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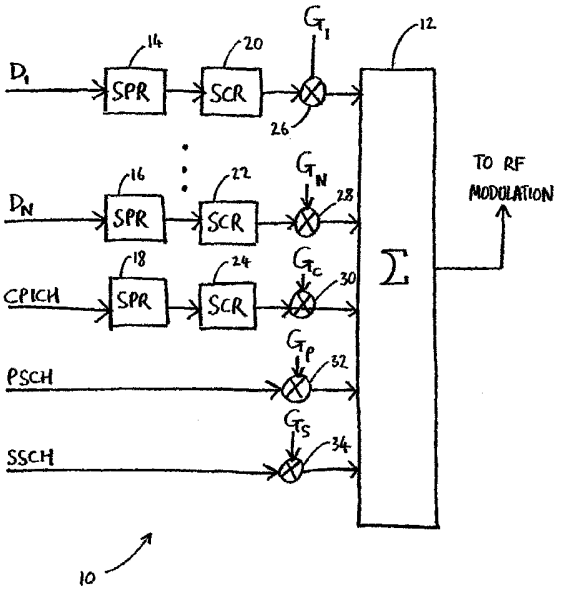
[Continued on next page]

(54) **Title:** FACILITATING REFERENCE SIGNAL CANCELLATION



(57) **Abstract:** A CDMA base station comprising means for transmitting a transmission to a subscriber unit, the transmission including a data signal and two reference signals that assist in the recovery of the data in the data signal by the subscriber unit and means for communicating the relative powers of the reference signals to the subscriber unit.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

FACILITATING REFERENCE SIGNAL CANCELLATION

The invention relates to the signalling of information about the relative power levels of reference signals sent out by a CDMA transmitter.

In a UMTS downlink transmission, a user equipment (UE), such as a mobile telephone, will normally receive a group of data channels and a common pilot channel (CPICH) that have been spread and scrambled using appropriate channelisation and scrambling codes and two synchronisation channels, the so-called Primary Synchronisation Channel PSCH and the so-called Secondary Synchronisation Channel SSCH, that are neither scrambled nor spread. The PSCH and SSCH channels are used to synchronise the UE with the downlink transmission to allow recovery of the channels that have been scrambled and spread.

The despreading and descrambling of a data channel present in the downlink transmission can be hampered by the presence in the downlink transmission of the PSCH and SSCH channels.

To ameliorate this problem, it is possible to subtract appropriately scaled copies of the PSCH and SSCH channels from a downlink transmission at a UE. This scaling process has to scale local copies of the SSCH and PSCH channels to the level at which they are received in the downlink transmission. This cancellation process can be achieved, as described in a UK patent application by UbiNetics Limited with even priority date, by causing the UE to subtract from the downlink transmission a scaled copy of the PSCH and a scaled copy of the SSCH. The factor used to scale the PSCH copy is the product of a power estimate derived for the CPICH channel and a factor accounting for the power difference between the CPICH and PSCH in the downlink transmission. The factor used to scale the SSCH copy is the product of the aforementioned CPICH power estimate and a factor accounting for the power difference between the SSCH and CPICH in the downlink transmission. It is possible for a UE to measure the power levels of the CPICH, PSCH and SSCH signals in the received downlink in order to derive the scaling factors but

inaccuracies in these scaling factors can seriously degrade the effectiveness of the cancellation scheme.

According to one aspect, the invention provides a CDMA base station comprising means for transmitting a downlink transmission to a subscriber unit (such as a mobile telephone), the transmission including a data signal and two reference signals that assist in the recovery of the data ("data" including both control and payload information) in the data signal by the subscriber unit and means for directly or indirectly communicating to the subscriber unit the relative powers used by the base station for the reference signals.

The invention also consists in a method of operating a CDMA communications network comprising a base station and a subscriber unit, the method comprising causing the base station to send to the subscriber unit a transmission including a data signal and two reference signals that assist in the recovery by the subscriber unit of data from the data signal and causing the relative powers of reference signals to be communicated to the subscriber unit.

Thus, the invention provides a way of signalling power information to subscriber units that may enhance the effectiveness of reference signal cancellation at a subscriber unit. The invention may be of particular benefit to HSDPA (high speed downlink packet access) channels in which the amount of error checking information has been reduced to increase data bandwidth.

