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(54) **Title:** AN FMCW VEHICLE RADAR SYSTEM

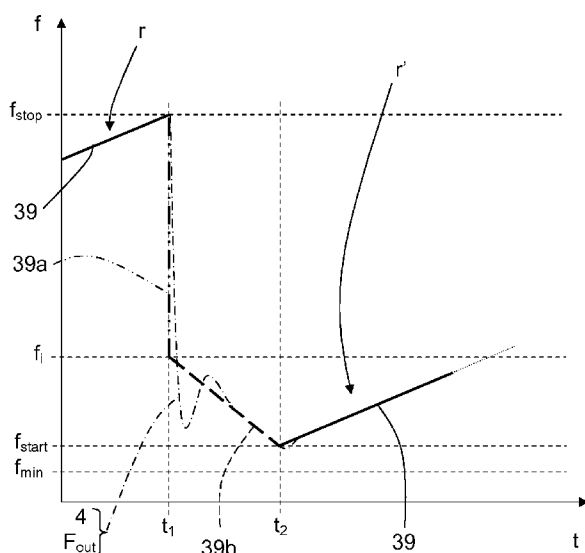


FIG. 5

(57) **Abstract:** The present disclosure relates to a vehicle radar system (3) comprising a signal generator (13) that generates a FMCW chirp signal (4) with a plurality of frequency ramps (r) running between a first frequency (f_{start}) and a second frequency (f_{stop}). At the second frequency (f_{stop}), the signal generator (13) is controlled to output an output signal (4) with an output frequency (F_{out}) for initializing a further frequency ramp (r') using a frequency control signal (31) corresponding to a desired frequency (39) with an initial desired frequency part (39a) and at least one further desired frequency part (39b). The initial desired frequency part (39a) runs from the second frequency (f_{stop}) to an intermediate frequency (f_i) between the first and second frequency ($f_{\text{start}}, f_{\text{stop}}$), and said further desired frequency part (39b) runs from the intermediate frequency (f_i) to the first frequency (f_{start}). The duration of the initial desired frequency part (39a) falls below the duration of said further desired frequency part (39b). The present disclosure also relates to a corresponding method.

TITLE

An FMCW vehicle radar system

DESCRIPTION OF THE DISCLOSURE

- 5 The present disclosure relates to a vehicle radar system where successive frequency ramps are generated and transmitted. When a ramp reaches a second high frequency, it is brought back to a first low frequency.
- 10 Many vehicle radar systems comprise radar transceivers that are arranged for generating so-called chirp signals that are transmitted, reflected and received by means of appropriate antennas comprised in the radar system. A chirp signal is an FMCW (Frequency Modulated Continuous Wave) signal with a
- 15 certain amplitude where the frequency is continuously ramped between two values, the chirp signal thus being in the form of a continuous sinusoid where the frequency varies from a first low frequency to a second high frequency over the course of the ramp. Alternatively the ramp may be such that the
- 20 frequency varies from a first high frequency to a second low frequency. The magnitude of the change in frequency from start to finish may for example be of the order of 0.5% of the starting frequency.
- 25 The received signals, thus constituted by reflected radar echoes, are mixed with the transmitted chirp signal in order to convert the received signals to baseband signals. These baseband signals, or IF (Intermediate Frequency) signals, are amplified and transferred in a plurality of channels to an
- 30 Analog Digital Converter (ADC) arrangement which is arranged to convert the received analog signals to digital signals. The digital signals are used for retrieving an azimuth angle of possible targets by simultaneously sampling and analyzing phase and amplitude of the received signals. The analysis is

generally performed in one or more Digital Signal Processors (DSP:s) by means of Fast Fourier Transform (FFT) processing.

Each radar transceiver comprises its own oscillator, normally
5 in the form of a VCO (Voltage Controlled Oscillator), which is controlled to vary the transmitted frequency from the first low frequency to the second high frequency via a phase-locked loop (PLL) which typically is achieved in a linear fashion. The frequency is controlled using a sequence of discrete frequency
10 steps that approximate the desired frequency function. After such a frequency ramp, when a ramp reaches the second high frequency, it is brought back to the first low frequency in preparation for the next ramp in a single step. Such a step should be as short as possible, enabling fast successive ramps
15 to be generated.

However, such a single step may result in an overshoot effect, where the frequency initially falls below the first low frequency. This is undesirable due to frequency restriction
20 requirements, and may create interference with other frequency bands. This may for example be due to the inherent signal leakage from the oscillator to the radiating antennas and/or to radiation from feeding lines that distribute the oscillator signal to other devices.

25

In US 8638139 this problem is solved by dividing the step into a number of equal and successively running smaller steps. However, a more versatile and efficient way to counteract an overshoot effect according to the above is desired.

30

The object of the present disclosure is thus to provide a vehicle radar system which is arranged for a more versatile and efficient way to counteract an overshoot effect when

changing the frequency from the second high frequency to the first low frequency.

This object is achieved by means of a vehicle radar system comprising a control unit and a signal generator that is arranged to generate a least one FMCW (Frequency Modulated Continuous Wave) chirp signal. Each chirp signal comprises a corresponding plurality of frequency ramps, and each frequency ramp runs between a first frequency and a second frequency.

When a frequency ramp has reached the second frequency, the control unit is arranged to control the signal generator to start outputting an output signal with an output frequency for initializing a further frequency ramp by means of a frequency control signal corresponding to a desired frequency, where the desired frequency comprises an initial desired frequency part and at least one further desired frequency part. The initial desired frequency part runs from the second frequency to an intermediate frequency having a magnitude between the first frequency and the second frequency. Said further desired frequency part runs from the intermediate frequency to the first frequency for said further frequency ramp. The duration of the initial desired frequency part falls below the duration of said further desired frequency part.

