

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 23 February 2001

Case Number: T 1084/96 - 3.4.3

Application Number: 89202351.6

Publication Number: 0361589

IPC: H01L 29/08

Language of the proceedings: EN

Title of invention:

Segmented-anode lateral insulated-gate bipolar transistor devices

Applicant:

Koninklijke Philips Electronics N.V.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (yes - after amendments)"

Decisions cited:

-

Catchword:

-



**Europäisches
Patentamt**

**European
Patent Office**

**Office européen
des brevets**

Beschwerdekammern

Boards of Appeal

Chambres de recours

Case Number: T 1084/96 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 23 February 2001

Appellant: Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven (NL)

Representative: Houbiers, Ernest Emile Marie Gerlach
INTERNATIONAAL OCTROOIBUREAU B.V.
Prof. Holstlaan 6
5656 AA Eindhoven (NL)

Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 22 May 1996
refusing European patent application
No. 89 202 351.6 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
M. J. Vogel

Summary of Facts and Submissions

I. European patent application No. 89 202 351.6 (Publication No. 361 589) was refused by a decision of the examining division dated 22 May 1996 on the ground that the subject-matter of claim 1 did not involve an inventive step having regard to the prior art documents

D3: International Electron Devices Meeting, Technical Digest, Washington, D.C., 6 to 9 December 1987, pages 778 to 781,

D4: EP-A-0 272 753, and

D5: GB-A-2 197 987.

II. Claim 1 forming the basis for said decision had the following text:

"1. A lateral insulated gate bipolar transistor, comprising

a semiconductor substrate of one conductivity type,

a layer of the opposite conductivity type formed on the surface of said substrate,

a laterally extending drift region defined in said layer,

means including a source and gate for controlling the introduction of majority carriers into one end of said drift region, and a drain region comprising a zone of said one conductivity type and a highly doped zone of said opposite conductivity type,

characterized in that

said zones comprises (sic) interleaved first and second segments adjacent the other end of said drift region, said first segments being of the one conductivity type and being adapted both to collect majority carriers from and to inject minority carriers into said drift region, and said second segments being of the opposite conductivity type and being adapted only to collect majority carriers from said drift region, said first and said second segments, at the side directed to the source, and at the intersection with the surface, both abutting on the drift region."

In the decision under appeal, the examining division took the following view:

A LIGT (lateral insulated gate bipolar transistor) device according to the first part of claim 1 is known from document **D3**. The device of claim 1 differs from this known device in that the drain region of the device according to the claim comprises interleaved first and second segments which abut the drift region at the side directed to the source. In document **D3**, on the other hand, the n-type second segment is formed further away from the drift region than the p-type region, and an interleaved structure is not present.

The problem to be solved by the application relates to an improvement of the turn-off properties of the LIGT (cf. page 1, line 26 to page 2, line 9) known from document **D3**.

The same type of device as in document **D3** but made as an SOI (silicon on insulator) device is known from

document **D4** (cf. Figure 1); the drain region (26) comprises interleaved segments on n- and p-type, respectively, i.e., the first and second segments are formed interleaved both facing the drift region (cf. Figure 4). A skilled person would regard the drain structure given in document **D4** as **an alternative** to that presented in document **D3**, since they relate to basically the same type of devices. It is therefore possible to replace the drain structure given in document **D3** by that described in document **D4** without employing inventive skills (emphasis by the Board).

Further comments:

The disclosure of Figure 1 of document **D5** gives the skilled person an indication that the interleaved drain structure has already been tried for an LIGT device, but only together with an n-type buffer zone and that it would be worthwhile to test a device without such a buffer zone.

- III. The appellant lodged an appeal against this decision.
- IV. In a communication dated 22 December 2000, the Board of appeal informed the appellant that the subject-matter of claim 1 appeared to lack an inventive step having regard to the documents **D3** and **D4**, but that a new, amended claim 1 annexed to the communication could be allowable in view of the appellant's arguments in the statement setting out the grounds of appeal.
- V. In his reply dated 16 January 2001, the appellant informed the Board that he agreed with the text of the claim proposed by the Board.

VI. The appellant thus requests that the decision under appeal be set aside and that a patent be granted on the basis of the following patent application documents:

Description: Pages 1 to 10, as filed;

Claims: No. 1, annexed to the communication dated 22 December 2000 of the Board and accepted by the appellant with his letter of 16 January 2001;
Nos. 2 to 7, filed with applicant's letter dated 17 June 1993;

Drawings: Sheets 1/2 to 2/2, as filed.