In some embodiments, the two reference signals may be accompanied by a third reference signal, in which case the base station is arranged to communicate to the subscriber unit information linking the power of the additional reference signal relative to the other two reference signals.

The invention can be used within the context of a UMTS network, in which case the reference signals are, or are drawn from, the group of signals: PSCH, SSCH and CPICH. An additional reference signal comprising the result of mixing together the PSCH and SSCH can also be included in this group.

In certain embodiments, the relative powers of the reference signals are communicated to the subscriber unit in the form of one or more ratios describing the relative powers of the reference signals.

By way of example only, certain embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a simplified block diagram of a UMTS base station; and

Figure 2 is a simplified block diagram of a UMTS handset.

Referring now to Figure 1, the base station 10 combines together, at 12, several different signals and arranges for the result to be transmitted in the downlink. In the example given in Figure 1, the signals that are combined by the summation process 12 include the CPICH (common pilot channel), the PSCH (primary synchronisation channel) and the SSCH (secondary synchronisation channel) of the base station together with several data channels D_1-D_N. Prior to the summation process, the data channels D_1-D_N and the CPICH each undergo spreading using respective channelisation codes at processes 14, 16 and 18 and then undergo scrambling using the same scrambling code at processes 20, 22 and 24. The PSCH and SSCH undergo neither scrambling nor spreading.

All of the signals that take part in the summation process 12 are weighted by respective gain factors to determine the relative power levels of the signals in the transmission from the base station. The gain factors of the data channels are G_1-G_N and the CPICH, PSCH and SSCH gain factors are G_c, G_p, G_s respectively. These gain factors are applied to their respective signals by multiplication processes 26 to 34. The base station is arranged to insert into one of the data channels D_1-D_N the ratio $R_1 = \frac{G_p}{G_c}$ and the ratio $R_2 = \frac{G_s}{G_p}$.

The handset 36 shown in Figure 2 is adapted to make use of the ratios R_1 and R_2 that are transmitted by base station 10. A downlink transmission received at the antenna (not shown) of the handset 36 undergoes RF demodulation and then analogue to digital conversion at ADC unit 38. The digitised downlink transmission then enters a subtraction process 48, in which a signal emanating from a scaling process 42 (which will be described

in more detail shortly) is subtracted from the digitised downlink transmission. After the subtraction process 48, the digitised downlink transmission undergoes base band layer 1 processing at 40, during which stage an estimate of the CPICH of the base station 10 is recovered. The CPICH estimate is filtered over a predetermined duration to produce a filtered CPICH estimate c that is made available to the scaling process 42. After layer 1 processing, the transport channels from the received downlink transmission undergo further base band processing at 44, during which the ratios R_1 and R_2 are recovered. The ratios R_1 and R_2 are made available to the scaling process 42.

The handset 36 also includes a synchronisation sequence generation process 46 that generates local copies of the known sequences of the PSCH and SSCH. The scaling process 42 multiplies the PSCH sequence from generation process 46 by a factor $c \cdot R_1$ and multiplies the SSCH sequence from generation process 46 by a factor $c \cdot R_1 \cdot R_2$. Thus, the scaling process 42 scales the PSCH and SSCH sequences to the power levels at which they are present in the transmission that is received from the base station 10. The scaled PSCH and SSCH sequences are then subtracted from the digitised downlink transmission at 48 so that the despreading and descrambling of channels within the received transmission in the layer 1 processing stage 40 is not hampered by the presence of the PSCH and SSCH channels in the downlink broadcast.

CLAIMS

1. A CDMA base station comprising means for transmitting a transmission to a subscriber unit, the transmission including a data signal and two reference signals that assist in the recovery of the data in the data signal by the subscriber unit and means for communicating the relative powers of the reference signals to the subscriber unit.

2. A base station according to claim 1, wherein the transmission includes a further reference signal and the communicating means is arranged to communicate to the subscriber unit information linking the power of the additional reference signal relative to the other two reference signals.

3. A base station according to claim 1 or 2, wherein the base station is a UMTS base station and the reference signals are, or are drawn from, the group of signals: PSCH, SSCH, CPICH and a combination of the PSCH and SSCH.

