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**D E C I S I O N**  
**of 23 January 2002**

**Case Number:** T 0340/98 - 3.4.3

**Application Number:** 93103320.3

**Publication Number:** 0559155

**IPC:** H01L 29/796

**Language of the proceedings:** EN

**Title of invention:**  
Charge-to-voltage converter

**Applicant:**  
SONY CORPORATION

**Opponent:**

-

**Headword:**  
charge-to-voltage converter/SONY

**Relevant legal provisions:**  
EPC Art. 56, 84

**Keyword:**  
"Inventive step - auxiliary request (after amendment) (yes)"  
"Clarity - main request (no); - auxiliary request (yes)"  
"Simplification of prior art device - not obvious"

**Decisions cited:**

-

**Catchword:**

-



**Case Number:** T 0340/98 - 3.4.3

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.3**  
**of 23 January 2002**

**Appellant:** SONY CORPORATION  
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Shinagawa-ku  
Tokyo (JP)

**Representative:** Müller, Frithjof E., Dipl.-Ing.  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 5 December 1997  
refusing European patent application  
No. 93 103 320.3 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** M. Chomentowski  
**Members:** G. L. Eliasson  
M. J. Vogel

## Summary of Facts and Submissions

I. European patent application No. 93 103 320.3 (publication No. 0 559 155) was refused in a decision of the examining division dated 5 December 1997. The ground for the refusal was that the subject matter of claim 1 according to the main request lacked novelty having regard to each of the prior art documents

D1: EP-A-0 321 953; and

D2: JP-A-59-52 877,

and that claim 1 according to the auxiliary request lacked novelty having regard to document D1.

II. Claim 1 according to the auxiliary request under consideration in the decision under appeal reads as follows:

"1. A charge-to-voltage converter of a floating diffusion output type for producing a signal voltage by injecting signal charge packets transferred from a charge transfer region (3) into a floating diffusion region (1) via an output gate (OG), said converter comprising:

a precharge drain region (2);

a diffusion region (6);

a first channel region (7) and a second channel region (8) separating said floating diffusion region (1) from said diffusion region (6) and said diffusion region (6) from said precharge drain

region (2), respectively,

a first precharge gate electrode (PG1) formed over said first channel region (7);

a second precharge gate electrode (PG2) formed over said second channel region (8), wherein the charge-to-voltage conversion factor being selectively changed in response to gate voltages selectively applied to said first and second precharge gate electrodes (PG1, PG2); characterized in that

said precharge drain region (2) is supplied with a reset voltage, and said floating diffusion region (1) is adjacent only to said output gate and connected only to said first channel region (7) and an output terminal (Vsig)."

III. The reasoning of the examining division in the decision under appeal concerning the auxiliary request can be summarized as follows:

- (a) The term "output terminal" in the characterizing part of claim 1 is based on Figures 1(a) to (c), and not on any specific disclosure in the original description. Therefore, the broadest possible meaning of this term is taken to mean any possible conductive area allowing detection of signal potential variations in the floating diffusion region (1) (cf. the published specification, page 1, lines 16 to 19). In the device shown in Figure 1 of document D2, a floating diffusion region FD is connected to an output amplifier A' via an output terminal. By comparing the

circuit diagram of the amplifier A' in document D2 with the device of document D1, it follows that the output terminal is identical with the floating diffusion region 102 of the device of document D1. Consequently, the floating diffusion 102 of the device of document D1 is adjacent only to the output gate 8, and is connected only to a first channel region (below gate 106), and an output terminal, as specified in claim 1 according to the auxiliary request.

Document D1 furthermore discloses all the features of the pre-characterizing part of claim 1 according to the auxiliary request and discloses a precharge drain 104 connected to a reset voltage VRD. Therefore, the subject matter of claim 1 according to the auxiliary request is not new.

- (b) Incidentally, the following is to be noted: A narrower interpretation of the term "output terminal", as suggested by the applicant, which is limited to a terminal to be connected to an amplifier, has no support in the application in suit. In any case, even if the term "output terminal" were interpreted in this manner, the subject matter of claim 1 according to the auxiliary request would not involve an inventive step having regard to the device of Figure 4(a) of document D1, since the omission of the gate 105 and the further precharge region 101 would be considered by the skilled person as a matter of mere routine whenever factors as cost or reduced device surface are considered important.

IV. The appellant (applicant) lodged an appeal on

5 February 1998, paying the appeal fee the same day. A statement of the grounds of appeal was filed on 1 April 1998 together with new application documents.

