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D E C I S I O N
of 16 July 2004

Case Number: T 1254/01 - 3.5.2

Application Number: 97116995.8

Publication Number: 0833441

IPC: H03F 1/22

Language of the proceedings: EN

Title of invention:

Negative-feedback amplifier circuit capable of independently
controlling a gain and an impedance

Applicant:

NEC Compound Semiconductor Devices, Ltd.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 84, 54, 56

Keyword:

"Claims - clarity (yes)"
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 1254/01 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 16 July 2004

Appellant: NEC Compound Semiconductor Devices, Ltd.
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Kanagawa 211-8666 (JP)

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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 2 July 2001
refusing European application No. 97116995.8
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: M. Ruggiu
P. Mühlens

Summary of Facts and Submissions

I. The applicant has filed an appeal against the decision of the examining division to refuse European patent application No. 97 116 995.8.

II. The refusal is based on Articles 123(2), 84, 54(1) and (2), and 56 EPC. The decision under appeal cites the following prior art document:

D1: US-A- 4 940 949.

III. The appellant requests that the decision under appeal be set aside and a patent be granted in the following version:

Description

Pages 1, 2, 4, 5 and 7 to 9 as originally filed,
Page 3 filed with a letter of 29 June 2004,
Page 6 filed with a letter of 14 November 2003.

Claims

No. 1 to 3 filed with the letter of 29 June 2004.

Drawings

Sheets 1/2 and 2/2 as originally filed.

IV. Claim 1 reads as follows:

"A wide-band negative-feedback amplifier circuit for amplifying an input electric signal into an output electric signal, including a plurality of active elements (11, 12) in cascode connection, said active elements including a first-stage active element (11)

and a final-stage active element (12) each of which comprises an element input terminal, an element output terminal, and an element control terminal, said element control terminal of the first-stage active element (11) being supplied with said input electric signal (IN), said element output terminal of the final-stage active element outputting said output electric signal (OUT), a negative-feedback circuit (14) connecting said element output terminal of the first-stage active element (11) to said element control terminal of the first-stage active element (11), said negative-feedback circuit (14) comprising a resistor (Rf2), characterized in that said negative-feedback amplifier circuit comprises a further negative-feedback circuit (13) connecting said element output terminal of the final-stage active element (12) and said element control terminal of the first-stage active element (11), said further negative-feedback circuit (13) comprising a further resistor (Rf1), wherein the output impedance of the amplifier circuit can be adjusted by said further resistor (Rf1) and the gain can be adjusted by said resistor (Rf2) in cooperation with said further resistor (Rf1)."

Claims 2 and 3 are dependent on claim 1.

V. The appellant essentially argued as follows:

At high frequency, the capacitors in the circuit of Figure 2 of document D1 acted as short-circuits, so that no negative-feedback loop was formed between the output terminal of the final-stage active element and the control terminal of the first-stage active element. At high frequency, the output impedance of this prior art circuit was obtained only by a resistor R_6 . At low

frequency, the capacitors acted as open-circuits so that no negative-feedback loop was formed between the output and control terminals of the first-stage active element. At low frequency, the output impedance was obtained as a combined impedance having a value different from that of the output impedance at high frequency. The operation of the circuit of D1 was limited to a high frequency range. Furthermore, the output impedance was not adjusted by the impedance of a negative-feedback circuit. Thus, D1 did not suggest a negative-feedback amplifier circuit as defined by claim 1, which was operable in a wide frequency band and included resistors in two different feedback loops for adjusting the output impedance and the gain of the circuit.

Reasons for the Decision

1. The appeal is admissible.

2. Present claim 1 comprises the features of claims 1 and 4 as originally filed and furthermore specifies that the claimed circuit is a wide-band negative feedback amplifier, which feature can be found on page 1, last paragraph, and page 8, penultimate paragraph, of the description as filed. The features of present claims 2 and 3 can be found in claims 2 and 3 as originally filed, respectively. The description has been amended to acknowledge the prior art disclosed in document D1 and be consistent with the amended claims. Thus, the amendments do not introduce subject-matter extending beyond the content of the application as filed and do not contravene Article 123(2) EPC.

