(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 December 2002 (27.12.2002)

PCT

(10) International Publication Number
WO 02/104043 A2

(51) International Patent Classification[7]: H04Q

(21) International Application Number: PCT/US02/19332

(22) International Filing Date: 19 June 2002 (19.06.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/298,886 19 June 2001 (19.06.2001) US

(71) Applicant *(for all designated States except US)*: **HARRIS CORPORATION** [US/US]; 1025 West NASA Boulevard, Melbourne, FL 32919 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **JAO, Tjo, San** [CA/CA]; 293 Brighton, Beaconsfield, Quebec H9W 2L9 (CA). **BOURBONNAIS, Jean-Rene** [CA/CA]; 4 Kanata Avenue, Pointe-Claire, Quebec H9R 5P7 (CA). **RICH, Alan, Philip** [CA/CA]; 127 Wildcrest, Pointe-Claire, Quebec H9R 3W2 (CA).

(74) Agent: **COMTOIS, Mark, C.**; 1667 K Street, N.W., Washington, DC 20006 (US).

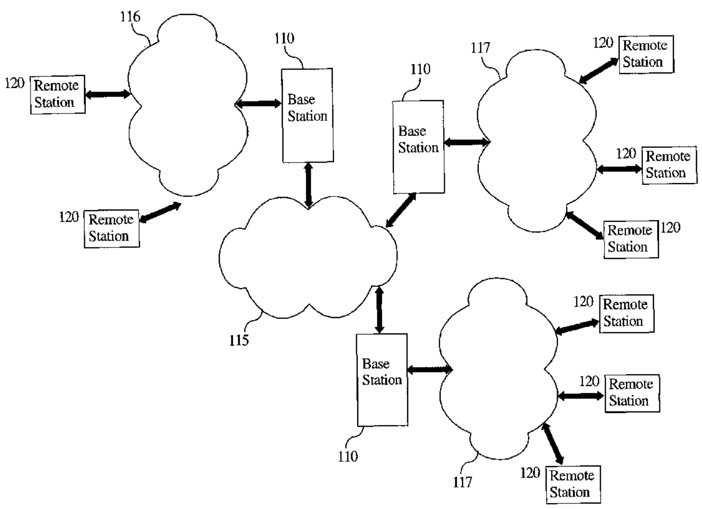
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

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.

(54) Title: METHOD AND SYSTEM FOR DETERMINING NOMINAL REMOTE STATION OPERATIONAL SETTING FOR MINIMAL BASE STATION NOISE INTERFERENCE



(57) Abstract: A remote station configuration and method of determining operational settings that provide a minimal interference when not transmitting is disclosed. The remote station configuration includes and ODU that upconverts an intermediate signal provided by an IDU and conditions the upconverted signal to achieve transmission output level that substantially produces a desired signal level at a base station. The upconverted signal is conditioned by a cascade of amplifiers and attenuators that are set dependent upon the distance between the remote station and the base station. In one aspect, a last attenuator controls the attenuation settings. In another aspect, a first attenuator controls the attenuation setting. Accordingly, in wireless communication systems, remote stations closest to a base station have a lower noise density than remote stations further from the base station.

WO 02/104043 A2

Method and System for Determining Nominal Remote Station Operational Setting for Minimal Base Station Noise Interference

Claim of Priority

[0001] This application claims the benefit pursuant to 35 USC 119, of the earlier filing date of U.S. Provisional Application Serial Number 60/298,886, entitled "Dynamic Power Control of Remote Transmitter by Base Station," having a filing date of June 19, 2001.

Background Of The Invention

[0002 [illegible]t invention is directed to point-to-multipoint wireless communication systems in general, and to Time Division Multiple Access (TDMA) Broadband Wireless Access (BWA) in particular.

