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D E C I S I O N
of 17 July 2002

Case Number: T 0216/98 - 3.4.2

Application Number: 87303866.5

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Language of the proceedings: EN

Title of invention:
Low cost high precision sensor

Patentee:
TEXAS INSTRUMENTS INCORPORATED

Opponent:
(01) Robert Bosch GmbH
(02) Endress + Hauser GmbH + Co.

Headword:
-

Relevant legal provisions:
EPC Art. 56, 84
EPC R. 67

Keyword:
"Main and auxiliary requests - inventive step (no)"
"Reimbursement of appeal fee (no)"

Decisions cited:
T 0433/93

Catchword:
-



Case Number: T 0216/98 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 17 July 2002

Appellant: TEXAS INSTRUMENTS INCORPORATED
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 22 December 1997
revoking European patent No. 0 245 031 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: M. A. Rayner
B. J. Schachenmann

Summary of Facts and Submissions

I. The present appeal is against the decision of the opposition division revoking European patent number 245 031 (application number 87 303 866.5). The patent concerns a low cost high precision sensor and in the proceedings before the first instance reference was made inter alia to the following documents:

ED1: DE-A-2 755 306 (=US-A-4 128 006)

ED8: EP-A-0 169 414

II. The opposition division found that the subject-matter of the independent claims before it lacked either novelty (main request) or inventive step (auxiliary requests) in view of document ED8. The division remarked in the decision (point 2.3 of the reasons) that the patent proprietor had insisted that calibration implied a fixed predetermined relationship between an output signal and the variable to be measured whereas compensation involved the introduction of a further correcting factor which enables disturbing influences to be removed from the output signal. A similar submission of the patent proprietor is recorded in the minutes of the oral proceedings (point 3.3). The opposition division gave both during the oral proceedings (point 3.6) and in the decision (point 2.3) its interpretation of the term "calibration" as meaning a process for establishing a relationship between a physical variable to be measured and an output signal so that the correct value of the variable can be measured. The opposition division considered compensation of temperature according to document ED8 to amount to a re-calibration.

III. In the appeal proceedings, oral proceedings were requested on an auxiliary basis by the appellant (=patent proprietor) and respondent 2 (=opponent 02) oral proceedings being appointed by the board consequent to these requests. In an annex to the summons, the board informed the parties of its intention, if possible, of reaching a decision at the end of the oral proceedings. The board also informed the parties of its provisional opinion that the position of the appellant in relation to the terms "calibration" and "compensation" appeared to have been taken into account in the decision of the opposition division, the board thus doubting that any procedural violation had occurred before the first instance. It seemed that, in its decision, the opposition division simply had a different view to the appellant. Following the summons to oral proceedings, the appellant made no further substantive comment but merely advised the board that the oral proceedings would, owing to budgetary constraints and despite continuing interest, not be attended. The oral proceedings accordingly took place in the absence of the appellant according to Rule 71(2) EPC but in the presence of both respondent 1 (=opponent 01) and respondent 2 (=opponent 2).

IV. The case of the appellant can be summarised as follows:

IV.i Requests

The appellant, in the grounds of appeal dated 30 April 1998, requests setting aside of the decision of the opposition division and maintenance of the patent in amended form based on claims filed as main request or one of seven auxiliary requests. Furthermore, reimbursement of the appeal fee was requested because a

substantial procedural violation had taken place.

IV.ii Independent claim 1 upon which the respective requests of the appellant are based has the following wording:

Main request

1. A low-cost high precision sensor (10,210,410,160) having a condition-responsive means (12,212,412) for providing initial electrical signals within a first predetermined range in response to particular conditions in a zone to be monitored and analog signal-conditioning means (43,243,443) for conditioning the initial electrical signals to provide electrical output signals from the sensor for performing predetermined control functions, the condition-responsive means and the analog signal-conditioning means being mounted on a common support (16,18,20), characterized in that there are also provided means for adjusting the calibration of the sensor (94,96,316,318,320,322,324,326,328,446,544,546,694), the calibration adjustment means also being mounted on the common support and being electrically actuatable when on the support to effect adjustment of the bias and gain applied to the initial electrical signals from the condition-responsive means by the analog signal-conditioning means after mounting those means on the support so as to calibrate the sensor to provide output signals within a second predetermined range to perform said control functions in response to said particular conditions.

