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Title of invention:
TRANSMISSION LINE SUBSTRATE AND SEMICONDUCTOR PACKAGE

Applicant:
Mitsubishi Electric Corporation

Headword:

Relevant legal provisions:
EPC 1973 Art. 54, 56, 84
EPC Art. 52(1), 123(2)

Keyword:
Novelty - (yes)
Inventive step - (yes)

Decisions cited:

Catchword:

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Case Number: T 2189/12 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 9 June 2016

Appellant: (Applicant)	Mitsubishi Electric Corporation 7-3, Marunouchi 2-chome Chiyoda-ku Tokyo 100-8310 (JP)
Representative:	Zech, Stefan Markus Meissner, Bolte Patentanwälte Rechtsanwälte Partnerschaft mbB Postfach 86 06 24 81633 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 10 May 2012 refusing European patent application No. 05765133.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	S. Ward
	C. Schmidt

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 05 765 133 on the ground that the subject-matter of the main request then on file failed to meet the requirements of Article 123(2) and 84 EPC, lacked novelty (Article 52(1) and 54 EPC) and lacked inventive step (Article 52(1) and 56 EPC); the first auxiliary request was not admitted into the procedure (Rule 137(3) EPC).

The second auxiliary request had been - with certain formal amendments - proposed by the Examining Division for grant, but the applicant (now the appellant) had indicated that it "refuses to agree to the version of the claims communicated with the Communication under Rule 71(3) EPC."

II. At the end of the oral proceedings held before the Board the appellant requested that the decision under appeal be set aside and that a patent be granted in the following version:

Claims:
1 to 7 of the main request, filed at the oral proceedings before the Board;

Description:
pages 1 to 3 as filed at the oral proceedings before the Board, and
pages 4 to 21 as filed with the letter setting out the grounds of appeal dated 20 September 2012;

Drawings:

figures 1 to 12 as published.

III. The following document cited by the Examining Division is referred to in this decision:

D1: GB 798 629 A

IV. Claim 1 reads as follows:

"A transmission line substrate that transmits a driving control signal input to and output from a semiconductor device (3), the transmission line substrate comprising a signal line (45a) connectable to the semiconductor device (3) and comprising a spurious-wave suppression circuit (50), wherein the signal line (45a) is connected to the spurious-wave suppression circuit (50) and wherein the spurious-wave suppression circuit (50) includes:

a divider (51) that divides the signal line (45a) into first and second signal lines in a same phase;

a delay unit (52) that is connected to the first signal line and includes a signal line with a length of substantially one half of an in-substrate effective wavelength of a spurious wave in a microwave band and a millimetre-wave band;

parallel two lines (53) including parallel third and fourth signal lines (53b, 53a), on which spurious waves are in opposite phases, the third signal line (53b) being connected to the delay unit (52) and the fourth signal line (53a) being connected to the second signal line;

a combiner (54) that combines the third and fourth signal lines; and

a resistor (55) that is located on the parallel two lines (53) and connects between the third and fourth signal lines (53b, 53a)."

V. The findings of the Examining Division, insofar as they remain relevant to the present decision, may be summarised as follows:

Claim 1 was not new with respect to the embodiment of Fig. 11 of document D1. This embodiment disclosed *inter alia* a divider (septum 66) which divided transmission lines 63 and 64, a delay unit (detour 67) including a signal line with a length substantially one half of an in-substrate effective wavelength of a spurious wave (page 8, lines 97-117), parallel two lines on which spurious waves were in opposite phases (lines 63 and 64 guiding waves in opposite phases after signals have passed detour 67), a combiner (transmission lines 63 and 64 joined together when septum 66 was no longer separating); and a resistor (lossy dielectric material used for spurious mode suppression). Hence, D1 disclosed a spurious-wave suppression circuit having all the features of claim 1 of the main request.

