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**Datasheet for the decision
of 22 October 2007**

Case Number: T 1498/05 - 3.4.02

Application Number: 98937326.1

Publication Number: 1046020

IPC: G01D 3/02

Language of the proceedings: EN

Title of invention:

Electronic circuit for automatically compensating for errors
in a displacement sensor

Applicant:

Siemens VDO Automotive Corporation

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Decision according to the state of the file"

Decisions cited:

-

Catchword:

-



Case Number: T 1498/05 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 22 October 2007

Appellant: Siemens VDO Automotive Corporation
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Representative: Lieck, Hans-Peter
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 11 July 2005
refusing European application No. 98937326.1
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: A. Klein
Members: F. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

I. European patent application No. 98937326.1 (publication number W099/35468) relating to an electronic circuit for automatically compensating for errors in a displacement sensor was refused in a decision, dispatched on 11 July 2005, of the examining division on the ground that the subject-matter of the independent claims according to the main and the second auxiliary requests then on file was anticipated by the teaching of document D3; and that the claims according to the first and third auxiliary requests did not involve an inventive step (Art. 52(1) and 56 EPC) in view of the teachings in documents D4 and D3:

D3: DE-U-296 22 602;

D4: US-A-5 274 328.

II. Against this decision the applicant (appellant) lodged an appeal which was received on 19 September 2005 and paid the fee for the appeal on the same day. With the statement setting out the grounds of appeal filed on 21 November 2005 the appellant filed new claims according to a main and first and second auxiliary requests. The appellant requested that the decision under appeal be set aside and the newly filed claims be allowed or, alternatively, oral proceedings.

III. The wording of claim 1 according to the main request reads as follows:

"Displacement sensor including an electronic circuit (300) for automatically compensating for errors in

sensor output signals, the electronic circuit (300) comprising:

an electronic memory (306) for storing predetermined compensation values including at least one first slope value and at least one second value;

compensating means (304) for automatically compensating said sensor output signals, wherein

said electronic memory (306) stores a plurality of successive ideal output values defining a range between each successive ideal output value, said electronic memory (306) storing compensation values in the form of a slope value and an offset value for each range; and

said compensating means (304) includes means for receiving said sensor output signals, means for determining the range of said sensor output signals, and means for multiplying said sensor output signal by said slope value corresponding to the range of said sensor output signal defining a product and adding the offset signal corresponding to the range of said sensor output signal to said product thereby compensating the sensitivity as well as the offset of said sensor output signals over an overall range of the sensor".

Claims 2 to 12 of this request are dependent claims.

Claim 1 according to the first auxiliary request is as claim 1 according to the main request with the additional features:

"...(of the sensor); and wherein the electronic circuit (300) comprises a test interface (310) which enables the compensation values to be determined and programmed into the electronic memory (306)".

Claim 1 according to the second auxiliary request is as claim 1 according to the main request with the additional features:

"...(of the sensor); and wherein the electronic circuit (300) comprises a test interface (310) which enables the compensation values to be determined and programmed into the electronic memory (306) and an isolation interface (362, 364, 366, 368, 370, 372, 400) for providing electrical isolation between the test interface (310) and the balance of the electronic circuitry (300)".

Claims 2 to 12 of the first and second auxiliary requests correspond to claims 2 to 12 according to the main request.

IV. In support of its requests the appellant developed the following arguments in the letter of 21 November 2005:

The new claims according to the main request correspond to the first auxiliary request of the proceedings before the Examining Division. For disclosure reference is made to the original claim 1 and to page 21, lines 18 - 21, or figure 19 of the published patent application, where it is described that "the embodiment illustrated in figures 18 - 30 is provided with electronic circuitry" and the expression "sensor with electronics" is disclosed. Support for the further amendments can be found on pages 34 and 35 and in figure 25 of the published specification. The new claim 1 according to the first auxiliary request corresponds to the third auxiliary request of the proceedings before the Examining Division. In addition

to the main request, it furthermore includes the feature "the electronic circuit comprises a test interface which enables the compensation values to be determined and programmed into the electronic memory". The disclosure for this can be found e.g. on page 24, para 2, of the published application. The new claim 1 according to the second auxiliary request includes in addition the feature "the electronic circuit comprises a test interface ... and an isolation interface for providing electrical isolation between the test interface and the balance of the electronic circuitry". This feature can be found e.g. on page 29, para 2, and on page 31, para 2, of the published patent application.