First auxiliary request

This request differs from the first request by insertion of the word "calibrated" between "precision"

and "sensor" in the first line of claim 1.

Second auxiliary request

1. A method of providing a low-cost high precision calibrated sensor (10,210,410,160), the method comprising,

providing on a common support a condition-responsive means (12,212,412) for providing initial electrical signals within a first predetermined range in response to particular conditions in a zone to be monitored, analog signal-conditioning means (43,243,443) for conditioning the initial electrical signals to provide electrical output signals from the sensor for performing predetermined control functions, and means for adjusting the calibration of the sensor, and then electrically actuating the calibration adjustment means to effect adjustment of the bias and gain applied to the initial electrical signals from the condition responsive means by the analog signal-conditioning means, so as to calibrate the sensor to provide output signals within a second predetermined range to perform said control functions in response to said particular conditions.

Third auxiliary request

1. A low-cost high precision calibrated sensor (10,210,410,160) having a condition-responsive means (12,212,412) for providing initial electrical signals within a first predetermined range in response to particular conditions in a zone to be monitored and analog signal-conditioning means (43,243,443) for conditioning the initial electrical signals to provide electrical output signals from the sensor for

performing predetermined control functions, the condition-responsive means and the analog signal-conditioning means being mounted on a common support (16,18,20), characterized in that there are also provided means for adjusting the calibration of the sensor (94,96,316,318,320,322,324,326,328,446,544,546,694), the calibration adjustment means also being mounted on the common support and being electrically actuatable when on the support to effect adjustment of the bias and gain applied to the initial electrical signals from the condition-responsive means by the analog signal-conditioning means after mounting the signal-conditioning means on the support so as to adjust response of the sensor to the variation of the particular conditions to be monitored such that the sensor provides output signals within a selected range corresponding to particular conditions in the zone to be monitored within a selected range, whereby control functions are performed in response to said particular conditions.

Fourth auxiliary request

1. A low-cost high precision sensor (10,210,410,160) having a capacitive condition-responsive means (12,212,412) for providing initial electrical signals within a first predetermined range in response to particular conditions in a zone to be monitored and analog signal-conditioning means (43,243,443) for conditioning the initial electrical signals to provide electrical output signals from the sensor for performing predetermined control functions, the condition-responsive means and the analog signal-conditioning means being mounted on a common support (16,18,20), characterized in that there are also

provided means for adjusting the calibration of the sensor (94,96,316,318,320,322,324,326,328,446,544,546,694), the calibration adjustment means also being mounted on the common support and being electrically actuatable when on the support to effect adjustment of the bias and gain applied to the initial electrical signals from the condition-responsive means by the analog signal-conditioning means after mounting the signal-conditioning means on the support so as to calibrate the sensor to provide output signals within a second predetermined range to perform said control functions in response to said particular conditions.

Fifth, sixth and seventh auxiliary requests

These requests are as the first, second and third requests, respectively, with the further amendment that the word "capacitive" be inserted before "condition responsive means" in the manner of the fourth auxiliary request.

IV.iii Submissions

The opposition division was wrong in not accepting there is a difference between calibration and compensation. In general, a calibrated sensor may be uncompensated and a compensated sensor may be uncalibrated. Document ED8 does not disclose a calibrated sensor having an electrically actuatable calibration adjustment means nor having the items required on a common support. The whole thrust of document ED8 is towards providing temperature compensation. Calibration is fixed before use to give a known output for a known input. However, the device of document ED8 makes frequent adjustments not to the