[0003] Figure 1 illustrates a block diagram of a BWA system 100 using conventional a TDMA system employing a Frequency Division Duplex (FDD) duplexing scheme. The system consists of a plurality of Base Stations (BS) 110 in communication over network 115 and each BS 110 controlling, and receiving information items from, a plurality of associated Remote Station (RS) 120. Base Station 110 continuously transmits signals, referred to as downstream transmission, to each associated RS 120 through an omni-directional antenna, or at least one sectorized, or directional antenna assigned to a frequency carrier in Time Division Multiplex (TDM) mode. The associated remote stations 120 are typically scattered around the coverage area of the corresponding BS 110. Hence, some RSs 120 may be located in significantly close proximity to the BS

110 while others may be located at considerable distance from BS 110. As would be appreciated, some remote stations 120 may be located at the edge of the coverage area.

[0004] Under the direction of downstream command or instructions, each remote station 120 responds to the associated base station 110. A transmission from remote station 120 to base station, referred to as an upstream transmission, is typically as a burst using frequency carrier different than the downstream frequency. Each RS 120 in Time Division Multiple Access (TDMA) mode shares the upstream carrier frequency.

[0005] In the upstream direction, it is desirable that the base station 110 receives substantially the same signal level from each associated RS 120. The nominal receive signal level (RSL) at BS 110 is typically chosen so that it is low enough to minimize inter-cell interference but high enough to have a good Carrier-to-Noise ratio (C/N) in order to provide a good received signal quality. In a conventional system configuration, the nominal receive signal level is 10 dB above the receiver signal threshold level, which will result in Bit Error Rate (BER) of 10-6. Hence, those RSs 120 closest to BS 110 are instructed to transmit lower signal levels than those RSs 120 positioned further from BS 110. As is known, the level of transmission of each RS 120 can be increased through downstream Medium Access Control (MAC) messages to compensate for any level change at the BS 110 that may be caused by transmission path perturbations, such as fading.

[0006] In order to maximize the number of RS120 per sector sharing the same RF carrier frequency, the noise level at each RS 120 antenna port must be kept as low as possible when a remote station is not actively transmitting. Otherwise, higher noise levels at each not actively transmitting RS 120 antenna port increases the interference level to the desired received signal at the base station 110. Hence, one criterion for determining the number of RSs 120 that may be placed in a sector is the total interference contributed by the remote stations 120 in the sector.

[0007] Thus, to maximize the number of remote stations that may be placed in a base station sector, the nominal gain value of each RS 120 to a level that has a minimal contribution to the noise generated interference when a remote site is not transmitting. Hence, a method is needed that sets the operational conditions of those remote sites close to the BS to a minimal noise power density such that the contribution of all RSs 120 within a sector is beneath an acceptable level at the base station.

Brief Description of the Drawings

[0008] Figure 1 illustrates a conventional TDMA point-to-multipoint wireless communication system;

[0009] Figure 2 illustrates a block diagram of a conventional remote station;

[0010] Figure 3 illustrates a conventional remote station amplifier configuration;

[0011] Figure 4 illustrates a flow chart of an exemplary process for determining remote station gain in accordance with the principles of the invention;

[0012] Figure 5 illustrates a flow chart of an exemplary process for determining remote station transmit output power;

[0013] Figure 6a-6e illustrate exemplary remote station operational settings as a function of distance; and

[0014] Figure 7 illustrates a flow chart of an exemplary process for determining nominal operational settings in accordance with the principles of the invention.

[0015] Figures 1 through 7 and the accompanying detailed description contained herein are to be used as an illustrative embodiment of the present invention and should not be construed as the only manner of practicing the invention. It is to be understood that these drawings are for purposes of illustrating the concepts of the invention and are not to scale. It will be appreciated that the same reference numerals, possibly supplemented with reference characters where appropriate, have been used throughout to identify corresponding parts.

Detailed Description of the Invention

[0016] Figure 2 shows a typical BS 110 and RS 120 each consisting of an Outdoor Unit (ODU) 210 and Indoor Unit (IDU) 220. ODU 210 contains all RF circuits 215 such as up-converter, down-converter, power amplifier, RF receivers, etc. IDU 220 contains modulator 225, demodulator 230, data processing circuits (MAC) 235 and user interfaces (not shown). The interconnection between the ODU 210 and IDU 220 is through a single IDU to ODU interconnection coaxial cable 270, shown as a first continuous received signal applied to demodulator 230 and a second burst transmit signal emanating from modulator 225. Conventionally, these signals are referred to as "receive (Rx) cont." and "transmit (Tx) burst". The IDU to ODU interconnection cable 270 is determined by the separation distance between the IDU and ODU.

