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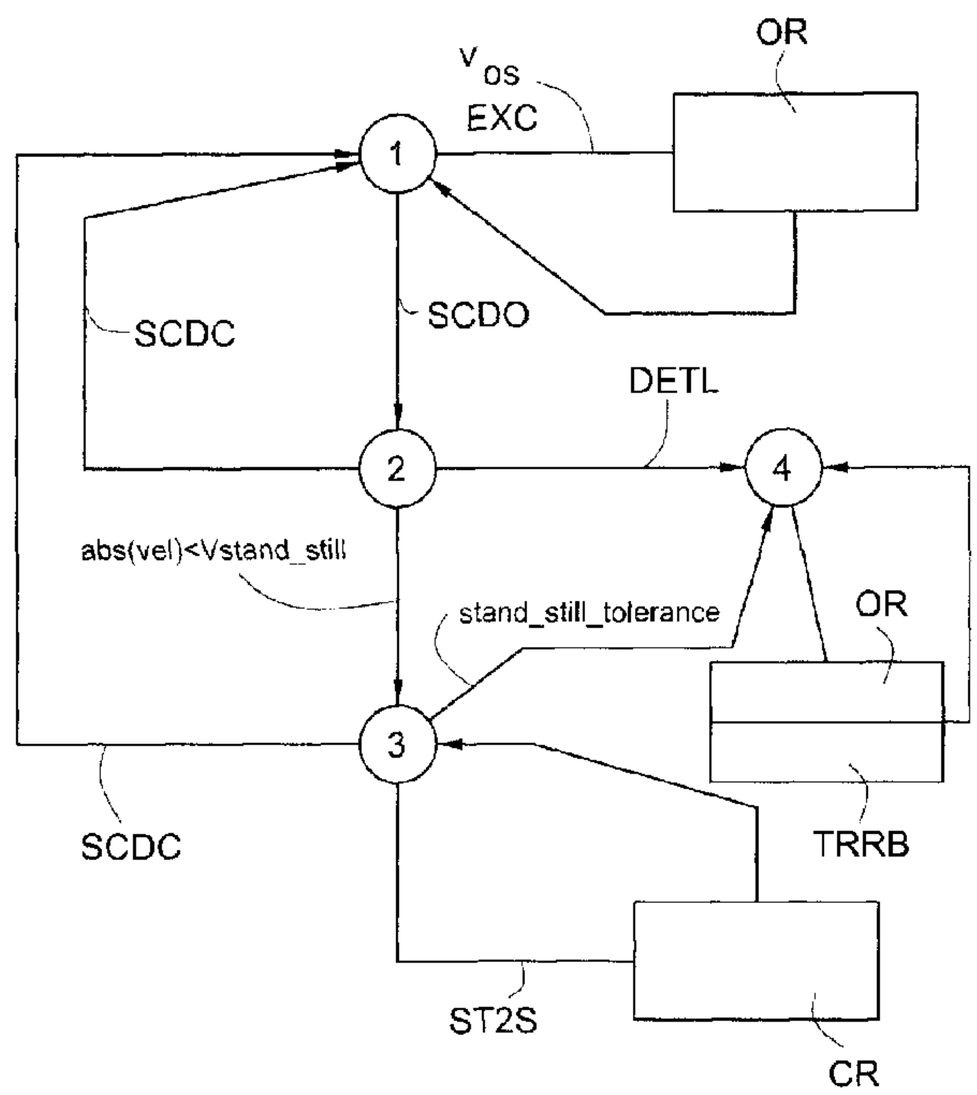
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(54) Title: METHOD AND DETECTION SYSTEM FOR MONITORING THE SPEED OF A LIFT CAGE



(57) Abrégé/Abstract:
In this method the speed of a lift cage is monitored. In the case of excess speed caused by brake failure of the motor brake or shaft fracture of the drive pulley shaft the safety circuit is opened and the detection system is transferred from the normal operational state (circle with a 1) to the retardation state (circle with a 2) in which it is monitored whether the lift cage is retarded after defined speed presets. After a successful retardation the detection system is transferred to the state of standstill monitoring (circle with a 3) in which it is monitored whether the lift cage leaves its standstill position. If the presets of state 2 or state 3 are not fulfilled, the detection system is transferred to the braking state of the brake (circle with a 4) in which a brake which fixes the lift cage is activated.

Abstract:

In this method the speed of a lift cage is monitored. In the case of excess speed caused by brake failure of the motor brake or shaft fracture of the drive pulley shaft the safety circuit is opened and the detection system is transferred from the normal operational state (circle with a 1) to the retardation state (circle with a 2) in which it is monitored whether the lift cage is retarded after defined speed presets. After a successful retardation the detection system is transferred to the state of standstill monitoring (circle with a 3) in which it is monitored whether the lift cage leaves its standstill position. If the presets of state 2 or state 3 are not fulfilled, the detection system is transferred to the braking state of the brake (circle with a 4) in which a brake which fixes the lift cage is activated.

METHOD AND DETECTION SYSTEM FOR MONITORING THE SPEED OF A LIFT CAGE

The invention relates to a method and a detection system for monitoring the speed of a lift cage, wherein the movement of a drive pulley driving the lift cager and a counterweight is detected and evaluated and in the case of impermissible deviation of the speed of the lift cage from a speed preset a retardation is initiated, according to the definition of the independent patent claims.

A motorised cable drum has become known from Patent Specification US 4 177 973, in which the motor shaft and the drum shaft are electrically monitored. A respective sensor for detection of shaft revolutions is provided for each shaft. The signals of the sensors are compared, wherein the ratio of the revolutions of the motor shaft to the revolutions of the drum shaft corresponds in the course of normal operation with the transmission ratio of the transmission. If a result departing from the transmission ratio is produced by the signal evaluation, a braking device acting on the cable drum is activated.

