

**Internal distribution code:**

- (A) [ - ] Publication in OJ
- (B) [ - ] To Chairmen and Members
- (C) [ - ] To Chairmen
- (D) [ X ] No distribution

**Datasheet for the decision  
of 24 October 2023**

**Case Number:** T 1557/20 - 3.5.01

**Application Number:** 15747459.4

**Publication Number:** 3183698

**IPC:** G06Q10/06

**Language of the proceedings:** EN

**Title of invention:**

MALFUNCTION PREDICTION FOR COMPONENTS AND UNITS OF TECHNICAL ENTITIES

**Applicant:**

Hitachi Energy AG

**Headword:**

Malfunction prediction/HITACHI ENERGY

**Relevant legal provisions:**

EPC Art. 56, 111(1), 123(2)  
RPBA 2020 Art. 11

**Keyword:**

Predicting a future specific malfunction of a transformer based on the measurement of specific parameters (technical)  
Remittal to the department of first instance (yes - search required)

**Decisions cited:**

G 0001/19, T 0641/00, T 1227/05, T 3226/19, T 0929/18



**Beschwerdekammern**  
**Boards of Appeal**  
**Chambres de recours**

Boards of Appeal of the  
European Patent Office  
Richard-Reitzner-Allee 8  
85540 Haar  
GERMANY  
Tel. +49 (0)89 2399-0  
Fax +49 (0)89 2399-4465

Case Number: T 1557/20 - 3.5.01

**D E C I S I O N**  
**of Technical Board of Appeal 3.5.01**  
**of 24 October 2023**

**Appellant:** Hitachi Energy AG  
(Applicant) Brown-Boveri-Strasse 5  
8050 Zurich (CH)

**Representative:** P&TS SA (AG, Ltd.)  
Avenue J.-J. Rousseau 4  
P.O. Box 2848  
2001 Neuchâtel (CH)

**Decision under appeal:** **Decision of the Examining Division of the  
European Patent Office posted on 19 February  
2020 refusing European patent application No.  
15747459.4 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman** W. Chandler  
**Members:** L. Falò  
E. Mille

## **Summary of Facts and Submissions**

- I. This is an appeal against the examining division's decision to refuse European patent application No. 15747459.4.
- II. The application was refused on the ground of lack of inventive step of all requests in view of notorious technical means. The division also had objections under Article 123(2) EPC in respect of the first and second auxiliary requests, and under Articles 83 and 84 EPC in respect of the third auxiliary request.
- III. In the statement setting out the grounds of appeal, the appellant requested the decision under appeal be set aside and a patent be granted on the basis of the main or the first to third auxiliary requests, filed with the statement of grounds of appeal.
- IV. In a communication pursuant to Article 15(1) RPBA, the Board set out its preliminary view that the amendments introduced on appeal had overcome the division's objections under Articles 83, 84 and 123 (2) EPC. However, they raised new issues under Article 123(2) EPC. The Board further tended to agree with the division as to lack of inventive step of the main, first and second auxiliary request. The Board was nonetheless of the opinion that claim 1 of the third auxiliary request had technical character going beyond the mere implementation of a non-technical scheme on notorious means, and thus inventive step could not be assessed without documentary prior art.

- V. In a letter of reply, the appellant filed a fourth, a fifth and a sixth auxiliary request and provided reasons as to their patentability.
- VI. With communication of 27 September 2023, the Board informed the appellant that it considered the fourth and fifth auxiliary request not inventive in view of notorious means, and moreover not compliant with the requirements of Article 123(2) EPC. The Board further informed the appellant that it was minded to remit the case to the first instance for further prosecution based on the sixth auxiliary request.
- VII. During the oral proceedings on 24 October 2023, held by videoconference jointly with those for T 0182/20, the appellant filed two new requests (auxiliary requests 5bis and 5ter). The appellant then requested that the decision to refuse the application be set aside and the case be remitted to the examining division for further prosecution based on the auxiliary request 5ter, and withdrew all the remaining requests.
- VIII. Claim 1 of the sole request (auxiliary request 5ter) reads:

*Method for predicting a malfunction of a transformer as an electrical component of a unit, said transformer having coils surrounded by oils or cooling fans, the malfunctions being an insulation defect, the method comprising the steps of:*

*measuring by a sensor of the component a current value of a parameter of the component, said parameter including one of the following parameters:*

*temperature of the coils, vibration of the cooling fans if the coils are surrounded by cooling fans, oil condition or temperature of the oil if the coils are surrounded by oil;*

*providing the current discrete value state of said parameter (S3) on the basis of the current value of the parameter;*