3. Present claim 1 specifies that the negative-feedback circuit (14) comprises a resistor (Rf2) and the further negative-feedback circuit (13) comprises a further resistor (Rf1). In the judgment of the board, this wording is clear, although it does not require that each negative-feedback circuit only consists of a resistor. Thus, claim 1 satisfies the requirements of Article 84 EPC.

4. Document D1 shows on Figure 2 a broadband RF negative-feedback amplifier circuit including active elements Q1, Q2 in cascode connection. A negative-feedback circuit, comprising a resistor RF and a capacitor C2, connects the output terminal (collector) and the control terminal (base) of the first-stage active element Q1. Figure 2 of D1 also shows a connection formed by a resistor R6, a transistor Q3 and a resistor R4 between the output terminal (collector) of the final-stage active element Q2 and the control terminal (base) of the first-stage active element Q1. This connection does not provide a negative feedback because part of the connection is intended to provide a bias (see column 1, lines 29 to 31 of D1), the high frequency output signal in the connection is bypassed to mass potential by a capacitor C3 and D1 indicates at column 1, lines 39 to 42, that "the high isolation of this amplifier is realized by ... not sampling the feedback voltage from across the load". This is confirmed by Figure 3 of D1, which represents the high frequency equivalent of the circuit of Figure 2 and shows a resistor connected between collector and base of the first-stage active element Q1, but no connection between the collector of the final-stage active element Q2 and the base of the first-stage active element Q1.

Thus, document D1 does not disclose the features included in the characterising portion of claim 1. The subject-matter of claim 1 is therefore considered to be new in the sense of Article 54(1) EPC.

5. The circuit illustrated on Figures 2 and 3 of document D1, which the board regards as the prior art closest to the invention defined by claim 1, comprises the features of the pre-characterising portion of claim 1. The problem solved by the features specified in the characterising portion of claim 1 is that of providing a negative-feedback amplifier circuit in which gain and impedance can be controlled independently (see the first paragraph of the "summary of the invention" on page 3 of the description of the present application). This problem is not mentioned in D1 and it is not apparent that it is obvious to a skilled person to address it. Even if it were, the board observes that D1 discourages the skilled person from sampling the feedback voltage from across the load (see column 1, lines 38 to 43 of D1) and thus from providing a further feedback circuit connecting the element output terminal of the final-stage active element and the element control terminal of the first-stage active element. Thus, the subject-matter of claim 1 is not obvious to a skilled person in view of D1 alone.

Figure 1 of the present application shows a prior art negative-feedback amplifier circuit having a cascode configuration. As shown in Figure 1 of the present application, a negative-feedback circuit 3 connects the output terminal of a final-stage active element to the control terminal of a first-stage active element. The

description of the present application explains from page 2, line 1, to page 3, line 3, that the gain of this prior art negative-feedback amplifier circuit is adjusted or changed by selecting the value of a resistor R_f in the negative-feedback circuit 3. The circuit of D1 already comprises a negative-feedback circuit R_f , C3 that can be used to adjust its gain. Furthermore, as explained above, D1 discourages the skilled person from providing a feedback circuit connecting the element output terminal of the final-stage active element and the element control terminal of the first-stage active element. Thus, in view of the state of the art, the skilled person would have no reason to apply the negative-feedback circuit shown in Figure 1 of the present application to the negative-feedback amplifier circuit illustrated in Figures 2 and 3 of D1.

Therefore, having regard to the state of the art, the subject-matter of claim 1 is not obvious to a skilled person and is considered as involving an inventive step in the sense of Article 56 EPC.

6. The subject-matter of claims 2 and 3 is considered to be new and involve an inventive step by virtue of their dependency on claim 1.

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 in the following version:

Description

Pages 1, 2, 4, 5 and 7 to 9 as originally filed,
Page 3 filed with the letter of 29 June 2004,
Page 6 filed with the letter of 14 November 2003.

Claims

No. 1 to 3 filed with the letter of 29 June 2004.

Drawings

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The Registrar:

The Chairman:

D. Sauter

W. J. L. Wheeler