A disadvantage of this known equipment resides in the fact that complicated hardware is necessary for monitoring the cable drum, which is costly in provision and maintenance.

Here the invention may provide at least one remedy. The invention in at least some aspects, fulfils the object of avoiding the disadvantages of the known equipment and of indicating a method by means of which the speed of a lift cage can be monitored by simple means.

In the case of the method according to the invention for monitoring the speed of a lift cage, the movement of a drive pulley driving the lift cage and a counterweight is detected and evaluated and, in the case of excess speed of the lift cage or in the case of an impermissible deviation of the speed of the lift cage from a speed preset a retardation of the elevator car is initiated, wherein it is monitored whether the lift cage after predetermined presets is retarded and if the retardation runs after the

predetermined presets it is further monitored whether the lift cage leaves its standstill position and/or if the retardation of the lift cage does not run after the predetermined presets or if the lift cage has left a standstill position a brake fixing the lift cage is activated.

Accordingly, in at least one aspect, the present invention provides a method of monitoring a speed of an elevator car, wherein movement of a drive pulley driving the elevator car and a counterweight is detected and evaluated and retardation of the elevator car is initiated in the case of an impermissible deviation of the speed of the elevator car from a speed preset, comprising the steps of: a. performing a learning travel by moving and measuring a speed of the elevator car, wherein the speed of the elevator car measured during the learning travel is stored as a nominal speed of the elevator car; b. providing the elevator car at a stop at a floor; c. monitoring the drive pulley directly for movement of the elevator car and comparing the speed of the elevator car with a standstill speed to detect whether the elevator car leaves a standstill position, wherein the standstill speed is a fraction of the nominal speed of the elevator car, and the standstill position is an instantaneous position of the elevator car when the speed of the elevator car is less than the standstill speed; and d. in response to detecting that the elevator car has left the stop by determining that the elevator car has exceeded a specific deviation from the standstill position, activating a brake to stop the elevator car.

In the case of the detection system according to the present invention for monitoring the speed of a lift cage a measuring system detects the movement of the drive pulley driving the lift cage and a counterweight and a computer evaluates signals of the measuring system, which computer in the case of excess speed of the lift cage initiates a retardation process, wherein if a speed limit is exceeded the detection system opens a safety circuit and stores the excess speed of the lift cage from the zero instant of detection of the safety circuit as open, and wherein the detection system after a defined time from the instant zero monitors whether the speed of the lift cage is less than the excess speed and wherein the detection system after a defined time from the instant

zero monitors whether the speed of the lift cage is less than half the excess speed and wherein the detection system after adefined time from the instant zero monitors whether the speed of the lift cage is less than a standstill speed.

Accordingly, in a further aspect, the present invention provides a detection system for monitoring a speed of an elevator car comprising: a measuring system for directly detecting and generating an output signal representative of a movement of a drive pulley driving the elevator car and a counterweight; and a computer for evaluating said output signal from said measuring system, wherein when the elevator car is provided at a stop at a floor, the computer monitors the output signal for movement of the elevator car and compares a speed of the elevator car with a standstill speed to detect whether the elevator car leaves a standstill position, wherein the standstill speed is a fraction of a nominal speed of the elevator car, wherein the nominal speed is determined by performing a learning travel by moving and measuring a speed of the elevator car, wherein the speed of the elevator car measured during the learning travel is stored as the nominal speed of the elevator car, and the standstill position is an instantaneous position of the elevator car when the speed of the elevator car is less than the standstill speed, and in response to detecting that the elevator car has left the stop by determining that the elevator car has exceeded a specific deviation from the standstill position, the computer activates a brake to stop the elevator car.

The advantages achieved by the present invention are that the speed or the speed change in the case of retardation of the lift cage can be monitored by the method according to the invention and the equipment according to the invention.

Advantageously, a brake is activated if the monitored speed does not fall below predetermined values or if the lift cage has left the standstill position. Safety risks arising from risky states such as excess speed of the lift cage, failure of the motor brake during travel on movement to a storey, failure of the motor brake at a storey stop or shaft fracture of the drive pulley shaft can be avoided by the method according to the invention or the equipment according to the invention.

A cable brake, a car brake or a safety brake device, for example, can be provided as a brake.

The cable brake is arranged to be fixed to the body of the building or to the support structure of the lift and acts on the support cable functioning as support means. In the case of braking the support cables are fixed. The cage brake or the safety brake device is arranged at the lift cage and acts on stationary guide rails. The brake can also be provided for braking the counterweight.

Further aspects of the invention will become apparent upon reading the following detailed description and drawings, which illustrate the invention and preferred embodiments of the invention.

The present invention is explained in more detail by reference to the accompanying figures, in which:

Fig. 1 shows a block circuit diagram of equipment for monitoring the speed of a lift cage,

Fig. 2 shows a diagram for illustration of the operational states of the equipment for monitoring the speed of the lift cage and

Fig. 3 shows a speed diagram for monitoring the speed of the lift cage.

