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Datasheet for the decision of 19 April 2007

Case Number: T 1596/06 - 3.5.03

Application Number: 96933069.5

Publication Number: 0857379

IPC: H04B 15/00

Language of the proceedings: EN

Title of invention:
Method and apparatus for interference suppression in spread spectrum signals

Applicant:
MOTOROLA, INC.

Opponent:
-

Headword:
Interference suppression/MOTOROLA

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - main request (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1596/06 - 3.5.03

D E C I S I O N
of the Technical Board of Appeal 3.5.03
of 19 April 2007

Appellant: MOTOROLA, INC.
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Decision under appeal: **Decision of the examining division of the European Patent Office posted 21 February 2006 refusing European application No. 96933069.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. S. Clelland
Members: F. van der Voort
M.-B. Tardo-Dino

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division to refuse European patent application No. 96 933 069.5 (publication No. 0857379), which was originally filed as international application PCT/US96/15107 (publication No. WO 97/15996).

The grounds for the decision read as follows:

"In the communication(s) dated 06.08.2003, 20.10.2004, 05.10.2005 the applicant was informed that the application does not meet the requirements of the European Patent Convention. The applicant was also informed of the reasons therein.

The applicant filed no comments or amendments in reply to the latest communication but requested a decision according to the state of the file by a letter received in due time on 20.12.2005.

The application must therefore be refused."

II. The following documents were cited in the international search report and/or referred to during the examination proceedings:

D1: US 5 029 184 A;

D2: US 5 410 750 A;

D3: J.G. Proakis *et al*, "Digital Signal Processing: Principles, Algorithms, and Applications", 2nd

ed., Macmillan Publishing Company, New York, USA, 1992;

D4: US 5 263 048 A;

D5: T.A. Brown *et al*, "Direct-sequence using transform domain processing", Proceedings of MILCOM '93 - IEEE Military Communications Conference, 11 - 14 October 1993, Vol. 3, pages 1018 - 1022, Boston, MA, USA; and

D6: US 5 363 401 A.

D1 and D2 were cited in the international search report in respect of the present application and referred to in a first communication dated 6 August 2003. D4 was also cited in the international search report and referred to in a third communication, dated 4 March 2005. D3 and D5 were cited by the examiner with reference to the Guidelines, C-VI, 8.7, for the first time in a second communication, dated 20 October 2004, and in a fourth communication, dated 5 October 2005, respectively. D6 was cited in the international search report only.

III. In reply to the third communication the applicant filed a new set of claims.

IV. In the fourth communication objections were raised under Articles 56, 84 and 123(2) EPC and Rule 29(2) EPC. In particular, the subject-matter of method claim 1 was held to lack an inventive step having regard to the disclosure of D5. The subject-matter of claim 7, which was directed to a receiver for receiving and decoding

corrupted data encoded in a direct sequence spread spectrum signal, was also held to lack an inventive step for the same reasons applied *mutatis mutandis*.

V. In the statement of grounds of appeal the appellant requests by way of a main request that a patent be granted on the basis of the following documents:

Description:
- pages 1 to 3 as originally filed;
- page 4 as filed with the letter of 28 April 2004;
- page 4a as filed with the statement of grounds;
- pages 5 to 12 as originally filed; and
- page 13 as filed with the letter of 28 April 2004;

Claims:
- claims 1 to 7 as filed with the statement of grounds;

Drawings:
- sheets 1/5 to 5/5 as originally filed.

VI. The wording of the independent claims 1 and 6 of the main request is identical to that of the independent claims 1 and 7 on which the impugned decision is based.

Claim 1 reads as follows:

"A method of interference removal from data in a spread spectrum signal that has been encoded and transmitted by modulating a repeating pseudo-noise sequence with the data, comprising the steps of:
at a receiver:

receiving the spread spectrum signal along with interference (41);

multiplying (42) the spread spectrum signal along with interference by a window function (44) providing a multiplied spread spectrum signal;

converting the multiplied spread spectrum signal into the frequency domain (46) providing a received signal with a phase information portion and a magnitude information portion;

multiplying (48) the received signal by a reciprocal of the spectrum of the repeating pseudo-noise sequence(50) to obtain a data spectrum with interference; and

normalizing (52) the data spectrum with interference to provide a data spectrum with reduced interference."

