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Datasheet for the decision of 18 February 2019

Case Number: T 0324/14 - 3.5.02

Application Number: 06739337.1

Publication Number: 1861920

IPC: H03F3/68

Language of the proceedings: EN

Title of invention:
High Power Doherty Amplifier Using Multi-Stage Modules

Applicant:
Cree Microwave, Inc.
Cree, Inc.

Relevant legal provisions:
EPC Art. 56
RPBA Art. 12(4), 13(1)

Keyword:
Inventive step - main request (no)
Late-filed requests - submitted shortly before oral proceedings

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Case Number: T 0324/14 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 18 February 2019

Appellant: (Applicant 1)	Cree Microwave, Inc. 160 Gibraltar Court Sunnyvale, CA 94089 (US)
Appellant: (Applicant 2)	Cree, Inc. 4600 Silicon Drive Durham, NC 27703 (US)
Representative:	Boult Wade Tennant LLP Verulam Gardens 70 Gray's Inn Road London WC1X 8BT (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 1 October 2013 refusing European patent application No. 06739337.1 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Lord
Members:	C. Vassoille
	W. Ungler

Summary of Facts and Submissions

I. This is an appeal of the applicants against the decision of the examining division to refuse European application no. 06739337.1 for lack of inventive step of the subject-matter of the main request.

II. The following documents are relevant for the present decision:

D1: Gajadharsing J. R. et al, "Analysis and Design of a 200W LDMOS Based Doherty Amplifier for 3G Base Stations", 2004 IEEE MTT-S international Microwave Symposium Digest
D2: JP 2004 222151 A & EP 1 592 126 A1

III. Oral proceedings before the board took place on 18 February 2019.

The appellants requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request, or of one of the first to fifth auxiliary requests, all filed with letter dated 18 January 2019. The main request is identical to the request on which the decision under appeal was based. The appellants further requested that the case be remitted to the examining division for further prosecution.

IV. Claim 1 of the appellants' main request reads as follows:

"A high power RF amplifier comprising:
a) a main amplifier (20) including at least two stages of amplification, biased for class AB operation,

b) at least one peak amplifier (22) connected in parallel with the main amplifier, each peak amplifier including at least two stages of amplification and being biased for class C operation,
c) a signal splitter (24) for receiving and splitting an input signal for the main amplifier and the at least one peak amplifier,
d) first impedance matching circuitry for coupling signals from the signal splitter to inputs to the main amplifier (20) and to the at least one peak amplifier (22), and
e) second impedance matching circuitry for coupling amplified signals from the main amplifier (20) and from at least one peak amplifier (22) to common output,
characterized in that a first stage in each amplifier (20, 22) provides signal pre-distortion, configured to increase linearity of the high power RF amplifier."

The amendments made in the first to fifth auxiliary requests are identified below in section 3 of the reasons for the decision.

V. The arguments of the appellants which are relevant for the present decision are as follows:

As regards the interpretation of the wording of the characterising portion of claim 1: "a first stage **in** each amplifier provides signal pre-distortion" (emphasis added), the description in paragraph [0024] referred to an embodiment, where a PMC-Sierra Paladin 15 digital pre-distortion entity is not located in the amplifier module. Nevertheless, the description in paragraph [0011] recited "the first stage of the module includes a field effect transistor Q1 connected to a RF input through input matching circuitry and pre-distortion circuitry". This passage

referred to a different embodiment of the invention, where the pre-distortion mechanism is located in the amplifier module.

The invention allowed for a modular solution implementing two stages of amplification and this solution would not have been taken into consideration by the skilled person. In particular, the negative effects of a module package as regards linearity and junction temperature would prevent the skilled person from replacing the amplifier in D2 by a two stage amplification module package. Furthermore, neither D1 nor D2 related to a modular packaged amplifier but would rather suggest the use of discrete components in view of the negative impact of a modular solution. Therefore, this modular solution would not have been the preferred solution for the skilled person, even though the test results illustrated in figure 10 of the application show an improved performance of the claimed high power RF amplifier.

