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(54) **Title:** SIGNAL EXTRACTION METHOD AND DEVICE FOR ITS IMPLEMENTATION

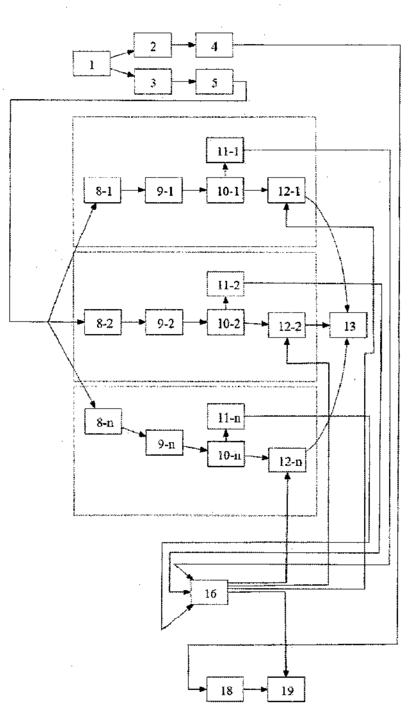

Fig.1

(57) **Abstract:** A signal extraction method, specifically a narrowband partial discharge signal extraction method from background noise, according to which a partial discharge sensor (1) located on a monitored object first captures a broad spectrum analog signal (a) which is by frequency filters (2,3) divided into analog signals (b, c) with a different frequency range, and subsequently these analog signals (b, c) are digitised in the digitising means (4,5) into data signals (d, e), which are subsequently processed in such a way that the magnitude of the partial discharge is determined along with its location in the fundamental harmonic sinusoidal voltage. A signal extraction device, specifically a device for narrowband partial discharge signal extraction from background noise, comprising a partial discharge sensor (1) located on a monitored object which is connected to frequency filters (2,3) with a different frequency range, with the frequency filters (2,3) being further connected to digitising means (4,5).

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Signal extraction method and device for its implementation

Technical Field

The invention relates to a method of signal extraction, specifically to a method of narrowband extraction of a partial discharge signal from a background noise, and to a device for its implementation.

State of the Art

The good condition of the insulation of electrical circuits is a basic condition for their proper function. The condition of the insulation is threatened by various factors, such as chemical, electrical or production imperfections. The end state of the insulation is an electric field breakdown and this breakdown is always built up of partial discharges, no matter what impairment of the state of the insulation is created by whichever degradation mechanism, for example degradation of the insulation due to inhomogeneities in production of the insulation, the formation of so-called cavities.

As the electric field approaches, due to polarisation, a positive charge accumulates on one side of the cavity and a negative charge accumulates on the other side. The value of these small charges increases until the moment when the resulting electric potential crosses the insulation barrier and the charges equalise. At that moment, a small discharge is generated, and since the flow of the balancing current stops after the charges have equalised, these discharges are referred to as partial discharges. The resulting flowing stream has several wholly unique properties that occur nowhere else. The balance of charges is not limited by anything, and so an extremely sharp and very short-lasting electrical impulse is generated. It is so unique that it can be likened to the theoretical impulse defined as a Dirac impulse, which is characterised by extreme sharpness and its frequency response is constant across all frequency bands.

This property is the basic approach to differentiate from other sources of interference and to detect partial discharges. Due to its similarity to Dirac's discharge, the partial discharge behaves very similarly, spreading over all frequency bands, with the only deviation being that with increasing frequency value there is a slight attenuation of this value.

The basic idea is therefore that the sources of interference occur mainly in certain bands only and not in the entire frequency spectrum.

At present, a large number of patent-protected technical solutions which deal with the problem of partial discharges are known.

Devices are known which deal with the measurement of partial discharges and not their evaluation. Very often this is a means of detection or evaluation, but with very classic tools such as a spectrum analyser or oscilloscope.

More modern devices are also known, which have however a significant feedback effect on the network, and thus the effect is significant interference. These simple procedures can be implemented in a little disturbed environment, or the device is powered from an isolated source for the needs of its own measurement. Related to these procedures is a standard defining of the method of measurement per bandpass and one peak detector. So in order for this to work, a dominant partial discharge pulse is required that is significantly higher than the surrounding noise. Discharge evaluation is performed by an operator. At a higher background noise level and a lower partial discharge level, this proves unreliable and the evaluation cannot be performed automatically.

After the year 2000, background noise levels have increased sharply and the performance of computing tools has increased significantly as well. Most patent documents, such as EP0408813B1, US20050035768A1, US20040263179A1, US7676333, US6822457, US6809523, US6433557, US5416430, US5416430, US4949001, US4238733, US4156846, JP2008366B, CZ284614B6, CN110907770A, CN106353649A and CA2656025C deal with the removal of background noise after this year and concern broadband access. Therefore, mathematical methods are used, namely DFT, HILBERT transform, Wavelet transform and statistical weighting processes. These are always general approaches and those patents address their application. These methods require high-performance processors with digital signal processing, which enables relatively simple sequential programming of the selected mathematical procedure. This has significant disadvantages, including the need to use very expensive technical equipment. Another disadvantage, given that the scanning takes place at a frequency of 60 million samples per second, meaning that the data flow, which can hardly transmit 1 GBIT, necessitates a very strong Internet connection. All this prevents the mass deployment of these measurement methods.

The object of the invention is to provide a method for extracting a partial discharge signal which will give highly reliable and accurate results, with a device which will have to be used for its operation being simple and therefore inexpensive, which will allow for its mass application.

