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**Datasheet for the decision  
of 15 September 2009**

**Case Number:** T 1428/07 - 3.5.03

**Application Number:** 98957509.7

**Publication Number:** 1031188

**IPC:** H04B 1/26

**Language of the proceedings:** EN

**Title of invention:**

A field programmable radio frequency communications equipment including a configurable IF circuit and method therefor

**Applicant:**

HARRIS CORPORATION

**Opponent:**

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**Headword:**

Field programmable radio/HARRIS

**Relevant legal provisions:**

EPC Art. 56

RPBA Art. 13(1)

**Relevant legal provisions (EPC 1973):**

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**Keyword:**

"Inventive step - no (main request)"

"Admissibility - no (auxiliary request)"

**Decisions cited:**

-

**Catchword:**

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Case Number: T 1428/07 - 3.5.03

**D E C I S I O N**  
of the Technical Board of Appeal 3.5.03  
of 15 September 2009

**Appellant:** HARRIS CORPORATION  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 6 February 2007  
refusing European application No. 98957509.7  
pursuant to Article 97(1) EPC 1973.

**Composition of the Board:**

**Chairman:** A. S. Clelland  
**Members:** T. Snell  
M.-B. Tardo-Dino

## Summary of Facts and Submissions

- I. This appeal is against the decision of the examining division refusing European patent application No. 98957509.7, with international publication number WO-A-9923761.

The refusal was based, *inter alia*, on the ground that the subject-matter of the claims of a first auxiliary request (which is the only request relevant to these appeal proceedings) did not meet the requirement of inventive step pursuant to Article 52(1) in combination with Article 56 EPC. The examining division referred to the disclosure of the document

D1: WO-A-97/08840

in combination with the common general knowledge of the skilled person.

- II. The appellant filed a notice of appeal against the above decision. Claims of a new request were subsequently filed together with a statement of grounds of appeal.

In the statement of grounds, the appellant requested that the decision under appeal be set aside and a patent granted on the basis of claims 1-12 of the aforementioned newly-filed request.

Oral proceedings were conditionally requested.

III. In a communication accompanying a summons to oral proceedings the board gave a preliminary opinion in which, *inter alia*, it was considered that the subject-matter of the independent claims did not involve an inventive step (Article 52(1) in combination with Article 56 EPC). The board argued, *inter alia*, on the basis of the disclosures of document D1 and the following document known to the board, which the board introduced into these appeal proceedings by virtue of its power under Article 114(1) EPC:

D4: US-A-5444863

IV. With a response to the board's communication, the appellant filed claims of a main and first to third auxiliary requests intended to replace the request on file.

V. Oral proceedings were held on 15 September 2009. At the oral proceedings the appellant withdrew the first to third auxiliary requests and submitted claims of a new auxiliary request. The appellant requested that the decision under appeal be set aside and a patent granted on the basis of claims 1-12 of the main request filed on 17 August 2009 in response to the summons, or alternatively on the basis of claims 1-9 of the auxiliary request filed during the oral proceedings.

At the end of the oral proceedings the board announced its decision.

VI. Claim 1 of the **main request** reads as follows:

"A field configurable transceiver comprising:  
a radio frequency transmitter section (126), a radio frequency receiver section (125), and an intermediate frequency signal processing section (24) coupled to the radio frequency transmitter and receiver sections for processing signals to be transmitted and processing received signals;  
the radio frequency transmitter section (126) includes an input circuit (130, 131, 132) for receiving intermediate frequency digital signals from the intermediate frequency section (24) and converting the intermediate frequency digital signals to radio frequency modulated signals for transmission;  
the radio frequency receiver section (125) is adapted to receiving radio frequency modulated signals, converts the radio frequency modulated signals to intermediate frequency modulated digital signals, and applies the intermediate frequency digital signals to the intermediate frequency section;  
the intermediate frequency section (24) includes configurable digital signal processing circuits (200, 202, 204, 206, 150, 152) responsive to digital commands for selectively configuring the intermediate frequency section to be operative either as a receiver or a transmitter in one of a plurality of receive and transmit modes of operation; and a configuration control circuit (18) coupled to the intermediate frequency section (24) applying digital commands for said configuration, wherein the intermediate frequency section includes a plurality of common circuits (160I, 160Q, 188I, 188Q, 170I, 170Q, 186I, 186Q, 176I, 176Q, 182I, 182Q, 172I, 172Q, 184I, 184Q, 174I, 174Q, 180I,