[0017] Conventional RS 120 in TDMA system using the FDD duplex method typically employ a fixed gain transmitter in ODU 210. The actual transmit output level at the output of the ODU 210 is thus set at the output of the modulator 225. The level at the modulator output 225 further must compensate for the loss in the IDU to ODU interconnection cable 270. In operation, the output of modem 225 is keyed, or turned, on when directed to transmit and keyed, or turned, off when directed not to transmit. However, RS 120 when is not actively transmitting it is an interference source to a desired signal coming from a transmitting RS 120 as the noise level of the non-transmitting RS 120 contributes to, and increases, the overall noise level at the BS 110 receiver. Hence, the greater the number of the non-transmitting RSs 120 the greater the degradation of the received signal carrier-to-noise ration (C/N) at the base station 110 receiver.

[0018] In a conventional system, an overall interference level at BS 110 receiver is at least 6dB lower than the BS receiver noise level that creates a Bit-Error-Rate (BER) of 10^{-6}. This is a commonly accepted interference level.

[0019] Figure 3 illustrates one exemplary embodiment 300 of RS 120 ODU 210 RF transmitting section in accordance with the principles of the present invention. In this exemplary embodiment, amplifiers and attenuators are incorporated into ODU 210, rather than in IDU 220, to condition the output signal in a desired manner. In this case, an Intermediate Frequency (IF) is generated in IDU 220 and applied to ODU 210, rather than a higher Radio Frequency (RF) signal. Within ODU 210, IF signal 310 is applied to mixer 320, which up-converts IF 310 using a local oscillator 330 to a known transmission Radio Frequency (RF) value 325. RF value 325 is next applied to at least one amplifier/attenuator combination to condition RF signal 325 to a known signal level that is then applied to power amplifier 360. Applying IF 310 rather than an RF signal to ODU

210 is advantageous as less loss is experienced in the cable 270 due to the lower frequency range of the modulated IF signal. Hence, better control of the amplified noise component is achieved.

[0020] In the illustrated embodiment, RF signal 325 is first applied to amplifier 1, 335, which amplifies RF signal 325 and any associated noise level to a first level of amplification. Amplified RF signal 325 and associated noise level are next applied to attenuator 1, 340 to condition, typically reduce, the amplified signal 325 and noise level to a first known level. Attenuators, as is known in the art, are operable to reduce the level of the applied signal. However, the reduction in signal level and noise level is disproportionate as the signal level and noise level are not reduced by the same amounts for the same attenuator setting.

[0021] In this exemplary embodiment, the conditioned signal and noise are next applied to second amplifier 345 and attenuator 350 for further amplification and conditioning (i.e., attenuation). The resultant conditioned signal is next applied to power amplifier 360 for transmission over an antenna (not shown).

[0022] Although, two amplifiers and two attenuators are shown in Figure 3, it would be appreciated that the present invention may include more or less amplifiers and attenuators dependent upon on the required transmission and non-transmission signal levels. Furthermore, the number of amplifiers and attenuators need not be comparable, as is shown, as a plurality of amplifiers may be cascaded or placed in series to achieve a desired signal level before the signal is applied to an associated attenuator. Similarly, multiple attenuators may also be placed in cascade or in series to increase a total attenuation and achieve desired level of signal conditioning. The attenuators accordingly are distributed between amplifier gain stages in a manner to preferable not degrade the C/N at any point along the path, while maintaining the required linearity. In a preferred embodiment, the distribution of components in the illustrated RF path is such that the last attenuator is located immediately before the power amplifier.

[0023] In accordance with the configuration shown in Figure 3, RS 120 transmitter output signal level achieves a desired carrier value with a minimum noise value (desired C/N ratio) at the transmission antenna port. Hence, RS 120 is representative of a minimal source of interference to the desired received signal at BS 110 when are not actively transmitting.