Claim 6 reads as follows:

"A receiver for receiving and decoding corrupted data encoded in a direct sequence spread spectrum signal, comprising:

a receiver module (40) for receiving the spread spectrum signal along with interference (41);

a multiplier (42) for multiplying the spread spectrum signal along with interference by a window function providing a multiplied spread spectrum signal;

a frequency domain converter (46) for converting the multiplied spread spectrum signal from a time domain into a frequency domain and providing a received signal with a corrupted phase information portion and a corrupted magnitude information portion; and

an interference suppression circuit (61, 64) for suppressing interference on the received signal, the

interference suppression circuit (61, 64) being arranged to multiply the received signal by a reciprocal of the spectrum of the repeating pseudo-noise sequence(50) to obtain a data spectrum with interference and to normalize the data spectrum with interference to provide a data spectrum with suppressed interference."

Claims 2 to 5 and 7 of the main request are dependent claims.

VII. The appellant also filed application documents relating to a first and a second auxiliary request and conditionally requests that oral proceedings be appointed. Since, for the reasons set out below, the board decided that the case is to be remitted to the department of first instance for further prosecution on the basis of the main request, the auxiliary requests need not be further considered in these appeal proceedings.

Reasons for the Decision

1. *Article 123(2) EPC*

1.1 The amendments to the claims of the main request comply with the requirements of Article 123(2) EPC.

1.2 In particular, throughout the claims it has been made clear that the repeating noise sequence is in fact a repeating pseudo-noise sequence. This is implicit in the original wording since only a pseudo-noise sequence can repeat.

Further, the features of claim 1 are based on those of claims 2 to 4 as originally filed, omitting the limitation of the modulation to phase modulation. This generalisation is based on the description, page 13, lines 11 to 14, and claim 1, lines 3 to 5, as originally filed, it being noted that in present claim 1 it is implicit from the step of normalizing the data spectrum that amplitude modulation is excluded. It is noted that the expression "clean data spectrum" in original claim 3 has been replaced by the more accurate expression "data spectrum with reduced interference". The added wording "with a phase information portion and a magnitude information portion" is of a descriptive nature only and is based on claim 1, lines 8 to 10, as originally filed.

The additional features of claims 2 and 3 are respectively based on the features relating to the receiver operation as defined in claims 5 and 6 as originally filed. The additional feature of claim 4 is based on the description, page 8, lines 20 to 27. The additional features of claim 5 are based on the features relating to the transmitter operation as defined in claim 3 as originally filed.

Claims 6 and 7 respectively define a receiver and a system in terms of constructional receiver features corresponding to the method features of present claim 1.

1.3 The board is therefore satisfied that the amendments to the claims according to the main request do not give rise to objections under Article 123(2) EPC.

2. *Article 84 and Rule 29(2) EPC*

2.1 The objections under Article 84 and Rule 29(2) EPC raised by the examining division exclusively relate to the fact that the set of claims included four independent claims.

2.2 The present set of claims includes only two independent claims, i.e. claims 1 and 6 directed to a method and a receiver, respectively, and therefore satisfy the requirements of Rule 29(2) EPC. Further, in the board's view, claims 1 to 7 do not give rise to any objections under Article 84 EPC.

3. *Article 56 EPC*

3.1 The examining division argued that the subject-matter of claim 1 lacked an inventive step having regard to the disclosure of D5. The board disagrees for the following reasons.

3.2 D5 describes a method of acquiring a direct-sequence spread spectrum (DSSS) signal, in the process of which narrow-band interference is removed from the data in the DSSS signal (see the abstract). A transmitter transmits the DSSS signal, which is encoded by modulating a repeating pseudo-noise sequence with data (see Fig. 1). At the receiver, see Fig. 2, the spread spectrum signal along with interference is received as the input signal. This signal is segmented into overlapping blocks and each block is weighted by a windowing function, which implies that the spread spectrum signal along with the interference is multiplied by a window function (page 1019, section 2.2,

second paragraph). The resulting multiplied spread spectrum signal is converted into the frequency domain by means of an FFT, i.e. a Fast Fourier Transformation, thereby obtaining a received signal having a phase information portion and a magnitude information portion.