The signal pre-distortion in D2 was not provided **in** the amplifier. Rather, the pre-distortion circuit preceded the amplifier and was therefore not arranged therein, contrary to the wording of claim 1. When combining document D2 with document D1, the skilled person would have placed the additional driver stage disclosed in D1 at a stage preceding the pre-distortion portion, since signal distortion mainly occurs in the second (power) stage of the amplifier. This was also the case because placing pre-distortion before the final stage of amplification was the conventional thinking at the priority date of the present application. D1 further showed a corresponding interstage circuit providing signal pre-distortion for the final stage of the peak amplifier.

The first to fifth auxiliary requests should be admitted into the appeal procedure. In sections 4 and 5 of the communication according to Article 15(1) RPBA, the board had raised new objections that were taken into account in the newly filed auxiliary requests.

Since the appellants had the impression that the application contains patentable subject-matter and in view of the new objections raised by the board, the case should be remitted to the examining division for further prosecution.

Reasons for the Decision

1. The appeal is admissible.

2. Main request - inventive step (Article 56 EPC)

2.1 The appellants have presented a number of arguments relating to the fact that the high power RF amplifier of the present invention basically uses amplifier modules. Modules of this type comprise serially connected transistors which are surface mounted on a substrate and are partitioned in a packaged thick-film hybrid microelectronic circuit and each of them comprises a discrete module package including RF input and RF output leads. A European patent (EP 2 442 444) has been granted for a high power RF amplifier of this type, which is based on a divisional application of the present application.

2.2 However, the appellants' extensive arguments in this regard are not convincing, because modular or packaged characteristics of the high power RF amplifier in the

present case are neither reflected in the wording of the claim nor was this aspect subject of the European search.

2.3 As regards the characteristics of the main and peak amplifiers of the claimed high power RF amplifier, claim 1 defines a main amplifier that includes at least two stages of amplification, biased for class AB operation, and at least one peak amplifier connected in parallel with the main amplifier, that includes at least two stages of amplification and being biased for class C operation. The characterising portion of claim 1 specifies that a first stage in each amplifier provides signal pre-distortion. It is therefore clear from the wording of claim 1 that the term "amplifier" does not solely imply an amplification functionality but additionally encompasses pre-distortion functionality. No further limitations regarding the construction or design of the overall amplifier are present in claim 1. Furthermore, claim 1 does not comprise any structural limitations of the specific amplification stages or of the pre-distortion circuit either. Claim 1 therefore must be interpreted in the broadest technically reasonable sense such that the term "amplifier" in the context of claim 1 is meant to generally encompass an aggregation and in particular a sequential arrangement of pre-distortion and amplification stages. In any case, claim 1 cannot be exclusively understood to mean that the amplifier forms a discrete module package as illustrated in figure 2 of the application and including the pre-distortion and amplification stages therein. Claim 1 does not contain any definition in this regard and a corresponding restricted interpretation therefore cannot be derived from the wording of claim 1.

2.4 Document D2, which is considered to be the closest prior art, does not disclose at least two stages of amplification but only one stage of amplification in the main and peak amplifier, respectively. The appellants have further disputed that the signal pre-distortion in D2 is provided **in** the amplifier. According to the appellants, the pre-distortion stage precedes the amplifier and is therefore not arranged therein, contrary to the wording of claim 1. However, the board notes that, as outlined in section 2.3 above, claim 1 and in particular the term "amplifier" has to be interpreted in terms of its functional characteristics such that it comprises a pre-distortion as well as the two amplification stages. D2 clearly discloses pre-distortion in combination with an amplification stage. The pre-distortion circuits 11 and 12 of D2, which precede the amplification stages 13 and 14, therefore have to be considered as forming part of the respective main and peak amplifiers in the sense of claim 1. The examining division came to a similar conclusion in their communication dated 25 February 2013 (see section 2 on the first page), which cannot be objected to in this respect.

2.5 Consequently, the examining division was correct in stating that document D2 only differs from the subject-matter of claim 1 in that only one stage instead of two stages of amplification is provided in the main and peak amplifiers (see the communication dated 25 February 2013 in section 2, last two paragraphs on page 1).

2.6 The board agrees with the appellants that the objective technical problem may be considered to be that of how to improve the efficiency of a high power RF amplifier

(see the appellants' letter dated 18 January 2019 in section 2.2, first paragraph).

