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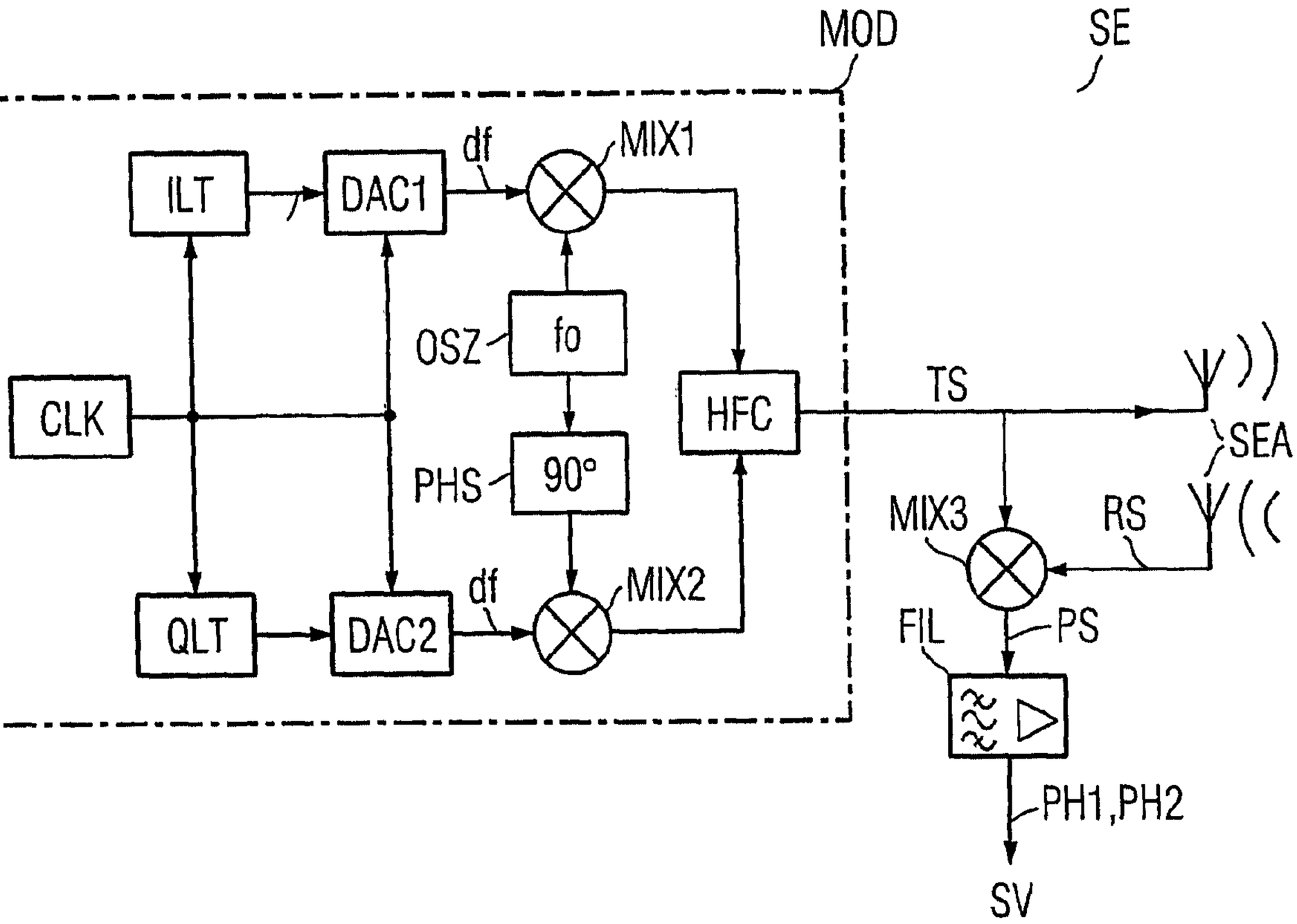
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(54) Titre : PROCEDE SERVANT A DETERMINER LA DISTANCE ENTRE UNE STATION DE BASE ET UN OBJET MOBILE, ET STATION DE BASE ET SYSTEME D'IDENTIFICATION CONCUS POUR CE PROCEDE

(54) Title: METHOD FOR DETERMINING THE DISTANCE BETWEEN A BASE STATION AND A MOBILE OBJECT, IN ADDITION TO A BASE STATION AND IDENTIFICATION SYSTEM FOR A METHOD OF THIS TYPE



(57) Abrégé/Abstract:
The invention relates to a method for determining the distance between a base station (SLG) and a mobile object (DT1-DT3), in particular in an identification system (IS) comprising at least one mobile data memory that is fixed to objects in order to act as a

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(57) Abrégé(suite)/Abstract(continued):
mobile object for recording object-specific condition and/or process data, e.g. in a dispatch, transport and/or manufacturing system. According to the invention: a HF carrier frequency and an offset frequency (df) are predetermined for a QAM modulation; the HF carrier frequency is increased and reduced by the offset frequency in sequence over time in such a way that the HF carrier base frequencies (fo+df, fo-df) resulting in an HF carrier signal (TS) thus modulated exhibit an identical phase when the frequency is changed; the HF carrier signal is subsequently transmitted and simultaneously mixed (MIX) with an HF carrier signal (RS) that has been backscattered by a mobile object to obtain a carrier phase signal (PS); the corresponding carrier phase (PH1, PH2) for the two HF carrier base frequencies is determined in sequence over time and the difference (dPH) between said phases is used to calculate the distance between the base station and the respective mobile object.

