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Datasheet for the decision of 13 June 2024

Case Number: T 0343/22 - 3.4.03

Application Number: 14798633.5

Publication Number: 2997601

IPC: H01L29/739, H01L27/06

Language of the proceedings: EN

Title of invention:
AN INSULATED GATE BIPOLAR TRANSISTOR AMPLIFIER CIRCUIT

Applicant:
K. Eklund Innovation

Headword:

Relevant legal provisions:
EPC Art. 84
RPBA 2020 Art. 13(1), 13(2)

Keyword:
Claims - clarity - main request (no)
Auxiliary request - submitted shortly before oral proceedings - admitted (no) - no exceptional circumstances, gives rise to new objections

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 0343/22 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 13 June 2024

Appellant: (Applicant)	K. Eklund Innovation Norrtäljevägen 14D 753 27 Uppsala (SE)
Representative:	Noréns Patentbyrå AB Box 10198 100 55 Stockholm (SE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 27 September 2021 refusing European patent application No. 14798633.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	T. Häusser
Members:	M. Papastefanou
	T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing the European patent application No. 14 798 633 (published as WO 2014/185852 A1) on the ground that claims 1 and 9 of the sole request then on file were not clear within the meaning of Article 84 EPC.

II. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims filed on 15 September 2020 and underlying the impugned decision, as a main request, or in the alternative, on the basis of the claims 1 to 15 filed by email on 13 June 2024 as an auxiliary request.

III. Reference is made to the following document:

D4: Elisabeth Kho Ching Tee et al., *A Review of techniques used in Lateral Insulated Gate Bipolar Transistor (LIGBT)*, IOSR Journal of Electrical and Electronics Engineering, Volume 3, Issue 1 (Nov.-Dec. 2012), pages 35-52

D5: US 4,890,146

IV. Claim 1 of the **main request** has the following wording:

A lateral IGBT transistor comprising a bipolar PNP transistor and an IGFET of n-type, where the IGFET is of conventional type, characterized by:

- *a low resistive connection between the drain of the IGFET and the base of the bipolar transistor, and;*
- *two n-well layers (130) and (120) arranged between the IGFET and the bipolar PNP transistor (102),*

together isolating the bipolar PNP transistor (102) from the substrate and then connected to the base, providing latch immunity.

V. Claim 1 of the **auxiliary request** is worded as follows (amendments with respect to claim 1 of the main request marked by the board):

A lateral IGBT transistor device comprising a bipolar PNP transistor and an IGFET of n-type, where the IGFET is of conventional type, characterized by:
- *a low resistive connection between the drain of the IGFET and the base of the bipolar transistor, and;*
- *two n-well layers (130) and (120) arranged between the IGFET and the bipolar PNP transistor (102), together isolating the collector (125b) of the bipolar PNP transistor (102) from the p-well (125a) of the IGFET (101) ~~substrate~~ and then connected to the base, providing latch immunity.*

VI. The appellant argued essentially that the claimed device functioned as a conventional lateral IGBT and its definition would be clear to the skilled person. The main point was that the claimed device was "latch - free", contrary to the known IGBTs.

Regarding the auxiliary request, the appellant argued that by adding the term "device" it was clear for the skilled person that the claimed device was not considered an IGBT transistor as such. Basis for the other amendments was to be found in Figure 2 of the application as originally filed. As to the late filing of the auxiliary request, the appellant explained that it had realised the full depth of the board's objections only shortly before the oral proceedings.

Reasons for the Decision

1. The claimed invention relates to an Isolated Gate Bipolar Transistor (IGBT) device consisting of an Isolated Gate Field Effect Transistor (IGFET) and a bipolar transistor.

One of the main problems of such devices is the so-called "latch-up", whereby a parasitic thyristor is created between the bipolar transistor and the substrate (see Figures 1A and 1B of the published application). This has the consequence that control of the device is lost as the device continues to conduct even when the voltage at the gate is removed (see page 3, lines 19 to 32 of the published application).

The claimed invention adds two n-layers between the bipolar transistor and the IGFET, effectively isolating one from the other and eliminating the risk of latch-up (see Figure 2 of the application as published).

2. Main request

2.1 According to the examining division, the claimed device could not be called an IGBT because the two n-well layers were separating the bipolar transistor from the IGFET (see also Figure 2 of the application). The claimed device did not operate in the way a skilled person would expect an IGBT to operate, and the term "IGBT" in claim 1 (and independent claim 9) contradicted the two n-well layers arranged between the IGFET and the bipolar transistor. Due to this internal inconsistency, claim 1 (and claim 9) was not clear within the meaning of Article 84 EPC (see points 10 to

10.5.1 of the Reasons for the decision under appeal).