Principle of the Invention

The mentioned disadvantages are largely eliminated and the goal of the invention fulfilled by a method of signal extraction, in particular a method of narrowband extraction of a partial discharge signal from background noises, characterised by that firstly, by the partial discharge sensor, is removed a broad-spectrum analog signal (a), which is located on the object to be monitored. which is divided by frequency filters into analog signals (b, c) with a different frequency range, and subsequently these analog signals (b, c) are digitised in a digitising means into data signals (d, e), which are subsequently processed in such a way that the magnitude of the partial discharge and its location in the fundamental harmonic sinusoidal voltage is determined. The monitored object may be a power system in which partial discharges may occur, such as power lines, cables, transformers, and the like. The advantage of the above-mentioned method of narrowband extraction of the partial discharge signal from background noise is that the equipment that will have to be used for its operation will be simple and therefore cheap, because the volume of processed data will be significantly lower.

It is to advantage if the broad spectrum analog signal (a) is filtered in a low-pass frequency filter to a signal (a) with a frequency in the range of 10 to 1000 Hz, and subsequently this signal (b) is digitised in the digitising means into a data signal (d). which contains data information about the signal (b) passing through the low-pass frequency filter, and further this data signal (d) is synchronised by a rotary counter. The advantage is that by dividing the measured signal and removing the higher frequency, the subsequent processing of the measured signal will be significantly simplified.

It is to further advantage if the broad spectrum analog signal (a) is filtered in a high pass frequency filter to a signal (c) with a frequency higher than 100 kHz, and subsequently this signal (c) is digitised in the digitising means into a data signal (e) which contains data information about the signal (c) passing through the high pass frequency filter. The advantage is that by removing the low band, the subsequent processing of the transmitted signal and the evaluation of the partial discharges is considerably simpler.

It is also to advantage if the data signal (e) output from the digitising means simultaneously enters at least two frequency bands at the same time, each of the frequency bands being set to a different range of pass frequencies and the other frequencies being suppressed by this frequency bandwidth, and in addition the data signals (f) output from the frequency band passes enter envelope blocks, which from the data signals (f) form data envelope files (a) which contain a numerical value which is the maximum value in the given band, which is the maximum value of the measured signal in data envelope files (a) and further enter correction blocks, in which the conversion of measured data to the value of discharge (pC) is performed with respect to the impedance of the measured system, and further the corrected data envelope files (a) enter the comparison blocks, in which the current envelope value, which is the maximum value for the given band, is compared with the set value, and from the comparison blocks is output data information (x), whether the background value has been exceeded in the respective frequency phase pass and thus that another signal is present, or whether another background value has been exceeded, and therefore no further signal is present, with the background value of individual comparison blocks being adjustable. The limits of the frequency band passes of these passes are adjustable and are spread gradually over the entire frequency band. The advantage is that data processing can take place in parallel on all channels, which reduces hardware requirements. Otherwise, if the data were processed sequentially, ie gradually, it would be necessary to use very powerful hardware so that everything could be evaluated quickly and the result not be distorted.

It is to further advantage if the data information (x) output from the individual comparison blocks is led into a block of logical sums of compared values, where if all the values of the individual data information (x) are active, the output is a logical sum which is the data information (y) which is also active.This means that at this moment the assumption that it is a partial discharge is fulfilled, otherwise it is an incoming interference that is not so homogeneously distributed over the whole frequency spectrum.

It is also to advantage if the corrected data envelope files (a) are output from the correction blocks to the evaluation blocks at the same time, and data information (y) from the logical product block are entered into the evaluation blocks at the same time, with each of the evaluation blocks evaluating the background noise values, and if the background noise values are exceeded, the discharge value (pC) is passed to the calculation block, in which the resulting discharge magnitude is determined, which is the highest discharge value (pC) from the values supplied from the individual evaluation blocks. The evaluation blocks are blocks searching for the maximum values from the data envelope (a) output from the correction blocks. In essence, this means that it is monitored whether the background noise values are exceeded in all bands. If they are exceeded in all bands, this monitored signal is declared as the just-measured partial discharge, and because it is necessary to know its magnitude, the highest value is monitored, which is declared as the magnitude of the just-measured partial discharge.

It is to further advantage if the synchronised data signal (d) further enters the discharge monitoring block, into which simultaneously, the data information (y) output from the block of the logical sum of the compared values enter, and based on the logical decision of the block which evaluated the presence of the partial discharge, the location of the partial discharge in the fundamental harmonic sinusoidal voltage is deducted.

It is also to advantage if the data signal (d) of the rotary counter synchronises so that it resets to zero at each zero crossing.

It is also to advantage if the data signal (d) is an 8-bit data signal (d). The advantage being that the data width of the 8-bit data signal is sufficient for this processing, while the respective integrated circuit is cheaper.

The data signal (e) is to advantage a 16-bit data signal (e). The advantage being that the 16-bit data signal allows the entire signal width to be covered, while a lower bit converter would introduce inaccuracy into its processing.

It is to great advantage if before the broad-spectrum analog signal (a) is removed from the monitored object, the partial discharge sensor is placed on an artificial signal source having an exactly defined partial discharge-like signal waveform with the partial discharge sensor additionally removing the broad-spectrum analog signal (a) and being performed by passing through the calibration evaluation chain. Carrying out calibration is important because the measurement of the partial discharge input sensor is loaded with impedance, such as a connected cable that is different for different measurements on different devices. To advantage, the artificial signal source has a very similar course to the partial discharges for which we know their magnitude.

Because we know what discharge is being transmitted from the artificial signal source, so for a measured value that comes out of the measuring chain after processing, we assign the value of the discharge of the transmitted artificial signal source. If, after processing, a higher or lower value comes out of the measuring chain, it is only mathematically adjusted. The basic calibrated value is taken as a constant, and if the resulting number is higher, what was calculated will be linearly adjusted. For example, if it is 10 percent higher, we will increase the calibrated value by 10 percent to the final value of the calculated discharge, and vice versa. Just before calibration, if no partial discharge is present, because the monitored object is in a voltage-free state, and therefore not connected to any source of partial discharges, only the values of ambient noise, we set this value in calibration mode as the background noise value.