180Q, 179I, 179Q, 183I, 183Q, 167, 195) that responsive to digital commands can be selected and interconnected as a configured digital intermediate frequency modulator circuit for use in the transmit mode of operation and as a configured digital intermediate frequency demodulator circuit for use in the receive mode of operation."

VII. Claim 10 of the main request reads as follows:

"A method for configuring a field configuration of a radio frequency transceiver for either a transmitter or a receiver mode of operation and for configuring the signaling scheme to be used in the operation of the transceiver, wherein the transceiver comprises a radio frequency transmitter section (126), a radio frequency receiver section (125), and an intermediate frequency signal processing section (24) coupled to the radio frequency transmitter and receiver sections for processing signals to be transmitted and processing received signals, wherein the intermediate frequency signal processing section (24) comprises a configurable digital processing circuit (200, 202, 204, 206, 150, 152), the method comprising:  
providing digital commands to the configurable digital signal processing circuit (200, 202, 204, 206, 150, 152) for selecting one of the plural receiver or transmitter modes of operation, providing digital commands to the configurable digital signal processing circuit (200, 202, 204, 206, 150, 152) for selecting one of a plurality of available signal schemes of operation, and  
selecting and interconnecting a plurality of common circuits (160I, 160Q, 188I, 188Q, 170I, 170Q, 186I,

186Q, 176I, 176Q, 182I, 182Q, 172I, 172Q, 184I, 184Q, 174I, 174Q, 180I, 180Q, 179I, 179Q, 183I, 183Q, 167, 195) included in the intermediate frequency section in response to digital commands for providing a configured digital intermediate frequency modulator circuit for use in the transmit mode of operation or a configured digital intermediate frequency demodulator circuit for use in the receive mode of operation."

VIII. Claim 1 of the auxiliary request corresponds to claim 1 of the main request, with the addition of the following wording:

"wherein said plurality of circuits includes a configurable numerical controlled oscillator (167) and inphase and quadrature mixers (160I, 160Q) that are configurable in response to digital commands as an intermediate frequency modulator circuit and as an intermediate frequency demodulator circuit, and said plurality of circuits includes digital filter circuits (172I, 172Q, 174I, 174Q) in both inphase and [sic] quadrature signal processing circuits that are configurable in response to digital commands, wherein:  
each of the inphase and quadrature signal processing circuits are configurable in response to digital commands to include decimation and interpolator circuits."

Independent claim 7 of the auxiliary request corresponds to claim 10 of the main request, with the addition of wording corresponding to that added to claim 1.

## Reasons for the decision

1. *Claim 1 (main request) - inventive step*
  - 1.1 The present invention concerns a "field configurable transceiver". This, in the board's view, unclear expression is interpreted in the light of the description as meaning that the transceiver can be reconfigured by the user in situ to operate with any of a plurality of radio frequency waveforms or signalling schemes (cf. description, page 10, lines 6-10).
  - 1.2 Document D1 was considered by the examining division as representing the closest prior art. The board agrees, since it is the only document at the board's disposal which discloses a field configurable transceiver in the above sense.
  - 1.3 Document D1 discloses a transceiver with separate modules for carrying out transmit functions and receive functions, referred to respectively as a "common transmit module" and a "common receive module". These modules each comprise intermediate frequency processing sections operating in the digital domain (cf. Fig. 1, "digital submodule" 106, 110). The common receive and the common transmit submodules are reprogrammable for different types of radio function (cf. page 13, lines 11-15). To this end, each digital submodule comprises a digital signal processing circuit DSP and a field programmable gate array FPGA, as well as a numerically controlled oscillator NCO and digital multipliers for quadrature modulation/demodulation (cf. Fig. 2B). Each module is further equipped with an



