involve an inventive step within the meaning of Article 56 EPC in view of a combination of documents D13 and D3.
- IV. The appellant (applicant) requested in writing that the contested decision be set aside and that a patent be granted on the basis of the main request filed on 19 August 2020 and resubmitted with the statement of grounds of appeal, corresponding to the main request on

which the contested decision was based. As an auxiliary measure, the appellant requested that the case be remitted to the examining division for further prosecution.

V. Claim 1 of the main request has the following wording (feature numbering in square brackets added by the board):

"A method of operating an oscillator circuit (100), comprising:

[1.1] in response to a supply of power to the oscillator circuit (100) being switched on,
[1.2] initialising the oscillator circuit, wherein initialising the oscillator circuit comprises:
[1.2.1] generating a bias current with an increasing level commencing at a first level;
[1.2.2] supplying the bias current to a crystal oscillator (10);
[1.2.3] generating a feedback signal in response to an amplitude of an oscillation signal generated by the crystal oscillator (10) reaching an amplitude threshold; and
[1.2.4] in response to the feedback signal, terminating the increasing and storing an indication of the final level of the bias current reached when the increasing is terminated; and
[1.3] during subsequent operation of the crystal oscillator (10), supplying the bias current at a second level dependent on the final level of the bias current reached when the increasing is terminated,
[1.4] wherein the method further comprises:
[1.4.1] in response to the supply of power to the oscillator circuit (100) being switched on after an intervening period of operation in a sleep mode in which the supply of power to the oscillator circuit is

switched off, generating the bias current at a third level dependent on the stored indication without again initialising the oscillator circuit."

Claims 2 to 10 are dependent on claim 1.

VI. Claim 11 has the following wording:

"An oscillator circuit (100) comprising:
a crystal oscillator (10) arranged to generate an oscillation signal;
a bias current generator (20) arranged to supply a bias current to the crystal oscillator (10);
a feedback stage (30) arranged to generate a feedback signal in response to an amplitude of the oscillation signal reaching an amplitude threshold; and
a storage device (260),
wherein the oscillator circuit (10) is configured to perform the method of any one of the preceding claims."

Claim 12 is dependent on claim 11.

VII. The appellant's detailed arguments are discussed in the reasons for the present decision.

Reasons for the Decision

1. **Main request - Inventive step (Article 56 EPC)**

- 1.1 The examining division considered **document D13** to be the closest prior art document in the assessment of inventive step. Document D13 discloses a method of operating an oscillator circuit being switchable between a full-power mode and a sleep mode based on a "full power threshold word" or a "low power threshold word" written by an amplifier controller 306 in a threshold register 406 (see e.g. paragraph [0032] and figures 3 and 4).
- 1.2 The examining division considered document D13 to differ from the subject-matter of claim 1 of the main request by the features referred to herein as 1.1, 1.2, 1.2.1, 1.2.2, 1.2.3, 1.2.4 and 1.3.
- 1.3 On the other hand, the examining division considered document D13 to disclose feature 1.4.1 of claim 1.
- 1.4 The appellant argued that document D13 disclosed an active low-power mode and that power was thus further supplied in this operating mode. In contrast, feature 1.4.1 explicitly required the power to be switched off during a sleep mode.
- 1.5 According to paragraph [0028] of document D13, the low-power mode can be a sleep mode of a smartphone. However, the board agrees with the appellant in that feature 1.4.1 clearly requires the supply of power to the oscillator circuit to be switched on after an intervening period of operation in a sleep mode and it

explicitly defines that the supply of power is switched off in this sleep mode.

On the contrary, in document D13, operating modes are switched between a full-power mode and a low-power mode (corresponding to an "active sleep mode"). Therefore, contrary to the explicit wording of feature 1.4.1, in document D13 the supply of power is not "switched on" after an intervening period of operation in a sleep mode, but is at most increased to a higher level. For this reason alone, feature 1.4.1 cannot be considered to be disclosed in document D13.

- 1.6 For the sake of completeness it is further noted that the appellant was also right to argue that the "stored indication" within the meaning of feature 1.4.1, in the overall context of claim 1, refers to the indication of the final level of the bias current reached when the increasing (of the bias current) is terminated, as defined in feature 1.2.4 of claim 1.

In contrast to this, document D13 in paragraph [0038] discloses the use of "a full-power mode threshold word" written by the amplifier controller 306 in a threshold register 406 for the transition from low-power mode to full-power mode. Furthermore, this paragraph further discloses that the registered threshold word is compared with the word 408, which represents an amplitude of the oscillating signal (see figure 4). Therefore, document D13 clearly does not disclose a "stored indication" within the meaning of claim 1.