[0024] In accordance with one aspect of the invention, the RS 120 transmit level may be determined to achieve a minimal noise level interference at BS 110 by first determining a BS desired nominal received signal level.

[0025] For example, a desired target nominal value received signal level (RSL) at a BS 110 receiver may be determined as a known signal level above the receiver threshold level, where the signal to noise ratio results in BER of 10-6 as:

$$RSL_{TARGET} = A + RSL_{10\text{-}6} \qquad [1]$$

where

A is the targeted level in dB above $RSL_{10\text{-}6}$, which is set between 5 and 15 dB. In a preferred embodiment this value is 10dB; and

$RSL_{10\text{-}6}$ is a configuration point of a BER of 10^{-6} for different data capacity and modulation level used.

[0026] The value of $RSL_{10\text{-}6}$ for each individual TDMA type system, i.e. (QPSK, 16 QAM), capacity, channel spacing, and modulation level may be stored in the non-volatile memory in the BS 110.

[0027] The RS 120 transmitter gain G_{RST} may next be determined as:

$$G_{RST} = (P_{RST} + L_{RSDUPLEXER} - P_{RSIFIN})\ \text{dB} \qquad [2]$$

where

P_{RST}: RS transmit output power in dBm at its antenna port;

$L_{RSDUPLEXER}$: RS duplexer and branching insertion loss in dB.
P_{RSIFIN}: ODU IF input signal level in dBm

[0028] The targeted receive signal level (RSL) at BS 110 antenna port may then be determined as:

$$RSL_{TARGET} = P_{RST} + G_{RSA} + G_{BSA} - Lp \qquad [3]$$

where

G_{RSA}: RS antenna gain in dBi;
G_{BSA}: BS antenna gain in dBi;
Lp: Free space path loss between BS and RS in dB and is may be determined as:

$$Lp = 92.4 + 20 \log D + 20 \log F \qquad [4]$$

where
D: Distance between RS and BS in Km; and
F: RF Frequency in GHz.

[0029] Now applying equation 1 to equation 3, the transmit output power may be determined as:

$$P_{RST} = A + RSL_{10\text{-}6} - G_{RSA} - G_{BSA} + Lp \qquad [5]$$

[0030] And applying equation 5 into equation 2, the transmitter gain may be determined as:

$$G_{RST} = A + RSL_{10\text{-}6} - G_{RSA} - G_{BSA} + Lp - P_{RSIFIN} + L_{RSDUPLEXER} \quad [6]$$

[0031] Although, it would be understood that atmospheric absorption further contributes to the free path space loss, this loss is considered negligible for the selected frequency ranges of 2.5, 3.5 and 10 Ghz. However, one skilled in the art would be well aware of how free-path space loss may be adjusted by the atmospheric absorption loss at other frequencies.

[0032] An example of the determination of RS transmitter output levels and associated nominal operational (gain/attenuation) settings for an ODU configuration shown in Figure 3, operating at a nominal transmission frequency of 3.450 MHz may be tabulated as:

Distance from BS (Km)	RS Transmit Output Power (dBm)	RS Transmit IF Signal Level at ODU Input (dBm)	RS Transmitter Gain (dB)	Transmitter first Attenuator Attenuation A1 (dB)	Transmitter second Attenuator attenuation A2 (dB)	Resulting Transmit Noise Power Density (dBm/Hz)
0.25	-20.6	-14.6	-6	24	32	-136
0.50	-14.5	-16.5	2	23	25	-136
1.0	-8.5	-18.5	10	23	17	-134.8
2.0	-2.5	-19.5	17	23	10	-131
5	5.5	-19.5	25	23	2	-124.1

10	11.5	-19.5	31	19	0	-118.6
15	15	-20	35	15	0	-114.8

Where: RF Frequency: 3450 MHz
Transmit bursting capacity rate: 5 Mb/s
Modulation: QPSK
Channel bandwidth: 3.5 MHz
Maximum RS to BS distance is 15 Km
Minimum RS to BS distance is 0.25 Km
IDU to ODU interconnection cable compensation capability: 10 dB
ODU temperature compensation capability: 5 dB
Dynamic modulator output level range to compensate for fading: 10 dB
Maximum IMD (intermodulation distortion) products: 30 dB (when its output level is increased by 10 dB to compensate for fading.