interface for reprogramming via an external computer (cf. Fig 2B and page 19, lines 9-17), or is configurable via internal memory interacting with the DSP and the FPGA (cf. page 19, lines 13-17). The common receive and common transmit modules also comprise respective analog submodules 104 and 108 for converting between an intermediate frequency processed by the intermediate frequency section and the radio frequency transmitted or received by the antenna. Each analog submodule has a respective frequency synthesizer (cf. Fig. 2A). However, in order to reduce overhead in half-duplex operation, it is proposed in a further embodiment to use the synthesizer of the common receive module to tune the common transmit module (cf. page 73, lines 33-37), ie to commonly use a single synthesizer for both transmitting and receiving.

- 1.4 Using the language of claim 1, document D1 discloses a field configurable transceiver comprising:

a radio frequency transmitter section (Fig. 1: 108), a radio frequency receiver section (104), and an intermediate frequency signal processing section (110, 106) coupled to the radio frequency transmitter and receiver sections for processing signals to be transmitted and processing received signals; the radio frequency transmitter section (108) including an input circuit (Fig. 2A: 102) for receiving intermediate frequency digital signals from the intermediate frequency section and converting the intermediate frequency digital signals to radio frequency modulated signals for transmission; the radio frequency receiver section (Fig. 2A: 104) being adapted to receive radio frequency modulated

signals, convert the radio frequency modulated signals to intermediate frequency modulated digital signals, and apply the intermediate frequency digital signals to the intermediate frequency section;

the intermediate frequency section (Fig. 2B: 110, 106) including configurable digital signal processing circuits (DSP 112, FGPA 114) responsive to digital commands for selectively configuring the intermediate frequency section to be operative in one of a plurality of receive and transmit modes of operation (cf. page 17, lines 4-32); and

a configuration control circuit coupled to the intermediate frequency section applying digital commands for said configuration (cf. page 19, lines 13-17).

1.5 The subject-matter of claim 1 differs from the disclosure of document D1 in that the intermediate frequency section is configurable to be operative either as a receiver or a transmitter, wherein the intermediate frequency section includes a plurality of common circuits that responsive to digital commands can be selected and interconnected as a configured digital intermediate frequency modulator circuit for use in the transmit mode of operation and as a configured digital intermediate frequency demodulator circuit for use in the receive mode of operation.

1.6 The technical effect of this difference is that the claimed apparatus has reduced circuitry as compared to D1, and is therefore lighter and consumes less power.

The problem to be solved starting out from D1 is therefore considered as being to improve the transceiver by reducing its weight and power consumption.

1.7 In the board's view, the skilled person would find a solution to this problem from document D4. D4, in a section on technical background, describes a conventional transceiver with separate receive and transmit processing chains (cf. Fig. 12 and column 1, lines 13-66). However, as in D1, a common synthesizer 51 is utilized in half-duplex operation. The skilled person would therefore recognise the parallels with the basic transceiver structure of D1.

1.8 D4 then outlines the problem to be solved and its solution as follows (cf. column 2, lines 4-32):

"However, the conventional radio telephone generally comprises an independent transmitter system and an independent receiver system. Thus, the circuit configuration of the entire apparatus is large and complex. In the prior art, individual circuits have been integrated in LSIs to reduce the size of the apparatus, but the number of chips is large and there is a limit in miniaturization of the entire circuits. In addition, there are circuits, such as filters, which are difficult to integrate, and this also limits the reduction in size and weight. Furthermore, the number of circuits is high and power consumption is also high

accordingly. Thus, it is difficult to reduce the power consumption of the entire apparatus.