These disadvantages are largely eliminated and the object of the invention is fulfilled by a signal extraction device, specifically a device for narrowband partial discharge signal extraction from a background noise, characterised by that it consists of a partial discharge sensor located on a monitored object which is connected to frequency filters with a different frequency range, with the frequency filters being further connected to a digitising means. The advantage of this device is that it can prepare a data signal so that it can be processed relatively easily and cheaply.

To advantage, the frequency filters with different frequency ranges are a low pass frequency filter for passing frequencies in the range of 10 to 1000 Hz, and a high pass frequency filter for passing frequencies higher than 100 kHz.

It is to further advantage if the low-pass frequency filter is connected to a digitising means which is connected to a rotary counter.

It is also to advantage if the high-pass frequency filter is connected to a digitising means which is connected to at least two frequency bandpass filters with a different range of pass frequencies which are connected to envelope blocks which are connected to correction blocks which are connected to comparison blocks, the individual comparison blocks being connected to a logical sum block of the compared values, and at the same time the correction blocks are connected to evaluation blocks which are connected to the logical sum block, with the evaluation blocks being simultaneously connected to the calculation block.

The circular counter is to advantage connected to a discharge monitoring block which is simultaneously connected to a logical sum block of the values for comparison.

The main advantage of the signal extraction method and the device for its implementation, according to the invention, is that it is possible to easily and cheaply determine the state of the insulation of the measured object. The measurement takes place continuously for at least one period of fundamental harmonic sinusoidal voltage. During the measurement, individual partial discharges are captured, as well as their value and also at what stage the fundamental harmonics occurred. Another advantage is that it is possible to process the data stream for the implementation of the signal extraction method due to the parallel use of gate arrays, i.e. at the same time, respectively step by step at clock rate. This technology makes it possible to process even a high data flow at low prices of the basic product. The device that will have to be used to operate the signal extraction method will be simple and therefore inexpensive, which will allow its mass implementation.

Overview of the Figures

The invention will be further elucidated using drawings, in which fig.1 shows a schematic connection of the individual parts of the device for realising a partial discharge signal extraction method, fig. 2 shows a graph of an input of a wide spectrum analog signal containing a partial discharge, fig. 3 shows graphically on the PRPD diagram the output information, fig. 4 shows on the graph a summary overview of the processing within individual bandpass filters, and fig. 5 shows on a graph the sequences on which envelope curves are formed.

Examples of the Performance of the Invention

According to the narrowband extraction method of the partial discharge signal from a background noise (fig. 1), before the partial discharge sensor 1 picks out the broad spectrum analog signal (a) from the monitored object, the partial discharge sensor 1 located on an artificial signal source having a precisely defined signal flow similar to the partial discharge, furthermore, the partial discharge sensor 1 picks out the artificial broad-spectrum analog signal (a) and a calibration is performed by passing through the following evaluation chain.

Next, the partial discharge sensor 1 located on the monitored object picks out a real broad-spectrum analog signal (a), which is divided by frequency filters 2,3 into analog signals (b, c) with a different frequency range. The input real broad-spectrum analog signal (a) (fig. 2) has a significant pulse from the partial discharge, which is marked by a strong resemblance to the theoretical Dirak pulse.

The broad-spectrum analog signal (a) contains the fundamental harmonic frequency of the electrical voltage (namely 50 Hz), and further analog waveforms that produce a partial discharge as well as interference, which may include, for example, various transmissions captured by the object being monitored, which acts as an antenna.

The wide-spectrum analog signal (a) is filtered in a low-pass frequency filter 2, which removes a spectrum of higher frequency signals, to a signal (a) with a frequency in the range of 10 to 1000 Hz, and this signal (b) is further digitised in the first digitising means 4 , which is an analog-to-digital converter, into a data signal (d), which is an 8-bit data signal (d) which contains data information about the signal (b) passing through the low-pass frequency filter 2, and further this data signal (d) is synchronised by a circular counter 18 in such a way that the circular counter 18 resets it to zero at each zero crossing, more precisely at each passing at the origin of the basic sinusoidal voltage. Thus, the length of the basic period of the sinusoidal supply voltage signal (20 ms) is defined. The circular counter has a length of 360 increments, being therefore calculated up to 360, so each value thus has a value of one degree of the sinusoid. The whole sine wave is divided into individual degrees and at the moment of evaluation of the partial discharge the device asks what is the current value of the circular counter and assigns this value to the partial discharge.

The wide-spectrum analog signal (a) is filtered in a high-pass frequency filter 3, which removes a spectrum of lower frequency signals, into a signal (c) with a frequency higher than 100 kHz, and subsequently this signal (c) is digitised in the second digitising means 5, into a data signal (e), which is a 16-bit data signal (e), which contains data information about the signal (c) passing through the high-pass frequency filter 3.

Furthermore, the data signal (e) output from the second digitising means 5 simultaneously enters into at least eight frequency bandpass filters 8.1 - 8.n, where n = 8, with each of the frequency bandpass filters 8.1 8.n being set to a different range of transmitted frequencies, in such a way that the individual pass-through frequencies have a size of 200kHz, 300kHz, 400kHz, 500kHz, 600kHz, 700kHz, 800kHz and 900kHz, with the proviso that the bandwidth is ±4.5 kHz.

On the graph (fig. 4) is shown a summary of processing in individual bandpass filters. The upper diagram is the input signal, the other diagrams are for individual bandpass filters, while the signal level after processing in individual bandpass filters can be seen here. The proviso for processing applies that a limit value is set in each individual bandpass, which may be different for each bandpass, depending on the primary setting after calibration. And if this signal level limit is exceeded, post-processing occurs. The proviso for processing is that all levels of signals processed in individual band passes exceed these limits.

