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Aktenzeichen / Case Number / N^o du recours : T 260/86 - 3.5.1

Anmeldenummer / Filing No / N^o de la demande : 80 302 396.9

Veröffentlichungs-Nr. / Publication No / N^o de la publication : 0 023 127

Bezeichnung der Erfindung: CMOS Schmitt-trigger circuit

Title of invention:

Titre de l'invention :

Klassifikation / Classification / Classement : H03K 3/353

ENTSCHEIDUNG / DECISION

vom / of / du 3 May 1988

Anmelder / Applicant / Demandeur : Fujitsu Limited

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence : Schmitt-trigger/Fujitsu

EPO / EPC / CBE Article 56

Kennwort / Keyword / Mot clé : Inventive step

Leitsatz / Headnote / Sommaire

Europäisches
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European Patent
Office
Boards of Appeal

Office européen
des brevets
Chambres de recours



Case Number : T 260/86 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 3 May 1988

Appellant : Fujitsu Limited
1015, Kamikodanaka Nakahara-ku
Kawasaki-shi Kanagawa 211
JP

Representative : Rackham, Stephen Neil
GILL JENNINGS & EVERY
53-64 Chancery Lane
London WC2A 1HN
GB

Decision under appeal : Decision of Examining Division 068
of the European Patent Office
dated 6 March 1986 refusing European
patent application No. 80 302 396.9
pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : E. Persson
Members : J.A.H. Van Voorthuizen
W. Riewald

Summary of Facts and Submissions

- I. European patent application No. 80 302 396.9 filed on 16.07.80 (publication No. 0 023 127) claiming a priority of 19.07.79 (JP) was refused by a decision of the Examining Division 068 dated 06.03.86. That decision was based on Claims 1-5 filed on 13.05.85.
- II. The reason given for the refusal was that the subject-matter of the application lacked inventive step having regard to: Dokter, Steinbauer, "Digitale Elektronik in der Meßtechnik und Datenverarbeitung", Vol. I, (1975), pages 190-191; US-A-3 882 331; Tietze, Schenk, "Advanced Electronic Circuits" (1978), pages 204-205 and the general knowledge in the art of CMOS technology to be expected from a person skilled in that art.
- III. The appellant lodged an appeal against this decision by telex on 30.04.86, which telex was duly confirmed by a letter received 02.05.86. The appeal fee was paid on 01.05.86. A Statement of Grounds was filed on 26.06.86.
- IV. In the Notice of Appeal the appellant requested to set aside the appealed decision and to grant a European patent on the basis of the Claims 1-5 as filed on 13.05.85. During the oral proceedings held on 03.05.88 the appellant submitted a set of restricted Claims 1-3 and a correspondingly amended description and requested to grant a European patent on the basis of the said claims. He essentially argued that the subject-matter of those claims had to be regarded as involving inventive step as none of the cited documents could suggest to the person skilled in the art the specific combination of features for which protection was sought. Claim 1 as filed on 03.05.88 reads as follows:

1. A CMOS Schmitt-trigger circuit having an input terminal (IN, Figure 3) for connection to a signal source, and an output terminal (OUT), a first CMOS inverter (INV₂), a second CMOS inverter (INV₃) connected in cascade to the first CMOS inverter and a feedback resistance (MOSR) connected between the output end (N₁₃) of the second CMOS inverter (INV₃) and the input (N₁₁) of the first CMOS inverter, characterized in that the circuit further comprises a third CMOS inverter (INV₁) in cascade with the first and second CMOS inverters and directly connected between the input terminal (IN) and the input (N₁₁) of the first CMOS inverter (INV₂), and in that the said feedback resistance (MOSR, Figure 6) comprises a p-channel MOS transistor (Q'_p, Figure 7) and an n-channel MOS transistor (Q'_n) connected in parallel, the gates of the said MOS transistors being connected to the power supply, and the said feedback resistance being dependent on the voltage of the power supply.

Claims 2 and 3 are dependent on Claim 1.

Reasons for the Decision

1. The appeal complies with Articles 106-108 and Rule 64 EPC and is therefore admissible.
2. Schmitt trigger circuits comprising two CMOS inverters in cascade and a feedback resistance (R_f) from the output of the second inverter to the input of the first inverter are generally known (cf. e.g. "Motorola CMOS, page 216 (1978) cited by the applicant in his letter of 08.03.84). This known Schmitt trigger comprises a series resistance (R_s) at the input, the ratio $\frac{R_s}{R_f}$ determining the Schmitt width. This

series resistance includes the output resistance of the signal source, so that the Schmitt width depends on the said output resistance which is clearly undesirable.

3. The application proposes firstly to prevent this dependence on the output resistance of the signal source by the provision of a third CMOS inverter between the signal source and the known Schmitt trigger, which inverter acts as a buffer, and to omit the input series resistance. The output resistance of the third inverter takes the place of the series input resistance and has therefore to be suitably dimensioned so as to obtain a desired Schmitt width. No inventive step is involved in these features as the Examining Division has correctly held in its decision now under appeal.
4. The Schmitt trigger circuit thus obtained has the property that the Schmitt width does not change in accordance with variations which may occur in the power supply voltage which is, at least for certain applications of the Schmitt trigger, a disadvantage. As a further step the application therefore proposes that the feedback resistance consists of a p-channel and an n-channel MOS transistor connected in parallel, the gates of both transistors being connected to the power supply, whereby the feedback resistance and consequently the Schmitt width become dependent on the power supply voltage.
5. From Tietze, Schenk, "Advanced Electronic Circuits", pages 204-205 it is known in itself to combine a p-channel and an n-channel MOS transistor in parallel, but this known combination only serves as an on-off switch. Furthermore, it is known from US-A-3 882 331 to use a single MOS transistor as a (fixed) resistance in a voltage division feedback circuit of a Schmitt trigger. Apart from the fact that only a single transistor and not a parallel

arrangement of two transistors is used, it is not the object of the said document that the value of the resistance of the transistor should be made dependent on the supply voltage. Moreover, the Schmitt trigger is of a different kind than that according to the present application as a third MOS transistor is present in series with the first stage of the trigger circuit.

6. The Board is therefore of the opinion that none of the said documents, taken either singly or in combination, could suggest to the person skilled in the art the combination of features in the Claim 1 filed at the oral proceedings and this claim must thus be held allowable.
7. The dependent Claims 2 and 3 describe further embodiments of the invention and are not open to objection.
8. The amendments to the description take account of the prior art and the scope of the claims in their present form. They are not open to objection.

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 European patent on the basis of the following documents:
 - (a) Claims 1-3 as filed on 03.05.88

(b) Description as amended on 03.05.88

(c) Drawings as originally filed.

The Registrar:

The Chairman:

S. Fabiani

E. Persson