#### SUMMARY OF THE INVENTION

It is one of the objects of the present invention is to provide a radio communication apparatus reduced the number of circuit [sic]. The second object of the present invention is to reduce the size and weight of the apparatus. The third object of the present invention is to reduce the power consumption so as to increase the life of batteries.

In order to achieve the above objects, the present invention has the following features. Circuits having similar functions and used separately by a transmitter system and a receiver system are integrated as much as possible and commonly used by the transmitter and receiver systems."

- 1.9 D4 further proposes that modulation and demodulation circuits (here, in the analog domain) make use of common multipliers (cf. column 4, lines 25-27), and that digital roll-off filters be commonly used for a transmit function and a receive function (cf. column 5, lines 3-7). In order to configure the transceiver in transmit mode or receive mode, "switch circuits are operated to connect the commonly used circuit selectively to the transmission system circuits of the transmitter system or to the reception system circuits of the receiver system" (cf. column 2, lines 64-68).

It is also stated in D4 that "the circuits from the radio high-frequency stage to the digital circuit of the demodulation base band are commonly used by the transmission and reception systems. However, only a part thereof may be commonly used on an as-needed basis" (cf. column 8, lines 9-14).

- 1.10 In the board's view, the skilled person would derive from these passages of D4 the general teaching that, in order to solve the above-mentioned problem, any circuit from the RF stage to the baseband stage may be a candidate for common use by a transmitter circuit and a receiver circuit, whereby switches under digital control are provided for each common component to configure the transceiver in either the transmit or receive mode.
- 1.11 When applying this teaching to D1, it would be apparent to the skilled person that certain components of the digital IF section, in particular the digital synthesizer and multipliers forming the quadrature modulator and demodulator circuits (cf. Fig. 2B, quadrature mixer 116, NCO 118 and the corresponding unnumbered circuits of the digital downconverter) may be designed for common use, all the more so as equivalent, albeit analog, components are proposed for common use in D4. The skilled person would therefore be led by D4 to provide the circuit of D1 with an intermediate frequency section as claimed without the exercise of inventive skill. In consequence, the board concludes that the subject-matter of claim 1 does not involve an inventive step (Articles 52(1) and 56 EPC).

1.12 The appellant provided the following main arguments against this view:

- (i) It is an essential aspect of D1 that the transmit and receive circuits are located in separate and self-contained modules with no circuit sharing. This modular processing and control architecture is deliberately chosen in D1 in order to reduce cross-talk, to simplify built-in-tests, fault-isolation-tests and maintenance, to simplify security isolation between channels and to more easily scale the system to larger or smaller simultaneous radio function capacity. D1 therefore only contains pointers teaching away from the common use of circuits for transmitter and receiver.
- (ii) The invention makes use of reprogrammable digital hardware in the form of an ASIC rather than a software-based reprogrammable DSP. This enables components to be easily connected in a different sequence for transmission and reception.
- (iii) D1 and D4 are transceivers providing both transmission and reception capability "simultaneously". According to the invention, however, the apparatus is configured to be either a transmitter or a receiver, which is an entirely different solution not addressed by D1 and D4.
- (iv) The invention relates to a transceiver which is field configurable to be either a transmitter or a receiver, in plural modes of operation, based on digital commands. In contrast, D4 discloses a static circuit comprised of hardwired components without any such digital control since the switch control signals VT and VR in D4 (see Figs. 1-11) cannot be regarded as "digital commands".

- (v) D4 suggests circuit sharing mainly for analog components, and in any case not for a digital intermediate frequency processing section, which is not present in D4. For this reason, D4 is hardly compatible with D1. Therefore it is unlikely that a combination of D1 and D4, even if attempted, would lead to the invention.

1.13 With respect to (i): The board disagrees that the skilled person starting out from D1 would, *a priori*, reject the idea of circuit sharing. The board can find no passage of D1 suggesting that the structure based on separate transmit and receive modules was deliberately and definitively chosen for the reasons advanced by the appellant. On the contrary, as has been pointed out, circuit sharing in the RF analog part of the transceiver is suggested in D1 in order to reduce overhead. The board therefore sees no inherent bar to extending this principle to other parts of the transceiver.