Furthermore, the data signals (f) output from the frequency bandpass filters 8.1 - 8.n enter envelope blocks 9.1 - 9.n, which form, from the data signals (f) data envelope files (a), which contain a numerical value, which is the maximum value in a given band.

On the graph (fig. 5) is shown the sequences on which the envelope curves are formed for the signal that has been evaluated as the active partial discharge, which is shown on the first upper record.

Furthermore, the data envelope files (a) enter the correction blocks 10.1 - 10.n, in which is carried out the conversion of the measured data into the discharge value (pC) with respect to the impedance of the measured system, and the corrected data envelope files (a) enter into the comparison blocks. 11.1 - 11.n, in which the current envelope value is compared with the set value, while from the comparison blocks 11.1 - 11.n is output data information (x), whether the background value was exceeded in the respective frequency phase pass 8.1 - 8.n and thus that another signal is present or that the background value has not been exceeded, and thus that no further signal is present, the background value for the individual comparison blocks 11.1 - 11.n is adjustable.

The data information (x) output from the individual comparison blocks 11.1 - 11.n is further led into the block 16 of the logical sum of the compared values, and if all values of the individual data information (x) are active, the output is the logical sum which is data information (y). which is also active.

From the correction blocks 10.1 - 10.n, the corrected data envelope files (a) simultaneously enter the evaluation blocks 12.1 - 12.n, and into the evaluation blocks 12.1 - 12.n simultaneously enters, from the block 16 of the logical sum, the data information (y), and each of the evaluation blocks 12.1 - 12.n evaluates whether the background noise values are exceeded in it, and if the background noise values are exceeded, the discharge value (pC) is passed into the calculation block 13, in which the final discharge size by which the highest value discharges (pC) from the values supplied by the individual evaluation blocks 12.1 - 12.n is determined.

The synchronised data signal (d) further enters the discharge monitoring block 19, into which the data information (y) output from the logical sum block 16 enters simultaneously, whereas, based on the logical decision of block 16, which evaluated the presence of the partial discharge, the location of the partial discharge is deducted in the fundamental harmonic sinusoidal voltage.

The output of the above signal extraction method is the magnitude of the partial discharge and its location in the fundamental harmonic sinusoid of the voltage. These values are passed on to subsequent graphical evaluation, during which is monitored both the frequency of discharges and their magnitude, as well as where the discharge occurred on the basic sinusoid voltage. The output information has the character of a PRPD diagram (fig. 3), where individual partial discharges are recorded on the basic sinusoid of the voltage derived from the basic frequency of the network at the moments of the detected partial discharges. From the density and location of the cluster of partial discharges, various analyses can be performed, because the discharges have their own characteristics, particularly where they are located on that sinusoid. These values are monitored for a time of measurement, for example, 1 to 2 seconds, i.e. 50 to 100 periods of the basic sinusoidal course of voltage. From the data distribution it can be determined what type of discharges it is.

The device for narrowband extraction of a partial discharge signal from a background noise comprises a partial discharge sensor 1 located on the monitored object, which is connected to a low-pass frequency filter 2, to pass frequencies in the range of 10 to 1000 Hz, and a high-pass frequency filter 3, to pass frequencies higher than 100 kHz, with these frequency filters 2,3 being further connected to the digitising means 4,5.

The low-pass frequency filter 2 is connected to the digitising means 4, which is connected to a rotary counter 18.

The high-pass frequency filter 3 is connected to the digitising means 5, which is connected to eight frequency bandpass filters 8.1 - 8.n, where n = 8, with a different range of transmitted frequencies, which are connected to the envelope blocks 9.1 - 9.n, which are connected to correction blocks 10.1 - 10.n, which are connected to comparison blocks 11.1 - 11.n, with the individual comparison blocks 11.1 - 11.n being connected to the block 16 of the logical sum of the compared values, and at the same time the correction blocks 10.1 - 10 .n are connected to the evaluation blocks 12.1 - 12.n, which are connected to the logic sum block 16, with the evaluation blocks 12.1 - 12.n being simultaneously connected to the calculation block 13.

The rotary counter 18 is connected to the discharge monitoring block 19, which is simultaneously connected to the block 16 of the logical sum of the compared values.

Industrial Application

The signal extraction method and the device for its implementation according to the invention can particularly be used for narrowband extraction of a partial discharge signal from a background noise.

List of Reference Marks

1 partial discharge sensor

2 low pass frequency filter

3 high pass frequency filter

4 digitising means I

5 digitising means II

8.1- 8.n frequency bandpass

9.1- 9.n envelope block

10.1 - 10.n correction block

11.1 - 11.n comparison block

12.1 - 12.n evaluation block

13 calculation block

16 logical sum block

18 rotary counter

19 discharge monitoring block

Patent Claims

1. A signal extraction method, in particular a narrowband partial discharge signal extraction method from background noise, **characterised by that** firstly a partial discharge sensor (1) located on the monitored object, captures a broad-spectrum analog signal (a), which is divided by frequency filters (2,3) into analog signals (b, c) with a different frequency range, and subsequently these analog signals (b, c) are digitised in digitising means (4,5) into data signals (d, e), which are subsequently processed in such a way that the magnitude of the partial discharge and its location in the fundamental harmonic sinusoid of the voltage is determined.
2. The signal extraction method according to claim 1, **characterised by that** the broad-spectrum analog signal (a) is filtered in a low-pass frequency filter (2) to a signal (a) with a frequency in the range of 10 to 1000 Hz, and subsequently this signal (b) is digitised in the digitising means (4) into a data signal (d) which contains data information about the signal (b) passing through the low-pass frequency filter (2), and further this data signal (d) is synchronised by a rotary counter (18).
3. The signal extraction method according to either one of claims 1 and 2, **characterised by that** the broad-spectrum analog signal (a) is filtered in a high-pass frequency filter (3) to a signal (c) at a frequency higher than 100 kHz, and subsequently this signal (c) is digitised in the digitising means (5) into a data signal (e) which contains data information about the signal (c) passing through the high-pass frequency filter (3).
4. The signal extraction method according to claim 3, **characterised by that** the data signal (e) output from the digitising means (5) further simultaneously enters at least two frequency bandpass filters (8.1 - 8.n), with each of the frequency bandpass filters (8.1 - 8.n) being set to a different range of transmitted frequencies, and furthermore the data signals (f) output from the frequency bandpass filters (8.1 - 8.n) enter the envelope blocks (9.1 - 9.n), which creates from the data signals (f) data envelope files (a), which contain a numerical value, which is the maximum of the value in the given band, and further these data envelope files (a) enter into correction blocks (10.1 - 10 .n), in which the conversion of the measured data to the value of the discharge (pC) with respect to the impedance of the measured system is performed, and furthermore the corrected data envelope files (a) enter into the comparison blocks (11.1 - 11.n), in which the current value of the envelope