[0033] Accordingly, the noise power density for remote stations 120 closer to base station 110 have nominally significantly lower noise density than the remote stations 120 further from base station 110. Hence, those remote stations 120 closest to base station 110 when not transmitting contributes less to the noise level at base station 110.

[0034] Furthermore, to achieve the required nominal transmitter level at the antenna port for RS 120 that is closer to BS 110 the gain in the RS 120 RF transmitter is set lower, while the IDU modulated signal is set higher. However, to set the nominal transmitter level for RS 120 that is further away from BS 110, the gain in the RS RF transmitter is set higher, while the IDU modulated signal level is set lower.

[0035] Figure 4 illustrates a flow chart 400 of an exemplary process for determining nominal operations (amplifier/attenuator) settings in accordance with the principles of the invention. At block 410, an acceptable receiver signal quality level is determined for BS 110. At block 420, a nominal receiver signal level at BS 110 is determined. In a preferred embodiment a nominal receiver signal level is at least 10dB above the level necessary to achieve a 10^{-6} Bit Error Rate.

[0036] At block 430, a remote station transmission level is determined which produces the desired nominal receiver signal level at BS 110. At block 430 a determination is made with regard to the distance of the remote station from the base station. If the remote station is considered close, then the remote station modulator output level is set high at block 440. Otherwise the modulator output level is set lower at block 450. Although only two levels are illustrated, it will be understood, that remote station modulator level may be determined as a function of the distance between the base station and the remote station. For example, a look-up table may contain pre-determined nominal values of remote station output level based on distance and transmission frequency, which may be accessed and used to determine output level.

[0037] At block 460, the remote station amplifiers and/or attenuators are set to achieve the determined remote station transmission signal level with minimum noise level contribution to the base station when not actively transmitting.

[0038] Figure 5 illustrates a flow chart of an exemplary process 500 performed at base station 110 to dynamically control the transmit output power of each RS 120 through downstream MAC messages to maintain an acceptable received signal level at base station 110 considering nominal operational settings at RS 120 in accordance with another aspect of the invention. In this exemplary process, a base station monitors the signal strength received from each associated or "connected" remote station 120 at block 510. At block 520, a determination is made whether the received signal strength is within a known tolerance of a targeted received signal strength level. If the answer is in the affirmative, then processing exits at block 570. In a preferred embodiment, the tolerance is 2dB.

[0039] However, if the answer is negative, then a determination is made at block 530 whether the received level is too low. If the answer is in the affirmative, then a determination is made at block 540 whether the remote station modulator is at a maximum output. If the answer is in the affirmative, then process exits at block 570.

[0040] However, if the answer is negative, then the remote station modulator output level is increased through a downstream MAC message. In one aspect, the remote station modulator output level is increased by the difference between the desired received signal level and the actual signal level. In another aspect, the modulator output level may be incrementally increased in 1 or 2 dB steps until the desired received signal level is achieved.

[0041] Returning to the determination at block 530, if the answer is negative, then the remote station modulator output level is decreased through a downstream MAC message. In one aspect, the remote station modulator output level is decreased by the difference between the desired received signal level and the actual signal level.

[0042] Figures 6a-6g illustrate exemplary nominal operational amplifier/attenuation settings for a remote station having an amplifier/attenuator configuration illustrated in Figure 3 positioned at distances of 15km, 10km, 5km, 2km, 1km, 0.5km and 0.25km, respectively. In each of these configurations, the ODU amplifier/attenuator configuration provides a signal out value that produces a desired received signal level at the receiving base station. In this case, the nominal operational amplifier/attenuator values are shown as the Clearsky values, denoted as (XX) and the faded values, i.e., dynamically adjusted output values to compensate for fading, are depicted as XX. Hence, at 15km, i.e., figure 6a, a nominal signal output level of 15.0 dBm, with a noise density level of -114.8 dBm/Hz is achieved with each amplifier set to produce a 10dB gain, a first attenuator set at -15 dB and a second attenuator set at 0 dB. Similarly, at 1km, i.e., figure 6e, a nominal signal output level of -8.5 dBm with a noise density level of -134.8 dBm/Hz is achieved with each amplifier set to produce a 10dB gain, a first attenuator set at -23 dB and a second attenuator at -17 dB. In each case, the associated amplifiers are nominally set to produce 10 dB of gain. However, it will be appreciated that the amplifier setting may be similarly adjusted to produce different levels of amplifications and attenuator settings may be adjusted accordingly.