ABSTRACT OF THE DISCLOSURE

The invention relates to a method for determining the distance between a base station (SLG) and a mobile object (DT1–DT3), particularly in an identification system (IS) including at least one mobile data memory that is fixed to objects in order to act as a mobile object for recording object-specific status and or process data, e.g., in a dispatch, transport and/or manufacturing system. According to the invention: a HF carrier frequency and an offset frequency (df) are predetermined for a QAM modulation; the HF carrier frequency is increased and reduced by the offset frequency in sequence over time in such a way that the HF carrier base frequencies (fo+df, fo–df) resulting in an HF carrier signal (TS) thus modulated exhibit an identical phase when the frequency is changed; the HF carrier signal is subsequently transmitted and simultaneously mixed (MIX) with an HF carrier signal (RS) that has been backscattered by a mobile object to obtain a carrier phase signal (PS); the corresponding carrier phase (PH1, PH2) for the two HF carrier base frequencies is determined in sequence over time, and the difference (dPH) between these phases is used to calculate the distance between the base station and the respective mobile object.

METHOD FOR DETERMINING THE DISTANCE BETWEEN A BASE STATION AND A MOBILE OBJECT, IN ADDITION TO A BASE STATION AND IDENTIFICATION SYSTEM FOR A METHOD OF THIS TYPE

Description

[001] The invention relates to a method for determining the distance between a base station and a mobile object, particularly in an identification system with at least one mobile data memory which is fixed to objects and acts as a mobile object for recording object-related status and/or process data, e.g., in a shipping, transport and/or production system.

[002] Methods for distance determination are known in the art, e.g., RADAR. From a stationary base station, radar waves are emitted and are backscattered by a mobile object, e.g., vehicles, persons, transponders, etc. To determine the distance, known modulation methods based on continuous sinusoidal signals (continuous wave) are preferably used, e.g., the FMCW, LFM or FSK modulation method. A common means to carry out the aforementioned modulation methods is the use of an IQ modulator (quadrature amplitude modulator). By measuring the carrier phase for different frequencies, the distance and possibly also the speed of a mobile object located in the vicinity can then be determined.

[003] Furthermore, identification systems are known, which have one or more stationary base stations—so-called read/write devices—which contactlessly exchange data with mobile data memories acting as mobile objects via a data transmission link, which is typically radio-based. Systems of this type are used in technical installations in which a plurality of objects or goods must be moved as quickly and freely as possible. The objects can be of a wide variety of types, e.g., packages in a shipping installation, components in a production plant, luggage in a transport system, etc.

[004] One example of an identification system of this type is described in the ISO 18000-4-MOD3 Standard entitled "Radio-frequency Identification Standard for Item Management – Air Interface." This standard provides that the read/write device polls for

the presence of a mobile data memory within the detection range. For this purpose, it emits an unmodulated HF carrier signal with a defined HF carrier frequency, e.g., 2.45 GHz. A mobile data memory located in the vicinity can passively backscatter this carrier signal modulated with data to the read/write device, which processes it.

[005] When operating two or more, particularly closely spaced base stations and mobile data memories, e.g., in adjacent assembly lines, care must be taken to avoid undesirable interactions, e.g., overshoots between the individual base stations and the corresponding mobile data memories. The detection range of the corresponding base station must therefore be restricted. This can be accomplished, for example, by determining the distance between the base station and the corresponding mobile data memory.

[006] Frequencies generated in a conventional manner to determine distances can be subject to significant measurement inaccuracies. This is because the zero phases of the frequencies generated in the base station are not connected, i.e., they do not correlate. This is true, for example, if the corresponding frequencies come from different oscillatoras or are generated by a PLL (Phase Locked Loop). As a result, to get the desired correlation, the signal phases must first be measured at each frequency in the transmitter part using complex circuits.

[007] The object of some embodiments of the invention is to provide an improved method for determining the distance between a base station and at least one mobile object. A further object of some embodiments of the invention is to provide a base station and an identification system for such a method.

