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# D E C I S I O N
## of 12 November 1999

**Case Number:** T 0731/99 - 3.5.1

**Application Number:** 96301705.8

**Publication Number:** 0733914

**IPC:** G01S 13/75

**Language of the proceedings:** EN

**Title of invention:**
Detector and modulator circuits for passive microwave links

**Applicant:**
AT&T IPM Corp.

**Opponent:**
-

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 52(1), 56

**Keyword:**
"Inventive step (yes, after amendment)"

**Decisions cited:**
-

**Catchword:**
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Beschwerdekammern | Boards of Appeal | Chambres de recours

**Case Number:** T 0731/99 - 3.5.1

**D E C I S I O N**
**of the Technical Board of Appeal 3.5.1**
**of 12 November 1999**

**Appellant:** AT&T IPM Corp.
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Florida 33134 (US)

**Representative:** Buckley, Christopher Simon Thirsk
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted 5 March 1999 refusing European patent application No. 96 301 705.8 pursuant to Article 97(1) EPC.**

**Composition of the Board:**

**Chairman:** P. K. J. van den Berg
**Members:** A. S. Clelland
P. H. Mühlens

## Summary of Facts and Submissions

I. This appeal is against the decision of the Examining Division to refuse application No. 96 301 705.8 on the ground that the subject-matter of claim 1 lacked an inventive step. The decision cited *inter alia* the following documents:

D1: EP-A-480 413

D4: US-A-5 119 099

II. In the notice of appeal the appellant requested that the Examining Division's decision be cancelled in its entirety and a patent granted; with a subsequent statement of grounds of appeal the appellant filed a revised set of claims constituting a main request and sets of claims A, B and C constituting auxiliary requests to be considered successively. It was argued that the claims of the requests were novel and inventive having regard to the prior art, which did not disclose a diode selectively biasable into and out of a negative resistance region so as to establish a zero ohm antenna port impedance. Although the document D4 disclosed a tunnel diode connected across the antenna it did not teach or suggest the capability of achieving a zero ohm antenna port impedance and did not necessarily obtain enhanced backscattering of the antenna. The specification of D4 did not correspond to the drawings and on a fair reading of the document the tunnel diode apparently always represented a power dissipation across the antenna port since its series resistance could not be eliminated or overcome by any teaching to be found in the document.

III. Following a communication from the rapporteur, primarily discussing the issue of inventive step, the appellant filed further auxiliary requests D and E and argued in favour of the patentability of the claims of each of the requests.

IV. Oral proceedings were held on 12 November 1999. In the course of the oral proceedings the appellant dropped all requests except for request B; he requested that the decision under appeal be set aside and a patent granted on the basis of the following documents:

**Claims:** 1 to 13 of auxiliary request B, with claim 2 as amended in the oral proceedings by deletion of the word "folded".

**Description:** pages 1a, 1b and 2 to 6 as filed at the oral proceedings;
page 1 as received on 15 September 1997;
page 7 as originally filed.

**Drawings:** Figures 1 to 5 as originally filed.

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

"Radio Frequency (RF) apparatus having an antenna (102) for receiving an RF signal, the antenna having an antenna port impedance, CHARACTERIZED BY:

a detector diode (111) connected across the antenna (102) to detect modulated signals received by the antenna (102), said detector diode (111) connecting to the antenna (102) through a matching network (113) such

that the impedance of the detector diode (111) at a predetermined RF frequency matches the antenna port impedance transformed through the matching network(113), and

a tunnel diode (121), being selectively biasable into and out of a negative resistance region, connected across the antenna (102) to enhance the backscattering of the antenna (102)."

Claim 13 is a further independent claim directed to substantially the same subject-matter as claim 1 but including the additional feature of a baseband modulator circuit for selectively biasing the tunnel diode to modulate back scattering of the antenna.