This object is also achieved by means of method for a vehicle radar system, where the method comprises:

- Generating a least one FMCW (Frequency Modulated Continuous Wave) chirp signal, where each chirp signal uses a corresponding plurality of frequency ramps, where each frequency ramp runs between a first frequency and a second frequency.
- Controlling an output frequency for initializing a further frequency ramp when a preceding frequency ramp has reached the second frequency, using a frequency

control signal corresponding to a desired frequency, where the desired frequency comprises an initial desired frequency part and at least one further desired frequency part. The initial desired frequency part runs from the
5 second frequency to an intermediate frequency having a magnitude between the first frequency and the second frequency. Said further desired frequency part runs from the intermediate frequency to the first frequency for said further frequency ramp. The duration of the initial
10 desired frequency part falls below the duration of said further desired frequency part.

According to an example, the signal generator comprises a VCO. For example, the VCO may be comprised in a phase-locked loop,
15 where the VCO is arranged to output a signal with a present output frequency.

According to another example, the signal generator comprises a reference oscillator that is arranged to output a signal of a
20 certain frequency, which signal is fed into a frequency converting unit. The frequency converting unit is arranged to multiply and/or divide the input signal, resulting in a signal having a reference frequency that is fed into a phase frequency detector. The present output frequency is fed back
25 to the phase frequency detector via a frequency divider.

According to another example, the control signal is arranged to set the divide-by ratios in the frequency divider and/or the frequency converting unit.

30 Other examples are disclosed in the dependent claims.

A number of advantages are obtained by means of the present disclosure. Mainly, the overshoot effect is eliminated in a versatile and straight forward manner.

- 5 This could for example mean that a linear PLL (phase-locked loop) architecture could be employed in such a system, despite the non-linear nature of the desired waveform trajectory.

- 10 In a linear PLL architecture, it is often beneficial to reduce the bandwidth of the analogue filter within the feedback loop, known as the loop filter. Reducing the bandwidth can have the beneficial effect of lowering the level of noise generated by the oscillator, known as phase noise. The present disclosure allows the loop bandwidth to be reduced in order to benefit
- 15 the performance of the section of the waveform used for measurement without problems of overshoot during the fly-back section.

BRIEF DESCRIPTION OF THE DRAWINGS

- 20 The present disclosure will now be described more in detail with reference to the appended drawings, where:

Figure 1 shows a schematic top view of a vehicle;

- 25 Figure 2 shows a simplified schematic of a vehicle radar system;

Figure 3 shows a first chirp signal;

- 30 Figure 4 shows details of a signal generator;

Figure 5 shows a graphical presentation of a desired frequency and an output frequency; and

Figure 6 shows a flowchart for a method according to the present disclosure.

DETAILED DESCRIPTION

5 Figure 1 schematically shows a top view of a vehicle 1 arranged to run on a road 2 in a direction D, where the vehicle 1 comprises a vehicle radar system 3 which is arranged to distinguish and/or resolve single targets from the surroundings by transmitting signals 4 and receiving reflected
10 signals 5 and using a Doppler effect in a previously well-known manner. The vehicle radar system 3 is arranged to provide azimuth angles of possible objects 6 by simultaneously sampling and analyzing phase and amplitude of the received signals 5.

15

With reference also to Figure 2, the vehicle radar system 3 comprises a transceiver arrangement 7 that is arranged for generating and transmitting sweep signals in the form of FMCW, Frequency Modulated Continuous Wave, chirp signals 4 of a
20 previously known kind, and to receive reflected signals 5. The transceiver arrangement 7 comprises a transmitter 8, a receiver 9, an Analog to Digital Converter (ADC) arrangement 10, a sampling and timing arrangement 11, a DSP (Digital Signal Processor) arrangement 12 and a control unit 32.

25

The transmitter 8 comprises a signal generator arrangement 13 and a transmit antenna arrangement 14, where the control unit 32 is connected to the signal generator arrangement 13. The receiver 9 comprises a receiver mixer 15 and a receiver
30 antenna arrangement 16.

With reference also to Figure 3, the transmitter 8 is arranged to transmit a chirp signal 4, and the receiver 9 is arranged

to receive reflected signals 5, where the transmitted chirp signal 4 has been reflected by an object 6.

A chirp signal 4 is in the form of a continuous sinusoid where
5 the frequency varies from a first frequency f_{start} to a second frequency f_{stop} over the course of a ramp r , where the chirp signal 4 comprises repeating cycles of a plurality of frequency ramps r . There the magnitude of the first frequency f_{start} falls below the magnitude of the second frequency f_{stop} .
10 The change in frequency from start to finish for each ramp r may for example be of the order of 0.5% of the first frequency f_{start} .

A cycle for the chirp signal 4 lasts for a certain cycle time
15 t_c , each ramp r lasts a certain ramp time t_r , having a ramp period time t_T . Between two consecutive ramps of the chirp signal 4 there is a delay time t_D , and during this delay time t_D the frequency of the signal generator 13 should be brought from the second frequency f_{stop} to the first frequency f_{start} ,
20 sometimes referred to as the fly-back.

Referring back to Figure 2, the reflected signals 5 are received by the receiver 9 via the receiver antenna arrangement 13. The received signals 5a, 5b, thus constituted
25 by reflected radar echoes, are then mixed with the transmitted chirp signal 4 in the receiver mixer 15.

In this way, IF (Intermediate Frequency) signals 17 are acquired and filtered in an IF filter 18 such that filtered IF
30 signals 19 are acquired.

The difference frequency of the filtered IF signals 19 relates to the target distance and are transferred from the receiver 9 to the ADC arrangement 10, where the filtered IF signals 19

are sampled at a certain predetermined sampling frequency f_s and converted to digital signals 20, the sampling frequency f_s being provided in the form of a sampling and timing signal 21 produced by the sampling and timing arrangement 11.