[0043] Figure 7 illustrates a flow chart of an exemplary process 700 for determining nominal operational (amplifier and/or attenuator) settings for the RS 120 configuration shown in Figure 3. In this exemplary process, the distance between BS 110 and RS 120 is entered at block 710. At block 720, the desired RS 120 output power is determined in accordance with equations 1-6 above. At block 730, the net attenuation is determined in accordance with known methods. In this exemplary process the amplifier settings are predetermined values. Although net attenuation is determined in this exemplary process it will be understood by those skilled in the art that net amplification may similarly be determined using preset attenuator settings.

[0044] At block 740, a determination is made whether the entered distance is less than a known value. In a preferred embodiment, the known value is one kilometer. If the answer is in the affirmative, then at block 750, a second attenuator is set to a maximum value and a first attenuator is set to the difference between the net attenuation and the second attenuator value.

[0045] However, if the answer is negative, then a first attenuator is set to a maximum value and a second attenuator is set to the difference between the net attenuation and a first attenuator value, at block 770. At block 780, a determination is made whether, the noise level is at a minimum value and the intermodulation distortion (IMD) is acceptable. If the answer is affirmative, then processing is ended.

[0046] However, if the answer is negative, then, at block 790, the first attenuator is decreased and the second attenuator is increased such that the net attenuation remains constant. Processing returns to the determination at block 780 to determine whether these new attenuator settings provide a minimum noise level and acceptable IMD.

[0047] Although a cascaded two stage amplifier/attenuator configuration is shown, it will be understood that any number of amplifier/attenuator configurations may be utilized. In such cases, in one aspect, when the second attenuator is set first, the second attenuator referred to in Figure 7 is representative of the last attenuator in the cascaded chain, i.e., closest to the power amplifier and the first attenuator is representative of the remaining attenuators. Similarly, when the first attenuator is set first, the first attenuator referred to in Figure 7 is representative of the first attenuator in the cascaded chain, i.e., closest to the first amplifier and the second attenuator is representative of the remaining attenuator. It would be understood that the processing of Figure 7 may then be applied to subsequent pair of attenuators.

[0048] While there has been shown, described, and pointed out, fundamental novel features of the present invention, it will be understood that various omissions and substitutions and changes in the apparatus described, in the form and details of the devices disclosed, and in their operation, may be made by those skilled in the art without departing from the spirit of the present invention to operate on other types of wireless communication protocols. It is expressly intended that all combinations of those elements which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Substitutions of elements from one described embodiment to another are also fully intended and contemplated.

Claims

What is claimed is:

1. A method for setting nominal operational amplifier/attenuator configuration values for a remote station in communication with a base station over a wireless communication system, to achieve a minimal interference level when not transmitting, said method comprising the steps of:

determining a received signal level at said base station, wherein said received signal level producing an acceptable signal quality;

determining an output transmission signal level for said remote station to achieve said received signal level; and

setting said nominal operational configuration to achieve an output level substantially comparable to said determined transmission signal level dependent upon a distance for a desired input signal level.

2. The method as recited in claim 1, wherein the step of determining said received signal level comprises the steps of:

determining a signal level to achieve an acceptable error rate; and

adjusting said acceptable error rate signal level higher by a known value.

3. The method as recited in claim 2, wherein said known value is in the range of 3 to 15dB.

4. The method as recited in claim 1, wherein the step of setting said operational values comprises the steps of:

determining an amplification level for each of at least one amplifiers in said remote station;

determining an attenuation value for each attenuator associated with said at least one amplifier, wherein said attenuation values depends on a distance between said remote station and said base station.

