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Datasheet for the decision
of 17 December 2018

Case Number:	T 1116/13 - 3.5.07
Application Number:	01000393.7
Publication Number:	1191699
IPC:	H03M13/29, H03M13/25, H03M13/47
Language of the proceedings:	EN

Title of invention:
Parallel concatenated trellis-coded modulation with asymmetric
signal mapping

Applicant:
Texas Instruments Incorporated

Headword:
Parallel concatenated trellis-coded modulation/TEXAS
INSTRUMENTS

Relevant legal provisions:
EPC Art. 84

Keyword:
Claims - clarity (no) - support in the description (no)

Case Number: **T 1116/13 - 3.5.07**

D E C I S I O N
of Technical Board of Appeal 3.5.07
of 17 December 2018

Appellant: Texas Instruments Incorporated
(Applicant)   7839 Churchill Way
                           Mail Station 3999
                           Dallas, Texas 75251 (US)

Representative: Zeller, Andreas
                           Texas Instruments Deutschland GmbH
                           Haggertystraße 1
                           85356 Freising (DE)

Decision under appeal: **Decision of the Examining Division of the**
                           European Patent Office posted on 4 January 2013
                           refusing European patent application
                           No. 01000393.7 pursuant to Article 97(2) EPC

Composition of the Board:

Chairman   R. Moufang
Members: M. Jaedicke
                   R. de Man

Summary of Facts and Submissions

I.   The appeal lies from the decision of the Examining
Division to refuse European patent application
No. 01000393.7 for lack of inventive step in the
subject-matter of claims 1 to 23 of the main request
and of claims 1 to 22 of the first auxiliary request,
in view of a combination of the following prior-art
documents:

D1:   S. Benedetto et al, "Parallel Concatenated
Trellis Coded Modulation", 1996 IEEE
International Conference on Communications (ICC),
Dallas, TX, US, 23 to 27 June, 1996, vol. 2,
pages 974-978;

D2:   EP 0 998 087 A1, published on 3 May 2000.

In an *obiter dictum* the Examining Division provided
further comments, stating that claims 2, 7, 10 and 17
did not meet the requirements of Article 84 EPC.

II.   In its statement of grounds of appeal, the appellant
requested that the decision be set aside and that a
patent be granted on the basis of the main request or
the auxiliary request considered in the contested
decision.

III.   In a communication under Article 15(1) RPBA
accompanying the summons to oral proceedings, the Board
expressed, *inter alia,* its provisional opinion that the
subject-matter of claim 1 of both requests lacked
clarity and support.

IV.   By letter dated 7 December 2018, the appellant withdrew
its request for oral proceedings and requested instead
a decision based on the file as it stands. It made no

substantive comments on the Board's communication.

V.   Oral proceedings were held as scheduled in the absence
        of the appellant. At the end of the oral proceedings,
        the chairman pronounced the Board's decision.

VI.   The appellant's final requests were that the contested
        decision be set aside and that a patent be granted on
        the basis of the main request or the auxiliary request.

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

        "A communication apparatus, comprising:
        an input for receiving uncoded bits from a
        communication application;
        a first coder coupled to said input for producing coded
        bits from said uncoded bits;
        an interleaver coupled to said input for producing from
        said uncoded bits an interleaved version of said
        uncoded bits; and
        a second coder coupled to said interleaver for
        producing an interleaved version of said coded bits
        from the interleaved version of said uncoded bits;
        a first mapper arranged for applying a first coded
        bits-to-signal mapping to said coded bits to produce a
        first output signal wherein said mapping is one of Gray
        mapping, 0231 mapping and 0213 mapping;
        a second mapper arranged for applying a second coded
        bits-to-signal mapping to the interleaved version of
        said coded bits to produce a second output signal,
        wherein said second coded bits-to-signal mapping
        differs from said first coded bits-to-signal mapping;
        and a combiner coupled to said first and second mappers
        for combining said first and second output signals to
        produce a combined output signal for interfacing to the

communication channel."

VIII.   Claim 1 of the auxiliary request is identical to
        claim 1 of the main request.

Reasons for the Decision

Admissibility

1.   The appeal complies with the provisions referred to in
        Rule 101 EPC and is therefore admissible.

Oral proceedings in absence of the appellant

2.   The duly summoned appellant having been absent from the
        oral proceedings, it is treated - in accordance with
        its request for a decision on the state of the file -
        as relying only on its written case (Article 15(3)
        RPBA).

The invention

3.   The application relates to coding and modulation in
        digital communications.

3.1   According to the application, the well-known Trellis-
        Coded Modulation (TCM) offers a substantial coding gain
        without requiring bandwidth expansion. This gain is
        achieved by an appropriate joint design of coding and
        modulation. Turbo codes, also known as parallel
        concatenated convolutional codes (PCCC), have been
        known to attain very low error rates within the signal-
        to-noise ratio range close to the Shannon limit.
        Attempts have therefore been made to combine TCM and
        turbo codes to obtain a class of powerful bandwidth-

efficient coded modulation schemes (description as published, paragraph [0003]).

Figure 2 of the application illustrates a conventional example of a parallel concatenated trellis-coded modulation (PCTCM) structure. In the example of Figure 2, the recursive systematic component code (RSCC) and mapping for the upper and lower branches are identical. This type of structure is referred to as symmetric mapping PCTCM. In conventional structures such as shown in Figure 2, the PCTCM is typically designed using the conventional approach of searching for a component code that has good properties for a given mapping. Typical examples of conventional mappings that are used in arrangements like Figure 2 include natural (set partitioning) mapping and Gray mapping (paragraph [0008]).