In order to remove narrow-band interference, the output signal of the FFT is applied to a TDP (Transform Domain Processor) exciser for excising the narrow-band interference by "notching out any frequency bins which exceed a user-defined threshold and any user-defined number of bins to either side of that bin" (see Fig. 2 and page 1020, section 2.3).

3.3 The subject-matter of claim 1 differs from the method disclosed in D5 particularly in that, according to claim 1, after the conversion into the frequency domain, the received signal is multiplied by a reciprocal of the spectrum of the repeating pseudo-noise sequence in order to obtain a data spectrum with interference, which is subsequently normalized in order to provide a data spectrum with reduced interference.

By multiplying, in the frequency domain, the received signal with the reciprocal of the spectrum of the repeating pseudo-noise sequence, high power narrow-band interference will be discernible as peaks in the resulting frequency spectrum which is otherwise of a constant magnitude (see also the description, page 8, lines 18 to 27). By subsequently normalizing the signal, the effect of the high power narrow-band interference on the magnitude of the Fourier transform of the DSSS signal is eliminated (see also page 10,

lines 23 to 25, page 11, lines 13 to 15, and page 12, lines 28 to 31).

3.4 The objective problem, when starting out from the disclosure of D5, may therefore be seen in providing a method of removing narrow-band interference from the spread spectrum signal other than the transform domain excision as discussed in D5 at page 1020, section 2.3.

3.5 D5 does not however describe or suggest any alternative method of removing narrow-band interference.

3.6 The board notes that the examining division held that the feature of multiplying the signal in the frequency domain by the reciprocal of the spectrum of the repeating pseudo-noise sequence in order to obtain a data spectrum with interference was known from D5, sections 2.1 and 2.2.

These sections describe two methods of performing the acquisition of the DSSS signal in order to synchronise at the receiver a locally generated pseudo-noise sequence with the spreading code sequence of the incoming DSSS signal. As explained in D5, section 2, first paragraph, and illustrated in Fig. 2, instead of circular correlation or convolution of the two pseudo-noise sequences in the time domain, the incoming DSSS signal is multiplied, in the frequency domain, by the Fourier transform of a locally buffered time-reversed copy of the locally generated pseudo-noise sequence, i.e. the complex conjugate of the locally generated pseudo-noise sequence. However, the complex conjugate of a pseudo-noise sequence is only equal to the reciprocal of the spectrum of the pseudo-noise

sequence, as referred to in claim 1, if the spectrum of the pseudo-noise sequence has a flat amplitude of magnitude 1, which is not disclosed in D5.

3.7 The examining division further argued that the normalization step would be recognized by the person skilled in the art as an equivalent to the transform domain excision described in D5 and it was held that placing the normalization step after instead of before the multiplication by the reciprocal was merely one of several straightforward possibilities which the skilled person would select in accordance with the circumstances without the exercise of inventive skill in order to solve the problem of how to remove peaks of interference in the spectral domain. This was all the more so, since the "spectral resolution in frequency of the signal" was changed neither by the normalization step nor the multiplication step.

The board does not find these arguments convincing. First, it is noted that no evidence in support of the arguments was given, not even that the alleged equivalency was based on the common general knowledge of the person skilled in the art. The argument that the claimed normalisation step is equivalent to the transform domain excision as described in D5 can therefore only be understood as an assertion which is based on hindsight. Even if it were assumed that the normalization step was known per se and that it was equivalent to the transform domain excision described in D5, this would still leave open the questions of whether or not the equivalent would have been an obvious equivalent and whether the skilled person would, when faced with the above technical problem,

apply it to the method of D5. Similar considerations apply to the subsequent step of applying the normalization step after and not before the step of multiplying the received signal by the reciprocal.

3.8 Since the board sees no reason to assume that the above-mentioned distinguishing features (see point 3.3) are part of the common general knowledge of the person skilled in the art, it concludes that the subject-matter of claim 1 would not be obvious to the person skilled in the art having regard to the disclosure of D5.

3.9 Nor are the above-mentioned distinguishing features disclosed in any of the other prior art documents known to the board:

D1 discloses a communication system with a low probability of interception of the communication signals. In the receive portion of a transceiver, see Fig. 5, a spike removal operator 76 cancels, in the frequency domain, any frequency within the monitored band that has an amplitude which is substantially greater than those of other components of the spectrum. Jammer frequencies that may have turned on at the time of transmission are thereby effectively excised (see col. 7, line 63 to col. 8, line 2). D1 further discloses, see Fig. 2, a transmitter including a multi-carrier generator, in which the amplitudes of the carriers are weighted in accordance with the reciprocal of a measured power density characteristic which represents the energy distribution of all the channels of a designated frequency band before the transmission is started. Only those channels which have been

measured to be "quiet" are subsequently selected for the multi-carrier transmission (see col. 1, line 66 to col. 2, line 26).