relationship between a known input pressure and the output voltage but to bias and gain so as to ensure output voltage is always the same for a particular pressure, this being called "re-calibration" in a specious manner by the opposition division. To achieve calibration adjustment by electrical actuation in document ED8 it would, however, at least be necessary to choose the numbers in the memory to be such that the relationship between the input and output is a desired one. Document ED8 mentions a standard or normalised output but this is associated with a fixed resistance, a resistor R_G also being shown in Figure 2. Document ED8 does not concern itself with how calibration is to be effected in Figure 5. The skilled person would thus be led to provide an additional amplifier stage for the Figure 5 embodiment with a chosen fixed resistance if he wanted to achieve a desired calibration. Since document ED8 does not disclose an electrically actuatable calibration means, it cannot disclose a support therefor. Moreover, it is immediately apparent that not all of the components shown in Figure 2 are included in the integrated circuit, where exactly the integrated circuit and sensing bridge are located not being explicitly stated. The use of the word "wires" for connecting implies however that the measuring bridge is some distance from the integrated circuit. The arrangement of document ED8 thus leads away from a common support. In relation to ED8 there are inventive step issues of whether ED8 would by itself have led the skilled person of itself to arrive at the invention as claimed in claim 1 and whether ED8 would have led the skilled person to modify the device disclosed in ED1 to arrive at the present invention. In either case, that would not have occurred because document ED8 simply does not disclose calibration adjustment, something

entirely different from compensation which it does disclose, by means of electrical actuation. Accordingly, the subject-matter of claim 1 of the main request is both novel and inventive. Claim 1 of the first auxiliary request specifically recites that the sensor claimed is calibrated. The claims of the second auxiliary request are cast in method form. The compensation technique disclosed by document ED8 may affect the bias and gain applied to the signals from the transducer but it does not result in the final level of the output signal corresponding to any particular input signal being a selected one as required by claim 1 of the third auxiliary request. With respect to the fourth auxiliary request, temperature compensation is unnecessary for capacitive sensors so that use of a capacitive arrangement cannot have been obvious in the context of document ED8. Accordingly, the subject-matter of claim 1 of all the auxiliary request is both novel and inventive.

Despite section 3.3 of the minutes of the oral proceedings acknowledging the submissions of the appellant relating to the differing meanings of "calibration" and "compensation", a procedural violation occurred because the opposition division had given its opinion at the beginning of the oral proceedings, whereas it should have been contained in the summons to oral proceedings. The opposition division did not hear submissions differing from its own interpretation of "calibration" and the appellant had no opportunity to provide evidence in support of its case in advance of the oral proceedings. Reference was now made during the appeal proceedings to text books on instrumentation and measurement and a technical dictionary. If, now, the board were to decide

on novelty against the proprietor, the appellant would thus have been denied a fair hearing before the first instance on this ground. Moreover, in view of the fact that the chairman of the opposition division was unwilling to hear the submissions of the patent proprietor, remittance to a differently constituted opposition division is appropriate (see case T 493/93).

V. The case of respondent 1 can be summarised as follows:

V.i Requests

Respondent 1 requests that the appeal be dismissed.

V.ii Submissions

During the oral proceedings, respondent 1 explained that according to document ED8, the test phase of the device, whether it be called calibration or compensation, involves various pressures at which temperature is varied. Since various pressures are used, a pressure calibration (Eichung) is effected. With respect to the common support, the patent discloses this term as meaning all the parts allocated to the sensor. In the case of document ED8, the integrated circuit is comprised in the sensor (see page 6, lines 10 to 14 or page 11, line 21 and the reference to a single IC and compact form) and thus falls within this definition of "common support". Respondent 1 also drew attention to ED1 as disclosing component 34, which is also calibrated according to the second part of the second paragraph on page 11 and where a common support 38 is shown. Therefore the subject-matter of claim 1 of the main request and first auxiliary request is not novel. Since the subject-

matter of claim 1 of auxiliary request II differs in form but not in substance from the preceding requests (method as opposed to apparatus claim), its subject-matter is also not new for corresponding reasons. The amendment made according to auxiliary request III is not clear and can amount to no more than some undefined adjustment. A capacitive sensor is well known to a skilled person in the sensor field and thus obvious and is moreover also explicitly disclosed in document ED1. The subject-matter of the fourth to seventh auxiliary requests does not contain anything not contained in the previous requests and is thus not patentable for corresponding reasons.