Claim 1 of the main request also lacked an inventive step with respect to the embodiment of Fig. 3 of document D1 which disclosed a transmission line substrate that transmitted a driving control signal to and output from a semiconductor device (cf. D1 , page 1 , lines 18-21), the transmission line substrate comprised a spurious-wave suppression circuit that included a divider that divided a signal line connected to the semiconductor device into first and second

signal lines in a same phase (D1, page 2, line 121 - page 3, line 7; D1, Fig. 3, main transmission line branching into transmission lines 12 and 13); a delay unit that was connected to the first signal line and included a signal line with a length substantially one half of an in-substrate effective wavelength of a spurious wave in a microwave band and a millimeter-wave band (cf. D1, page 2, lines 94-115; D1, Figs. 2/3, first section of transmission lines 6/13 being effectively half-wavelength long); parallel two lines that included third and fourth signal lines in parallel on which spurious waves were in opposite phases, the third signal line being connected to the delay unit and the fourth signal line being connected to the second signal line (D1, page 2, lines 94-115; D1, Figs. 2/3, second section of transmission lines 6/13 being in parallel to transmission lines 7/12); and a combiner that combined the third and fourth signal lines (D1, page 2, lines 94-115; D1, Figs. 2/3, transmission lines 6/13 and transmission lines 7/12 joined together at their ends).

Claim 1 differed only in that the circuit included a resistor that was located on the parallel two lines and connected between the third and fourth signal lines.

However, to solve the problem of attenuation of spurious modes, suitably disposed lossy material might be used (see D1, page 4, lines 12-18). Therefore, a layer of lossy material provided over the transmission line filter arrangement as disclosed in D1, Fig. 3 was an evident option the skilled person would select and thus would arrive at the subject-matter of claim 1 of the main request without inventive effort.

VI. The appellant's arguments, insofar as they are relevant to the present decision, may be summarised as follows:

The subject matter of claim 1 was not anticipated by document D1. The septum 66 disclosed in the embodiment of Fig. 11 was not a divider that divided a single signal line into two separate signal lines, but was merely disposed between the two transmission lines 63 and 64. The ribbon conductors 63 and 64 were separated by a layer of dielectric material 65; there was no combiner present that combined the transmission lines 63 and 64 when the septum 66 was no longer present. The dielectric material 65 did not represent a resistor connecting the transmission lines 63 and 64. A resistor according to the present invention was clearly a separate element, independent from the substrate on which the parallel two lines and the third and fourth signal lines were arranged. A resistor is a technical term, defined as a passive two-terminal electrical component that implements electrical resistance as a circuit element. The resistor according to the present invention was not comparable with a slightly lossy dielectric material 65 which is the substrate material for the transmission lines 63 and 64.

The subject matter of claim 1 was also inventive with respect to the embodiment of Fig. 3, seen as the closest prior art.

In Fig. 3 of document Dl there are no parallel two lines that include third and fourth signal lines on which spurious waves are in opposite phases. Rather, the spurious waves are only in opposite phases when the two signal lines 12 and 13 are combined at the intersection. Furthermore, parallel did not only mean electrically parallel, but rather the geometric

configuration of the lines as printed on the circuit board. As the arcuate portion 13 of D1 in Fig. 3 was curved over its length, it could at most be parallel to the straight portion at a single point, meaning the lines are not parallel over any length.

Should one choose to interpret "parallel" to mean "electrically parallel", document D1 still did not recite a resistor which connected the phase-shifted signal to the non-phase shifted signal line. Fig. 3 of document D1 clearly shows that the final phase shifted signal is in fact jointed to the non-phase shifted signal line; they are not connected by any resistor.

It was true that on page 4, D1 specified that the circuit might be printed on a lossy dielectric. Therefore, one might argue that the delay unit, i.e. the effective length of one half of a spurious wave, did not extend the entire length of the arcuate portion 13 of D1, Fig. 3 but rather corresponded to some fraction of the arcuate portion 13. However, in this interpretation the resistor (i.e. loss via the dielectric plating of the circuit) would not be applied after the delay unit, but rather over the course of the delay unit, as well as afterwards. This would lead to different electrical effects: signals that were only somewhat phase shifted (corresponding to an inversion of the signal at a higher frequency) would also be attenuated or cancelled. In essence, with a lossy dielectric, the circuit in D1 would act as a low-pass filter. However, the circuit described in the present application targeted a particular spurious wave frequency; i.e. the circuit was a bandstop filter (meaning a simultaneous high pass and low pass filter).

Reasons for the Decision

1. The appeal is admissible.

2. *Articles 84 EPC 1973 and 123(2) EPC*

The specific objections raised in the contested decision of extension of subject-matter and lack of clarity have been overcome by amendment, and the Board sees no reason to raise any further such objections in relation to the present request.