5

The DSP arrangement 12 that adapted for radar signal processing by means of a first FFT (Fast Fourier Transform) to convert the digital signals 20 to a range domain, and a second FFT to combine the results from successive chirp signal ramps
10 into the Doppler domain. This results in Range-Doppler matrices 22 that are transferred for further processing, which is not further discussed here, many examples of such further processing being well-known in the art.

15 In the following, with reference to Figure 4 that schematically shows a typical signal generator with a PLL, the signal generator 13 will be discussed more in detail.

The signal generator 13 comprises a voltage controlled
20 oscillator (VCO) arrangement 23 that in turn comprises a bias generator 24 and a VCO 25 which are connected to each other in this order. The VCO 25 outputs a signal having a frequency that is tunable over a certain frequency range by supplying an input control voltage in a previously known manner. The signal
25 generator 13 further comprises a phase frequency detector 27, a charge pump 28, a low pass (loop) filter 29, a reference oscillator 37 and a frequency divider 30.

The output of the VCO 25, an actual output signal 4, here the
30 chirp signal 4, with the present output frequency F_{out} , is fed back to the phase frequency detector 27 via the frequency divider 30. The reference oscillator 37 is arranged to output a signal of a certain frequency that is fed into a frequency converting unit 26 which is arranged to multiply and/or divide

the input signal, resulting in a signal having a reference frequency F_{ref} that is inputted into the phase frequency detector 27. The phase frequency detector 27 provides an up/down control signal 38 to the charge pump 28, which in turn
5 is connected to the VCO arrangement 23 via the low pass (loop) filter 29. The reference oscillator 37 may for example be a high accuracy crystal oscillator with low phase noise.

The control unit 32 is connected to the signal generator 13
10 and outputs a frequency control signal 31 to the signal generator 13 via this connection as indicated on Figure 2 and Figure 4. The frequency ramp is in practice defined by a number of discrete frequency steps (not shown). The discrete frequency steps are smoothed by the action of the loop filter.
15 The steps may have a fixed or varying time duration using previously known techniques. The ramp is generated by varying the divider ratio in the frequency divider 30 and/or the frequency converting unit 26 over time, where the frequency control signal 31 is used to set said divide-by ratios in the
20 frequency divider 30 and/or the frequency converting unit 26 as shown in Figure 4, such that frequency steps are created. The ramp is made linear and smooth with the use of the loop filter 29.

Figure 5 shows a desired frequency 39 as a function of time, indicated with a bold, initially solid, line, where the frequency control signal 31 corresponds to the desired frequency 39. Also shown in figure 5 is the frequency F_{out} of the actual output signal 4 4 of the signal generator 13,
25 indicated with a dash-dotted line. For a certain desired frequency, there is a certain corresponding frequency control signal, such that a certain corresponding frequency control signal intends to control the VCO 25 to output an actual output signal 4 having a frequency F_{out} that equals the desired
30

frequency although, in reality, there are discrepancies such that the frequency F_{out} of the actual output signal 4 differs from the desired frequency 39. This, for example, results in an overshoot that will be discussed later.

5

According to the present disclosure, the desired frequency 39 and the frequency F_{out} of the actual output signal 4 coincide until a first time t_1 where the second frequency f_{stop} is reached. Here, the present ramp r should end and the control
10 unit 32 is then arranged to control the VCO arrangement 23 to start outputting a further frequency ramp r' by means of the frequency control signal 31. The desired frequency 39 comprises an initial desired frequency part 39a indicated with a bold dash-double-dotted line, and a further desired
15 frequency part 39b indicated with a bold dashed line.

The initial desired frequency part 39a runs from the second frequency f_{stop} to an intermediate frequency f_i having a magnitude between the first frequency f_{start} and the second
20 frequency f_{stop} . The further desired frequency part 39b runs from the intermediate frequency f_i to the first frequency f_{start} for said further frequency ramp r' .

Here, there is a step from the second frequency f_{stop} to the
25 intermediate frequency f_i for the initial desired frequency part 39a that in Figure 5 is shown to occur at the first time t_1 , and then the further desired frequency part 39b decreases until a second time t_2 that occurs later than the first time t_1 , where the first frequency f_{start} is reached. Then, the
30 desired frequency 39 increases again, in accordance with the next frequency ramp r' .

How steep the step of the initial desired frequency part 39a is may of course vary, and generally the duration of the

initial desired frequency part 39a falls below the duration of said further desired frequency part 39b.

In Figure 5 it is evident that the frequency F_{out} of the actual
5 output signal 4 overshoots the intermediate frequency f_i
between the first time t_1 and the second time t_2 before
coinciding with the desired frequency 39. However, the
overshoot does not fall below a minimum frequency f_{min} of the
present frequency band. Due to an overshoot after the second
10 time t_2 , the minimum frequency f_{min} falls below the first
frequency f_{start} in order to retain the frequency F_{out} of the
output signal 4 within the present frequency band.

The intermediate frequency f_i would typically be set to be as
15 close to the first frequency f_{start} as possible in order to
minimize the duration of the overshoot occurring after the
second time t_2 . This further allows the first frequency f_{start}
to be close to the minimum frequency f_{min} which lets more of
the available bandwidth be used for measurements. However if
20 set too low, then the overshoot of the actual output signal's
frequency F_{out} during the further desired frequency part 39b
may extend below the minimum frequency f_{min} and hence create
out of band interference. Generally, according to an example,
the intermediate frequency f_i is closer to the first frequency
25 f_{start} than the second frequency f_{stop} .

With reference to Figure 6, the present disclosure also
relates to a method for a vehicle radar system 3, 3', where
the method comprises:

30 33: Generating a least one FMCW (Frequency Modulated
Continuous Wave) chirp signal 4, where each chirp signal 4
uses a corresponding plurality of frequency ramps r , where
each frequency ramp r runs between a first frequency f_{start} and
a second frequency f_{stop} .