VI. The case of respondent 2 can be summarised as follows:

VI.i Requests

Respondent 2 requested that the appeal be dismissed.

VI.ii Submissions

In relation to features of calibration and support argued novel over document ED8 by the appellant, in fact exactly the calibration concerned occurs according to the test phase described in document ED8. Figures 1 and 2 also disclose a common support. The subject-matter of claim 1 is therefore not new. The reference to calibration in claim 1 of the auxiliary request is self evident. Corresponding considerations apply following change of category to method claims according to the second auxiliary request. An objection under Article 84 EPC arises against claim 1 of auxiliary request 3. In particular, it is not clear because the "response" of the sensor is not defined. Although the

second line of the claim mentions condition responsive means, it is indeterminate whether the response of this means, for example in relation to the initial electrical signal, or a change in either the signal conditioning means or the output signal is meant. Therefore, a definite relationship between the physical parameter and output signal is no longer even necessary. A restriction to a capacitive sensor is not able to form the basis of an inventive step (auxiliary request 4). Respondent 2 underlined during the oral proceedings that the term support has to be read broadly and thus reads on to the components disclosed in document ED8. Moreover, document ED1 discloses a common support 38.

VII. The board gave its decision at the end of the oral proceedings.

Reasons for the Decision

1. *Admissibility of the appeal*

The appeal complies with the provisions mentioned in Rule 65(1) EPC and is therefore admissible.

2. *Prior art*

Pertinent disclosures in prior art documents in the proceedings are as follows:-

2.1 Document ED1

This document discloses (see Figure 2) a pressure transducer 10 comprising a metal housing 12, a

plurality of electrical leads 18 extending from the housing 12 for supplying electrical energy thereto and taking pressure indicative electrical signals therefrom, a seal 20 for providing a moisture-proof seal for the conductors 18 and a housing cover 14 which has a hollow stem 16 for receiving pressure signals. The pressure transducer includes an electrical circuit 36 comprising a printed circuit board 38 carrying a plurality of electrical components including a variable component 34 such as a capacitor or a variable resistor. Access to the variable elements is provided by a respective sealable aperture 32 in the side wall of the housing 12. After adjustment, apertures may be covered and the housing sealed with adhesive, also functioning as a label bearing indicia identifying the pressure sensor and its specifications. The electronic circuit is mounted on, parallel to and spaced from a substrate 42 mounted on and carried parallel to a mounting plate formed by cover 14. The substrate 42 includes three staking posts 40 with reduced diameter ends forming a shoulder 41 which bears against the underside of the circuit board 38. The reduced diameter ends extend through the circuit board 38 to secure the printed circuit board 38 to the staking posts. Pressure transducer 56 is mounted between substrate 42 and mounting plate 14.

2.2 Document ED8

This document discloses with reference to Figure 1 a piezoresistive pressure transducer with a measurement cell 1 with a measuring diaphragm 3 and resistances 5 thereon. The resistances 5 are disposed in the form of a measuring bridge 7 fed with current from a regulated power supply circuit, via wires 9. In a preferred

embodiment, the entire circuit arrangement can be accommodated in compact form on a single IC. According to Figure 2, the output signal is fed to an output differential amplifier 15 the output of which is the analog pressure measurement signal. A resistor R_G establishing, rangewise, the magnitude of the pressure measurement signal is connected to the amplifier 15. Changing temperature leads to changing analog voltage difference across the bridge input, which is fed to a differential amplifier 17, the output of which is applied over a line 37 to analog/digital converter 21 and converted into a digitalized compensation signal. Compensation values stored in fixed value memory 23 are provided for compensation of the pressure measurement signals, both for zero point compensation via the offset input of the output amplifier 15 and for sensitivity via the gain input (see Figure 5). In operation, cyclic compensation values are stored by reading over old values.