[008] According to one aspect of the present invention, there is provided method for determining distance between a base station and a mobile object, wherein, in the base station, a) an HF carrier frequency and an offset frequency are predefined for an IQ modulation, b) the HF carrier frequency is sequentially increased and decreased by the offset frequency over time, such that HF carrier base frequencies resulting in an HF carrier signal thus modulated have an identical phase

when the HF carrier frequency is changed, c) the HF carrier signal is subsequently transmitted and simultaneously mixed with an HF carrier signal that has been backscattered by a mobile object to obtain a carrier phase signal, and d) a corresponding carrier phase for the two HF carrier base frequencies is determined sequentially over time, and a difference between said phases is used to determine the distance between the base station and the respective mobile object.

[009] The method can be advantageously used in an identification system with at least one mobile data memory fixed to transported objects for recording object-specific status and/or process data.

[010] According to another aspect of the present invention, there is provided base station with a transceiver and an electronic signal processor for carrying out the method as described above or as detailed below, wherein the transceiver has at least a) one digital IQ modulator, b) one transceiver antenna for transmitting and receiving the HF carrier signals, and c) one mixer for the HF carrier signals for forming the carrier phase signal to determine the distance between the base station and the mobile object using the electronic signal processor.

[010a] According to another aspect of the present invention, there is provided identification system for at least one of recording object-specific status and processing data, the identification system comprising: at least one base station as described above or as detailed below; and at least one mobile object.

[011] To determine the distance between a base station and a mobile object in the method according to the invention, a HF carrier frequency and an offset frequency are predefined for an IQ modulation in the base station. The HF carrier frequency is sequentially increased and decreased by the offset frequency over time such that the HF carrier base frequencies resulting in a HF carrier signal thus modulated have the same phase when the frequency is changed. The HF carrier signal is subsequently transmitted and simultaneously mixed with an HF carrier signal that has been backscattered by the mobile object to obtain a carrier phase signal. The corresponding carrier phase for the two HF carrier base frequencies is determined sequentially over time and the difference between the phases is used to calculate the distance between the base station and the corresponding mobile object.

[012] As a result, the phase of the two IQ-modulated HF carrier base frequencies in the HF carrier signal is identical in the base station. This has the advantage that the phase jumps, which usually occur when the frequency is changed, are avoided. An additional measurement on the transmitter in the base station and the required measuring time are advantageously eliminated.

[013] According to an advantageous variant of the method, the HF carrier frequency and/or the offset frequency are changed between two distance determinations. Thus, if there is interference in one frequency band, it is possible to change to another frequency band. The frequency bands may correspond to different frequency channels.

[014] According to another advantageous variant of the method, multiple distance determinations can be made with subsequent averaging over all the individual distance determinations.

[015] This makes it possible to increase the measurement accuracy. The distance can thus be determined very precisely.

[016] In one variant of the method, the base station is a read/write device and the mobile object is a mobile data memory. Matching their frequencies ensures good backscattering properties for determining the distance.

[017] According to another advantageous variant of the method, the distance between the read/write device and the mobile data memory is measured in a transmission channel, particularly a transmission channel with four channels, such that signals of different frequencies are transmitted on the individual channels.

[018] Advantageously, the method according to the invention is based on the transmission method defined in the ISO 18000-4-MOD3 Standard and adopts at least one of the channels thereof with modification.

[019] If the ISO 18000-4-MOD3 Standard is adapted, the transmission channel can correspond to the ISO 18000-4-MOD3 notification channel. Where applicable, at least one channel of the communication channel according to the above standard can also be used for this purpose.

[020] In the corresponding allocation, the channels of the transmission channel can be R2 channels in the notification channel of the ISO 18000-4-MOD-3 Standard.

[021] The method can be advantageously used in an identification system with a base station and at least one mobile data memory that is fixed to transported objects for recording object-specific status and/or process data.

[022] According to the invention, the method can be carried out with a base station having at least one transceiver and one electronic signal processor. The transceiver has at least one digital IQ modulator, one transmit and receive antenna for transmitting and receiving the HF carrier signals and one mixer for the HF carrier signals to obtain the carrier phase signal, which the electronic signal processor uses to determine the distance between the base station and the mobile object.

[023] An essential advantage is that the carrier phase can be measured using existing circuit components, such as the PLL for HF carrier frequency modification and the IQ modulator for data modulation. As a result, the distance can be measured with sufficient accuracy without added complexity of electronic circuit components.

[024] The invention will now be described in greater detail with reference to the figures, in which:

FIG 1 shows an example of the use of a base station as a read/write device and a plurality of mobile data memories as exemplary mobile objects,

FIG 2 shows an exemplary data structure of a transmission channel,

FIG 3 shows an exemplary structure of a transceiver of a base station with an IQ modulator and a mixer for forming the carrier phase signal, and

FIG 4 shows an exemplary constellation diagram to graphically represent exemplary measuring points of the respective phase of each of two HF carrier base frequencies.

[025] FIG 1 shows an example of the use of a base station SLG as a read/write device and a plurality of mobile data memories DT1–DT3. Together with an air interface LS between the data memories DT1–DT3 and the base station SLG, they form an identification system IS. The different possible movement directions BR1–BR3 of the mobile data memories DT1–DT3 are entered in the figure by way of example. For data communication, the data memories DT1–DT3 and the base station SLG each have an antenna ANT, SEA. In the base station SLG, the dash-dotted rectangle indicates a transceiver SE, which is used to carry out the method according to the invention.

[026] FIG 2 shows an exemplary data structure of a transmission channel N-CH for communication between a mobile data memory DT1–DT3 and the read/write device SLG. The data structure of the transmission channel N–CH is based on the notification channel of the ISO 18000-4 MOD3 Standard. To carry out one or more distance measurements, one or more of the channels K1 to K4 are provided. These channels K1 to K4, if based on the ISO 18000-4-MOD3 Standard, correspond to the R2 channels R2 in the notification channel of the ISO 18000-4-MOD3 Standard. The figure depicts an exemplary substructure of an R2 channel R2 with five time blocks. In the first block KONF, the PLL is programmed to set the HF carrier frequency fo. In the following block NPM, a negative frequency jump to the lower HF carrier base frequency fo–df is set by the IQ modulator MOD. Thereafter, in the carrier phase signal PS, the first carrier phase

PH1 and the corresponding measured data DAT1 are processed, e.g., by a digital signal processor (DSP). Subsequently, the positive frequency jump to the frequency fo+df occurs in the time block PPM, and the first measured data DAT1 together with the second measured data DAT2 are used to form the carrier phase difference dPH. For the above standard, a distance measurement in an R2 channel is possible within approximately 0.5 ms.

[027] FIG 3 shows an exemplary structure of a transceiver SE of a base station SLG with an IQ modulator MOD and a mixer MIX3 for forming the carrier phase signal PS. In the example illustrated in the figure, the IQ modulator MOD has two so-called lookup tables ILT, QLT, which contain digital sampling values for the required signal waveform for the modulation. The sampling values are time-controlled via a clock generator CKL and are each supplied to a respective digital-to-analog converter DAC1, DAC2 where they are converted into an analog signal. The two mixers MIX1, MIX2 now modulate the analog signals in quadrature onto to the carrier using two 90° shifted HF carrier frequencies OSZ, fo, PHS. Using an HF combiner HFC, the two mixed signals are combined into a HF carrier signal TS and fed to an antenna SEA for transmission. The mixer MIX3 then mixes a HF carrier signal RS backscattered by a mobile object DT1–DT3 together with the HF carrier signal TS to be transmitted and forms a carrier phase signal PS. Interfering frequency components are removed by a downstream filter FIL, e.g., a lowpass. The corresponding phase PH1, PH2 is then supplied to an electronic signal processor SV, the difference dPH is formed, and the associated distance is calculated.

[028] FIG 4 shows an exemplary constellation diagram I, Q to graphically represent exemplary measuring points MP1, MP2 for determining the distance. Two measuring points each MP1, MP2 are entered for the corresponding phase PH1, PH2 of two HF carrier base frequencies fo+df, fo–df. The straight lines represent the exemplary averaging result for the phases PH1, PH2.

54106-193

CLAIMS:

1. Method for determining distance between a base station and a mobile object, wherein, in the base station,

a) an HF carrier frequency and an offset frequency are predefined for an IQ modulation,

b) the HF carrier frequency is sequentially increased and decreased by the offset frequency over time, such that HF carrier base frequencies resulting in an HF carrier signal thus modulated have an identical phase when the HF carrier frequency is changed,

c) the HF carrier signal is subsequently transmitted and simultaneously mixed with an HF carrier signal that has been backscattered by a mobile object to obtain a carrier phase signal, and

d) a corresponding carrier phase for the two HF carrier base frequencies is determined sequentially over time, and a difference between said phases is used to determine the distance between the base station and the respective mobile object.

2. Method as claimed in Claim 1, wherein at least one of the HF carrier frequency and the offset frequency are changed between two distance determinations.

3. Method as claimed in Claim 1 or 2, wherein multiple distance determinations are made and subsequently averaged.

4. Method as claimed in any one of Claims 1 to 3, wherein the base station is a read/write device and the mobile object is a mobile data memory.

5. Method as claimed in Claim 4, wherein the distance is determined in a transmission channel between the read/write device and the mobile data memory.

54106-193

6. Method as claimed in Claim 5, wherein the transmission channel has a plurality of channels.

7. Method as claimed in Claim 5 or 6, wherein the transmission channel corresponds to a notification channel of the ISO 18000-4-MOD3 Standard.

8. Method as claimed in Claim 6 or 7, wherein the channels in the transmission channel correspond to R2 channels in the notification channel of the ISO 18000-4-MOD3 Standard.

9. Use of the method as claimed in any one of the preceding Claims 3 to 8 in an identification system with a read/write device and at least one mobile data memory which is fixed to transported objects to at least one of record object-specific status and process data.

10. Base station with a transceiver and an electronic signal processor for carrying out the method as claimed in any one of Claims 1 to 8, wherein the transceiver has at least

a) one digital IQ modulator,

b) one transceiver antenna for transmitting and receiving the HF carrier signals, and

c) one mixer for the HF carrier signals for forming the carrier phase signal to determine the distance between the base station and the mobile object using the electronic signal processor.

11. Identification system for at least one of recording object-specific status and processing data, the identification system comprising:

at least one base station as claimed in Claim 10; and

at least one mobile object.

FIG 1

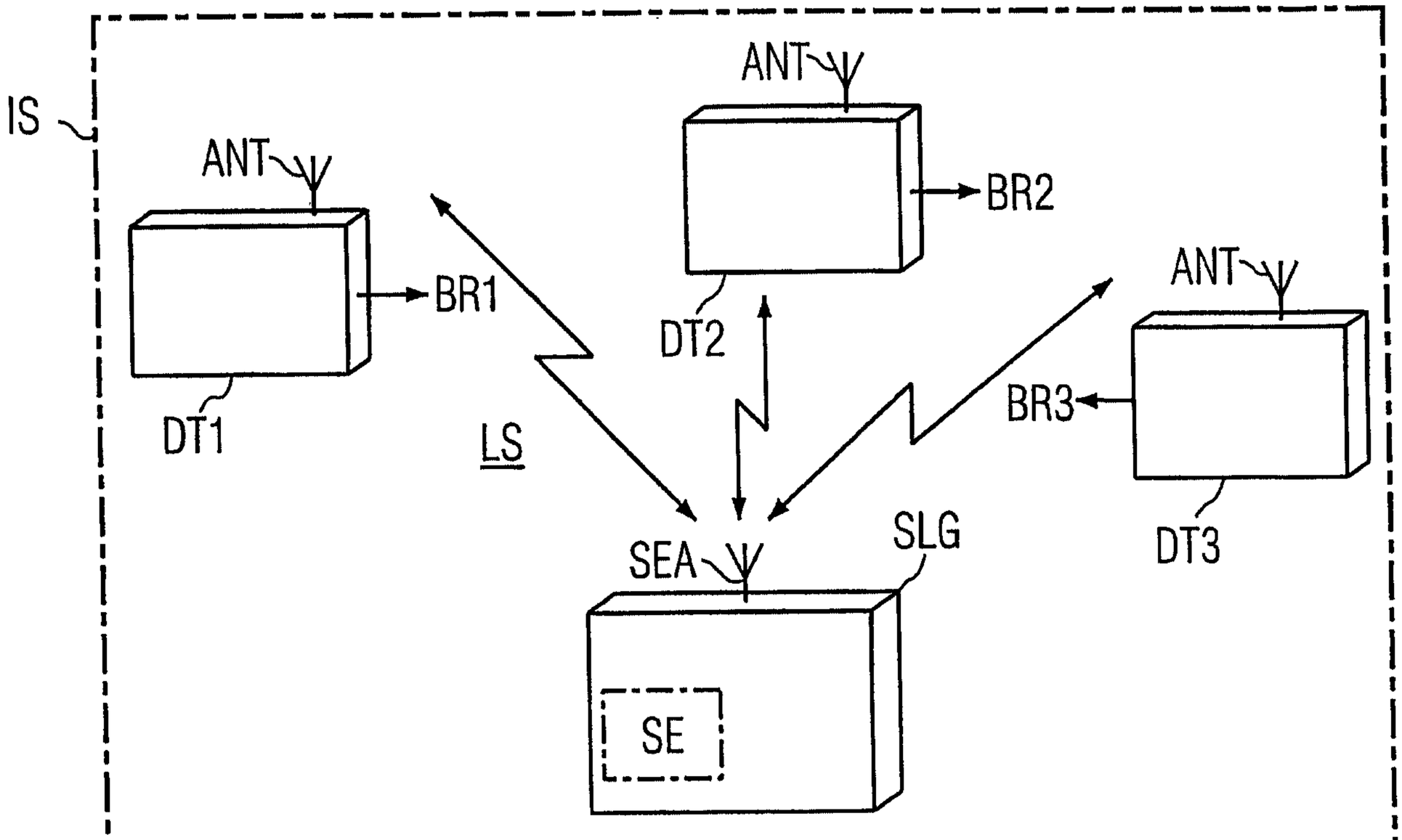

IS
ANT
BR1
DT1
LS
ANT
BR2
DT2
ANT
BR3
DT3
SEA
SLG
SE

FIG 2

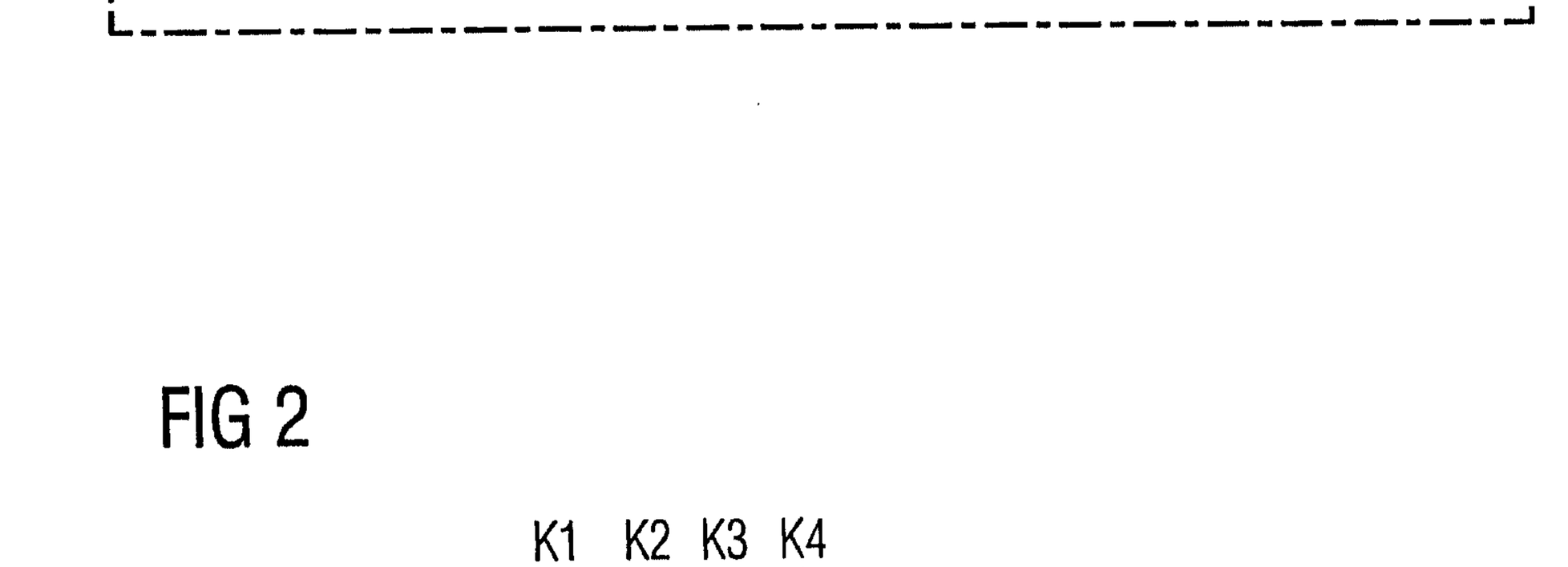

K1
K2
K3
K4
DT1-DT3
R2