is compared with the set value, while from the comparison blocks (11.1 - 11.n) data information (x) outputs whether the background value has been exceeded in the respective frequency phase pass (8.1 - 8.n) and thus that another signal is present, or whether another background value has been exceeded, and thus no further signal is present, whereby the value the background is adjustable for individual comparison blocks (11.1 - 11.n).

5. The signal extraction method according to claim 4, **characterised by that** the data information (x) output from the individual comparison blocks (11.1 - 11.n) is led into the logic sum block (16) of the compared values, wherein if all the values of the individual data information (x) are active, the output is a logical sum, which is data information (y), which is also active.
6. The signal extraction method according to claims 4 and 5, **characterised by that**, from the correction blocks (10.1 - 10.n) the corrected data envelope files (a) are output simultaneously to the evaluation blocks (12.1 - 12.n), and simultaneously entered into the evaluation blocks (12.1 - 12.n) from the logical sum block (16) is entered data information (y), while each of the evaluation blocks (12.1 12.n) evaluates whether in it background noise values are exceeded, and if the background noise values are exceeded, the discharge value (pC) is passed to the calculation block (13), in which the resulting discharge value is determined by the highest discharge value (pC) from the values supplied from the individual evaluation blocks (12.1 - 12.n).
7. The signal extraction method according to claim 2, **characterised by that** the synchronised data signal (d) further enters the discharge monitoring block (19), into which at that time the data information (y) also enters emerging from the block (16) of the logical sum of the compared values, whereby based on the logical decision of the block (16) the location of the partial discharge in the fundamental harmonic sinusoid of the voltage is subtracted.
8. The signal extraction method according to claim 2, **characterised by that** the data signal (d) synchronises the rotary counter (18) so that it resets it to zero at each zero crossing.
9. The signal extraction method according to either one of claims 2 and 8, **characterised by that** the data signal (d) is an 8-bit data signal (d).
10. The signal extraction method according to claim 3, **characterised by that** the data signal (e) is a 16-bit data signal (e).

11. The signal extraction method according to any one of claims 1 to 10, **characterised by that** before the partial discharge sensor (1) picks up the broad-spectrum analog signal (a) from the monitored object, the partial discharge sensor (1) is placed on an artificial signal source having a precisely defined signal sequence similar to the partial discharge, further, the partial discharge sensor (1) picks up the broad spectrum analog signal (a) and is processed by passing through a calibration evaluation chain.
12. A signal extraction device, specifically a device for narrowband partial discharge signal extraction from background noise according to any one of claims 1 to 11, **characterised by that** it comprises a partial discharge sensor (1) located on a monitored object which is connected to frequency filters (2,3) with a different frequency range, the frequency filters (2,3) being further connected to the digitising means (4,5).
13. The signal extraction device according to claim 12, **characterised by that** the frequency filters (2, 3) with a different frequency range are a low-pass frequency filter (2), to pass frequencies in the range of 10 to 1000 Hz, and a high-pass frequency filter (3), to pass frequencies higher than 100 kHz.
14. The signal extraction device according to either one of claims 12 and 13, **characterised by that** the low-pass frequency filter (2) is connected to a digitising means (4) which is connected to a rotary counter (18).
15. The signal extraction device according to any one of claims 12 to 14, **characterised by that** the high-pass frequency filter (3) is connected to a digitising means (5) which is connected to at least two frequency bandpass filters (8.1 - 8.n), with a different range of transmitted frequencies, which are connected to envelope blocks (9.1 - 9.n), which are connected to correction blocks (10.1 - 10.n), which are connected to comparison blocks (11.1 - 11.n), with the individual comparison blocks (11.1 - 11.n) being connected to the block (16) of the logical sum of the compared values, and at the same time the correction blocks (10.1 - 10.n) are connected to the evaluation blocks (12.1 - 12.n), which are connected to the logic sum block (16), while the evaluation blocks (12.1 12.n) are simultaneously connected to the calculation block (13).
16. The signal extraction device according to either one of claims 14 and 15, **characterised by that** the rotary counter (18) is connected to a discharge

monitoring block (19) which is simultaneously connected to the block (16) of the logical sum of the compared values.