5. The method as recited in claim 4, wherein the step of determining attenuation values for each of said associated attenuators comprises the steps of:

determining a total attenuation level to achieve said output level;

setting a second attenuator to a second attenuator value when said distance is less than a known distance;

setting at least one first attenuator to the balance between said total attenuation level and said second attenuator level.

6. The method as recited in claim 5, wherein said second attenuator value is a maximum value.

7. The method as recited in claim 4, wherein the step of determining attenuation values for each of said associated attenuators comprises the steps of:

determining a total attenuation level to achieve said output level;

setting a first attenuator to a first attenuator value when said distance is greater than a known distance; and

setting at least one second attenuator to the balance between said total attenuation level and said first attenuator level.

8. The method as recited in claim 7, wherein said first attenuator value is a maximum value.

9. The method as recited in claim 8 further comprising the steps of:

iteratively adjusting said first attenuator value and associated at least one second attenuator values until a measured noise density and Intermodulation distortion are within acceptable tolerances.

10. In a wireless communication system having a plurality of associated remote stations in communication with a base station, a method for achieving minimal interference from each of said remote stations to increase the number of remote stations in a sector comprising the steps of;

determining a base station received signal level;

determining for each of said remote stations a nominal transmitter power output level to substantially achieve said determined base station received signal level transmitter power output has a noise density dependent upon a distance between said remote station and said base station.

11. The method as recited in claim 10, wherein the step of determining said operational configuration comprises the steps of:

determining an amplification level for each of at least one amplifiers in said remote station;

determining an attenuation value for each attenuator associated with said at least one amplifier, wherein said attenuation values depends on a distance between said remote station and said base station.

12. The method as recited in claim 11, wherein the step of determining attenuation values for each of said associated attenuators comprises the steps of:

determining a total attenuation level to achieve said output level;

setting a second attenuator to a second attenuator value when said distance is less than a known distance;

setting at least one first attenuator to the balance between said total attenuation level and said second attenuator level.

13. The method as recited in claim 12, wherein said second attenuator value is a maximum value.

14. The method as recited in claim 12, wherein the step of determining attenuation values for each of said associated attenuator comprises the steps of:

determining a total attenuation level to achieve said output level;

setting a first attenuator to a first attenuator value when said distance is greater than a known distance; and

setting at least one second attenuator to the balance between said total attenuation level and said first attenuator level.

15. The method as recited in claim 14, wherein said first attenuator value is a maximum value.

16. The method as recited in claim 15 further comprising the steps of:

iteratively adjusting said first attenuator value and associated at least one second attenuator values until a measured noise density and intermodulation distortion are within acceptable tolerances.

17. A remote station in a wireless communication system in communication with a base station having a nominal configuration setting providing a minimal noise density when not transmitting, said remote station comprises:

an indoor unit; and

an outdoor unit operable to receive a intermediate frequency from said indoor unit, comprising:

a mixer to upconvert said intermediate frequency to a radio frequency;

a signal conditioner in communication with said mixer including at least one amplifier and at least one associated attenuator; and

a power amplifier to generate an output signal.

18. The remote station as recited in claim 17, wherein said signal conditioner nominal configuration is dependent upon a distance between said remote station and said base station.

19. The remote station as recited in claim 18, wherein said nominal configuration includes:

an amplification level for each of said at least one amplifiers is known;

an attenuation value for each attenuator associated with said at least one amplifier is determined by:

determining a remote station attenuation level to achieve said output level

setting a second attenuator to a second attenuator value when said distance is less than a known distance;

setting at least one first attenuator to the balance between said total attenuation level and said second attenuator level, wherein said second attenuator is closest to said power amplifier;

setting a first attenuator to a first attenuator value when said distance is greater than a known distance; and

setting at least one second attenuator to the balance between said total attenuation level and said first attenuator level, wherein said first attenuator is closest to said mixer.

20. The remote station as recited in claim 19, wherein said second attenuator value is a maximum value.

21. The remote station as recited in claim 20, wherein said first attenuator value is a maximum value.

22. The remote station as recited in claim 20, wherein said first attenuator value and associated at least one second attenuator values are iteratively adjusted until a measured noise density and intermodulation distortion are within acceptable tolerances.