Fig. 1 has, for illustrative reasons, been divided along the line L in Fig. 1a and Fig. 1b, which together show a block circuit diagram of equipment for monitoring the speed of a lift cage. The equipment, termed detection system 1 in the following, substantially consists of a two-channel computer 2 with channel A and channel B, actuators 4A, 4B connected into a safety circuit 3 of the lift control, a respective measuring system 5A, 5B per channel A, B for detection of the movement of the drive pulley driving the lift cage and the counterweight, a sensor 6 for monitoring a brake, a sensor 7 for monitoring the pressure medium (for example compressed air) of the brake, which acts in braking manner on the cable strand guided over the drive pulley, an actuator 8 for release of the brake against a spring force, a converter 9 for conversion in terms of voltage of sensor signals, and a voltage supply 10 for the computer 2, for the actuators and for the sensors. A respective measuring system 11A, 11B, which monitors the rotational movement of the drive motor, per channel can optionally also be connected with the computer 2. A memory 12A, 12B is provided for each channel. Maintenance personnel can communicate with the computer 2 by means of a man/machine interface 13.

The measuring system 5A, 5B can detect the movement of the drive pulley shaft or the movement of the drive pulley circumference, wherein, for example, scannable magnetic poles or optically scannable code discs are provided. The speed or the position of the lift cage, for example, can be determined by the measurement signals. The optional measuring system 11A, 11B monitoring the rotational movement of the drive motor is of comparable construction.

The man/machine interface 13 consists of, for example, a keyboard for input of data and parameters and a display for visualisation of data and operational states.

An actuator 4A, 4B, for example a relay, is provided in the safety circuit 3 for each channel A, B. The relay is controlled in drive by means of the line TRIA1, TRIB1 from the microprocessor μPA, μPB, wherein the microprocessor μPA, μPB monitors the switching state of the relay by means of the line FDBA, FDBB. Moreover, the microprocessor μPA, μPB monitors the state of the safety circuit 3 by means of the current sensor CUDA, CUDB.

A brake operated by compressed air is, for example, provided as brake, wherein the compressed air is switchable by means of actuator 8, for example a magnetic valve, and the pressure is measurable by means of sensor 7, for example a pressure transducer, wherein the pressure PRS measured at the brake is converted into an electrical signal. An actuator 14A, 14B, for example a switch, is provided for each channel A, B. The switch is controlled in drive by means of the line TRIA2, TRIB2 from the microprocessor μP. The brake is released if both actuators 14A, 14B are closed, wherein the compressed air overcomes the spring force of brake springs. It is established by the sensor 6 whether the brake is released or applied. Movement of the lift cage is freed only if the sensor 7 detects the corresponding pressure PRS in the pressure medium and the sensor 6 detects the brake as released.

The signals of the sensors 6, 7 are converted by means of the transducer 9 into microprocessor-compatible signals. In the present example the 24V signals are converted into 5V signals by means of converters UCONA1, UCONA2, UCONA3, UCONA4, UCONB1, UCONB2, UCONB3, UCONB4 and fed, electrically separated, to the corresponding microprocessor μPA, μPB.

The voltage supply 10 produces the necessary supply voltages for operation of the detection system 1, wherein the mains voltage 110-240 VAC is converted by means of transformer/rectifier TRRE into a low-voltage direct voltage LVDC. In the present example, 5 volts (5V) are produced by the supply S1μPA, S1μPB for the computer 2, 5V are produced by the supply S1CA, S1CB for the measuring systems 5A, 5B, 11A, 11B, 12 volts are produced by the supply S1REL for the actuators 4A, 4B, 24 volts (24V) are produced by the supply S2μPA, S2μPB for the computer 2, 24V are produced by the

supply S1MV for the actuator 8 and 24V are produced by the supply S1SW for the sensors 6, 7.

The microprocessors μPA, μPB communicate with one another by means of data lines UART1, UART2, as well as NPORT and MPORT.

Fig. 2 shows a diagram for illustration of the operating states of the detection system 1 and Fig. 3 the associated speed diagram of the lift cage. The illustration shown in Fig. 2 is based on the state/event technique, in which the circles signify states of the system. Arrows with text or reference numerals symbolise events, which trigger a transition from one state to another state. Actions are symbolised by rectangles and text or reference numerals. For improved legibility, events or actions are represented in the description by bold type.

State 1 (circle with a 1) signifies normal travel state. During travel of the lift cage a speed limit designated as excess speed v_{os} of the lift cage is monitored. The safety circuit 3 is closed in the normal case. In the case of exceeding the excess speed limit v_{os} the safety circuit 3 is opened. The actuators or relays 4A, 4B are controlled in drive by means of the lines TRIA1, TRIB1 from the microprocessors μPA, μPB, wherein the microprocessors μPA, μPB monitor the switching state of the relays 4A, 4B by means of the lines FDBA, FDBB. In Fig. 2, the action of the safety circuit 3 being open with **relay open** OR is symbolised in a rectangle. The event **safety circuit detected as open** SCDO (detected by the microprocessors μPA, μPB) triggers a transition from State 1 to State 2.

State 2 (circle with a 2) signifies retardation state. The drive unit (motor, brake) is switched over to braking, wherein the lift cage is retarded. The speed vel_decel of the lift cage has been stored at the time instant zero of detection of the safety circuit 3 as open. After a specific time t1, for example 500 ms, measured from the time instant zero the speed of the lift cage has to be less than vel_decel. The microprocessors μPA, μPB prepare the current data of the measuring system 5A, 5B and compare these with vel_decel. If this condition (event **too low retardation** DETL) is not attained, the transition to the State 4 (braking state by brake) is triggered (action **relay open** OR and **brake triggered** TRRB).