*providing a transition matrix (S1), wherein the transition matrix is based on probabilities to switch from one of a number of discrete value states of the parameter to another of the discrete value states;*

*in an apparatus (10), determining a conditional probability distribution of the parameter for a future point in time given the current value of the parameter based on the current value of the parameter (S4);*

*wherein the step of determining the conditional probability distribution of the parameter of the component for the future point in time given the current value of the parameter comprises the step of determining a conditional probability distribution of the discrete value states of said parameter for the future point in time given the current discrete value state of the parameter based on current discrete value state of the parameter and on the transition matrix (S4);*

*in the apparatus (10), determining a conditional probability for the malfunction at the future point in time given the current discrete value state of the parameter based on the conditional probability distribution of the discrete value state of said parameter for the future point in time given the*

*current discrete value state of the parameter and on a conditional probability distribution for the malfunction given the discrete value state of said parameter (S5);*

*a conditional probability distribution for the malfunction given the current value of the parameter being the conditional probability distribution for the malfunction given the discrete value states of said parameter (S2),*

*wherein the conditional probability distribution for the malfunction given the parameter is received, e.g. in a computer, server, database or other apparatus, or determined using a Bayesian assessment technique based on the probability ( $P(a_i|M)$ ) that the parameter is in a certain state ( $a_i$ ) when the malfunction ( $M$ ) occurs, on the probability ( $P(M)$ ) of the single malfunction ( $M$ ), and on the probability ( $P(a_i)$ ) of the discrete state ( $a_i$ ),*

*predicting the malfunction of the component on the basis of the conditional probability for the malfunction at the future point in time given the current value of the parameter.*

## **Reasons for the Decision**

The invention

1. The invention concerns predicting future malfunctions of mechanical or electrical components based on the measured current values of one or more parameters ([0001], [0005], [0009], [0021] of the published application).

2. Essentially, the invention is calculating the probability of a malfunction at a future point in time based the current state of the parameter(s). Mathematically, using the law of total probability, this is the sum of the conditional probabilities of the malfunction given each possible state of the parameter, multiplied by the probability of that state at the future point in time ([0063]). The latter is calculated, using a Markov chain, by multiplying the current state of the parameter by a transition matrix  $T$ , representing the conditional probability for the parameter to switch state after a time period  $\Delta T$ , given its previous state ([0062]).
  
3. In the claimed embodiment, the component is a transformer having coils surrounded by oil or cooling fans, the malfunction is an insulation defect, the measured parameter is one of temperature of the coils, vibration of the cooling fans, oil condition or temperature of the oil.

Article 123(2) EPC

4. The amendments introduced on appeal have overcome the examining division's objections under Article 123(2) EPC.
  
5. Moreover, the Board is satisfied that, in claim 1, the use of the conjunction "or" instead of "and" in the expression "*measuring by a sensor of the component a current value of a parameter of the component, said parameter including one the following parameters: ... condition or temperature of the oil if the coils are surrounded by oil*" does not extend the claimed subject



matter beyond the content of the originally filed application.

According to paragraph [0040], cited in support by the appellant, *"the parameter for predicting the malfunction is temperature of the coils, vibrations of the cooling fans, the condition and temperature of the oil surrounding the coils, or a combination thereof"*.

In principle, this formulation could be used in English to express the final two options in a list of alternatives, especially as they both relate to oil, or for a single parameter involving temperature and condition.

However, as observed by the appellant, in the originally filed claim 1 as well as in paragraph [0058] the condition of the oil is measured as a stand-alone parameter. Paragraph [0058] further discloses measuring "temperature" (albeit not specifically "temperature of the oil") as a possible parameter alternative to the oil condition. The Board concludes that the skilled person, in view of the application as a whole, would consider the temperature and condition of the oil as two different parameters. Therefore, the replacement of the "and" with the "or" in claim 1 merely clarifies the wording of the claim without introducing undisclosed subject matter.

Inventive step - Article 56 EPC

6. The examining division held that calculating the probability of an unspecified malfunction in a generic mechanical or electrical component constituted a non-technical modelling and forecasting process, which was an abstract intellectual activity. The calculated

probability was a piece of information which lacked a technical effect in itself; any effect depended on human decision-making. The only technical feature was the use of a known computer to automate the claimed method, which was obvious.

Specifying, as in the third auxiliary request, the type of component (transformer), the malfunction (insulation defects) and the parameters to be measured (temperature of the coils, vibration of the cooling fans, oil condition or temperature of the oil) was not sufficient to establish an inventive step, as no technical considerations concerning the specific component and parameters chosen were apparent from the application as a whole.

7. The Board essentially agrees with the division's assessment of technicality of the (then) main request.

However, it arrives at a different conclusion in respect of the present sole request, which is based on the refused third auxiliary request, for the reasons which follow.