## Reasons for the Decision

1. *Background to the invention*

1.1 RF transponders are used for identifying and tracking objects; the transponders are interrogated by means of, for example, a microwave interrogation signal and generate a reply signal including predetermined identification information. This reply signal can either be generated actively by means of a transmitter within the transponder, a power source being required, or passively by retransmitting the received radiation. One example of the latter is a so-called backscatter system in which the antenna, after receiving the transmitted signal, is switched so as to present an impedance mismatch and re-radiate rather than receive the signal. By appropriate switching, usually by means

of a diode across the antenna, information can be modulated onto the interrogating signal to generate a reply signal.

1.2 A problem which arises in backscatter systems is that if a single diode is used both to demodulate the interrogating signal and thereafter transmit a reply by switching across the antenna port, a sub-optimal performance is obtained as the diode must be biased at two different current levels in dependence on whether it acts as a detector or a modulator. A solution to this problem, known from D1, is to provide separate diodes for detection and modulation; Figure 15 of D1 discloses, using the terminology of claim 1 of the application, radio frequency apparatus having an antenna B1 for receiving an RF signal, a detector diode 190 connected across the antenna to detect modulated signals and being connected to the antenna through a matching network 182, 183 such that the impedance of the detector diode at a predetermined RF frequency matches the antenna port impedance transformed through the matching network, and a further diode 188 selectively biasable across the antenna to enhance the backscattering of the antenna.

1.3 Because of physical constraints such as internal resistance on the modulator diode the backscattering is not enhanced to the degree which might be desired. This problem is solved in accordance with claim 1 of the sole request in that the modulator diode is a tunnel diode selectively biasable into and out of a negative resistance region. Such a diode is said to have a characteristic which enables substantially perfect compensation of the antenna resistance at resonance, so

that a substantially perfect short-circuit is formed across the antenna port and the standing wave ratio becomes infinite, giving perfect backscattering.

2. *Inventive step*

2.1 The use of a tunnel diode in a transponder is known *per se* from D4, which discloses a transponder in which an antenna is switched to phase modulate the interrogating signal by means of a diode which is either biased well into its negative region so as to constitute a high impedance, or biased just conducting so that the antenna resonates and re-radiates a phase-shifted signal with a harmonic component derived from the non-linear diode characteristic. D4 includes at column 5, lines 32 to 36 the following passage:

"If a diode which causes a nondestructive breakdown phenomenon such as a constant voltage diode or a tunnel diode is used as the [modulating] diode..., the diode may be biased to a breakdown region...to resonate with a microwave...".

Figure 3 of D4, which is a graph of the characteristics of a suitable diode, suggests that some form of avalanche diode is envisaged which has a low impedance after being negatively biased into the breakdown region. As pointed out by the appellant in the course of the oral proceedings, a tunnel diode does not have a characteristic of this type, so that it is not clear what is to be understood by the reference in D4 to the use of a tunnel diode. The document contains no further reference which would elucidate the operation of a tunnel diode in such a circuit; the only other

reference to a tunnel diode is in the context of generating a strong harmonic component by using a diode with a high degree of nonlinearity, suggesting that the non-linear reverse characteristic of a tunnel diode may be meant.

2.2 The Board accordingly concludes that the skilled person would not be led by D4 to make use of a tunnel diode purely for switching purposes in a transponder. In particular, the D1 circuit referred to above is not concerned with the generation of harmonic components but rather with reflection of the fundamental interrogating signal. The skilled person would therefore only be led by D4 to use a tunnel diode in the context of the D1 circuit if he wished to provide for harmonic components as a reply signal.

2.3 Claim 1 is explicitly limited to a tunnel diode "selectively biasable into and out of a negative resistance region". The Board understands from the explanation in the course of the oral proceedings that such biasing permits the negative resistance characteristic to match the antenna impedance at resonance and provide a more or less perfect zero impedance. Such use of a tunnel diode is not suggested by D4. No other document making use of a tunnel diode has been drawn to the Board's attention.

2.4 The Board accordingly concludes that the subject-matter of claim 1 involves an inventive step.

2.5 Claim 13, the second independent claim, is limited by the same features as claim 1 and its subject-matter accordingly also involves an inventive step.

## Order

**For these reasons it is decided that:**

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent in accordance with the appellant's request.

The Registrar: The Chairman:

M. Kiehl P. K. J. van den Berg