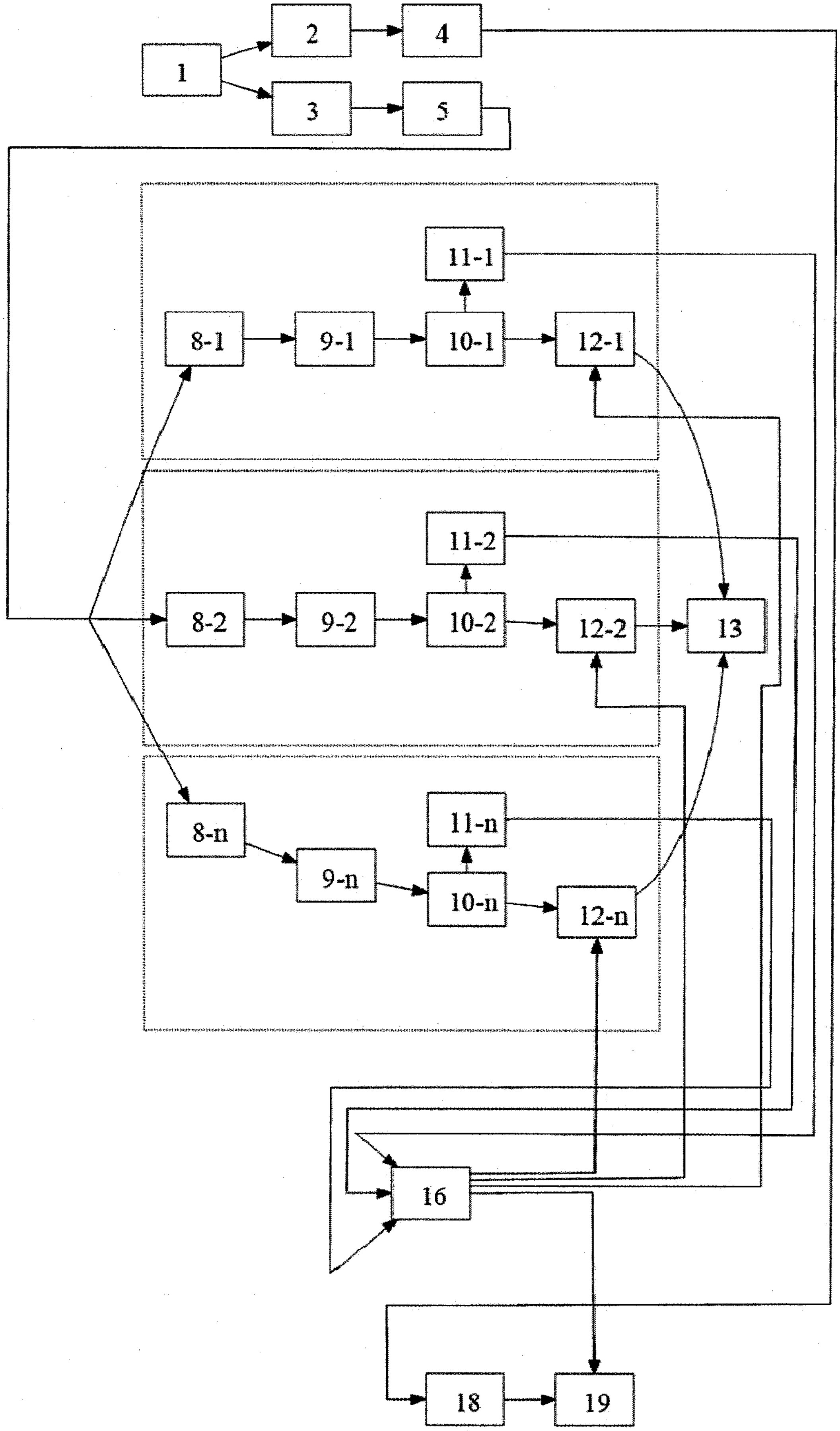
1
2
3
4
5
8-1
9-1
10-1
11-1
12-1
8-2
9-2
10-2
11-2
12-2
13
8-n
9-n
10-n
11-n
12-n
16
18
19