After a specific time t2, for example 2 s, measured from the time instant zero the speed of the lift cage has to be less than vel_decel/2. The microprocessors μPA, μPB prepare the current data of the measuring system 5A, 5B and compare these with vel_decel/2. If this condition (event **too low retardation** DETL) is not attained, the transition to the State 4 (braking state with brake) is triggered. After a specific time t3, for example 4 s, measured from the time instant zero the speed of the lift cage has to be less than a standstill speed v_{stand_still}. The microprocessors μPA, μPB prepare the current data of the measuring system 5A, 5B and compare this with v_{stand_still}. If this condition (event **too low retardation** DETL) is not attained, the transition to the State 4 (braking state with brake) is triggered.

If the condition v_{stand_still} is attained, the transition to the State 3 (state of standstill monitoring) is triggered.

If an external device has opened the safety circuit 3, the transition to the State 1 (normal travel state) is triggered (event **safety circuit detected as closed** SCDC).

As soon as the State 3 (circle with a 3) with the event **speed of the lift cage less than v_{stand_still}** (abs(vel) < v_{stand_still}) is attained, the instantaneous position of the lift cage is stored as standstill position, wherein the microprocessors μPA, μPB prepare the current data of the measuring system 5A, 5B and determine the standstill position of the lift cage. If in the case of opened safety circuit 3 the lift cage exceeds a specific deviation stand-_still_tolerance (for example, 50 mm) from the standstill position, the transition to the State 4 (braking state with brake) is triggered.

After a specific time, for example 2 s, in the state of standstill monitoring, the actuators 4A, 4B are activated (event **at least 2 s standstill** ST2S). In Fig. 2 the action safety circuit 3 closed with **relay closed** CR is symbolised in a rectangle. The event **safety circuit detected as closed** SCDC (detected by the microprocessors μPA, μPB) triggers a transition from State 3 to State 1. State 2 or State 3 can trigger the transition to the braking state with brake (circle with a 4). In the braking state the brake directly acting on the support cable of the lift cage is activated, wherein at least one actuator 14A, 14B is deactivated. In the activated state of the brake, compression springs produce the braking force at the support cables. For release of the brake, the actuators 14A, 14B are activated and the actuator according to Fig. 1 supplied with current, wherein the compressed air acts against the spring force and releases the brake. As shown in Fig. 2, the State 4 cannot be

left. Resetting of the State 4 can take place only by switching off or switching on the mains voltage.

The steps shown in Figs. 2 and 3 are filed in coded form in the program memory 12A, 12B and are executed by the microprocessors μPA, μPB.

For determination of the speed limit denoted as excess speed v_{os} of the lift cage a learning travel is performed, wherein the lift cage is moved, for example, in upward direction at nominal speed and in that case the speed measured by the measuring system 5A, 5B is stored as v_{knm}. The travel direction of the lift cage is also detected, which is of significance for the counting direction of the measuring system 5A, 5B. The excess speed v_{os} is referred to the nominal speed v_{knm} and lies, for example, 10% above the nominal speed v_{knm}. The standstill speed v_{stand_still} is referred to the nominal speed v_{knm} and is detected, for example, as follows:

$v_{stand_still} = v_{knm}/32$ for lifts with v_{knm} 1 m/s .. 1.75 m/s

$v_{stand_still} = v_{knm}/16$ for lifts with v_{knm} 0.5 m/s .. 0.99 m/s

$v_{stand_still} = v_{knm}/8$ for lifts with v_{knm} 0.25 m/s .. 0.49 m/s.

The monitoring of the standstill position of the lift cage is of significance particularly in the case of boarding and disembarking or when cage door and shaft door are open. Normally in the case of a stop at a storey the threshold of the cage door is, in height, approximately flush with the threshold of the shaft door. If the lift cage leaves its standstill position, then a height difference arises between the thresholds, which can lead to accidents during boarding and disembarking. In the extreme case a gap and thus an open lift shaft can arise between the lift cage and the storey.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of monitoring a speed of an elevator car, wherein movement of a drive pulley driving the elevator car and a counterweight is detected and evaluated and retardation of the elevator car is initiated in the case of an impermissible deviation of the speed of the elevator car from a speed preset, comprising the steps of:

a. performing a learning travel by moving and measuring a speed of the elevator car, wherein the speed of the elevator car measured during the learning travel is stored as a nominal speed of the elevator car;

b. providing the elevator car at a stop at a floor;

c. monitoring the drive pulley directly for movement of the elevator car and comparing the speed of the elevator car with a standstill speed to detect whether the elevator car leaves a standstill position, wherein the standstill speed is a fraction of the nominal speed of the elevator car, and the standstill position is an instantaneous position of the elevator car when the speed of the elevator car is less than the standstill speed; and

d. in response to detecting that the elevator car has left the stop by determining that the elevator car has exceeded a specific deviation from the standstill position, activating a brake to stop the elevator car.

2. The method according to claim 1 including closing a safety circuit of the elevator car after a specific time of the monitoring when the speed of the elevator car has remained lower than the standstill speed.

3. The method according to claim 1 including setting the standstill speed at the nominal speed divided by 32 when the nominal speed is in a range of 1 m/s to 1.75 m/s, at the nominal speed divided by 16 when the nominal speed is in a range of 0.5 m/s to 0.99 m/s, and at the nominal speed divided by 8 when the nominal speed is in a range of 0.25 m/s to 0.49 m/s.

4. The method according to claim 1 wherein the brake to stop the elevator car acts in braking manner on a cable strand guided over the drive pulley.

