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D E C I S I O N
of 16 November 1998

Case Number: T 0585/98 - 3.5.1

Application Number: 93111606.5

Publication Number: 0580125

IPC: H04B 10/14

Language of the proceedings: EN

Title of invention:

Predistorter for linearization of electronic and optical signals

Applicant:

Ortel Corporation

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 52, 56

EPC R. 88

Keyword:

"Inventive step (no)"

Decisions cited:

-

Catchword:

-



Case Number: T 0585/98 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 16 November 1998

Appellant:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 14 January 1998
refusing European patent application
No. 93 111 606.5 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: P. K. J. van den Berg
Members: A. S. Clelland
V. Di Cerbo

Summary of Facts and Submissions

I. This appeal is against the decision of the Examining Division to refuse the application on four separate grounds; three of these grounds are relevant to the present appeal, namely that amended Figures 3 and 5 of the drawings filed in accordance with Rule 88 EPC go beyond the originally filed disclosure (Article 123(2) EPC), that the subject-matter of claim 1 is not novel (Article 54 EPC), and that the subject-matter of claim 4, a separate independent claim, lacks an inventive step (Article 56 EPC). The novelty and inventive step objections were based on the disclosure of the following document:

D1: EP-A-416 622.

II. In the statement of grounds of appeal the appellant (applicant) put forward new claims 1, 2 and 4, of which claims 1 and 4 were independent claims, and argued that these claims were novel and inventive. It was also argued that the amended drawings were allowable because they clearly fell within the limits of what the skilled person would directly and unambiguously derive from the whole of the application as filed.

III. In a communication the rapporteur, on behalf of the Board, expressed the preliminary view that the content of Figure 3 was directly and unambiguously derivable from the originally filed application, but that of Figure 5 was not. The rapporteur also expressed the preliminary view that the subject-matter of claim 1 did not involve an inventive step having regard to the disclosure of D1, whilst the subject-matter of this claim also lacked an inventive step, and that of claim 4 lacked novelty, having regard to the disclosure of the following document:

D4: US-A-4 068 186.

D4 was introduced into the proceedings in accordance with Article 114(1) EPC, the document having been cited in the European Search Report of D1, which was a co-pending application filed by the present appellant.

IV. Oral proceedings were appointed for the 16 November 1998. Prior to these proceedings the appellant filed a revised set of claims of an auxiliary request and a revised sheet of drawings incorporating an amendment to Figure 4. In an accompanying submission it was argued that all the amended drawings met the requirement of Article 123(2) EPC as to added subject-matter, and that the claims of both requests were novel and inventive having regard to the disclosure of both documents D1 and D4.

V. At the oral proceedings the appellant maintained these requests. The appellant accordingly requested that the decision under appeal be set aside and that a patent be

granted on the basis of the following documents:

Main request

claims: 1, 2 and 4 as received on 25 May 1998; claims 3,
5 to 8 as received on 22 July 1997;

description: pages 1 to 20 as received on 15 October
1998;

drawings: Figures 1 and 2 as originally filed;
Figures 3 and 5 as received on 24 August
1993 and Figure 4 as received on
15 October 1998.

Auxiliary request

claims: 1 to 5 as received on 15 October 1998;

description: as for main request.

and drawings

VI. Claim 1 of the main request reads as follows:

"A predistortion circuit comprising:

means (20) for splitting an input modulation signal
(212) into a primary electrical path (213) and at least
one secondary electrical path (214);

a distortion generator (215) in the secondary
electrical path (214) for producing even order
intermodulation products (222) of the input frequencies

and suppressing fundamental frequencies;

means (217,221) in the secondary electrical path (114) for adjusting the relative amplitude and phase of the signal from the distortion generator (115); and

means (211) for combining signals on the primary and secondary signal paths (213,214) into a single signal for modulating a nonlinear device which exhibits known distortion;

characterised by

filter means (92) before the distortion generator (215) for altering the input signal (212) to the distortion generator (215) as a function of frequency to cause the intermodulation distortion generated by the predistortion circuit on the frequencies of the input signal to match the frequency dependent distortion of the nonlinear device."

Claim 4 of the main request reads as follows:

"A predistortion circuit comprising:

means (43) for splitting an input modulation signal into a primary electrical path and at least one secondary electrical path;

a distortion generator on the secondary electrical path for producing odd order intermodulation products of the input frequencies and suppressing even order intermodulation products;

means (44) in the secondary electrical path for adjusting the amplitude and phase of the signal from the distortion generator; and

means for combining signals on the primary and secondary signal paths into a single signal for modulating a nonlinear device (41) which exhibits known distortion;

characterised by

pre-filter means (56,57) before the distortion generator for altering the input signal to the distortion generator as a function of frequency; and

post-filter means (48,49,51,52) after the distorting generator for altering the output signal from the distortion generator as a function of frequency."

VII. Claim 1 of the auxiliary request differs from claim 1 of the main request only in the reference numerals. The auxiliary request includes only a single independent claim.