34: Controlling an output frequency F_{out} for initializing a further frequency ramp r' when a preceding frequency ramp r has reached the second frequency f_{stop} , using a frequency control signal 31 corresponding to a desired frequency 39. The desired frequency 39 comprises an initial desired frequency part 39a and at least one further desired frequency part 39b. The initial desired frequency part 39a runs from the second frequency f_{stop} to an intermediate frequency f_i having a magnitude between the first frequency f_{start} and the second frequency f_{stop} . Said further desired frequency part 39b runs from the intermediate frequency f_i to the first frequency f_{start} for said further frequency ramp r' . The duration of the initial desired frequency part 39a falls below the duration of said further desired frequency part 39b.

As indicated in Figure 1, the vehicle 1 comprises a safety control unit 35 and safety means 36, for example an emergency braking system and/or an alarm signal device. The safety control unit 35 is arranged to control the safety means 36 in dependence of input from the radar system 3.

The present disclosure is not limited to the examples above, but may vary freely within the scope of the appended claims. For example, all times mentioned are of course only mentioned by way of example, any suitable times and timing schedules are clearly possible in a radar system according to the above. The ramp may similarly be configured as an up-ramp as described, or a down-ramp, or some combination of both.

The radar system may be implemented in any type of vehicle such as cars, trucks and buses as well as boats and aircraft.

The schematics of vehicle radar systems are simplified, only showing parts that are considered relevant for an adequate

description of the present disclosure. It is understood that the general design of radar systems of this kind is well-known in the art. For example, no devices that are arranged to use the acquired target information is shown, but many different
5 such devices are of course conceivable; for example a warning and/or collision avoidance system. The actual output signal 4 is indicated to be the actual chirp signal 4; this is only an example since there may be intermediate components positioned between the VCO's output and the transmit antenna arrangement
10 14 that alter the actual output signal 4 before being transmitted as the chirp signal 4.

The number of antenna arrangements, antennas within each antenna arrangement and IF signals may vary.

15

The ADC arrangement and the DSP arrangement should each one be interpreted as having a corresponding ADC or DSP functionality, and may each be constituted by a plurality of separate components. Alternatively, each ADC arrangement may
20 be comprised in one ADC chip, and each DSP arrangement may be comprised in one DSP chip.

25

Each antenna arrangement 13a, 13b; 25a, 25b may for example comprise on or more antennas, and each antenna may be constituted by one antenna element or by an array of antenna elements.

30

Generally, the hardware used to generate the radar signal may be active only for part of the cycle period and powered down for the rest of the cycle, i.e. when it is not needed.

There may be more than one further desired frequency part following the initial desired frequency part 39a before the next ramp r' starts, but the duration of the initial desired

frequency part always falls below the duration of any of such a further desired frequency part.

Other types of signal generators are possible, for example a
5 signal generator working in an open-loop mode where the control signal is fed directly to the VCO. However, having a PLL decreases a possible VCO frequency drift with time and temperature, requiring calibration of the control signal in order to ensure that the VCO ramp is linear and stays within
10 the desired band. Using a PLL results in that the VCO mainly stays within the desired band, and mainly is linear, without the need for such a calibration.

Terms such as coincide should not be interpreted as being
15 mathematically exact, but within what is practical in this field of technology and present context. Here, the term coincide might be interpreted as closely follow.

Generally, the present disclosure relates to a vehicle radar
20 system 3 comprising a control unit 32 and a signal generator 13 that is arranged to generate a least one FMCW (Frequency Modulated Continuous Wave) chirp signal 4. Each chirp signal 4 comprises a corresponding plurality of frequency ramps r , and each frequency ramp r runs between a first frequency f_{start} and
25 a second frequency f_{stop} . When a frequency ramp r has reached the second frequency f_{stop} , the control unit 32 is arranged to control the signal generator 13 to start outputting an output signal 4 with an output frequency F_{out} for initializing a further frequency ramp r' by means of a frequency control
30 signal 31 corresponding to a desired frequency 39, where the desired frequency 39 comprises an initial desired frequency part 39a and at least one further desired frequency part 39b, where the initial desired frequency part 39a runs from the second frequency f_{stop} to an intermediate frequency f_i having a

magnitude between the first frequency f_{start} and the second frequency f_{stop} , and where said further desired frequency part 39b runs from the intermediate frequency f_i to the first frequency f_{start} for said further frequency ramp r' , where the
5 duration of the initial desired frequency part 39a falls below the duration of said further desired frequency part 39b.

According to an example, the radar system 3 is arranged to provide input to a safety control unit 35 that in turn is
10 arranged to control safety means 36, where the radar system 3, the safety control unit 35 and the safety means 36 are comprised in a vehicle 1.

According to an example, the radar system 3 is arranged to:

- 15 - process all ramps in a cycle by means of a first FFT, Fast Fourier Transform, to acquire target information at different ranges in a plurality of complex vectors that corresponds to the number of ramps in a cycle;
- analyze one vector element at a time for all complex
20 vectors by means of a second FFT and then create a two-dimensional matrix in the Doppler domain comprising data regarding range and relative speed.

According to an example, the signal generator 13 comprises a
25 VCO 25.

According to an example, the VCO 25 is comprised in a phase-locked loop, where the VCO 25 is arranged to output a signal with a present output frequency F_{out} .

30 According to an example, the signal generator 13 comprises a reference oscillator 37 that is arranged to output a signal of a certain frequency, which signal is fed into a frequency converting unit 26, which frequency converting unit 26 is

arranged to multiply and/or divide the input signal, resulting in a signal having a reference frequency F_{ref} that is fed into a phase frequency detector 27, where the present output frequency F_{out} is fed back to the phase frequency detector 27 via a frequency divider 30.