The subject matter of claim 1 according to the main request is novel over the cited references D1 to D6 as none of these documents shows the features of new claim 1 in their entirety. All of these documents show a device, an apparatus or a system including a sensor and separate therefrom an electronic circuitry for automatically compensating for errors, but not a sensor including such an electronic circuit. Particularly, document D3 discloses a device having a sensor 5 and separate therefrom a memory 6 and separate from both an evaluation device 3. Also document D4 shows a device or detector having the circuit 30 separate from sensor 32, 34. The Examining Division considered in document D4 the detector 10 itself as the sensor in the sense of the present invention. This is not correct, as may be seen for example from figure 1 of the original application papers and the corresponding description passages, where an angular position sensor 20 is shown and described. The angular position sensor 20 is coupled to a butterfly valve shaft 26 which again is

connected to a butterfly valve 28. Transferring the interpretation of the Examining Division of documents D3 and D4 to the present invention, the butterfly valve shaft 26 and butterfly valve 28 would also be part of the angular position sensor 20 which, however, is not the case. A sensor according to the present invention is not a complete metering device.

The subject matter of this claim 1 is also not obvious from the cited references, since a combination of features gathered from any of the references does not lead to the entirety of the features of claim 1, as some of the features are completely unknown from these references. As these features are not known from the references, they cannot be obvious therefrom. But independent thereof the inventive step also results from the following considerations: the use of known sensors in metering devices like those described in documents D3 and D4 is complicated, as additional elements for automatically compensating for errors have to be incorporated in those devices. This is not only time consuming but also requires special knowledge to find the appropriate elements, for example an appropriate electronic circuit for automatically compensating for errors, and furthermore requires adapting the electronic circuit to the specific sensor requirements. The object of the present invention is to simplify the use of a sensor, including determining and programming of compensation values. According to the present invention this object is achieved by the features of the new main claim. The displacement sensor according to the present invention can be incorporated in different metering devices without requiring accessory parts for compensating for errors. Therefore,

the assembly of such metering devices and their adjustment for the specific intended use is simplified, which saves time and costs. The technical teaching of the present invention, namely to provide a displacement sensor including an electronic circuit being able to compensate automatically and precisely for errors, the displacement sensor being intended to be incorporated in metering devices, is not known from the cited documents. From D3 a skilled man learns that a flow metering device comprises a flow meter and an evaluation device. The flow meter comprises a sensor and a memory separate therefrom for storing calibration data. The evaluation device has to be connected to the sensor and the memory and comprises a selection device for selecting calibration data (D3, e.g. claim 1 and page 5, paragraphs 3 and 4). The sensor and the memory may form a constructional unit or component, but the evaluation device (including the selection device) is separate therefrom (D3, page 5, paragraph 2). Therefore, document D3 cannot lead a skilled man to the technical solution of the present invention. D4 also teaches to provide a detection device with a sensor and a signal processing circuit separate therefrom. There is no hint in this document to provide the detection device with a sensor which includes the circuit. No corresponding advantage is indicated in D4, so that a skilled man cannot find any help in this document leading him to the technical teaching of the present invention. Also documents D1, D2, D5 and D6 teach to provide a device or system with a sensor and separate therefrom with an electronic circuit for automatically compensating for errors in sensor output signals. Therefore, none of these documents can help a skilled man to find the subject matter of claim 1 according to the main request.

These considerations also apply to claim 1 of the first auxiliary request, which includes the additional feature relating to a test interface. This test interface simplifies even more the handling of the displacement sensor according to the present invention. Because the test interface is part of the displacement sensor, not only may the sensor manufacturer determine the compensation values and programme such values into the electronic memory, but also the user is enabled to determine and programme the compensation values in a simple manner. This becomes relevant for example when the compensation values have to be amended. In the decision under appeal, see page 5, penultimate paragraph, the test interface was interpreted as possibly "just presented by a simple connecting possibility". This is not correct as may be seen from figure 1 and the corresponding description passages of the original application papers. The test interface is not only a connecting possibility, but for example also provides the CALIBRATE mode signal (original application papers, page 26, lines 4 to 6) or CALIBRATE TSET signal (original application papers, page 30, lines 8 and 9). This feature is neither known from D3 nor from the other cited documents. Therefore, this claim 1 is not only novel but also not obvious from the cited references.