5. A detection system for monitoring a speed of an elevator car comprising:

a measuring system for directly detecting and generating an output signal representative of a movement of a drive pulley driving the elevator car and a counterweight; and

a computer for evaluating said output signal from said measuring system, wherein when the elevator car is provided at a stop at a floor, the computer monitors the output signal for movement of the elevator car and compares a speed of the elevator car with a standstill speed to detect whether the elevator car leaves a standstill position, wherein the standstill speed is a fraction of a nominal speed of the elevator car, wherein the nominal speed is determined by performing a learning travel by moving and measuring a speed of the elevator car, wherein the speed of the elevator car measured during the learning travel is stored as the nominal speed of the elevator car, and the standstill position is an instantaneous position of the elevator car when the speed of the elevator car is less than the standstill speed, and in response to detecting that the elevator car has left the stop by determining that the elevator car has exceeded a specific deviation from the standstill position, the computer activates a brake to stop the elevator car.

6. The detection system according to claim 5 wherein said computer closes a safety circuit of the elevator car after a specific time of the monitoring when the speed of the elevator car has remained lower than the standstill speed.

7. The detection system according to claim 5 wherein said computer and said measuring system have two signal processing channels, and wherein said computer switches on and off by way of said two channels a safety circuit of the elevator or actuators of a brake, and detects signals of sensors of the brake.

8. The detection system according to claim 5 further comprising:

said computer being a two-channel computer;

a pair of actuators connected into a safety circuit of an elevator control;

said measuring system being a pair of measuring systems each connected to an associated one of the channels for detection of the movement of a drive pulley driving the elevator car and a counterweight through a cable strand;

a first sensor connected to said computer for monitoring a brake;

a second sensor connected to said computer for monitoring a pressure medium supplied to the brake, which brake acts in braking manner on the cable strand guided over the drive pulley;

a brake actuator for releasing the brake against a spring force;

a converter unit connected to said computer and to said second sensor for conversion of sensor signals to voltage signals; and

a voltage supply connected to said computer, said pair of actuators, said brake actuator, said first sensor and said second sensor.

9. The detection system according to claim 8 including another pair of measuring systems each connected to an associated one of the channels for detection of the movement of the drive pulley driving the elevator car and the counterweight through the cable strand.

10. The detection system according to claim 8 including a separate memory connected to each channel.

11. The detection system according to claim 8 including a man/machine interface connected to said computer whereby a person can communicate with said computer through said man/machine interface.

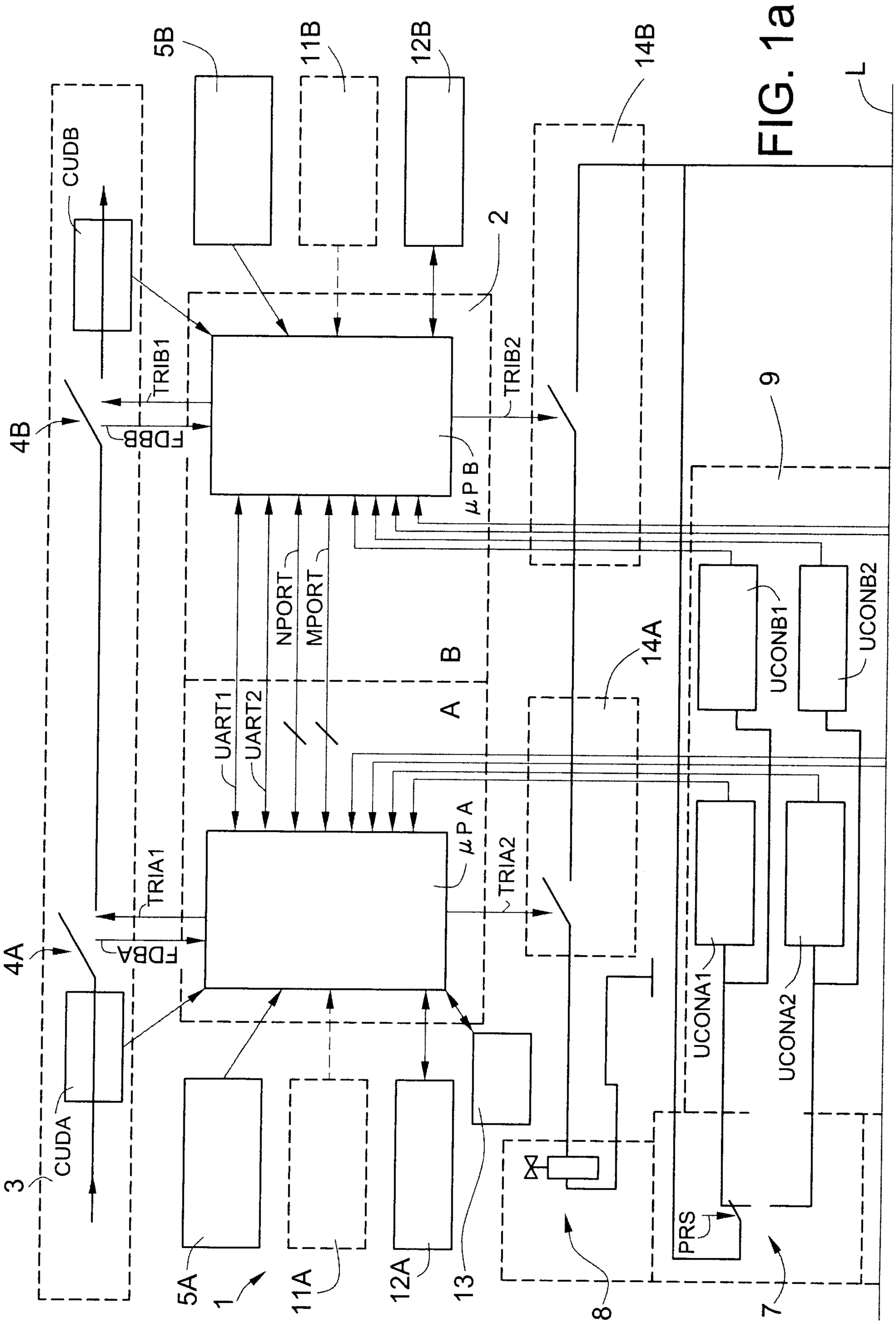

5B
11B
12B
14B
L
CUDB
2
TRIB1
TRIB2
4B
TDBB
μP B
9
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UART2
A
B
14A
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μP A
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8
7