According to an example, the frequency control signal 31 is arranged to set the divide-by ratios in the frequency divider 30 and/or the frequency converting unit 26.

Generally, the present disclosure also relates to a method for a vehicle radar system 3, where the method comprises:

33: generating a least one FMCW (Frequency Modulated Continuous Wave) chirp signal 4, where each chirp signal 4 uses a corresponding plurality of frequency ramps r , where each frequency ramp r runs between a first frequency f_{start} and a second frequency f_{stop} ; and

34: controlling an output frequency F_{out} for initializing a further frequency ramp r' when a preceding frequency ramp r has reached the second frequency f_{stop} , using a frequency control signal 31 corresponding to a desired frequency 39, where the desired frequency 39 comprises an initial desired frequency part 39a and at least one further desired frequency part 39b, where the initial desired frequency part 39a runs from the second frequency f_{stop} to an intermediate frequency f_i having a magnitude between the first frequency f_{start} and the second frequency f_{stop} , and where said further desired frequency part 39b runs from the intermediate frequency f_i to the first frequency f_{start} for said further frequency ramp r' , where the duration of the initial desired frequency part 39a falls below the duration of said further desired frequency part 39b.

According to an example, the method comprises the step of providing input to a safety control unit 35 that in turn is used to control safety means 36 in a vehicle 1.

- 5 According to an example, a VCO 25 is used for outputting a signal with a present output frequency F_{out} , working in a phase-locked loop.

CLAIMS

1. A vehicle radar system (3) comprising a control unit
5 (32) and a signal generator (13) that is arranged to generate
a least one FMCW, Frequency Modulated Continuous Wave, chirp
signal (4), where each chirp signal (4) comprises a
corresponding plurality of frequency ramps (r), and where each
frequency ramp (r) runs between a first frequency (f_{start}) and a
10 second frequency (f_{stop}), **characterized in** that when a frequency
ramp (r) has reached the second frequency (f_{stop}), the control
unit (32) is arranged to control the signal generator (13) to
start outputting an output signal (4) with an output frequency
(F_{out}) for initializing a further frequency ramp (r') by means
15 of a frequency control signal (31) corresponding to a desired
frequency (39), where the desired frequency (39) comprises an
initial desired frequency part (39a) and at least one further
desired frequency part (39b), where the initial desired
frequency part (39a) runs from the second frequency (f_{stop}) to
20 an intermediate frequency (f_i) having a magnitude between the
first frequency (f_{start}) and the second frequency (f_{stop}), and
where said further desired frequency part (39b) runs from the
intermediate frequency (f_i) to the first frequency (f_{start}) for
said further frequency ramp (r'), where the duration of the
25 initial desired frequency part (39a) falls below the duration
of said further desired frequency part (39b).

2. The vehicle radar system (3) according to claim 1,
characterized in that the radar system (3) is arranged to
30 provide input to a safety control unit (35) that in turn is
arranged to control safety means (36), where the radar system
(3), the safety control unit (35) and the safety means (36)
are comprised in a vehicle (1).

3. The vehicle radar system (3) according to any one of the claims 1 or 2, **characterized in** that the radar system (3) is arranged to:

- 5 - process all ramps in a cycle by means of a first FFT, Fast Fourier Transform, to acquire target information at different ranges in a plurality of complex vectors that corresponds to the number of ramps in a cycle;
- 10 - analyze one vector element at a time for all complex vectors by means of a second FFT and then create a two-dimensional matrix in the Doppler domain comprising data regarding range and relative speed.

4. The vehicle radar system (3) according to any one of the previous claims, **characterized in** that the signal
15 generator (13) comprises a VCO (25).

5. The vehicle radar system (3) according to claim 4, **characterized in** that the VCO (25) is comprised in a phase-locked loop, where the VCO (25) is arranged to output a signal
20 with a present output frequency (F_{out}).

6. The vehicle radar system (3) according to claim 5, **characterized in** that the signal generator (13) comprises a reference oscillator (37) that is arranged to output a signal
25 of a certain frequency, which signal is fed into a frequency converting unit (26), which frequency converting unit (26) is arranged to multiply and/or divide the input signal, resulting in a signal having a reference frequency (F_{ref}) that is fed into a phase frequency detector (27), where the present output
30 frequency (F_{out}) is fed back to the phase frequency detector (27) via a frequency divider (30).

7. The vehicle radar system (3) according to claim 6, **characterized in** that the frequency control signal (31) is

arranged to set divide-by ratios in the frequency divider (30) and/or the frequency converting unit (26).

8. A method for a vehicle radar system (3), where the
5 method comprises:

(33) generating a least one FMCW, Frequency Modulated Continuous Wave, chirp signal (4), where each chirp signal (4) uses a corresponding plurality of frequency ramps (r), where each frequency ramp (r) runs between a first frequency (f_{start})
10 and a second frequency (f_{stop});

characterized in that the method further comprises:

(34) controlling an output frequency (F_{out}) for initializing a further frequency ramp (r') when a preceding frequency ramp (r) has reached the second frequency (f_{stop}),
15 using a frequency control signal (31) corresponding to a desired frequency (39), where the desired frequency (39) comprises an initial desired frequency part (39a) and at least one further desired frequency part (39b), where the initial desired frequency part (39a) runs from the second frequency
20 (f_{stop}) to an intermediate frequency (f_i) having a magnitude between the first frequency (f_{start}) and the second frequency (f_{stop}), and where said further desired frequency part (39b) runs from the intermediate frequency (f_i) to the first frequency (f_{start}) for said further frequency ramp (r'), where
25 the duration of the initial desired frequency part (39a) falls below the duration of said further desired frequency part (39b).

9. The method according to claim 8, **characterized in**
30 that the method comprises the step of providing input to a safety control unit (35) that in turn is used to control safety means (36) in a vehicle (1).

