

Claims

1. Implantable medical device for stimulating a human or animal heart, comprising a housing (2), a processor, a memory unit, a stimulation unit configured to stimulate the His bundle (18) of a human or animal heart (6), and a detection unit configured to detect an electrical signal at the His bundle (18) of the same heart (6), wherein the detection unit comprises an electrode (15) having a first electrode pole (16),

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:

- a) stimulating the His bundle (18) of a human or animal heart (6) with a stimulation pulse (17) delivered by the stimulation unit;
 - b) measuring an electric signal at the His bundle (18) of the same heart (6) with the detection unit upon termination of a first period of time (25) starting upon delivering of the stimulation pulse (17), wherein the first period of time (25) lies in a time range of from 35 ms to 500 ms;
 - c) measuring an impedance (Z) of the same heart (6) with the detection unit upon termination of a second period of time (30) starting upon delivering of the stimulation pulse (17), wherein the second period of time (30) is equal to or longer than the first period of time (25) and lies in a time range of from 50 ms to 500 ms.
2. Implantable medical device according to claim 1, **characterized** in that the computer-readable program causes the processor to determine and set a sensing threshold (20, 21) prior to step b), wherein the sensing threshold (20, 21) is lower than a signal intensity of an R wave (23) of a cardiac contraction but higher than a signal of a P wave (22) of a cardiac contraction and higher than a His bundle signal.

3. Implantable medical device according to claim 1 or 2, **characterized** in that the computer-readable program causes the processor to perform step c) without having detected an R wave (23) of a cardiac contraction between steps a) and c), wherein the cardiac contraction has been evoked by the stimulation pulse (17).
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4. Implantable medical device according to claim 1 or 2, **characterized** in that the computer-readable program causes the processor to detect an R wave (23) of a cardiac contraction prior to step c), wherein the cardiac contraction has been evoked by the stimulation pulse (17).
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5. Implantable medical device according to claim 4, **characterized** in that the second period of time (30) comprises a first sub-period (25) corresponding to the first period of time (25), a second sub-period (28) extending from an end of the first sub-period (25) until a detection of a right ventricular event (27), and a third sub-period (29) extending from an end of the second sub-period (28) until an end of the second period of time (30), wherein the third sub-period (29) lies in a time range of from 10 ms to 100 ms.
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6. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to conduct a plurality of impedance measurements during a third period of time (26) starting at the end of the second period of time (30), wherein the third period of time (26) lies in a time range of from 50 ms to 400 ms.
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7. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to choose an initial value of an amplitude of current pulses for measuring the impedance (Z) from an amplitude range of from 5 μ A to 1000 μ A.
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8. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to choose an initial value of a width of current pulses for measuring the impedance (Z) from width range of from 5 μ s to 200 μ s.
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9. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to choose an initial value of a measuring gain for measuring the impedance (Z) from a gain range of from 1 to 600.
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10. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to measure the impedance (Z) in a unipolar manner between the first electrode pole (16) of the electrode (15) of the detection unit and the housing (2) of the implantable medical device.
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11. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to measure the impedance (Z) in a bipolar manner between the first electrode pole (16) and a second electrode pole of the electrode (15) of the detection unit.
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12. 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 (18) of the heart (6) after step c).
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13. Method for controlling the operation of an implantable medical device according to any of the preceding claims, the method comprising the following steps:
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- a) measuring an electric signal at the His bundle (18) of a human or animal heart (6) with a detection unit of the implantable medical device (1) upon termination of a first period of time (25) starting upon delivering of a stimulation pulse (17)

to the His bundle (18) by a stimulation unit of the implantable medical device (1), wherein the first period of time (25) lies in a time range of from 35 ms to 500 ms;

- 5 b) measuring an impedance (Z) of the same heart (6) with a detection unit of the implantable medical device (1) upon termination of a second period of time (30) starting upon delivering of the stimulation pulse (17), wherein the second period of time (30) is equal to or longer than the first period of time (25) and lies in a time range of from 50 ms to 500 ms.

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14. Computer program product comprising computer-readable code that causes a processor to perform the following steps when executed on the processor:

- 15 a) stimulating the His bundle (18) of a human or animal heart (6) with a stimulation pulse (17) delivered by a stimulation unit of an implantable medical device (1) for stimulating a human or animal heart (6);

- 20 b) measuring an electric signal at the His bundle (18) of the same heart (6) with a detection unit of the implantable medical device (1) upon termination of a first period of time (25) starting upon delivering of the stimulation pulse (17), wherein the first period of time (25) lies in a time range of from 35 ms to 500 ms;

- 25 c) measuring an impedance (Z) of the same heart (6) with the detection unit upon termination of a second period of time (30) starting upon delivering of the stimulation pulse (17), wherein the second period of time (30) is equal to or longer than the first period of time (25) and lies in a time range of from 50 ms to 500 ms.

- 30 15. 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 (6), wherein the implantable medical device (1) comprises a housing (2), a processor, a

memory unit, a stimulation unit configured to stimulate the His bundle (18) of a human or animal heart (6), and a detection unit configured to detect an electrical signal at the His bundle (18) of the same heart (6), the method comprising the following steps:

- 5 a) stimulating the His bundle (18) of a human or animal heart (6) with a first stimulation pulse delivered by the stimulation unit;
- b) measuring an electric signal at the His bundle (18) of the same heart (6) with the
10 detection unit upon termination of a first period of time (25) starting upon
 delivering of the first stimulation pulse (17), wherein the first period of time (25)
 lies in a time range of from 35 ms to 500 ms;
- c) measuring an impedance (Z) of the same heart (6) with the detection unit upon
15 termination of a second period of time (30) starting upon delivering of the
 stimulation pulse (17), wherein the second period of time (30) is equal to or
 longer than the first period of time (25) and lies in a time range of from 50 ms to
 500 ms;
- d) using the impedance (Z) as input value for adjusting at least one physical
20 parameter of a second stimulation pulse to be delivered by the stimulation unit
 to the His bundle (18) of the heart (6);
- e) delivering the second stimulation pulse to the His bundle (18) of the heart (6) by
 the stimulation unit.