

Claims

1. Implantable medical device (1) for stimulating a human or animal heart, comprising a processor, a memory unit, a stimulation unit comprising a stimulation electrode (2) configured to stimulate a first cardiac region (4) of a human or animal heart (5), and a
5 detection unit (3) configured to detect an intracardiac electrogram (7) at a second cardiac region (6) of the same heart (5), the second cardiac region (6) being a ventricle,

characterized in that

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

delivering a stimulation pulse (8) to a human or animal heart (5) by the stimulation
15 unit;

evaluating a time and at least one morphologic parameter of a signal (9) of an intracardiac electrogram (7) detected by the detection unit, the signal having been caused in response to the stimulation pulse (8), wherein the at least one morphologic
20 parameter is chosen from the group comprising of:

- an absolute value of an amplitude of the signal (9),
- a width of the signal (9),
- a positive and/or a negative and/or a total area under at least a part of the signal (9),
- 25 – a number of occurrences and/or a time of occurrence of zero crossings of the signal (9),

identifying a dislocation of the stimulation electrode (2) if a) the time of the signal (9) is below a first threshold value (11) and b) the morphologic parameter exceeds at least
30 one further threshold value (12).

2. Implantable medical device according to claim 1, **characterized** in that the computer-readable program causes the processor to evaluate both the amplitude of the signal (9) and the width of the signal (9).
- 5 3. Implantable medical device according to claim 1 or 2, **characterized** in that the computer-readable program causes the processor to identify a dislocation of the stimulation electrode (2) if a) the time of the signal is below a first threshold value (11) and b) the absolute value of the amplitude of the signal traverses in two instances the further threshold value (12) for the amplitude within a time exceeding the further
10 threshold value for the width of the signal.
4. Implantable medical device according to any of the preceding claims, **characterized** in that the first threshold value (11) is at least 80 ms.
- 15 5. Implantable medical device according to any of the preceding claims, **characterized** in that the further threshold value (12) for the amplitude is at least 2 mV.
6. Implantable medical device according to any of the preceding claims, **characterized** in that the further threshold value for the width is at least 4 ms measured at an absolute
20 value of the amplitude corresponding to the further threshold value (12) for the amplitude.
7. Implantable medical device according to any of the preceding claims, **characterized** in that the at least one further threshold value (12) is a relative value that is determined
25 in relation to a signal amplitude of an R wave of at least one cardiac cycle preceding the evaluated signal (9).
8. Implantable medical device according to any of the preceding claims, **characterized** in that the first cardiac region (4) is an atrium or a His bundle of a human or animal
30 heart (5).

9. Implantable medical device according to any of the preceding claims, **characterized** in that the stimulation unit is configured and designed to apply an atrial antitachycardial stimulation to an atrium (4) of a human or animal heart (5).
- 5 10. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to prevent a delivery of further stimulation pulses by the stimulation unit if a dislocation of the stimulation electrode (2) has been identified.
- 10 11. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to perform the steps of delivering a stimulation pulse (8), of evaluating a time and at least one morphologic parameter of a signal (9) of an intracardiac electrogram (7) and of identifying a dislocation of the stimulation electrode (2) in a time window of 5 seconds to 30 seconds
15 prior to an intended stimulation of the first cardiac region (4).
12. Implantable medical device according to any of the preceding claims, **characterized** in that the computer-readable program causes the processor to perform the step of delivering a stimulation pulse (8) at the beginning of a time window in which no
20 intrinsic ventricular signal is expected to occur.
13. Method for determining a dislocation of a stimulation electrode of a stimulation unit of an implantable medical device (1) for stimulating a human or animal heart, the stimulation unit being configured to stimulate a first cardiac region (4) of a human or
25 animal heart (5), the method comprising the following steps:
- delivering a stimulation pulse (8) to a human or animal heart (5) by a stimulation unit comprising a stimulation electrode (2);
- 30 evaluating a time and at least one morphologic parameter of a signal (9) of an intracardiac electrogram (7) detected by a detection unit (3) configured to detect an intracardiac electrogram (7) at a second cardiac region (6) of the same heart (5), the

second cardiac region (6) being a ventricle, wherein the signal (9) has been caused in response to the stimulation pulse (8), wherein the at least one morphologic parameter is chosen from the group comprising of:

- an absolute value of an amplitude of the signal (9),
- a width of the signal (9),
- a positive and/or a negative and/or a total area under at least a part of the signal (9),
- a number of occurrences and/or a time of occurrence of zero crossings of the signal (9),

identifying a dislocation of the stimulation electrode (2) if a) the time of the signal (9) is below a first threshold value (11) and b) the morphologic parameter exceeds at least one further threshold value (12).

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

delivering a stimulation pulse (8) to a human or animal heart (5) by a stimulation unit comprising a stimulation electrode (2);

evaluating a time and at least one morphologic parameter of a signal (9) of an intracardiac electrogram (7) detected by a detection unit (3) configured to detect an intracardiac electrogram (7) at a second cardiac region (6) of the same heart (5), the second cardiac region (6) being a ventricle, wherein the signal (9) has been caused in response to the stimulation pulse (8), wherein the at least one morphologic parameter is chosen from the group comprising of:

- an absolute value of an amplitude of the signal (9),
- a width of the signal (9),
- a positive and/or a negative and/or a total area under at least a part of the signal (9),
- a number of occurrences and/or a time of occurrence of zero crossings of the signal (9),

identifying a dislocation of the stimulation electrode (2) if a) the time of the signal (9) is below a first threshold value (11) and b) the morphologic parameter exceeds at least one further threshold value (12).

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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 (5), wherein the implantable medical device (1) comprises a processor, a memory unit, a stimulation unit comprising a stimulation electrode (2) configured to stimulate a first cardiac region (4) of a human or animal heart (5), the first cardiac region (4) being an atrium of the heart (5), and a detection unit (3) configured to detect an intracardiac electrogram (7) at a second cardiac region (6) of the same heart (5), the second cardiac region (6) being a ventricle, the method comprising the following steps:

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delivering a stimulation pulse (8) to a human or animal heart (5) by the stimulation unit;

evaluating a time and at least one morphologic parameter of a signal (9) of an intracardiac electrogram (7) detected by the detection unit (3), wherein the signal has been caused in response to the stimulation pulse (2), wherein the at least one morphologic parameter is chosen from the group comprising of:

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- an absolute value of an amplitude of the signal (9),
- a width of the signal (9),
- a positive and/or a negative and/or a total area under at least a part of the signal (9),
- a number of occurrences and/or a time of occurrence of zero crossings of the signal (9),

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identifying a dislocation of the stimulation electrode (2) if a) the time of the signal (9) is below a first threshold value (11) and b) the morphologic parameter exceeds at least one further threshold value (12);

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delivering stimulation pulses for an atrial antitachycardial stimulation to the human or animal heart (5) by the stimulation unit, if no dislocation of the stimulation electrode (2) was identified in the preceding step, or preventing delivering stimulation pulses for an atrial antitachycardial stimulation to the human or animal heart (5) by the stimulation unit, if a dislocation of the stimulation electrode (2) was identified in the preceding step.