10. The method according to any one of the claims 8 or 9, **characterized in** that a VCO (25) is used for outputting a signal with a present output frequency (F_{out}), working in a phase-locked loop.

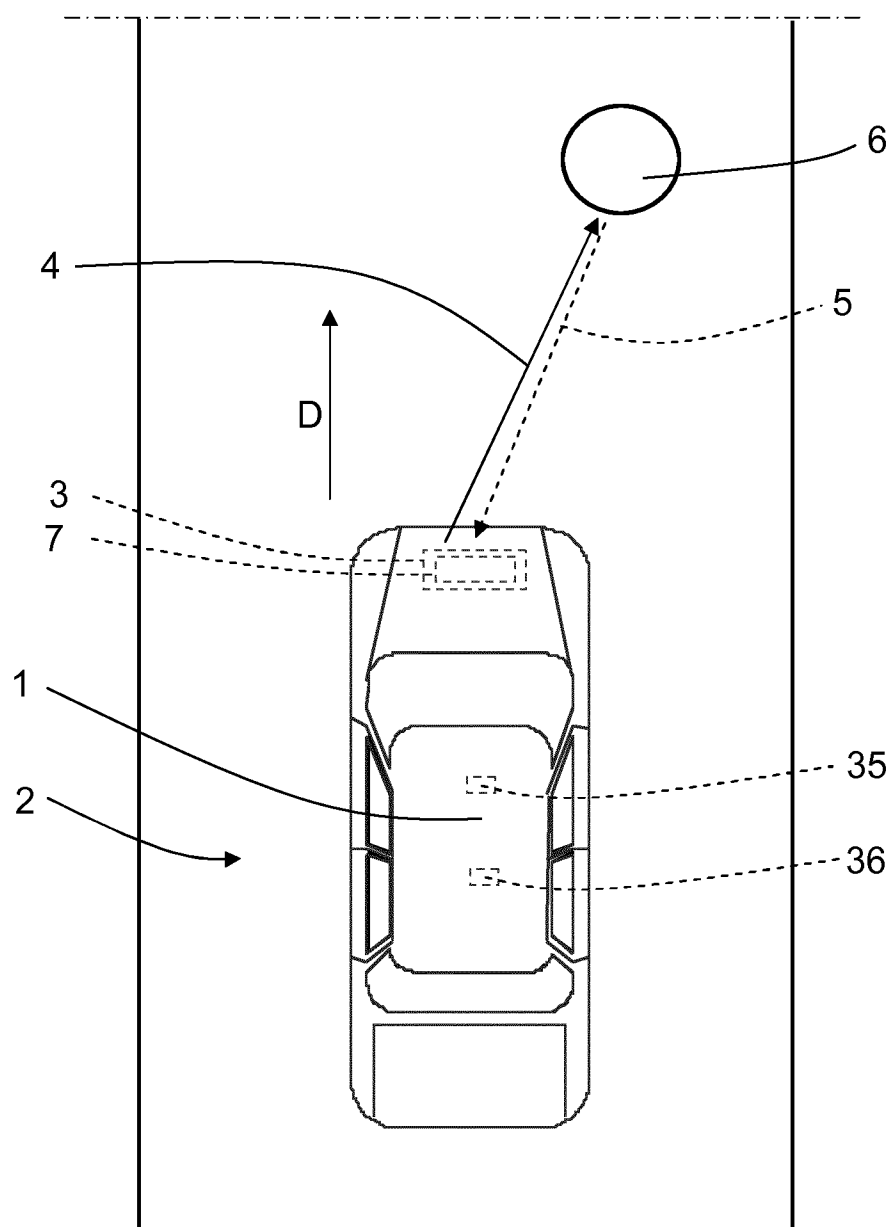


FIG. 1

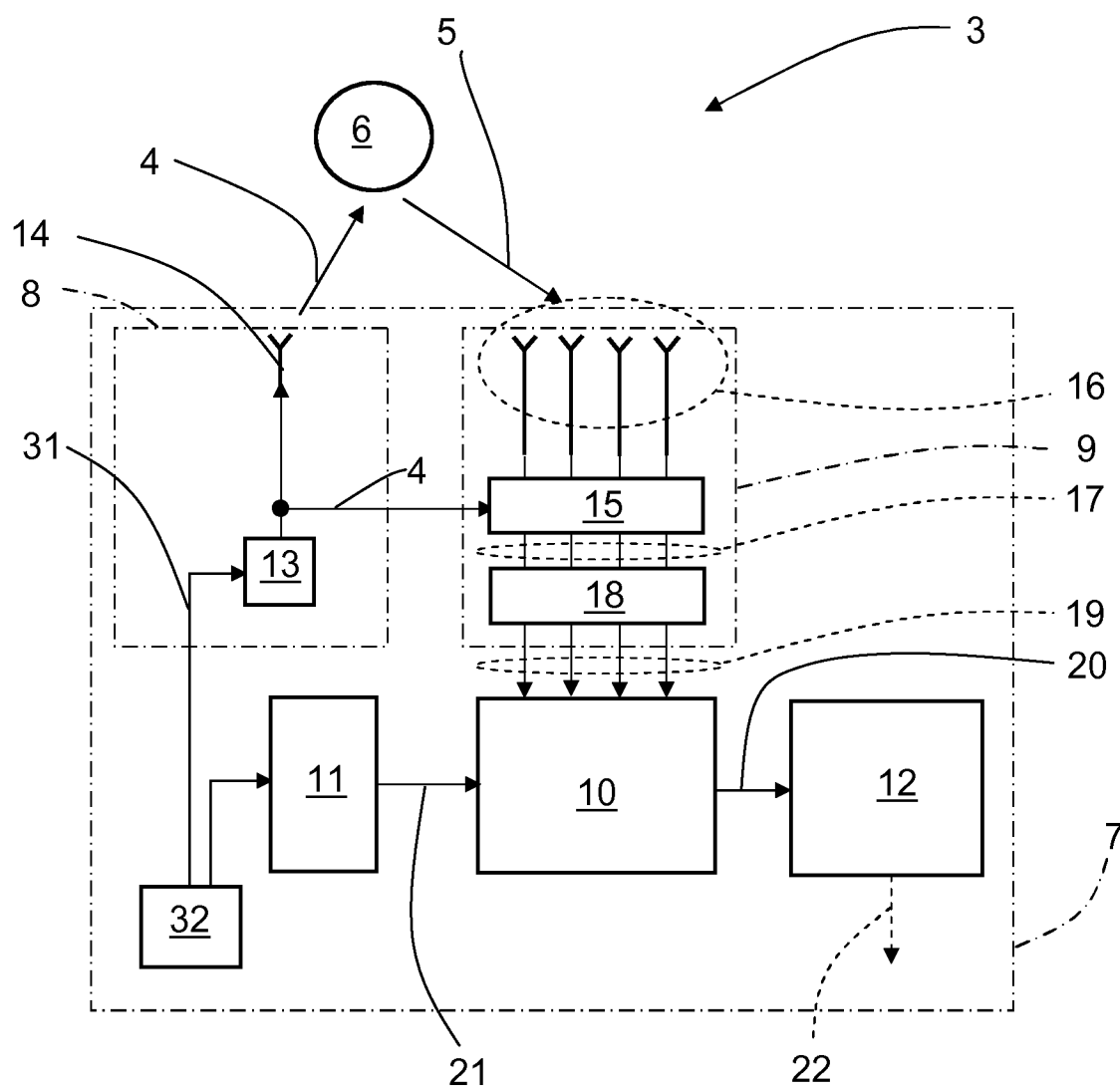


FIG. 2

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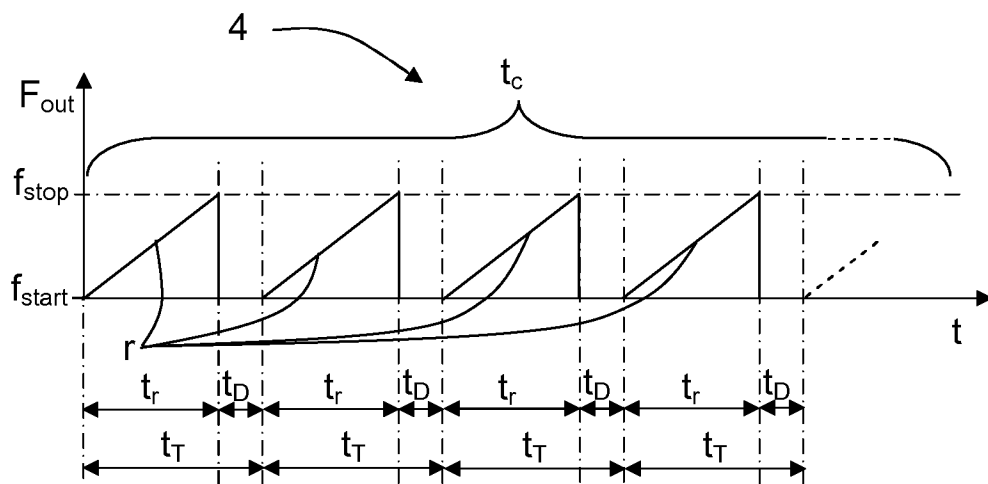