- V. At the oral proceedings held on 23 January 2002, the appellant requested that the decision under appeal be set aside and a patent be granted on the basis of one of the following requests:

**Main request**

**Claims:** 1 and 2 filed on 1 April 1998

**Description:** Pages 1 to 12 filed on 1 April 1998

**Drawings:** Sheets 1 to 3 filed on 1 April 1998;

**Auxiliary request**

**Claims:** 1 and 2 filed during the oral proceedings

**Description and Drawings** as main request.

- VI. Claim 1 according to the appellant's main request is identical to claim 1 according to the auxiliary request under consideration in the decision under appeal (cf. item II above).

- VII. Claim 1 according to the appellant's auxiliary request reads as follows:

"1. A charge-to-voltage converter of a floating diffusion output type for producing a signal

voltage by injecting signal charge packets transferred from a charge transfer region (3) into a floating diffusion region (1) via an output gate (OG), said converter comprising:

- a precharge drain region (2),
  - a diffusion region (6);
  - a first channel region and a second channel region separating said floating diffusion region (1) from said diffusion region and said diffusion region from said precharge drain region (2), respectively,
  - a first precharge gate electrode (7) formed over said first channel region; and
  - a second precharge gate electrode (8) formed over said second channel region;
  - wherein the charge-to-voltage conversion factor being selectively changed in response to gate voltages (PG1, PG2) selectively applied to said first and second precharge gate electrodes (7, 8),
  - said precharge drain region (2) is supplied with a reset voltage, and
- characterized in that
- said floating diffusion region (1) is adjacent only to said output gate (OG) and said first precharge gate (7) and connected only to said

first channel region, said charge transfer region (3) and an output terminal (Vsig)."

Claim 2 is dependent on claim 1.

VIII. The appellant presented essentially the following arguments in support of his requests:

- (a) Claim 1 is delimited with respect to document D1. The floating diffusion region 102 of the device of Figure 4 of document D1 is connected to four gates (an output gate (8), a first precharge gate electrode 106, a reset gate 105, and the gate electrode of the amplifying transistor Tr2). The same applies to the device of document D2. In contrast, the floating diffusion region of the claimed device is only surrounded by three gates.
- (b) The reduced number of surrounding gates allows for a smaller floating diffusion region and thereby smaller capacitance. Moreover, the overall size of the device is reduced, and at the same time, more freedom in choosing an efficient layout of the device is provided for. Thus, the technical problem addressed by the present application relates to simplifying a charge-to-voltage converter and reducing its size, and at the same time, maintaining a wide dynamic signal range.
- (c) Document D1 discloses consistently through all the embodiments a precharge transistor connected to the floating diffusion region without giving any hint that this precharge transistor can be omitted (cf. Figures 4 to 6). Therefore, document D1 teaches that a precharge transistor directly



connected to the floating diffusion region is required in order to ensure proper functioning of the device. The argument presented in the decision under appeal considering the omission of this precharge transistor to be obvious is therefore based on hindsight.

## Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.
2. *Main request*
  - 2.1 Claim 1 according to the main request contains the feature that the floating diffusion region is **adjacent only** to the output gate and **connected only** to the first channel region and an output terminal. In Figures 1(a) and 2(a) of the application in suit, however, the floating diffusion region is shown adjacent to **both** the output gate OG and the first precharge gate electrode PG1 where the latter is overlying the first channel region, or stated differently, the diffusion region is connected to an output terminal, the first channel region, and the channel region below the output gate, ie three connections. Therefore, uncertainty arises whether the devices depicted in Figures 1(a) and 2(a) would fall within the scope of claim 1 or not.

Claim 1 according to the main request is therefore not clear, contrary to the requirements of Article 84 EPC.

3. *Auxiliary request*

### 3.1 Clarity and amendments

Claim 1 according to the auxiliary request specifies that the floating diffusion region is adjacent only to the output gate and the first precharge gate, and that the floating diffusion region is connected only to the first channel region, the charge transfer region and an output terminal, as the case is for the devices shown in Figures 1(a) and 2(a) of the application in suit. Thus, the objection raised under Article 84 EPC against claim 1 according to the main request is overcome.

Claim 1 according to the auxiliary request is based on claim 1 as filed together with the features disclosed in connection with Figures 1 and 2 of the application as filed.

Claim 2 is based on claim 2 as filed and is reformulated as a dependent claim.

Therefore, in the Board's judgement, the requirements of Articles 84 and 123(2) EPC are met.