FIG. 1a

FIG. 1b

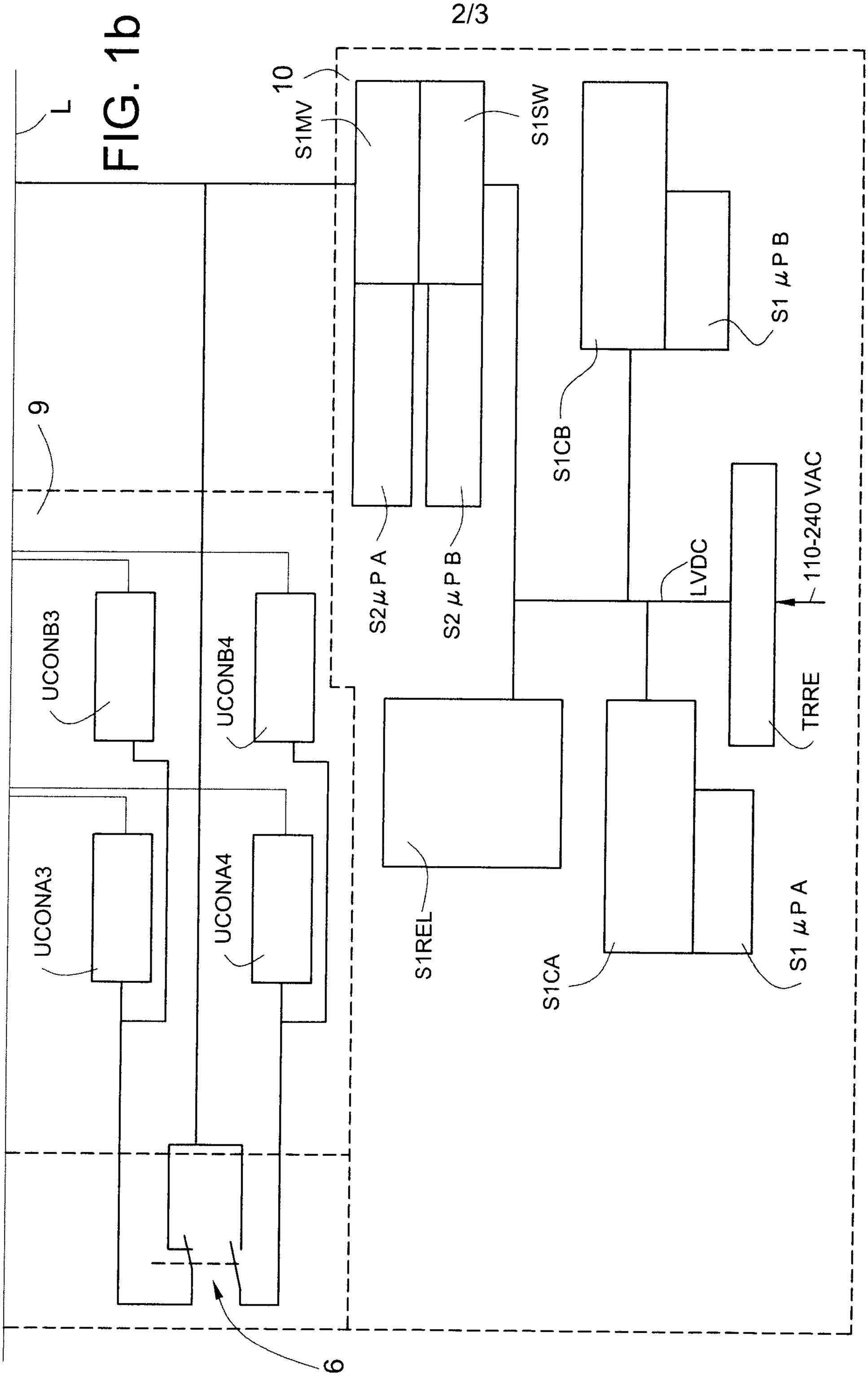

L
10
S1MV
S1SW
9
S1 μP B
S1CB
S2μP A
S2 μP B
LVDC
110-240 VAC
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UCONB4
TRRE
S1REL
S1CA
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UCONA3
UCONA4
6