The above statements are also valid for new claim 1 according to the second auxiliary request, which includes as a further feature an isolation interface: this provides in non-calibration modes the complete electrical isolation between the test interface and the balance of the electronic circuitry, thereby preventing

any interferences from entering the balance of the electronic circuit via the test interface. This further simplifies the use of a displacement sensor according to the present invention and in addition assures the correct operation of the sensor, especially when the user determines the compensation values and programmes these values into the electronic memory. The automatic electrical isolation enhances the operational ease and the reliability of operation.

- V. In a communication pursuant to Article 11(1) RPBA, dated 26 June 2007 and accompanying the summons to oral proceedings on 8 November 2007, the board expressed the following provisional opinion:

" *Main Request*

1. With respect to the amended description reference is made to the official communication of 29 April 2003, point 5.3: as pointed out, the parts of the description referring to Figures 1 - 17 do not relate to the claimed subject-matter, therefore these should be deleted or it should at least be made clear that this part of the description does not relate to the claimed invention (see in particular newly filed page 2b, lines 33 - 35).

2. *Claim 1*
 - 2.1 According to the letter of 21 November 2005, point 1.1, claim 1 is based on original claim 1 and the passage at page 21, lines 18-21 together with Figure 19; and the further passages at pages 34 and 35 together with Figure 25 of the published patent application. It is

observed that original claim 1 was directed to an "electronic circuit" and, indeed, that none of the further original claims defined a "displacement sensor". Furthermore the passage on page 21 and Figures 18-30 disclose "automatic calibration for a displacement sensor". Finally Figure 25 shows a graphical representation of measured output voltage of a sensor as a function of ideal values. Therefore the only unambiguous disclosure in the above passages appears to be that an automatic compensation circuit *may be used* in a linear displacement type sensor (see also page 1 of the published application, "Field of the Invention"). Therefore at the oral proceedings it will have to be considered whether the claim wording finds unambiguous support in the description and whether this claim meets the conditions of Articles 84 and 123(2) EPC.

2.2 In this respect it is noted that claim 1 does not include the following feature of original claim 1: "means for receiving an analog sensor output signal and digitizing said signal to define a digitized signal". Since this feature is also included in the embodiment of Figure 18 (ADC 302) it would appear that this represents an essential feature if the circuitry is part of a displacement sensor (see the description at page 23, second paragraph).

2.3 In claim 1, lines 9 - 11, the expression "a plurality of successive ideal output values defining a range between each successive output value" appears unclear, since the term "range" usually means a length between two values.

2.4 *Patentability*

2.4.1 As pointed out by the appellant, claim 1 according to the main request corresponds to claim 1 according to the first auxiliary request of the decision under appeal. In point 2 of the decision the examining division considered that document D4 disclosed the closest prior art. In point 2.1 of the letter of 21 November 2005 the appellant argues that all documents (D1 to D6) "...show a device, an apparatus or a system including a sensor and separate therefrom an electronic circuitry for automatically compensating for errors, but not a sensor including such an electronic circuit" (emphasis by the board).

2.4.2 The basis of such a purported difference in the original disclosure is not clear to the board: as pointed out supra the board is not yet convinced that the part of the original patent application addressing the embodiment in Figures 18 - 30 discloses a displacement sensor including an electronic circuit at all. In any case, since this part of the description apparently does not provide any details of the sensor the board was unable to locate any specific information about the arrangement of the electronic circuit within the displacement sensor which, according to the appellant, would be different from prior art sensor devices such as the one in document D4. In this respect it is added that the expression "displacement sensor including an electronic circuit" merely indicates that the electronic circuit is included, i.e. forms part, of the displacement sensor arrangement. The board understands this to be the case in the embodiment of Figure 1 of document D4, where the signal processing