8. Present claim 1 is limited to the prediction of a specific malfunction (insulation defect) of a transformer, based on the measurement of well-defined parameters (temperature of the coils, vibration of the cooling fans, oil condition or temperature of the oil).

Performing a measurement has a technical character (see for example decision G1/19, OJ EPO 2021, A77, point 99). Moreover, the Board agrees with the appellant that the choice of the parameters to be measured in function of the type of malfunction to be predicted inherently reflects technical considerations and knowledge

concerning the functioning of the transformer. In the Board's judgement, in order to acknowledge technicality it is not necessary that these considerations be explicitly mentioned in the description, as long as they would be apparent to the skilled person in the context of the application.

9. On the other hand, the claimed mathematical steps, when considered in isolation, are non-technical. These steps generate numerical data, i.e. the conditional probability of a future malfunction in an electrical or mechanical component.
10. The key question for the assessment of inventive step is therefore whether these steps contribute to the technical character of the invention, i.e. whether they contribute to the solution of a technical problem by providing a technical effect. If they do, they must be examined for obviousness. If not, they can be incorporated into the formulation of the technical problem (T 641/00 - *Two identities/Comvik*).
11. For the question of technicality dealt with in this case, decision G 1/19 prevails over decision T 1227/05, cited by the appellant. G 1/19 identifies two main situations in which numerical calculations/data may contribute to the technical character of the invention.

First, when they are used to provide a technical effect, and said use ("further use") is specified in the claim, at least implicitly. This is the case when their potential use is limited to technical purposes (G 1/19, points 124, 128).

Second, when they represent an indirect measurement of the physical state or property of a specific physical

entity. Even though they may involve significant computing effort, indirect measurements are still related to physical reality and thus, like direct ones, have a technical nature regardless of what use is made of the results (G 1/19, point 99; see also decision T 3226/19, points 2.5 to 2.7).

12. The Board considers that the first situation does not apply here, since the calculated conditional probability might be used for non-technical purposes. For example, it can be used to assess financial loss or determine insurance premiums due to potential component downtime.
  
13. However, the Board sees the conditional probability obtained by the method of claim 1 as an indirect measurement of the physical state of the transformer. This conclusion is based on the following observations:
  - 13.1 The claimed method involves taking a measurement of a specific physical entity at a first point in time, and inferring the state of this physical entity (i.e. its probability of failure) at another point in time. This is similar to the example in G 1/19, point 99, where the measurement of a specific physical entity at a specific location is obtained from measurements of another physical entity and/or measurements at another location.
  
  - 13.2 The estimate of the future state of the component credibly reflects reality. The Board considers this an essential factor in deciding whether the calculated numerical data can be seen as an indirect measurement.

Arbitrary or speculative models and algorithms that are not grounded in reality are not capable of predicting

the physical state or property of a real physical entity. Such abstract calculations could not be regarded as (indirect) measurements.

In claim 1, however, there is a credible causal link between the parameters measured (temperature of the coils, vibration of the cooling fans, oil condition or temperature of the oil) and the specific malfunction predicted (insulation defect).

Moreover, the malfunction probability is calculated from the transition matrix  $T$ , the conditional probability distribution  $P(M|a)$ , and the current measurement of the parameter. The mathematical framework in the claim is rooted in stochastic modelling and simulation, specifically Markov chains, which are recognised for credibly capturing and predicting the transition dynamics of systems based on empirical data.

The fact that the result is a probability does not detract from its ability to provide a technically meaningful estimate of the component's state. Making accurate predictions in the real world, given all its uncertainties, is rarely possible.

14. In summary, the Board is satisfied that the calculated quantity provides a credible estimate of the future physical state of a specific physical entity and can be seen as an indirect measurement.

For these reasons, the Board judges that the mathematical steps in claim 1 are part of a technical measurement method, and that all features in claim 1 contribute to the technical character of the invention and must be examined for obviousness.

15. Notoriously known technical means are not an appropriate starting point for this examination. As the search report does not cite any prior art document, the Board deems a search necessary. This is a special reason for remitting the case in the sense of Article 11 RPBA.
  
16. Accordingly, the Board remits the case to the examining division for further prosecution, which shall include a search (Article 111(1) EPC). The search results should be documented and made accessible in the public file (see e.g. T 0929/18 - *Mobile location data sharing/BLACKBERRY*, point 3.13).

## **Order**

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

1. The decision under appeal is set aside.
  
2. The case is remitted to the examining division for further prosecution including a search.

The Registrar:

The Chairman:



T. Buschek

W. Chandler

Decision electronically authenticated