- 1.7 In the examining division's opinion, the features of claim 1 referred to herein as 1.1, 1.2, 1.2.1, 1.2.2, 1.2.3, 1.2.4 and 1.3 were obvious in view of the further document D3. Notwithstanding the board's

finding that document D13 also fails to disclose feature 1.4.1, the disclosure of document D3 will be discussed below.

- 1.8 **Document D3** discloses a method of operating an oscillator circuit that includes switching between a "single-ended mode" (using a single inverting amplifier, see figure 8a) and a "differential mode" of operation (using two inverting amplifiers, see figure 8b). The change between the two modes can be effected by switches 830 and 832 (figures 8a, 8b). The operation of the oscillator circuit is started in the "single-ended mode" and is then transitioned to the "differential mode" operation to provide a more balanced output oscillation signal (paragraphs [0022] and [0047]). The oscillator circuit 802 includes a differential detector 840, the output signal of which is a representation of the amplitude of the oscillation, which is compared with a switchover threshold by a window comparator 842. Exceeding the switchover threshold causes the first and second switches 830, 832 to change the mode of operation from single-ended to differential. The detector 840 and comparator 842 may continue to be used to set and maintain a desired amplitude of oscillation (see paragraphs [0062] and [0063]). The output of the differential detector 840 is provided to a comparator 842, which compares the output of the differential detector 840 with one or more target levels 844, which may also be referred to as target thresholds.

Paragraph [0064] of document D3 further discloses that the digital signal processor (DSP) generates control signals that can be used to regulate one or more circuit parameters of the oscillator circuit 802 in order to ensure that the amplitude of the oscillations

is kept between the upper and lower target values 844. Paragraph [0065] mentions as control parameters the capacitance of coupling capacitors C_{ss} 814, 818, which can be set by the control signal labelled "capVal" 848, the gain of the inverters 806, 808, which can be set by the control signal labelled "gmVal" 850, and the supply voltage "Vsup" 856 to the inverters 806, 808, which can be set by the control signal labelled "vddVal" 852.

- 1.9 In the decision under appeal, the examining division referred to paragraphs [0009] and [0072] of D3 in section 15.6 of the reasons and concluded that these passages disclosed feature 1.2.4 of claim 1, i.e. "in response to the feedback signal, terminating the increasing and storing an indication of the final level of the bias current reached when the increasing is terminated". A detailed assessment of the disclosure of these paragraphs as well as of further relevant paragraphs of document D3 reveals the following:

According to paragraph [0008] of document D3, the oscillator circuit may indeed be configured to set one or more of the circuit parameters to one or more preset values when switching the oscillator circuit from the first mode of operation to the second mode of operation. This paragraph further explains that the use of such preset values can reduce transient effects and speed-up the settling of the oscillator amplitude to a value needed for optimal performance after entering the second mode of operation. Paragraph [0009] in this context further discloses that one or more preset values may correspond to values established and saved in memory, for example non-volatile memory, during a previous operation of the oscillator circuit. In this way, environmental and time-varying conditions can be taken into account to improve the settling performance

of the oscillator circuit when changing to the second mode of operation.

Furthermore, paragraph [0072], with reference to figure 9 illustrating a start-up sequence of the circuit, discloses that at the switchover from single-ended mode operation to differential mode operation, one or more of the control variables gmVal 906, capVal 908 and vddVal may be set to values that are suitable for operating in differential mode. It is further disclosed in this paragraph that the new values for the control variables can be fixed preset values, or values retrieved from a memory that are representative of values that were previously used while operating in differential mode. Furthermore, presetting the values of control signals at changeover to differential mode (as opposed to letting the control loop establish the correct values) are described as advantageous because they can reduce transient effects and speed-up the settling of the oscillator amplitude to values needed for optimal performance after entering the second mode of operation.

1.10 In the contested decision, the examining division appears to have equated the presetting of specific gain values gmVal of the amplifiers with the claimed "indication of the final level of the bias current reached when the increasing is terminated" (feature 1.2.4), see section 15.5 of the contested decision.