unit 30 is integrated in the detector arrangement 10, much as in the present patent application, where it is explained at page 23 in the context of Figures 18 and 16 that the output of the Hall device 204 (Fig.16), which in the strict sense of wording is the "sensor", forms an input ("Sensor in", Fig.18) to the ADC 302. Furthermore it would appear that in the process of designing a sensor apparatus with associated electronics the skilled person would usually select the positional arrangement of the respective apparatus parts according to the needs of the particular case: for instance, for sensors to be positioned in a hostile environment (chemical, temperature, radiation) it might be advisable to connect the sensor with the electronics via a larger cable in order not to expose the circuit board to the extreme conditions; on the other hand, if the kind of sensor and processing circuitry enables this, all could be integrated onto a single circuit board or even in an electronic chip. Therefore the (not further restricted) arrangement of a sensor "including" an electronic circuit is considered as a standard design step in this technical field.

- 2.4.3 The argument that the examining division considered in document D4 the detector 10 itself as the sensor "in the sense of the present invention" which, according to the appellant, was not correct, is not persuasive. Claim 1 defines a displacement sensor including an electronic circuit. This implies that the electronic circuit (to be specified further in the remainder of the claim) is electrically coupled to and in communication with the sensor for treating the sensor output signals ("..for automatically compensating for errors in sensor output signals"). Furthermore the

skilled person understands from this characteristic that the displacement sensor and the electronic circuit together define the mechanical and electrical / electronic parts of the device and that these units are somehow spatially arranged with respect to each other. In the board's view, neither claim 1 defines any further details or restrictions with respect to the spatial arrangement of these components nor can such information be found in the original patent application. Therefore the board does not share the assessment of D4 by the appellant at page 6, third paragraph of the letter of 21 November 2005, that "there is no hint in this document to provide the detection device with a sensor which includes the circuit".

- 2.4.4 For this reason the board provisionally agrees with the assessment in point 2 of the appealed decision that document D4 discloses a (magnetostrictive) displacement sensor including an electronic circuit (microcontroller 30) for automatically compensating for errors (temperature effects) in the sensor output signal. In the electronic memory (ROM 52, see col. 5, 1.19) the calibration values consisting of a plurality of successive ideal output values (namely: two, first and second temperatures S1 and S2; and first and second known positions P1 and P2) and compensation values (first and second slopes M1, M2 and offset values B1 and B2 for each range, namely: one) are stored for the temperature range between the successive temperatures S1 to S2. Finally in the processor for a position measurement at an unknown temperature the sensor output signals (T1, T2, resulting in the difference $Dx=T2-T1$ and the temperature $Sx=T1+T2$) are received and (after the intermediate calculations shown in col. 6, lines 8-

11) the compensated sensor signal is calculated by multiplying the signal D_x by the slope value M_x and adding the offset value B_x . Therefore it appears that the sensor apparatus disclosed in document D4 comprises all technical features of the subject-matter of claim 1 and that also the calculation steps defined in this claim are carried out in the electronic circuit (microcomputer 50 with ROM 52) of that document. The subject-matter of claim 1 is therefore not new.

2.4.5 In case claim 1 were to be amended to include the additional feature that a plurality of ranges is determined, it is pointed out that the technical problem underlying such a step - namely to compensate for a stronger nonlinearity or to provide a better compensation over a larger temperature range - is already mentioned in document D4, where it is explained in col. 5, lines 2 - 24, that the first calibration scheme (addressed in point 2.4.4 supra) is based on the assumption that the system is linear, and that the thermal effects on position measurement are proportional to temperature changes. In a further approximation discussed in col. 6, lines 56 - 65, it is disclosed that, in case nonuniform or stronger nonlinearities occur, a more precise calibration can be carried out by mapping the difference $T_2 - T_1$ for many temperatures and storing these data in lookup tables in the ROM. Finally col. 7, lines 20 - 24 discusses the use of equations generated by curve fitting techniques, in which case each position can be calculated from the equations and the measured time intervals. Since mapping and calibrating at many temperatures is tantamount to providing a corresponding plurality of ranges and since the simplest curve fitting for each

range involves the method proposed in col. 5, line 22 - col. 6, line 14, it appears that the subject-matter of such an amended claim would be obvious in the light of the disclosure in document D4.