Fig.1

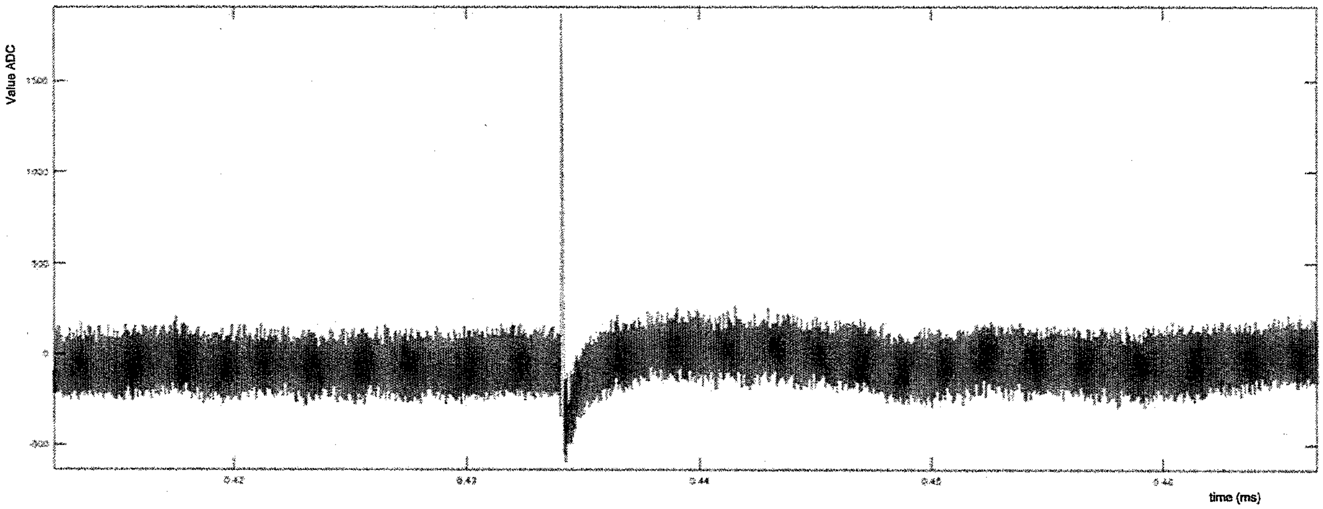

Fig.2

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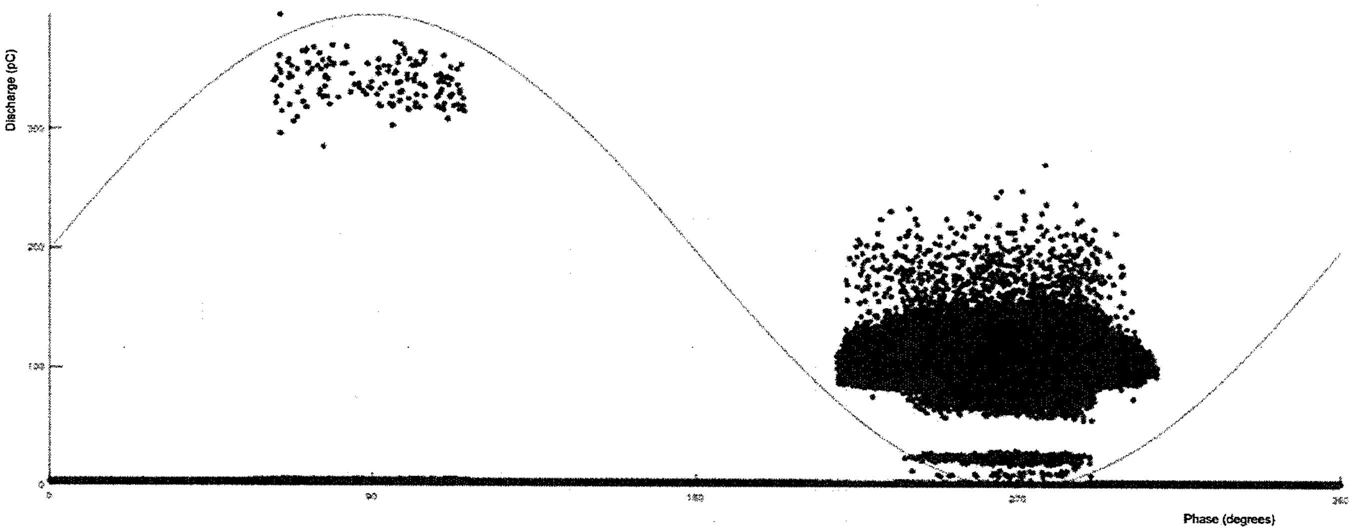

Fig.3

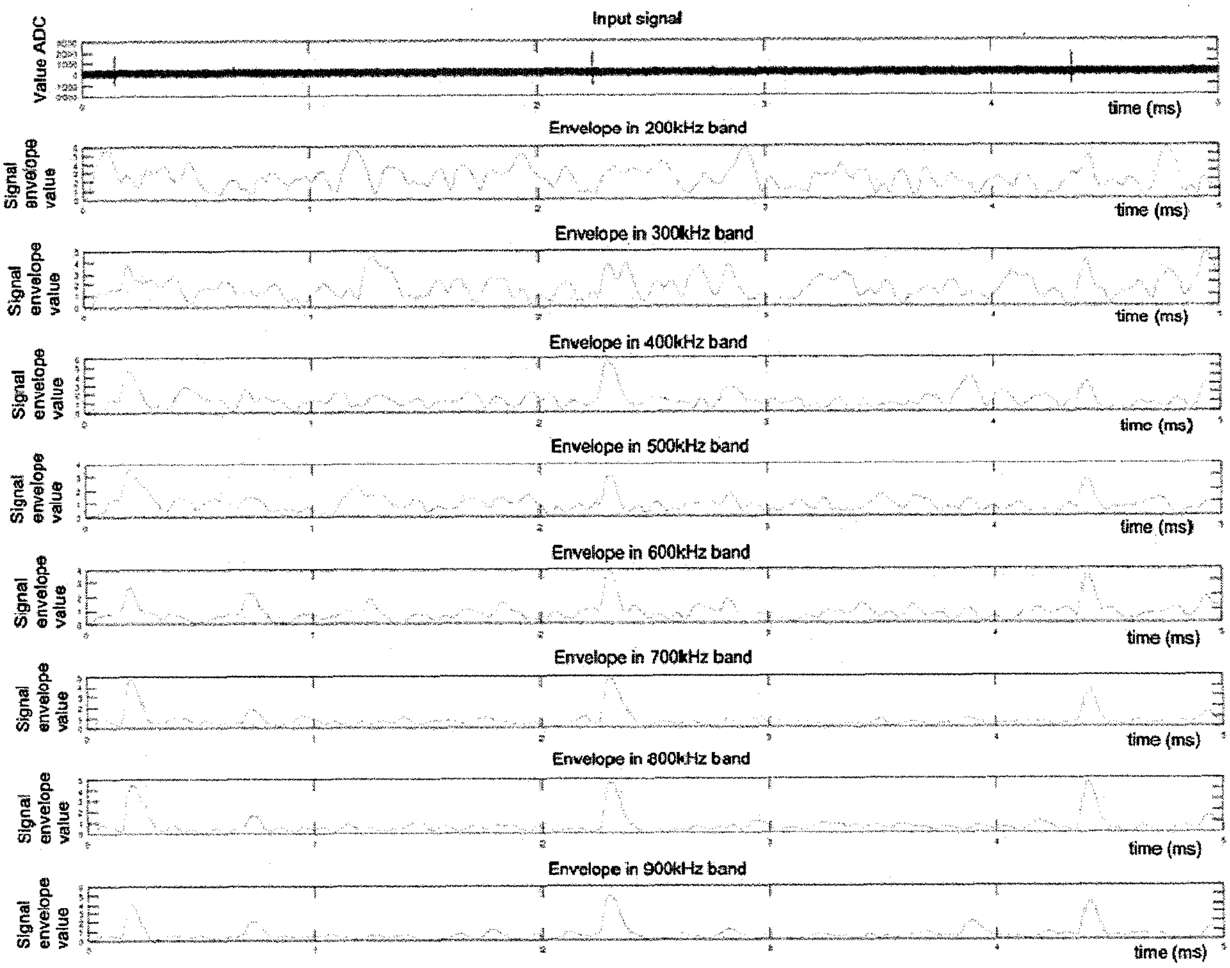
Input signal
Value ADC
time (ms)
Envelope in 200kHz band
Signal envelope value
time (ms)
Envelope in 300kHz band
Signal envelope value
time (ms)
Envelope in 400kHz band
Signal envelope value
time (ms)
Envelope in 500kHz band
Signal envelope value
time (ms)
Envelope in 600kHz band
Signal envelope value
time (ms)
Envelope in 700kHz band
Signal envelope value
time (ms)
Envelope in 800kHz band
Signal envelope value
time (ms)
Envelope in 900kHz band
Signal envelope value
time (ms)