With respect to (ii): This aspect is not reflected in the wording of claim 1, but in any case D1 makes use of the same type of reprogrammable hardware (cf. page 15, line 26 and page 21, lines 34-37).

With respect to (iii): The board sees no fundamental difference between half-duplex operation (ie as proposed in D1), whereby the transceiver changes its configuration between transmit and receive modes relatively often, time-division duplex operation (ie as proposed in D4), whereby the transceiver changes its configuration between transmit and receive modes

continuously, and a more static situation in which the transceiver is programmed to be in one mode or the other for a long period, as apparently is the case for the present invention.

With respect to (iv): The starting point for the invention is D1, which describes a "field configurable transceiver" (see point 1.1 above) for multimode operation under digital control, not D4. As regards D4, the board disagrees that it discloses a static circuit, since it comprises switches for configuring the circuit dynamically as either a transmitter or a receiver. The board also disagrees that the control signals VT and VR for these switches are not digital control signals. In any case, as regards digital control of switches, the board observes that D1 makes use of digital control signals to adaptively route signals among the various units within the digital submodule (cf. D1, page 21, line 34 - page 22, line 5). Providing digital switch control signals for reconfiguring between transmit and receive modes is therefore an obvious step.

With respect to (v): The fact that D4 in its exemplary embodiment uses direct conversion without an IF stage is in the board's view unimportant, since IF values are in general also radio frequencies. The RF input signal to the mixer circuit in D4 could therefore equally well be an IF signal. In any case, document D4, in column 7, lines 60-64, mentions that a non-zero IF frequency may be used, ie contemplates a similar transceiver structure to document D1. With respect the use of common analog instead of digital circuits in D4, the skilled person would be well aware that certain transmitter or receiver circuit components, in



particular mixers, synthesizers and filters, may be implemented in either the analog or digital domains according to circumstances. Thus, the skilled person would immediately recognise that the quadrature demodulator circuit of D4, although carried out in the analog domain, could equally well have been implemented in the digital domain, as in D1. Moreover, although the appellant alleges that D4 concentrates on the common use of analog components, the system of D4 makes use of reconfigurable filters in the digital processing part (cf. column 5, lines 4-7) and expressly states that circuits from the RF stage to the digital demodulation baseband may be commonly used (cf. column 8, lines 9-14). For these reasons, the board considers that D1 and D4 are not in any way incompatible and that, based on the teaching of D4, it would be obvious for the skilled person to modify the digital intermediate frequency section of the transceiver of document D1 to include configurable digital processing circuits as claimed.

In consequence, the board finds the appellant's arguments unconvincing.

1.14 The above reasoning applies *mutatis mutandis* to method claim 10.

2. *Auxiliary request - admissibility*

2.1 The auxiliary request was filed at a late stage of the oral proceedings after the main request had been debated at length. The independent claims of the auxiliary request are further limited with respect to the independent claims of the main request to include

specific components of the intermediate frequency section which may be reconfigured to operate in either transmit or receive mode. However, in the board's view these components are only those which the skilled person having regard to the disclosures of D1 and D4 would immediately consider as suitable for common use in both transmit and receive modes. *Prima facie*, the claims of the auxiliary request would therefore not overcome the objection of lack of inventive step. In this light, given the late stage reached in the oral proceedings before this request was filed, the board has exercised its discretion not to admit the request (cf. Article 13(1) RPBA).

3. *Conclusion*

As claims 1 and 10 of the main request are not allowable, the main request as a whole is not allowable. Since the auxiliary request is not admissible, it follows that there is no allowable request. The appeal must therefore be dismissed.

**Order**

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

The appeal is dismissed.

The Registrar:

The Chairman:

D. Magliano

A. S. Clelland