FIG. 3

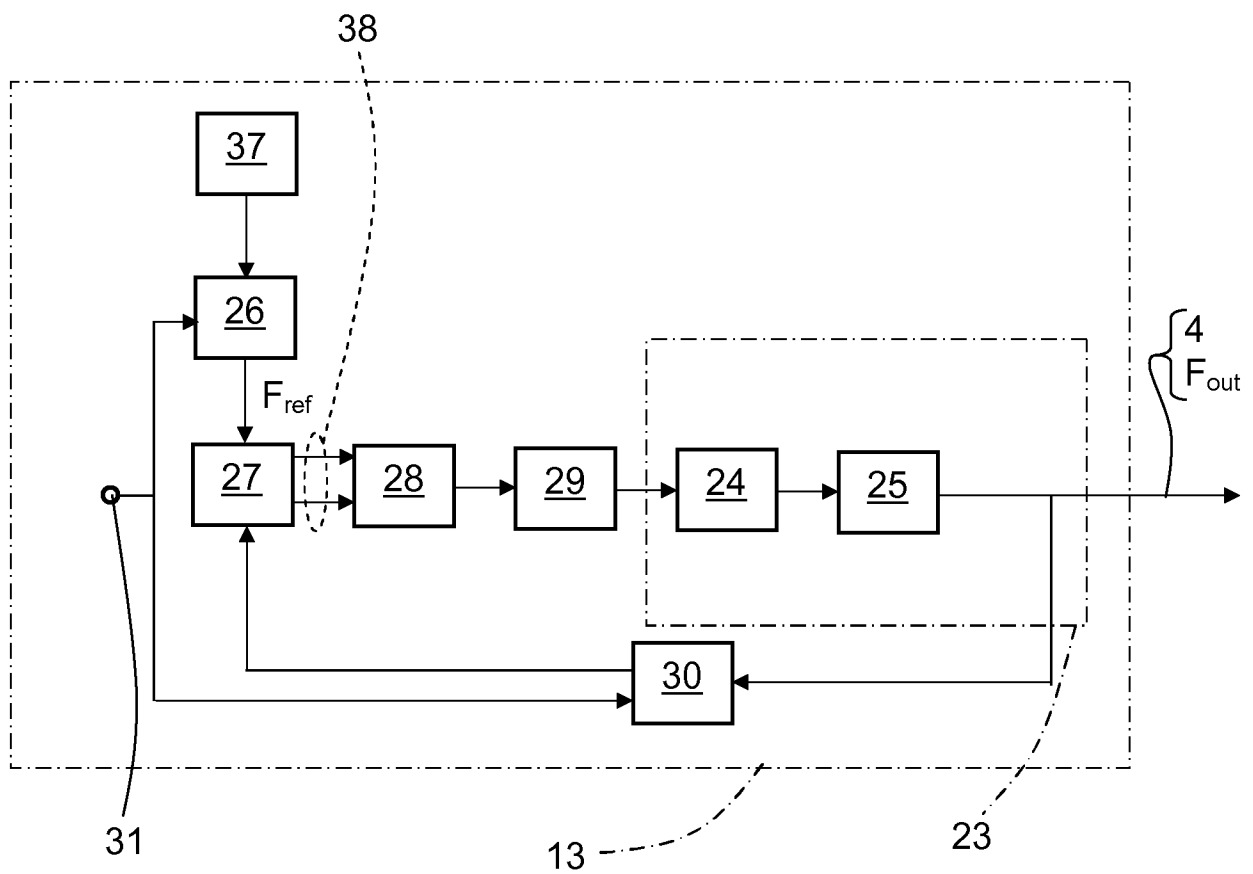


FIG. 4

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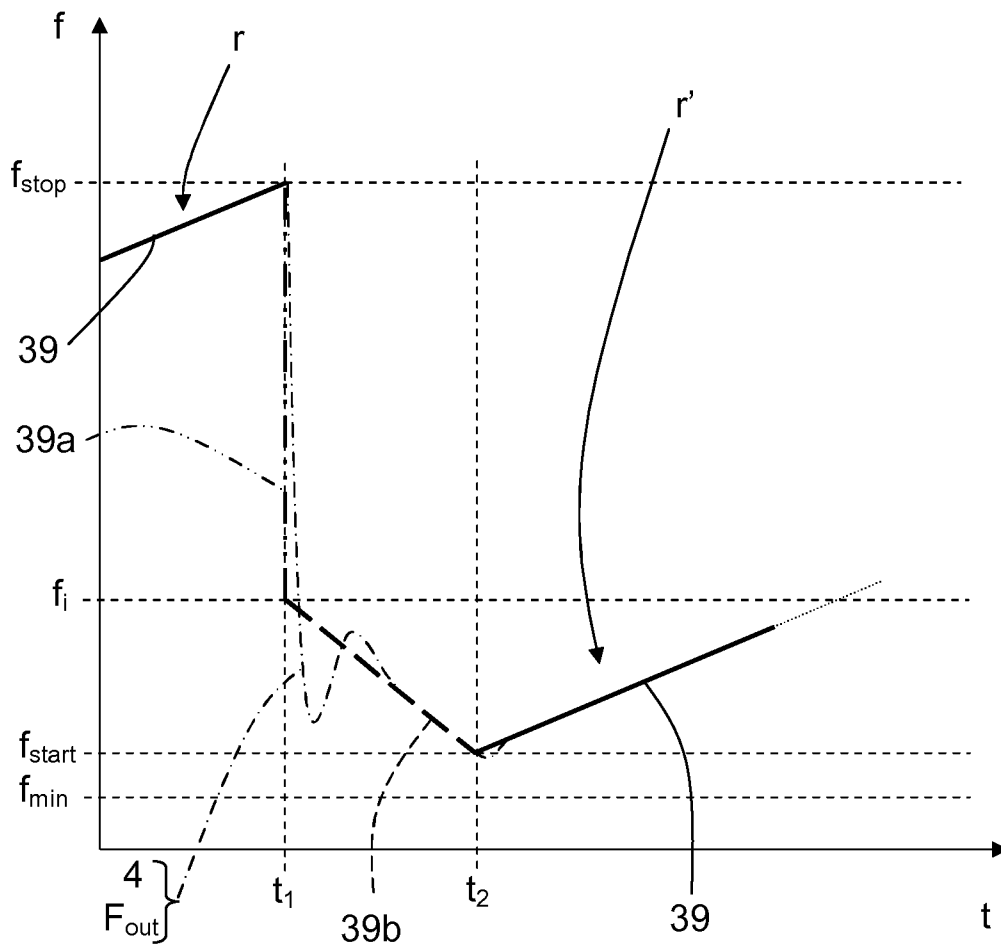


FIG. 5

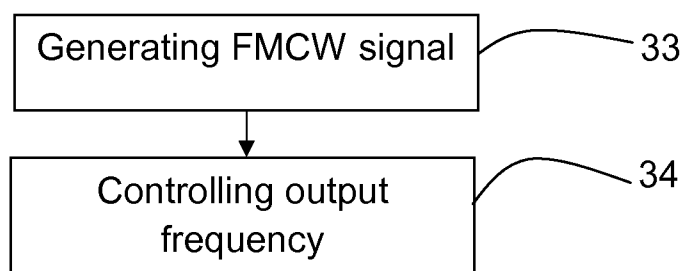


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/061014

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S13/93
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)
G01S

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	US 8 638 139 B2 (KEAVENEY MICHAEL [IE] ET AL) 28 January 2014 (2014-01-28) cited in the application abstract column 7 - column 8 figures 1, 3, 5, 7, 8	1-10
X	EP 2 818 887 A1 (NXP BV [NL]) 31 December 2014 (2014-12-31) abstract paragraph [0079] - paragraph [0081] figure 10	1-10
A	EP 1 806 598 A1 (VALEO RAYTHEON SYSTEMS INC [US]) 11 July 2007 (2007-07-11) abstract paragraph [0002]	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

6 July 2016

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18/07/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/061014

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			US 2007152870 A1 05-07-2007