D2, see in particular Figs. 1 and 2 and col. 7, line 55 to col. 8, line 10, discloses an interference suppressor for a radio receiver, in which after a time-to-frequency conversion of the received signal, interference is detected and estimated. The estimated interference is subsequently subtracted from the received signal.

D3 is a standard text book on digital signal processing, certain pages of which were referred to by the examining division only in relation to the step of multiplying the spread spectrum signal by a window function in the time domain.

D4 discloses a narrow-band interference frequency excision method in which, after a time-to-frequency conversion, the magnitude of the signal is simply disregarded and replaced by some arbitrary value, e.g. unity (see D4, Fig. 4 and col. 4, lines 4 to 9). To some extent this method resembles the substitution method as described in the present application with reference to Figs. 4 and 5, which is however not the subject of present claim 1, which is directed to the reconstruction method as illustrated in Fig. 3.

The board notes that in D4, in the acknowledgment of the prior art, see col. 2, lines 5 to 11, reference is made to an algorithm for excising narrow-band interference, which also belongs to the frequency domain excision category. According to this algorithm,

the magnitude of each frequency bin of the received signal is calculated and divided by its magnitude. The resultant spectrum is normalized to unity magnitude. This algorithm differs from the steps of reciprocal multiplication and subsequent normalization as defined in present claim 1 in that, according to the claim, the converted spread spectrum signal is effectively divided by the spectrum of the repeating pseudo-noise sequence, which is the same spectrum as of the sequence used for modulating the data at the transmitter, see claim 1, lines 5 to 7. In D4 on the other hand the divisor includes the magnitude of the Fourier transform of the received signal, i.e. including the data and pseudo-noise sequence, distorted by interference and the communication channel characteristics.

D6 was cited in the international search report but not considered of particular relevance to the claimed subject-matter. It discloses, see Fig. 1, a hybrid frequency hopping direct sequence (FH/DS) spread spectrum system which includes an *a priori* frequency excisor 15 for removing certain known frequencies from the output signal of a FFT operator 13, e.g. radio station carrier signals, and a maximum normalization operator 17 for normalizing the magnitudes of the FFT samples within each window by limiting the magnitude of the largest energy sample value within the window of FFT samples to a value no greater than a given threshold (see col. 5, lines 1 to 26).

3.10 Hence, none of the prior art documents on file discloses the distinguishing features referred to above, see point 3.3. Consequently, when starting out from D5, a person skilled in the art, applying his common

general knowledge in the art, see point 3.8, would not arrive at the subject-matter of claim 1, even if he were to additionally take into account the teaching of any one or combination of the above-mentioned other prior art documents on file, without the exercise of inventive skill (Articles 52(1) and 56 EPC).

The same applies, *mutatis mutandis*, to claim 6 which specifies constructional features of a receiver which correspond to the method features of claim 1, and to claims 2 to 5 and 7 which each include all of the features of either claim 1 or 6.

4. The board notes that the reference signs used in claim 6 do not comply with the requirements of Rule 29(7) and 32(2)(i) EPC in that, in accordance with Fig. 3, reference sign "40" should refer to the "receiver" and reference sign "41" to the receiver module, and in that "(61, 64)" should be replaced by "(48, 50, 52)". In the description it should further be made clear that the receivers as shown in Figs. 4 and 5 do not represent embodiments of the claimed invention. Alternatively, Figs. 4 and 5 and the corresponding parts of the description should be deleted. Further amendments to the description are necessary in order to adapt it to the present set of claims.

5. Since, apart from the above-mentioned erroneous use of reference signs, which needs to be corrected in order to comply with Rule 29(7) and 32(2)(i) EPC, the claims of the main request are found allowable, it has not proved necessary to consider the auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance for further prosecution on the basis of claims 1 to 7 of the main request.

The Registrar: The Chairman:

D. Magliano A. S. Clelland