FIG. 2

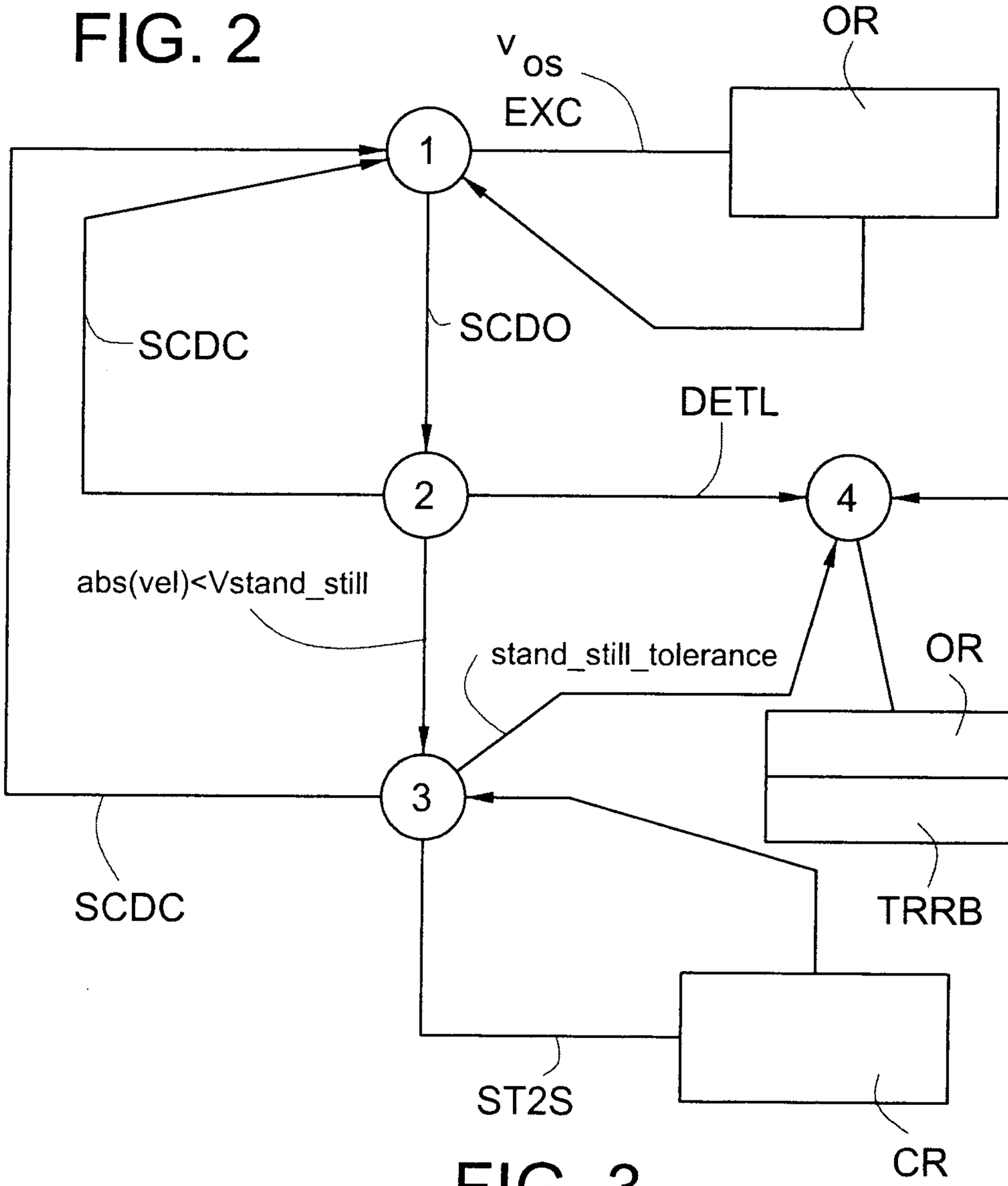
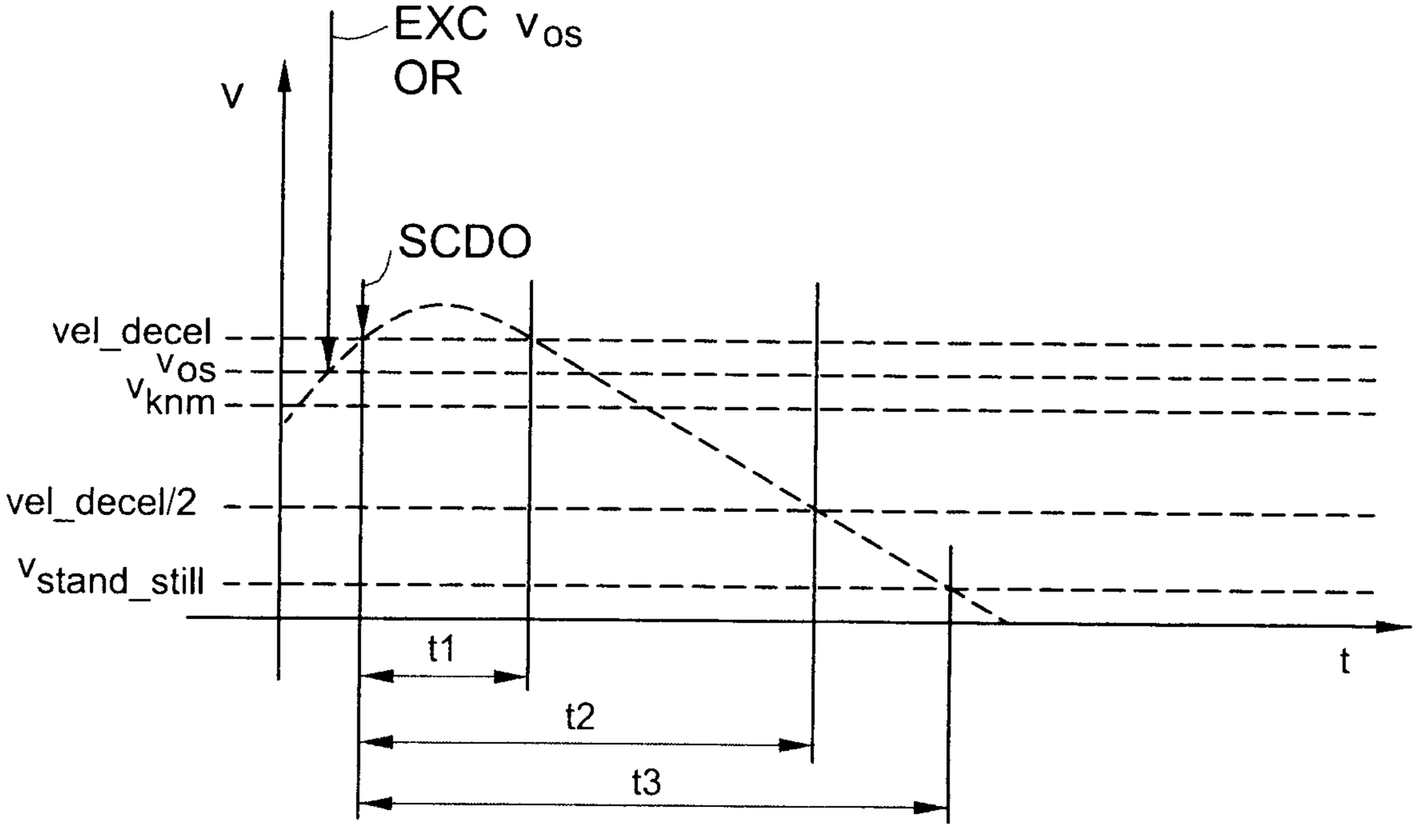
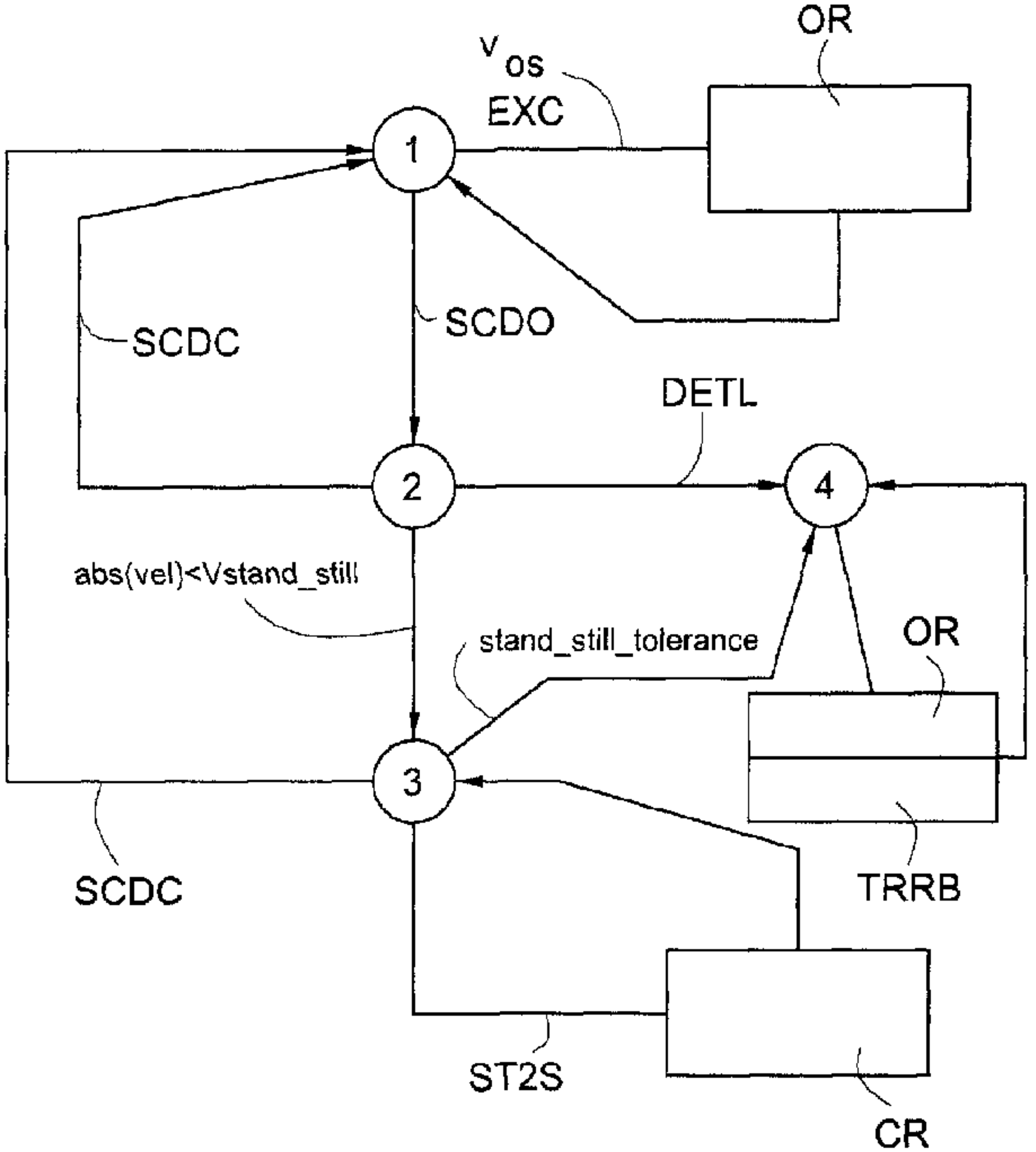

OR
v_{os}
EXC
1
SCDC
SCDO
DETL
2
4
abs(vel)<Vstand_still
stand_still_tolerance
OR
3
SCDC
TRRB
ST2S
CR

FIG. 3


EXC v_{os}
OR
v
SCDO
vel_decel
v_{os}
v_{knm}
vel_decel/2
v_{stand_still}
t1
t2
t3
t


OR
V_{OS}
EXC
1
SCDO
SCDC
DETL
2
4
abs(vel)<Vstand_still
stand_still_tolerance
OR
3
SCDC
TRRB
ST2S
CR