2.2 The appellant argued that the device according to claim 1 (see also Figure 2 of the published application) comprised a low resistive connection (136c) between the drain (136a) of the IGFET (101) and the base contact (136b) of the bipolar transistor (102) so that the IGFET and the bipolar transistor were not completely separated, contrary to the finding of the examining division. When a voltage over the corresponding threshold was applied at the gate of the IGFET, electrons would flow from the drain of the IGFET via the low resistive connection into the base of the bipolar transistor. These electrons would combine with the holes flowing into the base from the collector (125b), increasing thus the conductivity. The claimed device therefore functioned as a lateral IGBT and there was no contradiction or inconsistency in the definition of claim 1.

2.3 It is common ground that a lateral IGBT is a well-known and widely used electronic device, see also Figure 1A of the published application and Figure 1 of D4.

2.3.1 The IGBT is usually characterised as "a combination of an IGFET and a bipolar transistor". As it can be seen in the figures cited above, this characterisation serves only as a model to understand the operation of the device (see also Fig. 1B of the published application). In reality there are no distinct IGFET and bipolar transistor in the IGBT. In the board's view, the expression "combination of an IGFET and a bipolar transistor" is not to be understood literally, such that an IGBT comprises indeed an IGFET and a bipolar transistor connected or combined to each other in any way. The IGBT is rather a bipolar transistor

with a gate instead of a base, so that it can be controlled by a voltage (the gate voltage) instead of a current (the base current), as is the case in normal bipolar transistors.

2.3.2 Referring to the model of the combined IGFET and bipolar transistor (see Figures 1A and 1B of the published application), the IGBT's three contact terminals can be understood as follows:

- the anode corresponds to the collector of the bipolar transistor,
- the cathode corresponds both to the source of the IGFET and the emitter of the bipolar transistor, and
- the gate corresponds to the gate of the IGFET.

The device comprises further a drift region, which corresponds both to the drain of the IGFET and the base of the bipolar transistor.

2.3.3 In operation, when an appropriate voltage is applied between the anode and the cathode and the voltage at the gate exceeds a threshold, electrons flow from the cathode into the drift region and to the anode (so that a current conventionally flows from the anode to the cathode). In the drift region these electrons combine with holes flowing from the anode. This changes the doping concentration of the drift region, affecting both the conductivity of the bipolar transistor and the on-resistance (the drain to source resistance) of the IGFET, providing an IGBT with modulated conductivity.

2.4 In the board's opinion the claimed device in which the IGFET is distinct and separated from the bipolar transistor is not a combination of an IGFET and a transistor in the sense of the model used in a

conventional lateral IGBT.

As a first remark, the claimed device has more than three contact terminals, see Figure 2 of the published application. Although not explicitly stated in the application, it seems evident that in order for a current to flow in the channel under the gate (when a voltage above the corresponding threshold is applied to the gate), a voltage must be applied between the source (135) and drain (136a) of the IGFET. At the same time, for the bipolar transistor to conduct, an appropriate voltage between the collector (125b) and the emitter (145) of the transistor is also necessary. Since these parts of the IGFET and the bipolar transistor are not "combined" as in the conventional lateral IGBT, there must be two distinct voltages applied (besides the gate voltage), to two different pairs of contact terminals. The claimed device has thus five terminals instead of three. Already from a structural point of view, the claimed device does not correspond to the known lateral IGBT devices, as also acknowledged by the appellant.

2.5 The appellant argued that the low resistive connection between the drain of the IGFET and the base of the transistor (136c in Figure 2) would allow for the bipolar operation to take place in the claimed device. When the voltage at the gate exceeded the threshold, electrons would flow into the base of the bipolar transistor from the drain of the IGFET, where they would combine with the holes flowing from the collector, increasing thus the conductivity of the bipolar transistor, just as it would occur in a conventional lateral IGBT.

2.6 The board does not dispute that the operation as described by the appellant may take place. However, the

board agrees with the examining division that any such bipolar action takes place within the isolated bipolar transistor and there is no apparent interaction between the IGFET and the transistor. In a conventional IGBT such action would take place in the drift region, which is common to the IGFET and the transistor. For example, in the claimed device there is no influence on the doping concentration of the drain and the on-resistance of the IGFET by this bipolar action (which takes place in the base of the isolated transistor), as it would be the case in a conventional IGBT.

2.7 The appellant mentioned an "extended drain" of the IGFET, which would include also the low resistive connection (136a, 136c and 136b in Figure 2). However the board cannot see how this low resistive connection could be considered as part of the drain of the IGFET, especially when this low resistive connection can also be implemented as a metallic bridge (see e.g. claim 6).

2.8 The claimed device appears rather to comprise an IGFET with its drain (136a) connected to the base of a bipolar transistor (127b) via a base contact (136b), which are otherwise isolated from each other. In this structure, the bipolar transistor can act as an amplifier of the IGFET current, if the appropriate voltage is applied at the collector.

The board thus concludes that claim 1 provides the skilled person with contradictory/inconsistent information regarding the definition of the claimed device and the scope for which protection is sought. Claim 1 is thus not clear (Article 84 EPC).