3. *Novelty*

3.1 In the contested decision the subject-matter of claim 1 was held not to be new in the light of the embodiment depicted in figures 11A to 11D of document D1.

3.2 In the application, the term "signal line" refers to a single conducting line or strip forming a component part of a transmission line. In particular, the signal line may be an inner conducting strip, which, in combination with a pair of ground conductors, forms a triplate transmission line.

If the term "signal line" is considered to be thus limited, the claimed subject-matter clearly would not be anticipated by the embodiment of figures 11A to 11D of document D1. In this case the claimed "signal line (45a)" would have to be identified with one of the ribbon conductors 63, 64, neither of which is divided into "first and second signal lines" as required by the claim.

3.3 What is actually disclosed in document D1 is that the septum 66 divides the input transmission line into two transmission lines ("two branches" - see page 8, lines 91-117). Since the meaning of the term "signal line" is not explicitly defined in claim 1, it is at least arguable that it should be considered to encompass also a complete transmission line on which a signal propagates, i.e. a plurality of conducting strips separated by a dielectric.

3.4 According to such a view, and with reference to figures 11A-11C, the following identifications could be made: the claimed "signal line (45a)" is the transmission line formed by the pair of conductors 63, 64 (and the intervening dielectric) as they appear at the far left of the figures. This signal transmission line is then divided at the start of the septum 66 into two further transmission lines (see page 8, lines 104-117) in the region between the left hand end of the septum and the delay unit 67: a "first signal line" (left hand parts of conductor 63 and septum 66) and a "second signal line" (left hand parts of conductor 64 and septum 66).

Next comes the delay unit 67, which is connected to the first signal line and includes a half wavelength detour. To the right of the delay unit 67 are two further signal transmission lines arranged in parallel: a "third signal line" (right hand parts of conductor 63 and septum 66) and a "fourth signal line" (right hand parts of conductor 64 and septum 66). The third signal line is connected to the delay unit, and the fourth signal line is connected to the second signal line. At the right hand end of the septum the third and fourth signal lines are combined.

Furthermore, the claimed resistor connecting the third and fourth signal lines was identified by the Examining Division with the lossy dielectric (see e.g. page 9, lines 55-61).

3.5 The appellant disputes that the "slightly lossy dielectric", provided to introduce "a small amount of inherent dissipation" (page 9, lines 40-61), would be considered by a skilled person to constitute a "resistor".

3.6 It is also open to question whether there is anything in the relevant embodiment of D1 which could reasonably be identified with the claimed "combiner". In the light of the wording of the claim, a combiner would presumably be a structure, the input to which would be the parallel third and fourth signal lines, and the output from which would be a combined single signal line.

In figures 11A to 11C, using the identifications above, and further considering the plane perpendicular to the substrate and containing the right-hand dotted line marking the end of the septum 66, it is clear that before (to the left of) this plane the parallel third and fourth signal lines exist, and after (to the right of) this plane they have been combined into a single transmission line.

Hence, this plane would appear to be the only possible candidate which could represent the claimed combiner. Whether an apparently concrete feature such as a combiner can be realistically identified with an essentially geometrical concept, such as the plane at which the dividing septum ceases to be present, is again questionable.

3.7 However, the Board does not find it necessary to decide whether a "resistor" and a "combiner" are disclosed in the embodiment of figures 11A-11D, or whether the claimed "signal line" can be identified with a transmission line, since the Board is of the opinion that there is at least one claimed feature which, even if all the above identifications were accepted, is not disclosed in the relevant embodiment.

3.8 Claim 1 defines the following:

"a resistor (55) that is located on the parallel two lines (53) and connects between the third and fourth signal lines (53b, 53a)."

The Board takes this to mean that the resistor is in physical contact with ("on") the third and fourth signal lines thereby connecting them, both physically and electrically.

3.9 According to the identifications above, the third and fourth signal lines only exist in the region to the right of the detour 67 and to the left of the plane referred to above (the "combiner"). However, it can be seen in Fig. 11D that the septum 66 extends laterally across the entire substrate. Hence, it may at most be said that a first resistor (the upper part of the lossy dielectric in this region) is located "on" the third signal line, and a second resistor (the lower part of the lossy dielectric in this region) is located "on" the fourth signal line, but these are two separate resistors. It is not disclosed in this embodiment of document D1 that there is "a resistor" located on the parallel two lines which connects between the third and fourth signal lines.