In a test phase, at a given amplification (see especially the last paragraph of page 12), variation of output signal is measured for a few pressures with changing temperature. Only a few temperatures need be measured as the compensation values can be interpolated for the remaining temperatures. Programming of the fixed value memory 23 is done via input 64 in Figure 4. Since the resistances in the measurement bridge 7 can vary within certain limits from one transducer to another, an individual test provides the temperature compensation required for the pressure measurement signal for any given pressure transducer. It is also possible to compensate for subsequent stability displacements of the zero point by connection of an additional potentiometer or resistance bridge, by which

it is possible to establish a normalised or standard output.

3. *Novelty - main request*

3.1 The features in the preamble of claim 1 are disclosed in document ED1. In addition, since component 34 (=calibration adjustment means) is adjusted and is also mounted on the circuit board 38 (=common support), only the features from "and being electrically actuatable" are novel over the disclosure of document ED1.

3.2 In relation to document ED8, the bridge is a condition responsive means and the amplifier is an analogue signal conditioning means with electrically actuatable adjustment of bias and gain. There are two issues in dispute between the parties in relation to novelty of the subject-matter of claim 1 which concern the meaning of "calibration" and of a "common support". It is therefore necessary to analyse what is meant by these terms in the patent and how this compares with document ED8.

3.3 The term "Calibration"

Reference to the patent in dispute shows that there is provided calibration means which can be integrally incorporated on chip in an integrated circuit mounted on a common support with the transducer to be actuated by electrical input through the integrated circuit after assembly on the common support. The calibration means comprises, for example, a shift register receiving clock input and calibrating data for cooperating with memory means such that calibration data for the sensor is entered into the memory via the

shift register from sensor testing apparatus while the pressure in the zone to be monitored is set first at a desired low level and then at a desired high level. That is, the sensor is first subject to calibration testing at each of the high and low pressure and additional calibration data is inserted into the register as necessary to adjust the sensor output voltages within the desired output voltage range to provide bias and gain calibration (see for example page 5, lines 33 to 46).

In the view of the board, the "test phase" of document ED8 as explained in point 2.2 above and the "calibration testing" disclosed in the patent both involve relating pressures to outputs, i.e. testing output signal at different pressures amounts in both cases to calibration. The board reaches this view because the values programmed according to document ED8 are taken at several pressures. There is therefore no doubt that the values concerned adjust the bias and gain applied to the amplifier thus calibrating input and output. Therefore, contrary to the perception of the appellant calibration testing as represented by the wording of the claim is not novel over the test phase disclosed in document ED8. The references to third documents in the form of textbook and dictionary citations as concerning the meaning of "calibrate" and "compensate" do not bear on the novelty issue in the present case, which is concerned with what is actually done according to document ED8 and the patent according to the "calibration testing" and "test phase" rather than what it is called. In particular, the test phase referred to in document ED8 takes place before use and establishes input and output relationship thus being consistent with the concept of calibration. In the view

of the board, the references to third documents in the present case thus generate a purely semantic argument which no more than blurs the novelty issue in relation to post calibration operation of the sensor. Cyclic reading over of amplitude and offset occurs in such post calibration operation and is thus not part of the "test phase" and thus the reference of the appellant to frequent adjustment of the relationship between the input and output signals in the context of an allegedly specious argument of the opposition division does not persuade the board as to novelty. Similar the optional provision of a ranging resistor is also not part of the "test phase" and thus does not affect the lack of novelty of the calibration testing of the patent over the test phase of document ED8. Equally, questions relating to the needing for calibration of further amplitude stages and the like as postulated by the appellant do not bear on the calibration effected in the test phase.

3.4 The term "Common Support"

Reference to the patent in dispute shows that the common support comprises an annular supporting portion of a sensor body and has a metal support ring secured by a metal cap (see page 4, lines 8 to 11 as well as the reference numerals used in the claim). The respondents are therefore correct in arguing that the support includes virtually the entire casing of the transducer carrying the circuit board. There are strong indications in document ED8 that all the electrical parts are also mounted in a common housing, e.g. the reference to a compact form referred to by respondent 1. Nevertheless, in the view of the board such indications are not sufficient to remove novelty

from this feature as it is possible that the remaining circuitry could be removed from the transducer bridge, for example in view of the mention of "wires" as argued by the appellant.