Fig.4

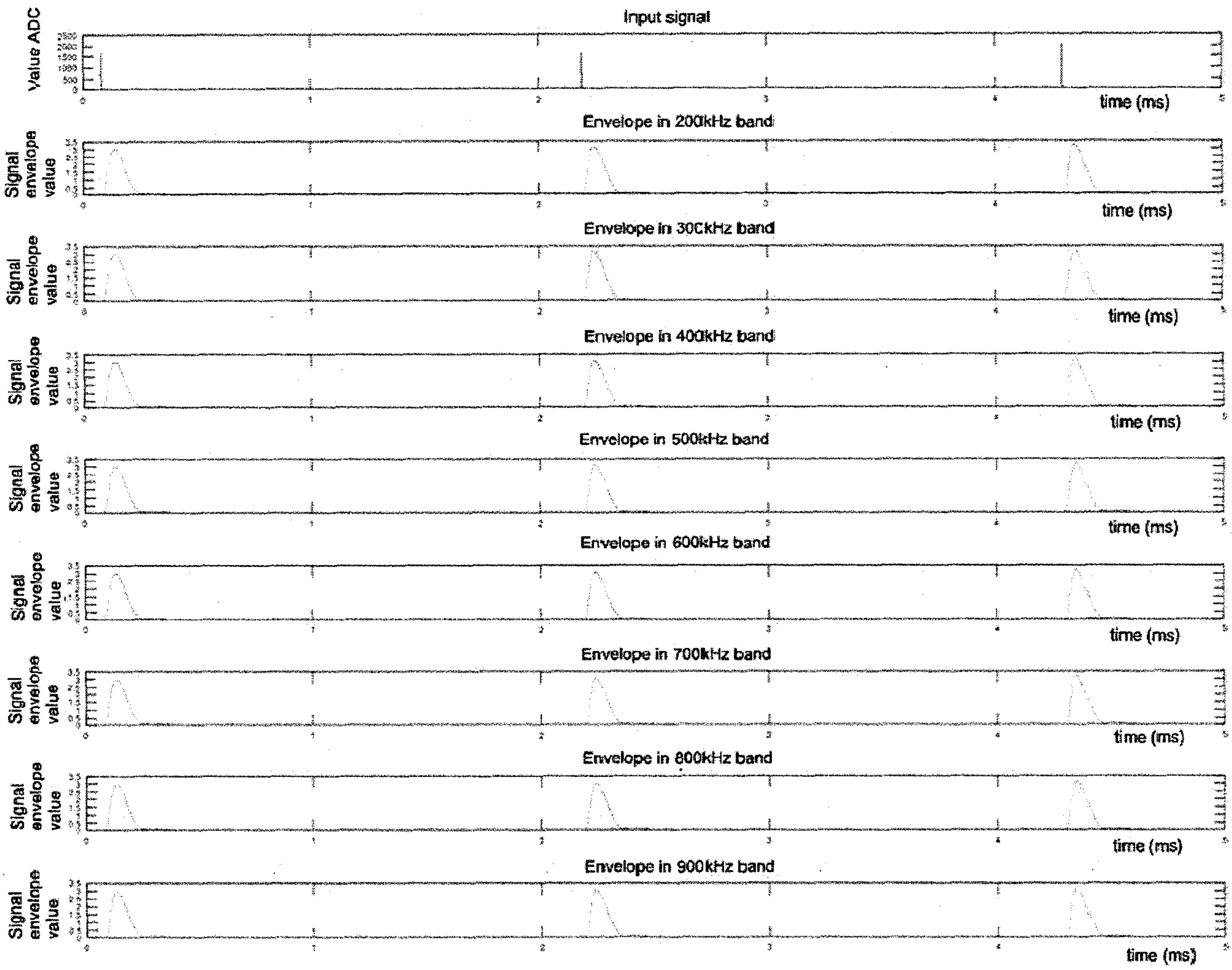
Input signal
Value ADC
time (ms)
Envelope in 200kHz band
Envelope in 300kHz band
Envelope in 400kHz band
Envelope in 500kHz band
Envelope in 600kHz band
Envelope in 700kHz band
Envelope in 800kHz band
Envelope in 900kHz band
Signal envelope value

Fig.5

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2022/000002

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01R31/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 321 661 A1 (ESKOM HOLDINGS LTD [ZA]) 18 May 2011 (2011-05-18) paragraphs [0009] - [0018], [0027], [0031] - [0036], [0050] - [0064] abstract; figures 1-22 -----	1-16
A	JP H04 269671 A (KANSAI ELECTRIC POWER CO) 25 September 1992 (1992-09-25) abstract; figures 1-8 paragraphs [0006] - [0018] -----	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 May 2022	19/05/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kleiber, Michael

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2022/000002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2321661 A1	18-05-2011	AU 2009278834 A1	11-02-2010
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JP H04269671 A	25-09-1992	NONE	