The appellant has submitted the following arguments in support of his request:

Figure 2 of document **D3** concerns a device which is a lateral insulated gate bipolar transistor (also designated as LIGBT) comprising a substrate of a first conductivity type (p) with a surface layer of the opposite conductivity type (n) comprising, at its surface, a source, a gate, a drain, and a drift region between the source and the drain; the drain region is formed of p- and n-regions which are short-circuited by the drain contact. The essential feature of this LIGBT device resides in the fact that, during operation, as a result of the current flow of electrons in the drift region, a forward voltage is built-up across the anode (drain) diode; the p+ anode region injects holes in the n type drift region, so that the current between cathode and anode consists of electrons and holes, and this leads to a very low on-resistance of the device.

The main purpose of the present invention is to improve this LIGBT device by decreasing the turn-off time. This is achieved by providing the anode in the form of interleaved p - and n - zones which each adjoin the drift region, facing the source region.

Document **D4** discloses a thin-film device comprising a silicon layer on an isolating substrate, the different parts of this LIGBT being provided in the form of zones and regions which extend across the whole thickness of the silicon layer up to the isolating substrate. Thus, it is not possible to locate the p - and n - zones of the drain one behind the other, as shown in document **D3** because, in the thin film device, the electrons would not be able to flow under the p - type anode zone, and this is the reason why, in document **D4**, the p and n zones of the drain are provided besides each other. However, there is no suggestion that this structure of the drain of document **D4** could be used in the structure of the device of document **D3**, especially for decreasing the turn-off time of the device, so that such a measure would be based purely on unallowable hindsight.

With regard to document **D5**, there is no definite information about the function of the n+ region surrounding the interleaved p and n zones in the embodiment of Figure 1, so that the deletion of said surrounding region, i.e., of a region of ambiguous function, cannot be considered as being obvious.

Therefore, the subject-matter of present claim 1 involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.
2. *Admissibility of the amendments*

Claim 1 forming the basis of the contested decision was based on originally filed claims 1 and 2 with the additional feature that the device is a lateral insulated gate bipolar transistor (LIGBT), and that "said first and second segments, at the side directed to the source, and at the intersection with the surface, both abut on the drift region (see page 1, first sentence and claim 4, and the embodiments of Figures 3 and 4).

The further feature inserted in the above claim 1 and resulting in the present claim 1, i.e., that the drain region comprising a zone of said one conductivity type and a highly doped zone of said opposite conductivity type formed on the surface of the substrate "**both having a depth less than the thickness of the layer of the opposite conductivity**", is clearly derivable from the whole content of the application as filed for the following reasons:

Figures 1 and 2 of the application as filed illustrate a conventional LIGBT device which is described on page 1, lines 19 to 26 of the application. These Figures show that the drain region of the conventional device comprises a zone of one conductivity type and a highly doped zone of the opposite conductivity type formed on the surface of the substrate "**both having a depth less than the thickness of the layer of the**

opposite conductivity".

Moreover, it is stated in the present application (see page 6, line 25 to page 7, line 5) that the present device is identical with the conventional device illustrated by Figures 1 and 2 except for the modifications in the drain region thereof as set out in the characterising part of the claim (see for instance Figure 3). Therefore, it follows that the zone of one conductivity type and the highly doped zone of the opposite conductivity type both have a depth less than the thickness of the opposite conductivity type layer in the device according to the invention as claimed.

Present claims 2 to 7 correspond to claims 5 to 10 as filed.

Therefore, the Board is satisfied that the present patent application has not been amended in such a way that it extends beyond the content of the application as filed (Article 123(2) EPC).

3. *Novelty*

The subject-matter of present claim 1 does not form part of the state of the art, and is thus new in the sense of Article 54 EPC.

4. *Inventive step*

- 4.1 A lateral insulated gate bipolar transistor (LIGBT) is known from document **D3** (see in particular the integrated LIGBT of Figure 2 and the corresponding text); the LIGBT comprises:

a semiconductor substrate of one conductivity type (p),

a layer of the opposite conductivity type (n) formed on the surface of said substrate,

a laterally extending drift region defined in said layer,

means including a source and gate for controlling the introduction of majority carriers into one end of said drift region, and a drain region comprising a zone of said one conductivity type (p) and a highly doped zone of said opposite conductivity type (n+).

Moreover, in the known integrated LIGT device, the drain region comprises a zone of said one conductivity type (p) and a highly doped zone of said opposite conductivity type (n) formed on the surface of the substrate "**both having a depth less than the thickness of the layer of the opposite conductivity**".

