

Claims

1. Implantable medical device for stimulating a human or animal heart, comprising a housing (6), an analog-to-digital converter, a processor, a memory unit, a stimulation unit configured to stimulate the His bundle (8) of a human or animal heart (4), and a detection unit configured to detect an electrical signal at the His bundle (8) of the same heart (4), wherein the detection unit comprises an electrode (7) having a first electrode pole (5) and a second electrode pole (9),

10 **characterized**

in that the memory unit comprises a computer-readable program that causes the processor to perform the following steps when executed on the processor:

- 15 a) determining a first value of at least one parameter of a first measuring pulse measured between the first electrode pole (5) and the housing (6);
- b) determining a second value of the same at least one parameter of a second measuring pulse measured between the first electrode pole (5) and the second electrode pole (9);
- 20 c) comparing the first value of the at least one parameter of the first measuring pulse and the second value of the at least one parameter of the second measuring pulse;
- 25 d) determining, based on the comparing of the preceding step, whether the first measuring pulse or the second measuring pulse enables a higher available level control range of the analog-to-digital converter;
- 30 e) measuring an impedance (Z) in a unipolar manner between the first electrode pole (5) and the housing (6) if the first measuring pulse enables a higher available level control range of the analog-to-digital converter than the second measuring

pulse; or measuring an impedance (Z) in a bipolar manner between the first electrode pole (5) and the second electrode pole (9) if the second measuring pulse enables a higher available level control range of the analog-to-digital converter than the first measuring pulse.

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2. Implantable medical device according to claim 1, **characterized** in that the at least one parameter is chosen from the group consisting of an amplitude of a measuring current, measuring gain, the length of a current pulse, the number and the rate of the current pulses.

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3. Implantable medical device according to claim 2, **characterized** in that both the amplitude of a measuring current and the measuring gain are used as the at least one parameter.

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4. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to classify the first value and the second value of the at least one parameter into a predefined class comprising a value range encompassing the respective value, wherein a numeric index is assigned to each class.

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5. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to determine the values of at least two parameters of the first measuring pulse and the second measuring pulse and to classify the values into a predefined class comprising a value range encompassing the respective value, wherein a numeric index is assigned to each class.

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6. Implantable medical device according to claim 4 or 5, **characterized** in that the numeric index increases with increasing values of the value range.

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7. Implantable medical device according to any of claims 4 to 6, **characterized** in that the computer-readable program causes the processor to accomplish the determining whether the first measuring pulse or the second measuring pulse enables a higher

available level control range of the analog-to-digital converter by the following steps:
a) determining whether the numeric index assigned to a single value of the at least one
parameter of the first measuring pulse or the numeric index assigned to a single value
of the at least one parameter of the second measuring pulse is lower if the value of
exactly one parameter has been determined; or a') calculating a first sum of numeric
indices assigned to all values of the at least one parameter of the first measuring pulse
and calculating a sum of numeric indices assigned to all values of the at least one
parameter of the second measuring pulse if the values of more than one parameter have
been determined and determining whether the first sum or the second sum is lower;
and b) determining that the first measuring pulse enables a higher available level
control range of the analog-to-digital converter if the numeric index assigned to a
single value of the at least one parameter of the first measuring pulse is lower than the
numeric index assigned to a single value of the at least one parameter of the second
measuring pulse or if the first sum is lower than the second sum; or b') determining
that the second measuring pulse enables a higher available level control range of the
analog-to-digital converter if the numeric index assigned to a single value of the at
least one parameter of the second measuring pulse is lower than the numeric index
assigned to a single value of the at least one parameter of the first measuring pulse or
if the second sum is lower than the first sum.

8. Implantable medical device according to any of the preceding claims, **characterized**
in that the computer-readable program causes the processor to use the measured
impedance (Z) as input value for adjusting at least one physical parameter of a
stimulation pulse to be delivered by the stimulation unit to the His bundle (8) of the
heart (4).

9. Implantable medical device according to any of the preceding claims, **characterized**
in that the first electrode pole (5) is located in a tip region of the electrode (7) and in
that the second electrode pole (9) is located proximally of the tip region of the electrode
(7).

10. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to adjust a measuring gain and to repeat steps a) to e) of claim 1.
- 5 11. Implantable medical device according to claim 10, **characterized** in that the computer-readable program causes the processor to measure the impedance (Z) using that measuring gain that resulted in the highest available level control range of the analog-to-digital converter.
- 10 12. Method for determining whether a cardiac impedance (Z) is to be measured in a unipolar manner or in a bipolar manner with an implantable medical device (1) for stimulating a human or animal heart (4) according to any of the preceding claims, the method comprising the following steps:
- 15 a) determining, with a detection unit configured to detect an electrical signal at the His bundle (8) of a human or animal heart (4), a first value of at least one parameter of a first measuring pulse measured between a first electrode pole (5) of an electrode (7) of the detection unit and a housing (6) of the implantable medical device (1);
- 20 b) determining a second value of the same at least one parameter of a second measuring pulse measured between the first electrode pole (5) and a second electrode pole (9) of the same electrode (7);
- 25 c) comparing the first value of the at least one parameter of the first measuring pulse and the second value of the at least one parameter of the second measuring pulse;
- 30 d) determining, based on the comparing of the preceding step, whether the first measuring pulse or the second measuring pulse enables a higher available level control range of an analog-to-digital converter of the implantable medical device (1);

- 5 e) measuring an impedance (Z) in a unipolar manner between the first electrode pole (5) and the housing (6) if the first measuring pulse enables a higher available level control range of the analog-to-digital converter than the second measuring pulse; or measuring an impedance (Z) in a bipolar manner between the first electrode pole (5) and the second electrode pole (9) if the second measuring pulse enables a higher available level control range of the analog-to-digital converter than the first measuring pulse.
- 10 13. Computer program product comprising computer-readable code that causes a processor to perform the following steps when executed on the processor:
- 15 a) determining, with a detection unit configured to detect an electrical signal at the His bundle (8) of a human or animal heart (4), a first value of at least one parameter of a first measuring pulse measured between a first electrode pole (5) of an electrode (7) of the detection unit and a housing (6) of an implantable medical device (1) for stimulating a human or animal heart;
- 20 b) determining, with the detection unit, a second value of the same at least one parameter of a second measuring pulse measured between the first electrode pole (5) and a second electrode pole (9) of the same electrode (7);
- 25 c) comparing the first value of the at least one parameter of the first measuring pulse and the second value of the at least one parameter of the second measuring pulse;
- 30 d) determining, based on the comparing of the preceding step, whether the first measuring pulse or the second measuring pulse enables a higher available level control range of an analog-to-digital converter of the implantable medical device (1);

- 5 e) configuring the detection unit to measure an impedance (Z) in a unipolar manner between the first electrode pole (5) and the housing (6) if the first measuring pulse enables a higher available level control range of the analog-to-digital converter than the second measuring pulse; or configuring the detection unit to measure an impedance (Z) in a bipolar manner between the first electrode pole (5) and the second electrode pole (9) if the second measuring pulse enables a higher available level control range of the analog-to-digital converter than the first measuring pulse.
- 10 14. Method of treatment of a human or animal patient in need of such treatment by means of an implantable medical device (1) for stimulating a human or animal heart, wherein the implantable medical device (1) comprises a housing (6), an analog-to-digital converter, a processor, a memory unit, a stimulation unit configured to stimulate the His bundle (8) of a human or animal heart (4), and a detection unit configured to detect an electrical signal at the His bundle (8) of the same heart (4), wherein the detection unit comprises an electrode (7) having a first electrode pole (5) and a second electrode pole (9), the method comprising the following steps:
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- 20 a) determining, with the detection unit, a first value of at least one parameter of a first measuring pulse measured between the first electrode pole (5) and the housing (6);
- 25 b) determining, with the detection unit, a second value of the same at least one parameter of a second measuring pulse measured between the first electrode pole (5) and the second electrode pole (9);
- c) comparing the first value of the at least one parameter of the first measuring pulse and the second value of the at least one parameter of the second measuring pulse;

- d) determining, based on the comparing of the preceding step, whether the first measuring pulse or the second measuring pulse enables a higher available level control range of the analog-to-digital converter;
- 5 e) measuring an impedance (Z) in a unipolar manner between the first electrode pole (5) and the housing (6) if the first measuring pulse enables a higher available level control range of the analog-to-digital converter than the second measuring pulse; or measuring an impedance (Z) in a bipolar manner between the first electrode pole (5) and the second electrode pole (9) if the second measuring pulse
10 enables a higher available level control range of the analog-to-digital converter than the first measuring pulse;
- f) using the impedance (Z) as input value for adjusting at least one physical parameter of a stimulation pulse to be delivered by the stimulation unit to the
15 His bundle (8) of the heart (4);
- g) delivering the stimulation pulse to the His bundle (8) of the heart (4).