4. A base station according to any one of claims 1 to 3, wherein the communicating means communicates the relative powers of the reference signals by communicating to the subscriber unit one or more ratios describing the relative powers of the reference signals.

5. A method of operating a CDMA communications network comprising a base station and a subscriber unit, the method comprising causing the base station to send to the subscriber unit a transmission including a data signal and two reference signals that assist in the recovery by the subscriber unit of data from the data signal and causing the relative powers of the reference signals to be communicated to the subscriber unit.

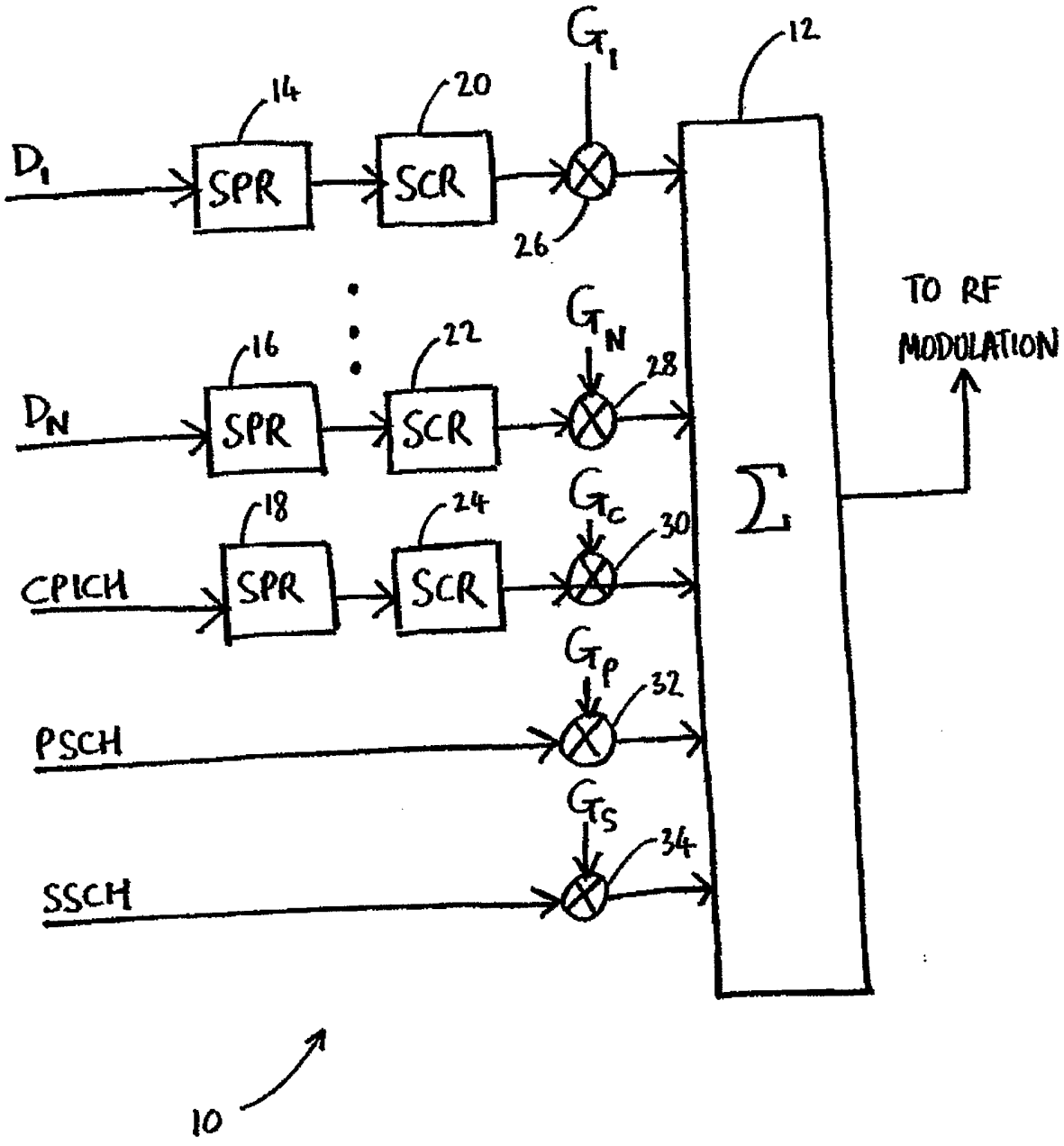
6. A method according to claim 5, wherein the transmission includes a further reference signal and the method further comprises the step of causing the communication to the subscriber unit of information linking the power of the additional reference signal relative to the other two reference signals.