2.7 The skilled person, when starting from D2 and confronted with the objective technical problem, would encounter document D1, which teaches the possibility to increase the efficiency of a Doherty amplifier by adding a driver stage in the main/carrier amplifier as well as in the peak amplifier. More specifically, document D1 in figure 9 illustrates main and peak amplifiers, each of which comprises two sequential stages of amplification. Furthermore, the description on page 530, right column, last paragraph to page 531, left column, first paragraph, states the following:

"Since single stage class-C amplifiers have low gain relative to class-AB amplifiers, a lot of drive power will be lost when the Doherty amplifier is operating below its transition point. It is therefore necessary to add a driver stage to maximize efficiency. A driver is also added to the main amplifier to accommodate shaping of the transfer characteristics, which is critical in a Doherty amplifier."

2.8 The skilled person, in order to solve the technical problem identified above, would transfer the teaching of D1 to document D2 and would consequently add a driver stage in the main amplifier 13 as well as in the peak amplifier 14. Since document D2 explicitly teaches to provide pre-distortion at a stage preceding the amplifier stage, the skilled person would provide the driver stage after the pre-distortion circuit such that pre-distortion is provided at a stage preceding the amplifier stages.

2.9 The board is not convinced by the appellants' arguments that the person skilled in the art would have provided the driver stage preceding the pre-distortion circuit such that the pre-distortion circuit would have become an interstage circuit, since "placing pre-distortion before the final stage of amplification was the conventional thinking at the priority date of the present application" (see the appellants' letter dated 18 January 2019, section 2.2, third paragraph).

2.10 The board acknowledges that the skilled person may in principle have considered it sufficient to provide the pre-distortion circuit such that it precedes only the final stage of amplification, since distortions are predominantly generated in this stage. However, the mere fact that document D1 shows a corresponding order of stages is not sufficient to prove that this corresponded to the "conventional thinking" of the skilled person at the priority date. Considering the specific circumstances of the present case, and in particular the fact that document D2 expressively teaches the provision of pre-distortion at a stage preceding the main and peak amplifiers, the skilled person would rather have retained this order of stages and would have consequently provided the additional driver stage at a stage (directly) preceding the amplification stage, as also illustrated in figure 9 of D1. Contrary to what was argued by the appellants, the person skilled in the art would not have encountered any difficulties in this respect.

2.11 Furthermore, the board does not recognise any incompatibilities between documents D1 or D2 which would hinder the skilled person from applying the teaching of D1, as regards the provision of an amplifier driver stage, to the high power RF amplifier

of D2. Contrary to the appellants' arguments, the aspect of improving the amplifier's efficiency by means of a driver stage is independent from the question of whether D1 uses similar or different configurations for the main and the peak amplifier. The board further notes that claim 1 does not contain any features relating to this aspect of the design.

2.12 The board therefore concludes that the subject-matter of claim 1 is an obvious combination of concepts known from documents D1 and D2. In particular, the combination of two stages of amplification in each amplifier with pre-distortion provided in a first stage in the amplifier is obvious to the person skilled in the art and the subject-matter of claim 1 of the main request therefore does not involve an inventive step in the sense of Article 56 EPC.

3. First to fifth auxiliary requests - Admittance (Articles 12(4) and 13(1) RPBA)

3.1 The first to fifth auxiliary requests were only submitted one month before the oral proceedings before the board. These amended requests consequently represent amendments to the appellants' case, the admittance of which is subject to the requirements of Articles 12(4), 13(1) and (3) RPBA. According to an approach frequently adopted by the boards, a request filed after arrangement of the oral proceedings may be admitted and considered at the board's discretion, *inter alia* if they are clearly or obviously allowable, i.e. it must be immediately apparent to the board, with little investigative effort on their part, that the amendments made successfully address the issues raised without giving rise to new ones (see case law of the boards of appeal, 8th edition 2016, section IV.E.

4.2.5). This condition is not met in the case of the first to fifth auxiliary requests.