However, contrary to the present LIGT device, the device of document **D3** does not comprise the features of the characterizing portion of present claim 1, i.e.,

the zones do not comprise interleaved first and second segments adjacent the other end of said drift region and the first and second segments, at the side directed to the source, and at the intersection with the surface, do not abut the drift region.

4.2 According to the present application (see page 1, line 2 to page 2, line 1), the LIGT device is a high-voltage integrated circuit which can provide a low value of on-resistance with small area properties and

short turn-off times; this results from the injection of electron and holes from the n+ - and p-type zones of the drain region in the drift region of the LIGT device and the bipolar action of part of the structure.

An object of the present invention (see page 2, lines 2 to 9) is to decrease the turn-off time of this known LIGT device while substantially preserving its low on-resistance and small area properties.

A LIGT device made according to the principles of the present invention (see page 6 lines 20 to 24) is identical with the conventional device depicted in Figures 1 and 2 (and thus with the integrated LIGT device of Figure 2 of document **D3**) except for unique modifications in the drain region.

As convincingly argued by the appellant, turn-off time is decreased by providing the drain in the form of interleaved p- and n-zones which each adjoin the drift region, as stated in the claim.

- 4.3 The same type of device as in document **D3** but made as an SOI (silicon on insulator) device is known from document **D4** (cf. Figure 1); the drain region (26) comprises interleaved segments on N- and P-type, respectively, i.e., the first and second segments are formed interleaved both facing the drift region (cf. Figure 4). The different parts of the device are provided in the form of zones and regions which extend across the whole thickness of the silicon layer, up to the isolating substrate.

Thus, contrary to the present LIGT device, the device of document **D4** does not comprise the feature that the

zone of said one conductivity type (p) and the highly doped zone of said opposite conductivity type (n) which are comprised in the drain region formed on the surface of the substrate "**both have a depth less than the thickness of the layer of the opposite conductivity**".

Therefore, the appellant's argument that the electrons would not be able to flow under the p-type drain zone of the device of document **D4**, i.e., that the movement of electrons in the drain region is different in the devices of documents **D3** and **D4**, respectively, can be accepted.

Thus, in view of this distinguishing feature and the lack of indications in document **D4** about the ability of this feature to provide a turn-off characteristics which is at least comparable to that provided by a drain region according to document **D3**, the drain region of the device of document **D4** cannot be considered as an **alternative** to that of document **D3**.

Moreover, as convincingly argued by the appellant in the statement of the grounds of appeal, there is no suggestion in document **D4** that it might be advantageous to use this anode structure in a LIGT as disclosed in document **D3** in order to shorten the turn-off time, so that this modification cannot be regarded as obvious to a person skilled in the art.

- 4.4 Document **D5** (see page 1, line 7 to page 2, line 15) discusses a "previously proposed device" as shown in Figure 1, comprising a lateral insulated gate transistor with vertical integral diode wherein the anode comprises alternate conductivity type (p and n)

emitter regions.

As convincingly argued in the statement of the grounds of appeal, drawbacks of said structure are indicated in the cited text locations and, moreover, there is no definite information in the document concerning the n+ region shown in Figure 1 and surrounding the interleaved structure of the anode, so that, contrary to the finding in the decision under appeal, no reason for deleting said surrounding region is directly and unambiguously derivable from the document.

Therefore, document **D5** is not relevant.

- 4.5 Consequently, in the Board's judgement having regard to the state of the art, the subject-matter of claim 1 is not obvious to a person skilled in the art, and thus it involves an inventive step in the sense of Article 56 EPC.

Therefore, claim 1 is patentable in the sense of Article 52(1) EPC.

The present dependent claims 2 to 7 concern particular forms of the drain region and contact metallisation of the device as defined in claim 1, which are patentable for the same reasons.

Therefore, a European patent can be granted (Article 97(2) EPC).

5. Oral proceedings, which had been requested auxiliarily by the appellant, were thus not necessary.

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 the order to grant a patent on the basis of the following patent application documents:

Description: Pages 1 to 10, as filed;

Claims: No. 1, annexed to the communication dated 22 December 2000 of the Board and accepted by the appellant with the letter of 16 January 2001;
Nos. 2 to 7, filed with applicant's letter dated 17 June 1993;

Drawings: Sheets 1/2 to 2/2, as filed.

The Registrar:

The Chairman:

L. Martinuzzi

R. Shukla