7. A method according to claim 5 or 6, wherein the reference signals are, or are selected from the group of signals: PSCH, SSCH, CPICH and a combination of the PSCH and the SSCH.

8. A method according to any one of claims 5 to 7, wherein the base station is a UMTS base station and the relative powers of the reference signals are caused to be communicated as one or more ratios describing the relative powers of the reference signals.

9. A CDMA base station, substantially as hereinbefore described with reference to the accompanying figures.

10. A method of operating a CDMA network, the method being substantially as hereinbefore described with reference to the accompanying figures.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SSCH
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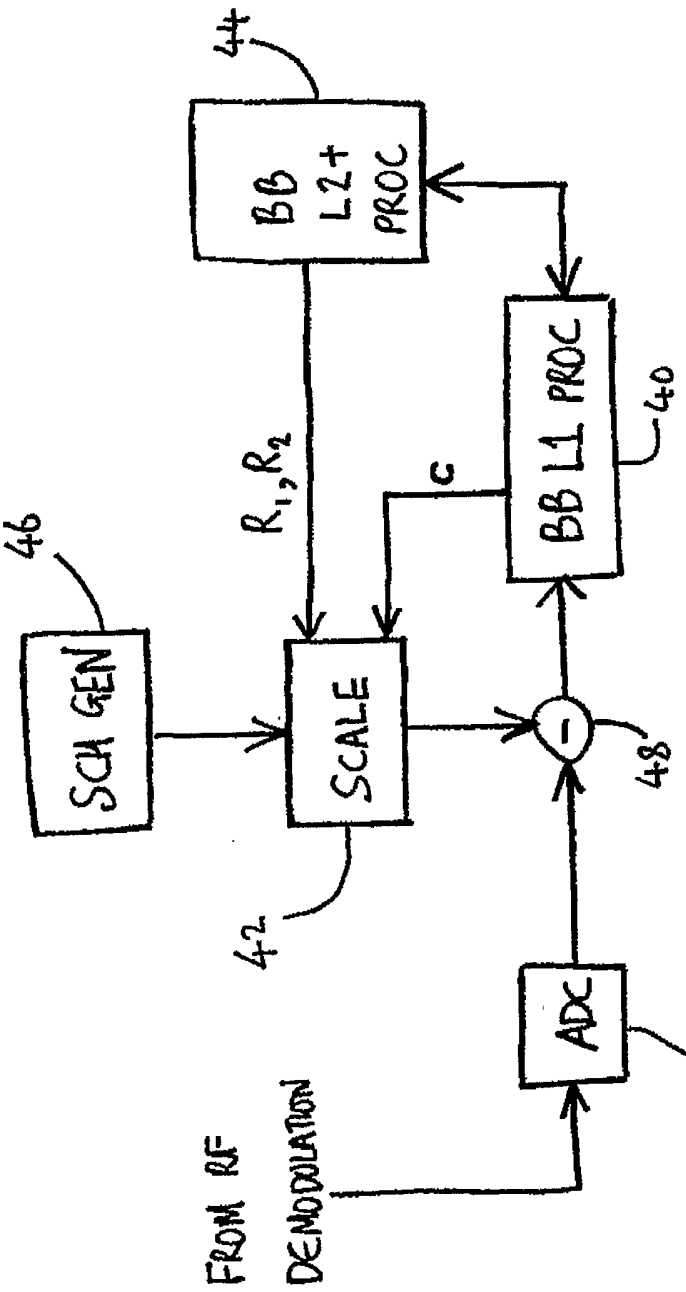
Figure 1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44
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BB L1 PROC
40
R_1, R_2
C
46
SCH GEN
SCALE
42
48
ADC
38
FROM RF DEMODULATION

Figure 2