2.4.6 The board also has taken note of the solution of this problem in document D3 (page 2, line 13 to page 3, line 9) referred to in point 2 of the "Reasons for the Decision".

2.4.7 Therefore in the provisional opinion of the board the patentability of claim 1 of the main request is in doubt.

3. *First auxiliary request*

3.1 Claim 1 according to this request includes the additional feature "and wherein the electronic circuit (300) comprises a test interface (310) which enables the compensation values to be determined and programmed into the electronic memory". In point 3, third paragraph, of the letter of 21 November 2005 the appellant has argued that the interpretation given in the decision under appeal to the concept "test interface" was not correct, since this interface was not only a connecting possibility, but, as disclosed in the patent application, provided calibration ("CALIBRATE MODE" or "CALIBRATE TEST") signals.

3.2 The board does not share this position of the appellant: in claim 1 according to this request the "test interface" is defined in a generic way: the only properties of this interface are to enable the determination and programming in the memory of the

compensation values. In this generic sense also the sensor apparatus of D4 must include (even if not explicitly disclosed) a "test interface", since the electronic circuit enables the calibration mode (Figure 4) in which the compensation values are determined and programmed in the ROM 52.

- 3.3 As noted in point 3 of the appealed decision the determination and storing of calibration or compensation values is also disclosed in document D3, therefore the inclusion of a generic "test interface" appears to be common practice in sensor technology applying some kind of computer-based correction to the sensor signals. Therefore claim 1 of this request does not appear to include patentable subject-matter.

4. *Second auxiliary request*

- 4.1 Claim 1 according to this request defines the further feature "...and an isolation interface ...for providing electrical isolation between the test interface and the balance of the electronic circuitry". The use of isolation circuits or interfaces, in particular optocouplers, for galvanic isolation in sensor systems including microprocessors is well known in the technical field as documented, e.g. by the following document:

D7: Sensors, May 1996, Vol. 13, Nr.9, pages 46 - 48;
B.C. Baker, "The Basics of Isolation Circuits".

- 4.2 At page 46, left column, first paragraph, D7 discloses that isolation circuits " ...transmit and condition small signals between two portions of a circuit, such

as a sensor and the system microprocessor; and they isolate one side of the circuit from the other". In the same column it is disclosed "Optical coupling is not an appropriate medium for high-power applications such as DC/DC-converters, but works for digital coupling and can be built into a circuit that transmits analog signals". An example of an optocoupler is further shown in Figure 1B.

- 4.3 The board is of the provisional opinion that, depending on the particular requirements of galvanic isolation between the sensor/transducer in the position detector apparatus of D4, the skilled person would consider including such an optocoupler as a normal design option. The subject-matter of claim 1 according to this request therefore does not include an inventive step.

5. *The dependent claims*

- 5.1 In dependent claims 2 - 12 (identical for all requests) the board could not identify any technical features making a contribution towards inventive step. "

- VI. In a reply of 14 September 2007 the appellant withdrew its request for oral proceedings and requested that a decision be issued based on the file as it stands. In consequence the board by a notice of 8 October 2007 cancelled the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. In the communication of 26 June 2007 the board indicated in detail that, irrespective of reservations under Article 84 and 123(2) EPC, the subject-matter claim 1 according to the main request appeared to be anticipated by the disclosure of document D4 (Article 52(1) and 54 EPC); that the subject-matter of claim 1 according to the first auxiliary request did not involve an inventive step over the combined teachings of documents D4 and D3 (Article 52(1) and 56 EPC); and that the further features of claim 1 according to the second auxiliary request merely added standard features well known to the person skilled in the art, for instance from document D7. Finally the board also expressed its view that the dependent claims did not include patentable subject-matter.

3. The appellant has not filed any counterarguments to the position of the board. Instead, in its letter of 14 September 2007 the appellant has withdrawn the request for oral proceedings and has requested that a decision be made according to the state of the file.

4. The appellant has had the opportunity to comment on the objections raised in the board's communication (Article 113(1) EPC) and the board, not having been confronted with any counterarguments, sees no reason to change its view. Therefore, none of the independent claims nor the appended dependent claims of the requests on file being allowable, the appellant's requests must be refused.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Kiehl

A. G. Klein