1.11 In the board's view, whilst the control parameter gmVal, i.e. the amplifier gain, is one parameter which may have an influence on the bias current supplied to the oscillator, this also applies to the further control parameters capVal and vddVal. Accordingly, in order to store "the final level of the bias current" in

the sense of feature 1.2.4, all control parameters that together determine the level of the bias current, i.e. all parameters that have an influence on the bias current, would have to be stored in combination. However, document D3 does not contain any direct and unambiguous teaching in this respect. It only discloses that "one or more of the control variables gmVal 906, capVal 908 and vddVal (not shown in Figure 9) may be set to values that are suitable for operating in differential mode". It is therefore not directly and unambiguously derivable from document D3 that the combination of stored control parameters is such that they constitute an indication of a specific "final level of the bias current" as defined in feature 1.2.4 of claim 1.

1.12 Furthermore, claim 1 specifically requires storing an indication of the final level of the bias current reached when the increasing (of the bias current) is terminated. In document D3 there is no direct and unambiguous disclosure that it is the final level of the bias current reached when the increasing is terminated, i.e. the amplitude of the oscillation circuit has reached the amplitude threshold, that is used as preset value or "stored indication" in the language of claim 1. Rather, document D3 only generally refers to "values that were previously used while operating in differential mode" (see paragraph [0072]).

1.13 The board concludes that neither of documents D13 or D3 directly and unambiguously discloses "storing an indication of the final level of the bias current reached when the increasing is terminated" according to feature 1.2.4 or "in response to the supply of power to the oscillator circuit (100) being switched on after an intervening period of operation in a sleep mode in

which the supply of power to the oscillator circuit is switched off, generating the bias current at a third level dependent on the stored indication without again initialising the oscillator circuit" according to feature 1.4.1.

Nor are these features, to the board's knowledge, of such a nature that they were generally known and would therefore have been immediately recognised or readily taken into account by a person skilled in the art.

- 1.14 Consequently, irrespective of which technical effect and resulting objective technical problem would be taken into account, if the person skilled in the art had combined document D13 with document D3 or *vice versa*, he/she would in any event not have arrived at the subject-matter of claim 1. The subject-matter of claim 1 was therefore not obvious to the person skilled in the art from a combination of documents D13 and D3.
- 1.15 The other documents D1, D2, D4 to D12 and D14 were mentioned in the international search report and/or during the examination procedure. In particular, documents D1, D2 and D4 to D8 were already mentioned in the International Search Report. Documents D9 to D12 were found during a further search after the appellant had paid additional search fees for lack of unity of the invention. Document D14, together with document D13, was introduced only shortly prior to the oral proceedings before the examining division.

Documents D1, D2 and D4 to D7, together with document D3, were *inter alia* used as starting points for an objection under Article 56 EPC against claim 1 of the main request in combination with document D9. At least some of these documents were also considered relevant

with respect to some of the dependent claims of the main request.

Documents D10 to D12 were considered by the examination division to represent the general state of the art. Document D14 was not discussed in substance in any of the examining division's communications or in the contested decision.

The board does not see that any of the other documents go beyond the teaching of documents D3 and D13 and, in particular, do not disclose either of the features 1.2.4 or 1.4.1.

- 1.16 The board therefore concluded that, in view of the relevant prior art on file, the subject-matter of claim 1 was not rendered obvious by the combination of any of these prior art documents and therefore involves an inventive step within the meaning of Article 56 EPC.

2. Further requirements of the Convention

- 2.1 According to Article 84 EPC, the claims shall define the matter for which protection is sought. They shall be clear and concise and be supported by the description. These requirements are considered to be met by the main request.
- 2.2 The claims of the main request are also considered to meet the requirements of Article 123(2) EPC, as the amendments made are directly and unambiguously derivable from the original application documents (reference is made to the international publication no. WO 2015/185103 A1).

In particular, claim 1 is a combination of the original claims 13 and 15 and the description on page 8, line 29 to page 9, line 10.

The dependent claims 2 to 10 are based on the corresponding apparatus features of original claims 2 to 8, 10 and 11.

Independent claim 11, referring to an oscillator circuit, is based on the original claim 1 and, *inter alia*, defined to be configured to perform the method of any of the preceding claims.

Dependent claim 12 of the main request corresponds to the original claim 12.

2.3 The board further considers the requirements of Rules 42 and 43 EPC to be fulfilled by the main request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with order to grant a patent in the following version:

Description:

Pages 1-4 filed in electronic form on 02 December 2019
Pages 5-13 as published

Claims:

Numbers 1-12 filed with the statement setting out the grounds of appeal

Drawings:

Sheets 1/4-4/4 as published

The Registrar:

The Chairman:



U. Bultmann

G. Flyng

Decision electronically authenticated