2.9 For the sake of completeness, reference is also made to document D5, which discloses a device very similar to

the one defined in claim 1 of the main request.

Figure 8 for example shows a semiconductor device comprising an IGFET ("N-channel transistor" 51) and a bipolar transistor ("PNP transistor" 97). The drain of the IGFET (61) is connected via a low resistance connection (72, 102, 101) to the base of the transistor (98). Two n-layers (85-87; 85 can be considered part of 86) separate the transistor from the IGFET and isolate it from the substrate (see column 16, lines 31 to 57).

There is no mention of an IGBT in D5, although the device is structurally and functionally very similar to the claimed device. This is seen as another indication that the claimed device cannot be considered an IGBT within the common meaning of the term in the art.

3. Auxiliary request, admittance

3.1 The auxiliary request was filed by email shortly before the start of the oral proceedings on 13 June 2024.

3.2 The appellant argued that this request was filed in an effort to clarify how the claimed device solved the problem of the conventional IGBT by providing a "latch-free" device. Moreover, claim 1 defined now an "IGBT transistor device" making it clear for the skilled person that the claimed device was not an IGBT transistor as such.

To the board's question about the late filing of this request, the appellant explained that it had only become aware of the full depth of the board's objections shortly before the oral proceedings and reacted as soon as it was possible.

3.3 The board notes that the lack of clarity objection relating to the use of the term IGBT was the main issue of discussion during the proceedings before the examining division and it was the ground which led to the refusal of the application. It was thus the main issue of discussion from the beginning of the appeal proceedings. The board merely reiterated that objection in its preliminary opinion.

There are thus no exceptional circumstances that might justify a filing and admittance of an auxiliary request so late in the proceedings. The handling of the case by the appellant, e.g. the fact that it understood the board's objections only shortly before the oral proceedings may be subjectively perceived by the appellant as an exceptional situation, but this is not a circumstance that the board can objectively verify on the basis of tangible facts. As such, it is not a suitable criterion for the purposes of Article 13(2) RPBA. While the board has no reason to call into doubt the veracity of the appellant's statements in the present case, there is nothing in the file that could excuse the appellant's late amendments to the claim. The objection was present from the beginning of the appeal proceedings and even in the examination proceedings. Even the board's communication was issued four months before the oral proceedings, providing ample time for a submission that the board could have studied in good time before the oral proceedings, rather than being confronted with a request immediately at the oral proceedings. The board hence cannot see any reason, let alone any cogent reason, for admitting this request (Article 13(2) RPBA).

3.4 In addition, the board notes that according to claim 1 of the auxiliary request, the two n-layers isolate the

collector of the bipolar transistor from the p-well of the IGFET. This is different from the definition in claim 1 of the main request, where the two n-layers isolate the bipolar transistor from the substrate.

3.4.1 The appellant admitted that there was no explicit basis for this amendment in the description of the application as originally filed but pointed to Figure 2. According to the appellant, the skilled person would have understood from this figure that isolating the collector of the transistor from the p-well of the IGFET was key to the provision of a latch-free device.

It also mentioned another of its patents where this was explained in more detail. The board notes, however, that there is no reference to that patent in the present application at all, neither was this patent submitted by the appellant at any point during the proceedings.

3.5 Regarding the addition of the term "device" in the claim, the board does not see any difference between the terms "IGBT transistor" and "IGBT transistor device". For the board, a transistor is a device and the skilled person would not understand it differently. This amendment thus does not overcome the lack of clarity objection.

3.6 The board also considers it at least questionable that Figure 2 can provide a basis for the amended feature in the sense of Article 123(2) EPC. For example, Figure 2 is a schematic lateral representation (cross section) of a 3D device, so that it cannot be ascertained that the two n-layers indeed isolate the collector of the bipolar transistor from the p-well of the IGFET without

any relevant explanation in the description.

3.7 Moreover, there is no explanation in the application how or why isolating the collector of the bipolar transistor from the p-well of the IGFET would solve the problem of latch-up, since the application only explains that this problem is solved by isolating the bipolar transistor from the substrate. Therefore, the skilled person would not have understood from the cited figure alone that it is the isolation of the collector of the transistor from the p-well of the IGFET that actually solves the latch-up problem, as the appellant argued.

3.8 The board's conclusion is therefore that the amendments carried out in claim 1 of the auxiliary request do not *prima facie* overcome the outstanding issue (lack of clarity; Article 84 EPC) and give rise to new objections (extension beyond the originally filed content of the application; Article 123(2) EPC). These are additional reasons not to admit the auxiliary request into the proceedings (Article 13(1) RPBA).

3.9 In view of the above, the board does not admit the auxiliary request into the proceedings.

4. Since the main request is not allowable and the auxiliary request is not admitted into the proceedings, there is no request on file which could be a basis for the grant of a patent. Hence the appeal cannot succeed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

B. Atienza Vivancos T. Häusser

Decision electronically authenticated