VIII. The appellant argued as follows:

D1 did not disclose a pre-filter, the essential inventive feature of the application. Only a single filter circuit 19 was present in Figure 3 of D1, corresponding to filter 219 in Figure 4 of the application. Although the examining division had drawn attention to a passage in D1 which suggested that in

the secondary electrical path the various elements could be varied in order without departing from the functional purpose of the invention, this merely meant that the filter could be varied in position along the path once the pre-distortion had been generated; there was no suggestion that a filter could be provided to control the frequency-amplitude characteristic of the fundamental frequency, which was the purpose of the pre-filter.

D4 was not relevant because the device provided in the secondary electrical path operated in a "linear operation range", see column 5, lines 12 to 14, suggesting that it fulfilled a different purpose to the pre-distortion generator of the application.

Claims 1 and 4 of the main request and claim 1 of the auxiliary request were therefore novel and inventive.

The amended drawings filed under Rule 88 EPC complied with Article 123(2) EPC and should be admitted.

Reasons for the Decision

1. At the oral proceedings the primary issue addressed was the question of whether claim 1 of both requests complied with Article 56 EPC as to inventive step.

2. A problem which rises in high-frequency broadband amplifiers is that non-linearity, which is inherent in all amplifying devices, can cause intermodulation

products which fall within the amplified band and are accordingly extremely difficult to remove. One solution to this problem is to provide a pre-distortion circuit. Such a circuit takes a portion of the signal to be amplified and processes it so that when it is recombined and amplified with the main signal the amplifier distortion is cancelled out. Clearly the nature of the pre-distortion required will depend on the characteristics of the amplifier itself: if, for example, the amplifier distortion is frequency-dependent it will be necessary for the pre-distortion also to be frequency-dependent.

3. It was common ground at the oral proceedings that the single most relevant document is D1, as noted at point III above an earlier application by the present appellant. D1 is primarily concerned with an amplifier which generates even order frequency dependent intermodulation products, in particular an amplitude modulated semiconductor LED or laser. To cancel out distortion of the modulated light signal the pre-distortion signal is split into two paths of opposite phase which are subjected to identical distortions and then recombined; the phase difference between the paths results in the fundamental and odd order products cancelling so that only even order products are left. The signal is then filtered to provide the desired frequency-amplitude characteristic and thereafter recombined with the main modulating signal prior to amplification.

4. The features of the preamble of claim 1 of both requests are known from Figures 1 and 3 of D1. Using

the terminology of claim 1 of both requests, the document discloses a pre-distortion circuit comprising a directional coupler 10 for splitting an input modulation signal into a primary electrical path 13 and a secondary electrical path 14, a distortion generator 15 in the secondary electrical path for producing even order intermodulation products of the input frequencies and suppressing fundamental frequencies, circuits in the secondary electrical path for adjusting the relative amplitude 17 and phase 19 of the signal from the distortion generator, and a second directional coupler 11 for combining the signals on the primary and secondary paths into a single signal for modulating the non-linear device which exhibits distortion.

D1 does not disclose filter means before the distortion generator as required by the characterising part of claim 1 of both requests.

5. However, D1 does teach the skilled person that the distortion generated by a non-linear device such as an amplitude modulated semiconductor LED or laser is frequency-dependent. Column 2, lines 23 to 29 of D1 indicates that a disadvantage of known methods is the lack of any means of compensating for amplitude and phase distortion characteristics which are dependent on the frequency of the modulating signal. In practice, D1 compensates for the amplitude-frequency characteristics of the harmonics rather than the modulating signal itself.

6. Given that the characteristics of known amplifiers are well understood, the question arises of how the skilled person, starting out from the D1 arrangement and aware

that distortion is dependent on the modulating frequency, would solve this problem. The Board considers that, given that it is known to provide a filter for controlling the frequency-amplitude characteristic of the harmonic distortion components, it is obvious to provide a similar filter prior to distortion if the required characteristic suggests this is necessary. To provide a frequency-amplitude characteristic which is shaped not merely by the harmonics but by the fundamental, a filter is required before the distortion generator in addition to the filter known from D1 after the distortion generator. Although it was argued by the appellant that no suggestion of such a filter could be found in the prior art, this is not the case. D4 shows at Figure 3A that at the claimed priority date it was known in the art to provide correction of the amplitude-frequency characteristic both before and after the distortion generator.

7. The subject-matter of claim 1 of both the main and auxiliary requests accordingly does not involve an inventive step.
8. It was argued by the appellant that D4 was not concerned with pre-distortion in the same sense as the application, the passage at column 5, lines 12 to 14 suggesting that the device which appeared to be providing pre-distortion in fact operated linearly. The Board is unable to accept this argument. D4 compensates for the non-linear characteristics of a high frequency amplifier by generating the pre-distortion by means of a smaller version of the same device; thus, in the case of a travelling wave tube (TWT), a smaller TWT is

provided to generate pre-distortion to compensate for the distortion that the larger device generates. Both the larger and smaller devices are nominally linear but, as can be seen from column 4, lines 30 to 43, the low power TWT generates non-linear distortion which compensates for the characteristics of the main amplifier. Thus, D4 shows that no technical prejudice existed against the provision of amplitude frequency characteristic filtering before the distortion generator in a pre-distortion circuit.

9. Since claim 1 of both requests is not allowable it follows that the requests as a whole are not allowable. It is therefore not necessary for the Board to take a position either on the allowability of claim 4 or on the amendments to the drawings requested under Rule 88 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Beer

P. K. J. van den Berg