### 3.2 Inventive step

3.2.1 Document D1 discloses a charge-to-voltage converter device of a floating diffusion output type where signal charge packets transferred from a charge transfer region 3 are transferred into a floating diffusion region 102 via an output gate 8 (cf. D1, Figure 4(a); page 4, lines 8 to 35). A diffusion region 103 is separated from the floating diffusion region 102 by a first channel region formed below a first precharge gate electrode 106. The diffusion region is furthermore separated from a precharge drain region 104 by a second

channel region formed below a second precharge gate electrode 107. The precharge drain region 104 is supplied with a reset voltage  $V_{RD}$ . The sensitivity of the device can be changed by applying appropriate signals to the first and second precharge gate electrodes 106, 107 (cf. page 4, line 41 to page 5, line 15). The floating diffusion region is adjacent to the output gate 8, the first precharge gate electrode 106, as well as to a further precharge gate electrode 105, and is connected to the first channel region, the charge transfer region 3, an output terminal (connection to amplifier transistor Tr2), and a further precharge region 101. Thus, the device of document D1 has all the features of the precharacterizing part of claim 1 according to the auxiliary request.

- 3.2.2 In the decision under appeal, it was argued that since the term "output terminal" was not based on any specific disclosure in the application as filed, "output terminal" could be construed as meaning the floating diffusion region 102 of the device of document D1 (cf. item III(a) above). The Board, however, agrees with the appellant that the "output terminal" in claim 1 corresponds to the terminal shown in Figures 1(a) and 2(a) labeled "SIGNAL VOLTAGE" in the application in suit. This is also consistent with the fact that claim 1 is directed to a charge-to-voltage converter, ie a device producing an output signal in the form of a signal voltage resulting from a signal charge packet transferred into the floating diffusion region. An interpretation identifying the output terminal with the floating diffusion region, as suggested in the decision under appeal, would render claim 1 unclear, since claim 1 specifies that the

floating diffusion region is connected to the "output terminal".

Therefore, as submitted by the appellant, the device of claim 1 differs from that of document D1 in that the floating diffusion region is adjacent only to the output gate 8 and the first precharge gate electrode 106, whereas in the device of document D1, the floating diffusion region 102 is also adjacent to a further reset gate electrode 105 and is connected to a further precharge region 101.

3.2.3 Document D2 discloses a charge-to-voltage converter device having floating diffusion region  $FD_1$  which is connected via an output gate OG to a charge transfer region 1 (cf. D2, Figure 2). The floating diffusion region  $FD_1$  is connected via a first precharge gate  $DFG_1$  to a diffusion region  $FD_2$  which, in turn, is connected to a further diffusion region  $FD_3$ . The further diffusion region is however not supplied with any voltage. The signal voltage of the floating diffusion region  $FD_1$  is detected through an output terminal (cf. Figure 1).

The device of claim 1 differs from that of document D2 in particular in that, in the known device, the floating diffusion region  $FD_1$  is connected to a transistor having a drain region which is supplied with a reset voltage.

3.2.4 Document D1 is considered the closest prior art, since it has a precharge drain region supplied with a reset voltage adjacent the diffusion region.

3.2.5 In the light of the differences between the claimed device and that of document D1, the technical problem

addressed by the application in suit thus relates to providing a simplification of the known device while at the same time, maintaining a wide dynamic signal range.

3.2.6 In the decision under appeal, it was held to be evident that the device of document D1 would also operate in a simplified version without the gate 105 and the further precharge region 101. Therefore, the skilled person would adopt such a simplified version of the device of document D1 whenever factors such as cost or reduced device surface were considered important.

3.2.7 As convincingly argued by the appellant, however, all the embodiments of document D1 consistently show at least two precharge transistors. Thus, document D1 implicitly teaches that the gate 105 and the further precharge region 101 are necessary for the proper functioning of the device. The Board is also unable to find any disclosure in document D1 which would suggest or hint that the gate 105 and the further precharge region 101 may be omitted without jeopardizing a proper functioning of the device. Therefore, the Board follows the appellant's argument that it would not be obvious for a skilled person to modify the device of document D1 so as to arrive at the claimed device.

3.2.8 Also the other available prior art document D2 fails to suggest omitting the gate 105 and the further precharge region 101 of the device of document D1, since the device of document D2 does not have a precharge drain region adjacent to the diffusion region which is supplied with a reset voltage.

3.2.9 Therefore, in the Board's judgement, the subject matter of claim 1 according to the auxiliary request involves

an inventive step within the meaning of Article 56 EPC.

The application therefore meets the requirements of Article 52(1) EPC.

## **Order**

### **For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:
  - claims 1 and 2, filed during the oral proceedings;
  - description pages 1 to 12, filed on 1 April 1998;
  - drawings sheets 1 to 3, filed on 1 April 1998.

The Registrar:

The Chairman:

D. Spigarelli

M. C. Chomentowski