3.5 The subject-matter of claim 1 of the main request is therefore novel within the meaning of Article 54 EPC having regard to documents ED1 and ED8.

4. *Inventive step - main request*

4.1 Since document ED8 discloses an electrically set up device, it is considered to be the closest prior art document and the subject-matter of claim 1 differs from this disclosure by virtue of the provision of a common support. The problem solved by this feature can be seen as enabling the circuit components to be mounted together. A common support solving this problem is disclosed by printed circuit board 38 in document ED1 which carries a plurality of circuit components and is mounted in the same housing as pressure transducer 56. In the view of the board, the references to a compact form in document ED8 (page 11) make obvious technical sense in the context of mounting the circuitry in the same housing as the transducer and therefore the board sees no inventive step in applying this measure to the device of document ED8.

4.2 Accordingly, the board reached the conclusion that the subject-matter of claim 1 of the main request cannot be considered to involve an inventive step within the meaning of Article 56 EPC.

5. *Auxiliary requests*

- 5.1 A specific reference to "calibrated" in the claims according to the first auxiliary request does not change the conclusion reached in point 4.1 as to lack of inventive step because the board considers this subject-matter known from document ED8 for the reasons given in point 3.3 above. Quite apart from this, the board considers it, in general, to be completely routine for sensors to be calibrated and considers that, in practical pressure measuring, the skilled person prefers a calibrated sensor to an uncalibrated sensor. Since calibration and a common support as expressed in the claims do not lead to patentable subject-matter, recasting the claim in method form according to the second auxiliary request is not considered to result in subject-matter involving an inventive step.
- 5.2 The board agrees with the respondents that the amended feature of the claim relating to adjusting response of the sensor is not clear because unlike the precise term "calibration" used in preceding versions of the claim, this terminology leaves open whether a precise relationship between a physical variable to be measured and an output signal is defined. Therefore the amendment effected according to the third and seventh auxiliary requests cannot be considered clear as required by Article 84 EPC.
- 5.3 Both piezoelectric and capacitive sensors are well known for pressure measurement as argued by the respondents and so in principle are interchangeable within the framework of the knowledge of the skilled person without any inventive step. The appellant stressed that temperature compensation is not necessary for capacitive transducers as opposed to piezoelectric

transducers and that therefore document ED8 would not have been taken into account by the skilled person. The board is not persuaded by this argument because in making the sensor of document ED8 compact as explained in point 4.1 above, the capacitive sensor supported according to document ED1 is automatically taken into account, so that the skilled person knew it to be obvious to calibrate any type of sensor known from document ED1 or ED8. Accordingly, the subject-matter of the fourth to sixth auxiliary requests cannot be considered to involve an inventive step within the meaning of Article 56 EPC.

5.4 Therefore, the subject-matter of claim 1 of the third and seventh auxiliary request is not clear within the meaning of Article 84 EPC and that of the first, second and fourth to sixth auxiliary requests cannot be considered to involve an inventive step within the meaning of Article 56 EPC.

6. *Procedural error*

6.1 It is not unusual for opposition divisions to advance a preliminary opinion at the beginning of oral proceedings especially if it is believed this might be helpful as an orientation help for the parties or to procedural efficiency. The parties remain of course free to present their cases as they see fit and in the present case the opposition division heard and took into account in its decision the submissions of the appellant relating to the meaning of terms used in documents in the proceedings, but was not persuaded by these submissions. The board cannot identify any procedural error in this situation. Furthermore, no reason for remittal is provided by the reference of the

appellant to textbook and dictionary definitions as these form neither part of the patent nor of the prior art references considered in the arguments on novelty and inventive step. Moreover, despite the concern of the appellant that it had not had opportunity to present these reference to the opposition division, it then did not avail itself of the opportunity of presenting its case orally before the board. The present case differs from that of decision T 433/93 (new ground of opposition introduced into the proceedings) and as the board cannot identify any procedural violation as having occurred, no reason for reimbursement of the appeal fee under Rule 67 EPC exists. Consideration of the composition of the opposition division is not therefore necessary.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

P. Martorana

E. Turrini