3.2   The invention aims to provide an improved PCTCM system by mapping the coded bits of the different component coders of the turbo coder using different coded bits-to-signal mappings, i.e. it uses an asymmetric signal mapping in combination with a turbo coder (see Figures 9, 9A, 9B and 12).

Main request

4.   Claim 1 of the main request relates to a "communication apparatus", which comprises the following features, as itemised by the Board:
        (a) an input for receiving uncoded bits from a communication application;
        (b) a first coder coupled to said input for producing coded bits from said uncoded bits;

(c) an interleaver coupled to said input for producing
    from said uncoded bits an interleaved version of
    said uncoded bits;

(d) a second coder coupled to said interleaver for
    producing an interleaved version of said coded bits
    from the interleaved version of said uncoded bits;

(e) a first mapper arranged for applying a first coded
    bits-to-signal mapping to said coded bits to
    produce a first output signal wherein said mapping
    is one of Gray mapping, 0231 mapping and 0213
    mapping;

(f) a second mapper arranged for applying a second
    coded bits-to-signal mapping to the interleaved
    version of said coded bits to produce a second
    output signal, wherein said second coded bits-to-
    signal mapping differs from said first coded bits-
    to-signal mapping;

(g) a combiner coupled to said first and second mappers
    for combining said first and second output signals
    to produce a combined output signal for interfacing
    to the communication channel.

5.   **Clarity and support - Article 84 EPC**

5.1   According to feature (a) of claim 1, the communication
        apparatus receives uncoded bits from a communication
        application as input. The received uncoded bits are
        processed in two different ways: the interleaver
        according to feature (c) interleaves the uncoded bits
        to produce an interleaved version of the uncoded bits
        and the first coder according to feature (b) codes the
        uncoded bits into coded bits. This is also
        diagrammatically illustrated by Figure 9 of the
        published application, which is reproduced below and
        shows exemplary embodiments of a PCTCM system according
        to the invention. Figure 9 shows that the uncoded bits

serve as input for the interleaver 27 and the recursive
systematic component code coder 25 (labelled RSCC)
which provides the input for the component labelled
"Mapping 1".

FIG. 9
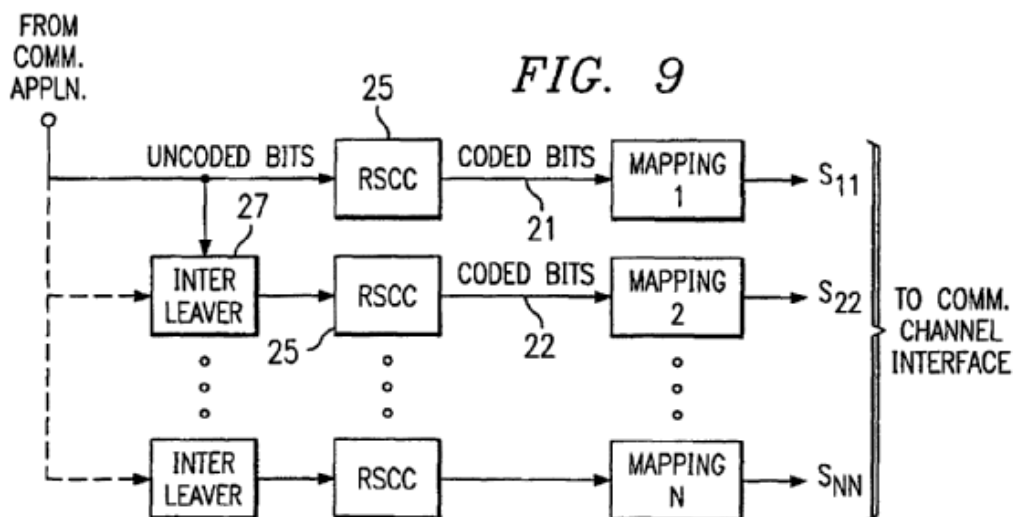
Feature (d) of claim 1 refers to a second coder coupled
to the interleaver defined in feature (c), for
producing "an interleaved version of said coded bits
from the interleaved version of said uncoded
bits" (emphasis added by the Board). The expression
"said coded bits" in feature (d) apparently refers to
the coded bits produced by the output of the first
coder in feature (b), which contains the first
reference in claim 1 to "coded bits". However, it is
unclear how the second coder could produce an
interleaved version of the coded bits obtained as
output from the first coder, as the claim does not
specify that the output of the first coder is used as
input for the second coder.

Moreover, feature (d) is not supported by the
embodiments disclosed in the application (see Figure 9
and the corresponding description, in particular

paragraph [0030]). According to Figure 9, the second
coder (the RSCC coder 25 producing the input for the
component labelled "Mapping 2") produces a coded
version of the interleaved uncoded bits which are
obtained as the output of the interleaver 27. A further
interleaving function of the second coder, applied to
the coded bits, is not supported by the embodiments
disclosed. Hence, an interleaving of coded bits as
defined by feature (d) is not supported by the
application.

5.2   The above objections under Article 84 EPC were raised
        for the first time by the Board in its communication.
        As the appellant did not provide a substantive reply to
        the objections, there are no relevant arguments on
        file.

5.3   Hence, the wording of claim 1 is unclear and not
        supported by the description (Article 84 EPC).

Auxiliary request

6.   As claim 1 of the auxiliary request is identical to
        claim 1 of the main request, the above objections under
        Article 84 EPC to claim 1 of the main request likewise
        apply to claim 1 of the auxiliary request.

Conclusion

7.   As none of the appellant's requests can form the basis
        for the grant of a patent, the appeal is to be
        dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

I. Aperribay   R. Moufang

Decision electronically authenticated