3.10 Since not all of the features of claim 1 are disclosed in combination in document D1, the Board concludes that the subject-matter of claim 1 is new within the meaning of Article 52(1) EPC and Article 54 EPC 1973.

4. *Inventive Step*

4.1 In the contested decision, the subject-matter of claim 1 was held not to involve an inventive step in the light of the embodiment depicted in figure 3 of document D1.

In particular, the Examining Division took the view that the claimed subject-mater differed only in that the circuit included a resistor that was located on the parallel two lines and connected between the third and fourth signal lines. The problem was the attenuation of spurious modes, and this was solved in document D1 by a suitably disposed lossy material (see D1, page 4, lines 12-18). It was considered that applying this solution would lead to the subject-matter of claim 1.

4.2 Claim 1 defines:

"parallel two lines (53) including parallel third and fourth signal lines (53b, 53a), on which spurious waves are in opposite phases, the third signal line (53b) being connected to the delay unit (52) and the fourth signal line (53a) being connected to the second signal line".

In other words, when the spurious wave signals are propagating on the third and fourth signal lines, they are in opposite phases, i.e. they have a fixed phase relationship (half a wavelength delay).

4.3 The problem to be solved is to provide a spurious-wave suppression circuit capable of suppressing a spurious mode of a particular wavelength (where more than one wavelength is to be suppressed, a plurality of spurious-wave suppression circuits are provided, the lengths of the delay units being varied so that each attenuates a particular spurious frequency - see the description as filed, paragraph [0047]).

According to the claimed invention, the problem is solved by ensuring that the divided signals having the particular spurious wavelength to be attenuated propagate on the third and fourth signal lines in opposite phase. As a result, the resistor (e.g. printed resistor 55 in figure 6) located on and connecting the third and fourth signal lines will attenuate the specific spurious wave to be suppressed.

4.4 Since figure 3 of document D1 clearly does not disclose geometrically parallel signal lines, the Board presumes that the word "parallel" in claim 1 was interpreted by the Examining Division as meaning electrically - but not necessarily geometrically - parallel.

The question of the correct interpretation of the word "parallel" is dealt with below (point 4.6), however, even if the word "parallel" is interpreted broadly to mean merely electrically parallel, the claimed feature referred to above is not disclosed in figure 3 of document D1. In this arrangement, in each of the "tandem connected networks 8, 9, 10" the phase relationship between the two lines 12, 13 is not fixed, but varies continuously.

4.5 This difference cannot be dismissed as trivial, as it would lead to a significantly different technical

effect to that achieved by the claimed invention. If the dielectric 15 were made lossy (or if a layer of lossy material were provided over the transmission line arrangement, as suggested by the Examining Division), the combination of the "resistor" and the continuously varying phase relationship between the lines 12, 13 would presumably provide a degree of attenuation of spurious modes of different wavelengths at different parts of the line. This is not the result aimed for in the present application and achieved by the features of claim 1, nor can the Board see any hint or suggestion in the prior art which would lead the skilled person to consider it obvious to modify the arrangement of figure 3 to correspond to the claimed invention.

4.6 It may also be added that this analysis clarifies, in the opinion of the Board, that the word "parallel" in the expression "parallel two lines" must be interpreted in a geometrical sense, and hence establishes a further difference between the claimed subject-matter and document D1.

Not only is this interpretation more plausible linguistically from the wording of the claim, but it is clear that what is essential technically is that a constant opposite phase relationship must be maintained between the spurious waves on the third and fourth signal lines. This is conveniently achieved by forming them as two straight geometrically parallel lines, whereas a geometry such as that of figure 3 of document D1 does not achieve a constant phase relationship.

4.7 The Board therefore concludes that the subject-matter of claim 1 involves an inventive step within the meaning of Article 52(1) EPC and Article 56 EPC 1973.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division with the order to grant a patent in the following version:

Claims:
1 to 7 of the main request, filed at the oral proceedings before the Board;

Description:
pages 1 to 3 as filed at the oral proceedings before the Board, and
pages 4 to 21 as filed with the letter setting out the grounds of appeal dated 20 September 2012;

Drawings:
figures 1 to 12 as published.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated