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(54) **Commodity consumption registering meters**

(57) A commodity consumption registering meter includes a transceiver (5) which comprises a transmitter (9) operative to transmit consumption data to a base station, a receiver (12) operative to utilise a local oscillator (11) to effect conversion of a received signal to a demodulated signal, and control means (2) for adjusting the frequency of the local oscillator in response to the received signal to reduce drift in the frequency of the local oscillator. The difference in frequency between the received carrier and the local oscillator (11) may be measured via the counter (19) to control the local oscillator. Alternatively the received signal may be modulated with data indicative of the amount of frequency correction or of the required local oscillator frequency and the recovered data is applied to a processor for control of the local oscillator. The control signal may be corrected by the output of a temperature sensor. The control signal may be stored in a memory 4 when the transceiver is in the stand-by state.

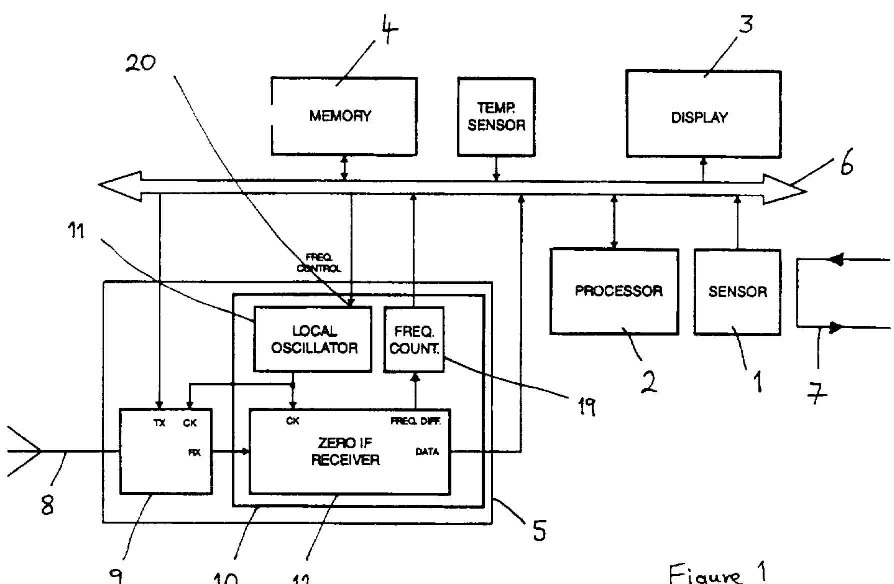

Figure 1

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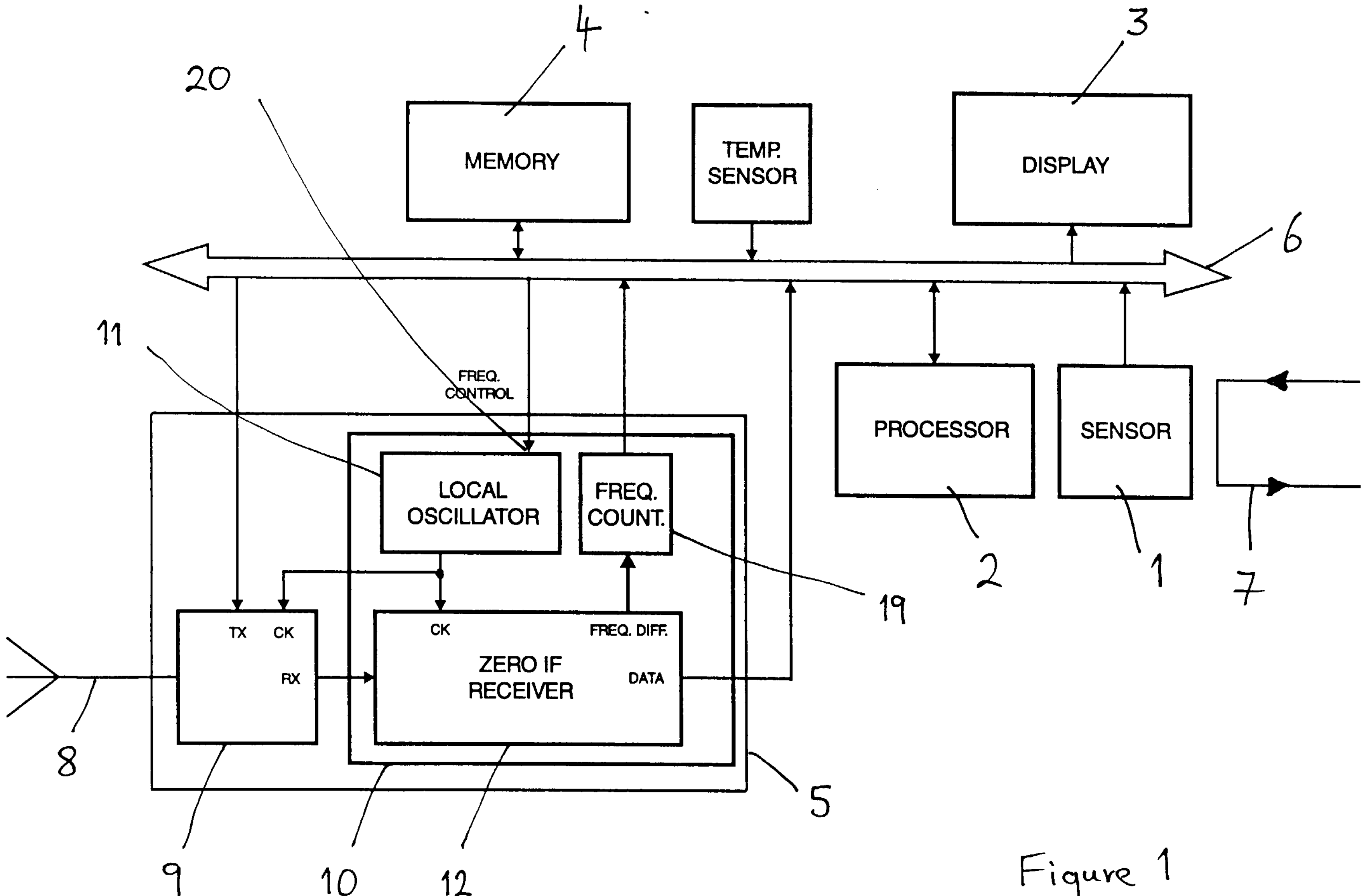
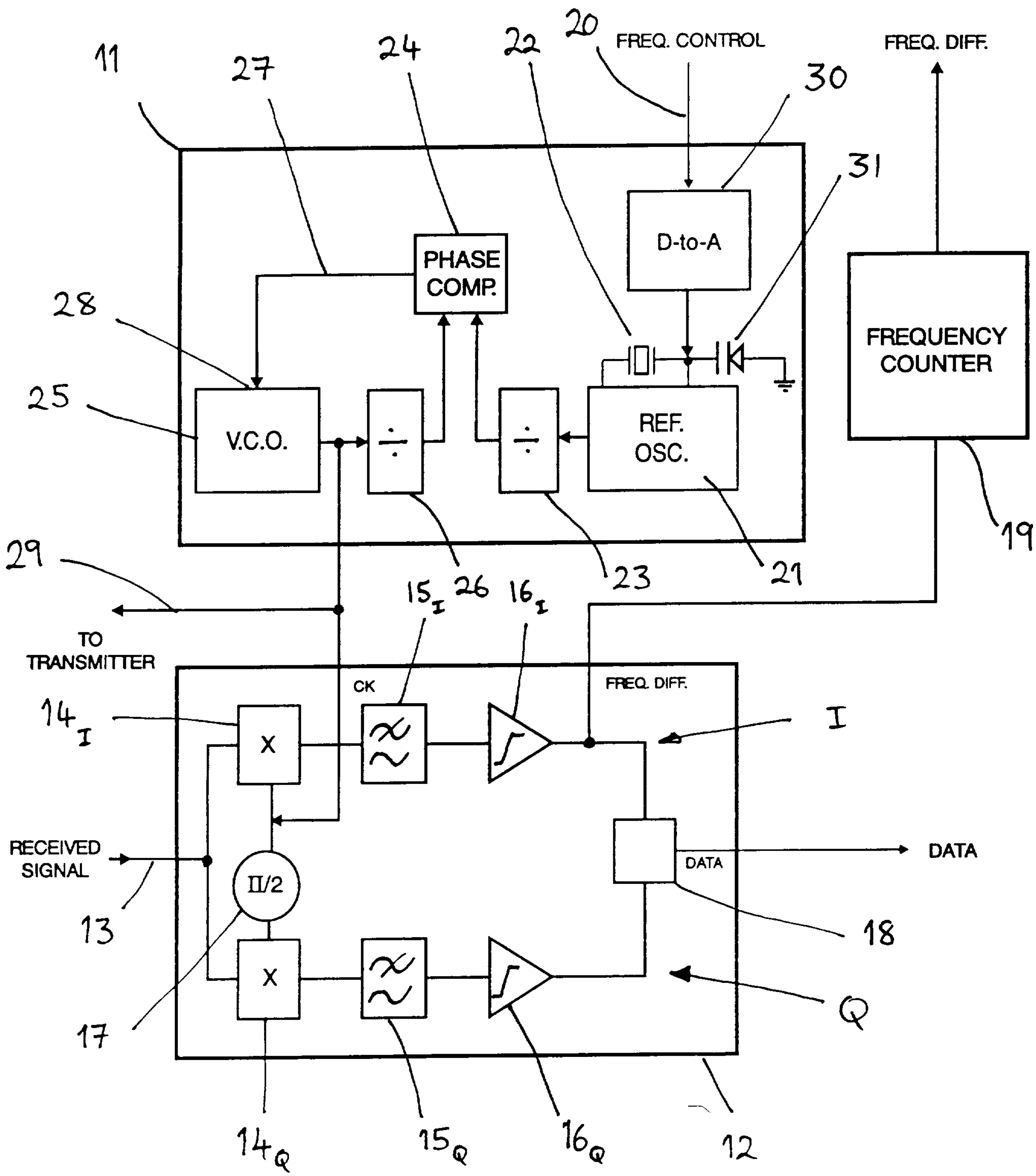

MEMORY
TEMP. SENSOR
DISPLAY
PROCESSOR
SENSOR
FREQ. CONTROL
LOCAL OSCILLATOR
FREQ. COUNT.
TX
CK
RX
CK
FREQ. DIFF.
ZERO IF RECEIVER
DATA
1
2
3
4
5
6
7
8
9
10
11
12
19
20

Figure 1



11
27
24
22
20
FREQ. CONTROL
FREQ. DIFF.
30
31
PHASE COMP.
D-to-A
28
25
V.C.O.
REF. OSC.
FREQUENCY COUNTER
19
29
26
23
21
TO TRANSMITTER
15_I
16_I
CK
FREQ. DIFF.
14_I
X
I
RECEIVED SIGNAL
II/2
DATA
DATA
13
18
X
17
Q
14_Q
15_Q
16_Q
12

Figure 2

COMMODITY CONSUMPTION REGISTERING METERS

This invention relates to commodity consumption registering meters, for example electricity, gas or water consumption meters, and in particular to a transceiver arrangement for use with such meters.

With the privatisation of many of the utility companies providing metered commodities, for example electricity, water and gas, and the resultant need to improve efficiency, remote meter reading is becoming increasingly attractive. Despite continued efforts to install commodity consumption registering meters in areas of public access, many thousands of meters still remain behind locked doors. It is not always possible for the commodity consumer to be present when the commodity supplier wishes to make a meter reading. Inaccessibility is therefore a source of annoyance both for the commodity supplier and consumer alike. Remote reading, which does not require access to the consumer's premises, is therefore advantageous in these circumstances.

Many systems for remote reading of commodity consumption registering meters have been proposed, for example, radio based systems in which a series of fixed, or mobile, base stations are provided to communicate with consumption meters which include a radio transceiver. The present invention relates to a consumption meter and transceiver arrangement for use in such a remote reading system.

According to the present invention there is provided a commodity consumption registering meter including a transceiver which comprises a transmitter operative to transmit consumption data to a base station, a receiver which utilises a local oscillator to effect conversion of the received signal to a demodulated signal, and control means for adjusting the frequency of the local oscillator in response to the received signal to reduce drift in the frequency of the local oscillator from its nominal value.

In one embodiment the receiver is of a type which utilises the local oscillator output to effect direct conversion of the received signal to a demodulated signal and the control means is arranged to measure the difference between the frequency of the local oscillator and the carrier frequency of the received signal and to adjust the local oscillator frequency to minimise this difference.

In another embodiment the received signal is modulated with data representative of an amount by which the local oscillator frequency is to be adjusted and the control means is operative to adjust the frequency of the local oscillator in dependence upon this received data. For a receiver of the direct conversion type the amount by which the frequency is to adjusted is the difference between the carrier and local oscillator frequencies. Conveniently with such an arrangement the base station derives this data using the carrier frequency of signals received form the meter which indicate the local oscillator frequency.

In a further embodiment the received signal is modulated with data which is indicative of the required local oscillator frequency and the control means is operative to set the frequency of the local oscillator according to this data.

In a preferred embodiment the local oscillator includes a frequency control input and the control means sets the frequency of the local oscillator by applying a digital value to the frequency control input. With digital control the transceiver can be set to a standby state when not in operation and the control means be arranged to store the digital value in a memory when the transceiver is not operative and arranged to set the local oscillator using this digital value upon subsequent reactivation of the transceiver.

Advantageously the meter further comprises a temperature sensor and the control means is operative to correct the digital value in dependence upon the temperature sensor upon the subsequent activation of the transceiver.

One meter in accordance with the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of the meter; and

Figure 2 is a block diagram of a receiver circuit of the meter.

Referring to Figure 1, the meter comprises a sensor 1, a processor 2, a display 3, a memory 4, a radio transceiver 5 and a data bus 6. The sensor 1 detects consumption of electricity passing through a cable 7 and produces a pulse for each unit of electricity consumed. The processor 2 is arranged to count these pulses and determine the total number of units of electricity consumed since the meter was commissioned and/or any other data that may be required such as the number of units of electricity consumed in a selected period. This data is stored in the memory 4. The display 3 is provided for displaying information to the consumer, for example the total number of units consumed, whether the current tariff is at a high or low rate, time and date etc.

The radio transceiver 5 is a multichannel half duplex mode transceiver which receives and transmits frequency modulated signals at a carrier frequency of between 183.5 and 184.5 MHz. The transceiver 5 comprises an antenna 8, a transmitter and front end circuit 9 and a receiver circuit 10. The processor 2 is arranged to transmit in operation, periodically or in response to an interrogating signal received by the receiver circuit 10 from a base station (not shown), consumption data from the memory 4 to the base station using the transmitter circuit 9. The transmitter circuit 9 operates at a carrier frequency which is derived from the receiver circuit's local oscillator 11 and frequency modulates this carrier with the data using the known technique of frequency shift keying (FSK). The receiver circuit 10 may also be used to allow the meter to be remotely programmed by the base station with information such as the changeover times between low and high tariff rates, current time and date, etc.

Referring now also to Figure 2, the receiver circuit 10 includes a receiver 12 of the direct conversion type (sometimes referred to as zero intermediate frequency (zero-IF) receivers) which detects data in a received signal applied to an input 13. The received signal, which consists of an FSK modulated carrier signal is applied to an in-phase channel I and a quadrature-phase channel Q. The two channels are substantially identical and each comprises a respective mixer 14_I, 14_Q, a channel filter 15_I, 15_Q and a limiting amplifier 16_I, 16_Q. The output from the local oscillator 11 is applied directly to the in-phase mixer 14_I and via a 90° phase shifter 17 to the quadrature-phase mixer 14_Q The channel filters

15_I, 15_Q serve to reject unwanted signals from the output of the mixers 14_I, 14_Q The limiting amplifiers 16_I, 16_Q remove any amplitude variations from the channel filter output signals and produce output signals containing only phase information. These signals are applied to a detector 18.

Each of the mixers 14_I, 14_Q produces signals which are related to the difference between the frequency of the received signal at the input 13 and the frequency of the local oscillator 11. In the situation where the local oscillator frequency and the carrier frequency of the received signal are the same, the I and Q channels produce signals which correspond to the frequency shift imposed by the data and the detector 18 produces a different dc signal depending on whether the frequency shift increases or decreases the carrier frequency. If the carrier frequency of the received signal differs from the local oscillator frequency, the I and Q channels produce signals which reflect this difference in frequency.

A frequency counter 19 connected to the I channel of the receiver 12 produces a digital value which is related to the difference between the local oscillator frequency and the carrier frequency of the received signal. This digital value is used by the processor 2 to adjust the local oscillator's frequency by means of a frequency control input 20 such that it matches the carrier frequency.

In the illustrated embodiment, the oscillator 11 is a frequency synthesizer and comprises a reference oscillator 21 which produces a reference frequency which is primarily determined by a crystal 22. The output of the reference oscillator 21 is connected to a divider 23 whose output is applied to a first input of a phase comparator 24. The output of a voltage controlled oscillator 25 is connected to a second divider 26 whose output is applied to a second input of the phase comparator 24. The output of the phase comparator 24 is a voltage whose magnitude depends upon the frequency difference between the voltage controlled oscillator (VCO) 25 and reference oscillator 21. This voltage is applied by a feedback path 27 to a control input 28 of the voltage controlled oscillator 25 and ensures frequency synchronisation of the reference and voltage controlled oscillators 21, 25. The output of the local oscillator 11 is derived via a line 29 from the output of the voltage controlled oscillator 25.

Whilst the output of local oscillator 11 needs to be stable, it is also necessary that its output frequency is at the required carrier frequency. To this end, the local oscillator 11 includes a frequency control input 20 which is such that the frequency of the local oscillator 11 depends upon a digital value applied to this input. The digital value applied to the frequency control input 20 is latched into a digital to analogue (D-to-A) converter 30 which converts the value into an analogue voltage. A variable capacitance (VARICAP) diode 31 is connected between a first side of the crystal 22 and ground and the analogue voltage produced by D-to-A converter 30 is applied to the first side of the crystal. A change in voltage produces a change in capacitance of the VARICAP diode which in turn alters the resonant frequency of the reference oscillator 21 and the voltage controlled oscillator locks onto this new frequency. Therefore by latching data into the D-to-A converter 30, the frequency of the local oscillator 11 can be set.

In the field of commodity consumption registering meters, it is often only required to make remote meter readings, and therefore use the transceiver circuit 5, on a periodic basis such that the transceiver circuit 5 only operates for a few minutes, or even seconds, within a period of many months. Providing a digital feedback arrangement between the frequency counter 19 and local oscillator 11 enables the transceiver 5 to be set in a reduced power, or standby, state for a selected period of time during which the transceiver is not required. The processor 2 is configured to store in the memory 4 the last digital value required to set the local oscillator 11 to the correct carrier frequency before setting the transceiver to a standby state. After the selected period of time has elapsed the transceiver is powered-up and the digital value recalled from memory and latched into the D-to-A converter 30 of the local oscillator 11 enabling the transceiver 5 to be quickly activated to the correct carrier frequency.

Whilst the frequency of the local oscillator 11 will be correct when a received signal is present, the resonant frequency of the reference oscillator 21 and hence local oscillator 11 are temperature dependent and it is possible that, upon subsequent operation of the local oscillator after the transceiver has been in a standby condition, the frequency may have changed slightly due to changes in ambient temperature. To reduce any effects of temperature a temperature sensor 32 is provided. The processor 2 is arranged to use the digital output of the temperature sensor 32 to access a look-up table in the memory 4 to determine what correction factor should be applied to the digital value which is latched into the D-to-A converter 30.

In an alternative embodiment, the base station is configured to transmit to the consumption registering meter data which gives a statement of the carrier frequency, this data being modulated onto the carrier using FSK. The data is detected by the receiver 10 and the processor 2 configured to then set the frequency of the local oscillator 11 to this value. Since the local oscillator frequency is never too dissimilar to the carrier frequency, the receiver circuit 10 is able to detect the statement of the carrier frequency. An advantage of this arrangement is the reduced circuitry required in the meter since the frequency counter 19 is no longer required.

In a further alternative embodiment, the base station is configured to transmit to the meter data which corresponds to the difference between the incoming carrier frequency and the local oscillator frequency. This data is modulated onto the carrier using FSK. The base station determines this difference using the carrier frequency of signals received from the meter which indicate the local oscillator frequency. Using the method described above, this frequency difference is used by the processor 2 to adjust the local oscillator 11 such that the carrier and local oscillator frequencies coincide. Again, with this arrangement there is no need to provide the frequency counter 19 in each meter.

It will be appreciated that whilst the use of a receiver of the direct conversion type is convenient, since it is both inexpensive and readily provides a means of the difference in frequency between the received carrier and local oscillator, the present invention can be applied to other forms of receiver architecture. For example the present invention can be used to adjust the frequency of a local oscillator of a conventional superheterodyne receiver in which the local oscillator operates at an intermediate frequency. With such a receiver architecture the base station transmits data to the meter which is representative of the required local oscillator frequency and the local oscillator frequency is set according to data. Alternatively data representative of an amount by which the frequency is to adjusted is transmitted to the meter and the local oscillator adjusted according to this data.

CLAIMS

1. A commodity consumption registering meter including a transceiver which comprises a transmitter operative to transmit consumption data to a base station, a receiver which utilises a local oscillator to effect conversion of the received signal to a demodulated signal, and control means for adjusting the frequency of the local oscillator in response to the received signal to reduce drift in the frequency of the local oscillator from its nominal value.

2. A meter according to claim 1, in which the receiver is of a type which utilises the local oscillator output to effect direct conversion of the received signal to a demodulated signal and in which the control means is arranged to measure the difference between the frequency of the local oscillator and the carrier frequency of the received signal and is operative to adjust the local oscillator frequency to minimise this difference.

3. A meter according to Claim 1 in which the received signal is modulated with data representative of an amount by which the local oscillator frequency is to be adjusted and the control means is operative to adjust the frequency of the local oscillator in dependence upon this received data.

4. A meter according to Claim 1 in which the received signal is modulated with data which is indicative of the required local oscillator frequency and the control means is operative to set the frequency of the local oscillator according to this data.

5. A meter according to Claim 3 or Claim 4, in which the receiver is a direct conversion type.

6. A meter according to any preceding claim, in which the local oscillator includes a frequency control input and the control means sets the frequency of the local oscillator by applying a digital value to the frequency control input.

7. A meter according to claim 6, in which the control means is arranged to store the digital value in a memory when the transceiver is not operative and is arranged to set the local oscillator using this digital value upon subsequent reactivation of the transceiver.

8. A meter according to claim 7, further comprising a temperature sensor and in which the control means is operative to correct the digital value in dependence upon the temperature sensor upon the subsequent activation of the transceiver.

9. A meter according to any preceding claim in which the local oscillator is a frequency synthesizer.

10. A meter according to any preceding claim in which the received signal is modulated using frequency shift keying.

11. A commodity consumption registering meter substantially as hereinbefore described and illustrated with reference to Figure 1 of the accompanying drawings.

The Patent Office

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Application No: GB 9605471.3
Claims searched: ALL

Examiner: Mr.SAT SATKURUNATH
Date of search: 28 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H3A: AB, AK, AN, AQX, ASD, ASX, AXD;H4L: LACF, LADCS

Int Cl (Ed.6): H03J, H03L, H04B, G01S

Other: Online: WPI, JAPIO, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2272135 A SCHLUMBERGER - see especially figure 1	1, 9
X	GB 2253751 A MOTOROLA - see especially figure 9	1, 9
X	GB 2253750 A NOKIA - see especially the figures	1, 9
X	GB 2219157 A MARCONI - see especially figure 2	1, 9
X	WO 94/03981 A1 MOTOROLA - see especially figure 2	1
P, X	DERWENT abstract of Japanese patent JP08032507 A (NTT) 2.2.96 - see abstract	1

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