3.2 Claim 1 of the first auxiliary request differs from claim 1 of the main request in that it refers to amplifier modules. The term "module" is however vague and not only raises the question as to what the exact meaning of the term is and whether it limits the subject-matter of claim 1 at all, but also if it complies with the requirements of Article 123(2) EPC, which is at least questionable. The board therefore has strong doubts as to whether the subject-matter of claim 1 of the first auxiliary request is suitable to overcome the board's objections raised with respect to the main request. Since claim 1 of the second to fifth auxiliary requests also comprise the feature at issue, the reasoning set out above applies *mutatis mutandis* to these auxiliary requests.

3.3 Claim 1 of the second auxiliary request has additionally been amended to further define the configuration of the main and peak amplifier modules as follows:

"...wherein a first stage of the main amplifier module (20) includes a transistor (Q1) connected to an RF input through first input matching circuitry and pre-distortion circuitry, and a second stage of the main amplifier module includes a second transistor (Q2) connected to receive the output of the first transistor through second input matching circuitry" (emphasis added)

and

"...wherein a first stage of the at least one peak amplifier module includes a transistor connected to the RF input through first input matching circuitry and pre-distortion circuitry, and a second stage of the at least one peak amplifier module includes a second transistor connected to receive the output of the first transistor through second input matching circuitry" (emphasis added)

3.4 Similar amendments are present in claim 1 of the third to fifth auxiliary requests. The board observes in this context that the new features have been extracted from the original description in paragraph [0011]. These features are however described in an interrelated manner with other features not forming part of the amended claims, such as the specific type of module (CREE PFM19030SM), which is used as a peak amplifier and as a main amplifier. Therefore, the second to fifth auxiliary requests require an in-depth assessment of the question as to whether the subject-matter of claim 1 of each of these requests fulfils the requirements of Article 123(2) EPC.

3.5 The board further observes that the appellants had multiple opportunities in the first instance proceedings to submit auxiliary requests, in particular in response to the examining division's communications dated 22 September 2011, 25 February 2013 and 9 September 2013. A further opportunity to discuss the subject-matter and to file auxiliary requests would have been at the oral proceedings before the examining division. However, the appellants requested that the oral proceedings be cancelled and that instead a decision according to the state of the file be taken. No auxiliary requests were filed with the statement of grounds of appeal either.

3.6 The appellants have argued that the auxiliary requests should be admitted into the appeal procedure because the board's communication under Article 15(1) RPBA in sections 4 and 5 raised new objections, which required fresh considerations and which were taken into account with the auxiliary requests.

3.7 Contrary to what was argued by the appellants, no new objections were raised in the board's communication under Article 15(1) RPBA that could have justified a substantive reconsideration of the case. Rather, the remarks in sections 4 and 5 of the board's communication were consistent with and further refined the examining division's opinion as discussed in the communication dated 25 February 2013, namely that the pre-distortion of document D2 can be considered to be a part of the first stage of the amplifier in the sense of claim 1. A reference to the examining division's communication was explicitly included in section 6 of the board's communication. The board in sections 7 to 12 of the communication further provided their preliminary view on the question of inventive step, which confirmed the opinion of the examining division.

3.8 In consideration of the specific circumstances of the present case, in particular the late stage of the proceedings as well as the new complex issues raised by the auxiliary requests, the board exercised its discretion under Articles 12(4) and 13(1) RPBA to not admit the first to fifth auxiliary requests into the appeal procedure.

4. Remittal to the department of first instance

4.1 The appellants have requested that the case be remitted to the examining division for further prosecution. They have particularly argued that the new objections raised by the board as well as the fact that there seemed to be patentable subject-matter included in the application, justified remittal and further consideration by the examining division.

4.2 Contrary to the appellants' arguments, no new objections have been raised by the board during the appeal procedure (see the reasons under point 3.7 above). Furthermore, the mere presumption of potentially patentable subject-matter in the application does not justify a remittal to the department of first instance. Should the appellants have wished to proceed with requests that they considered to contain potentially patentable subject-matter and thus as a promising basis for the examination proceedings, requests defining subject-matter of this nature should have been filed already in the first instance proceedings.

4.3 For these reasons, the board refuses the request for remittal of the case to the examining division.

4.4 Since there is no allowable request on file, the appeal has to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Rodríguez Rodríguez R. Lord

Decision electronically authenticated