R2
R2
R2
N-CH
KONF
NPM
DAT1
PPM
DAT2
R2

FIG 3

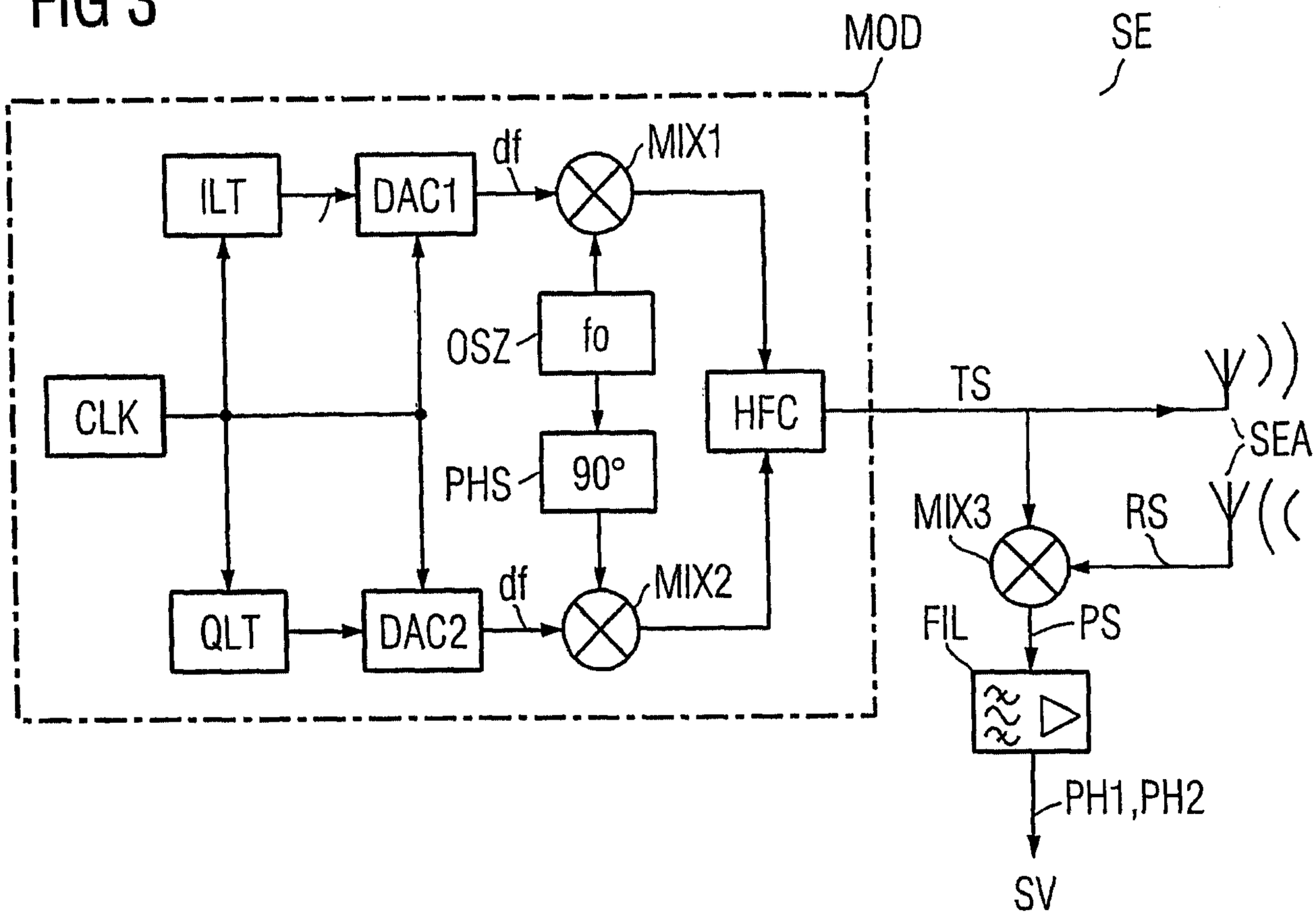
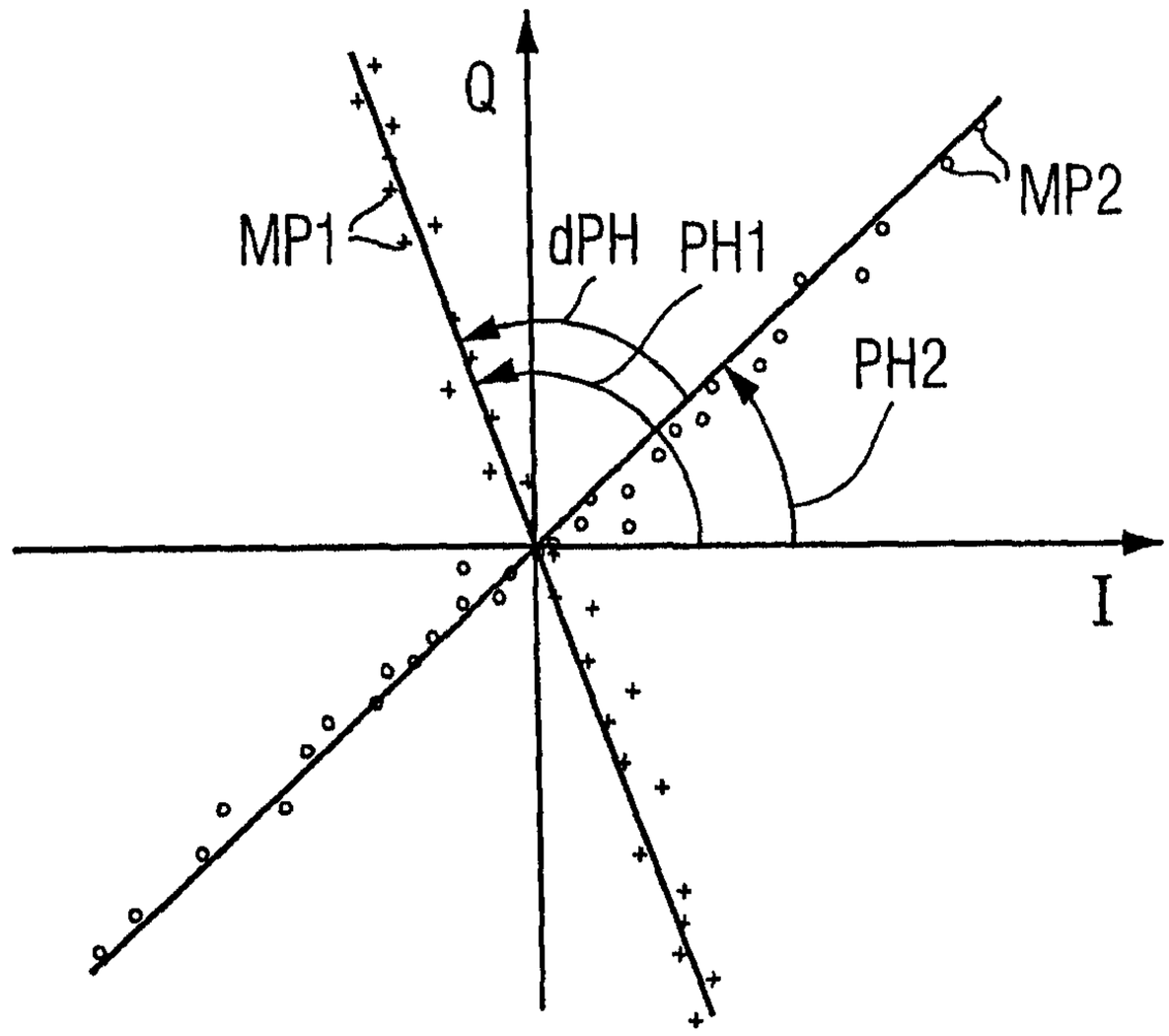
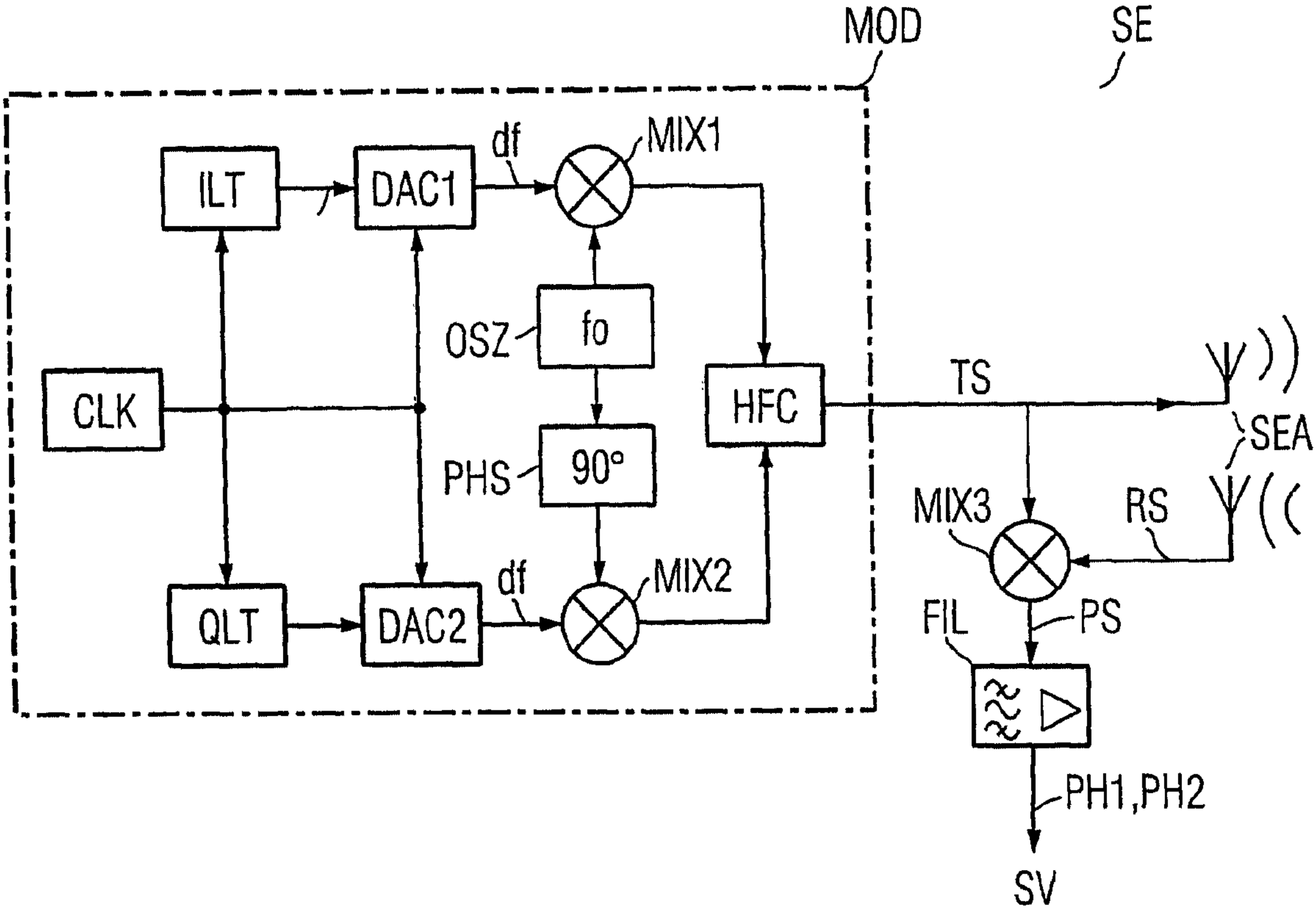

MOD
SE
ILT
DAC1
df
MIX1
OSZ
fo
CLK
HFC
TS
PHS
90°
SEA
MIX3
RS
df
MIX2
QLT
DAC2
FIL
PS
PH1,PH2
SV

FIG 4


Q
MP1
dPH
PH1
MP2
PH2
I


MOD
SE
ILT
DAC1
df
MIX1
OSZ
fo
CLK
HFC
TS
SEA
PHS
90°
MIX3
RS
df
MIX2
QLT
DAC2
FIL
PS
PH1,PH2
SV