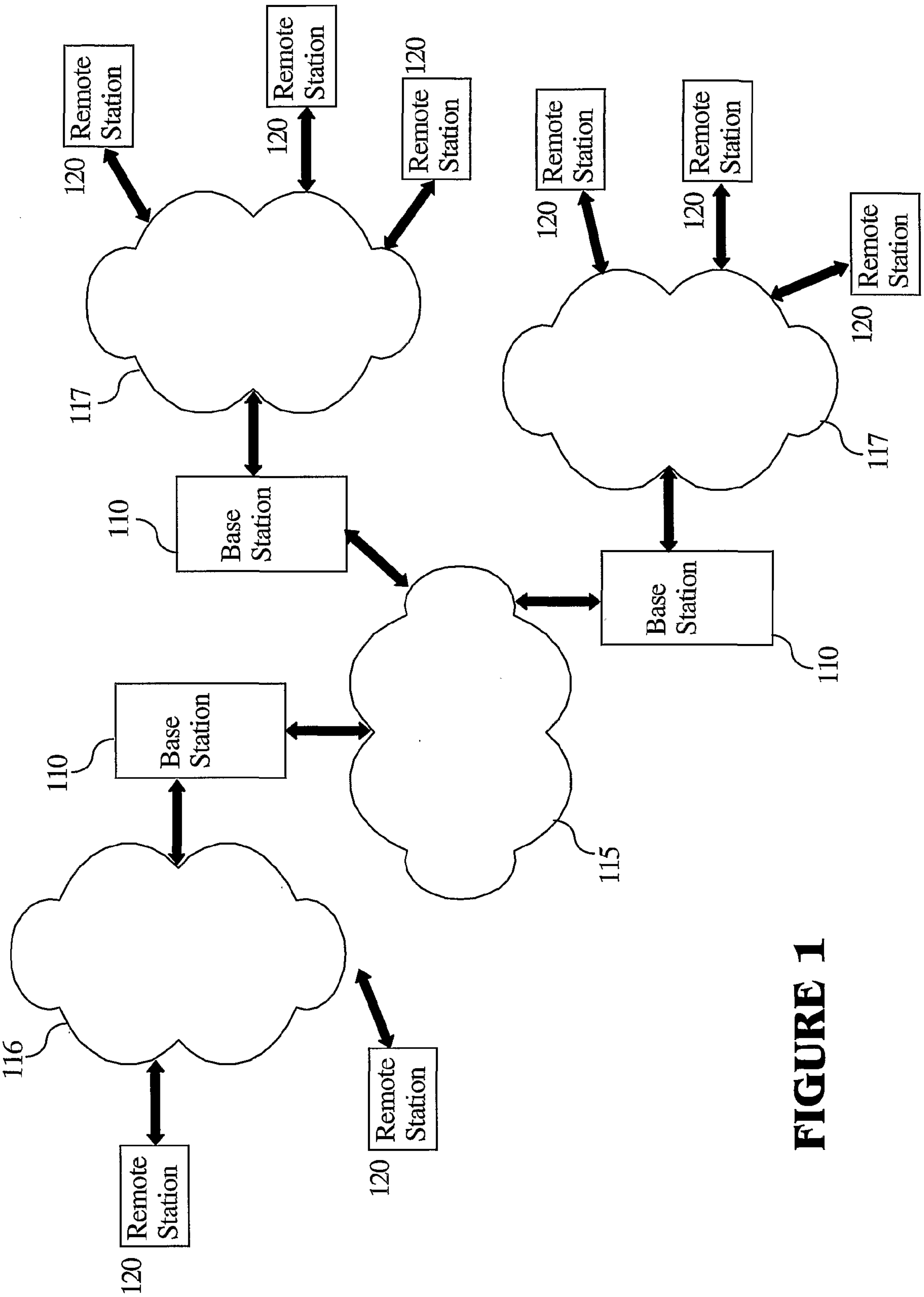


FIGURE 1

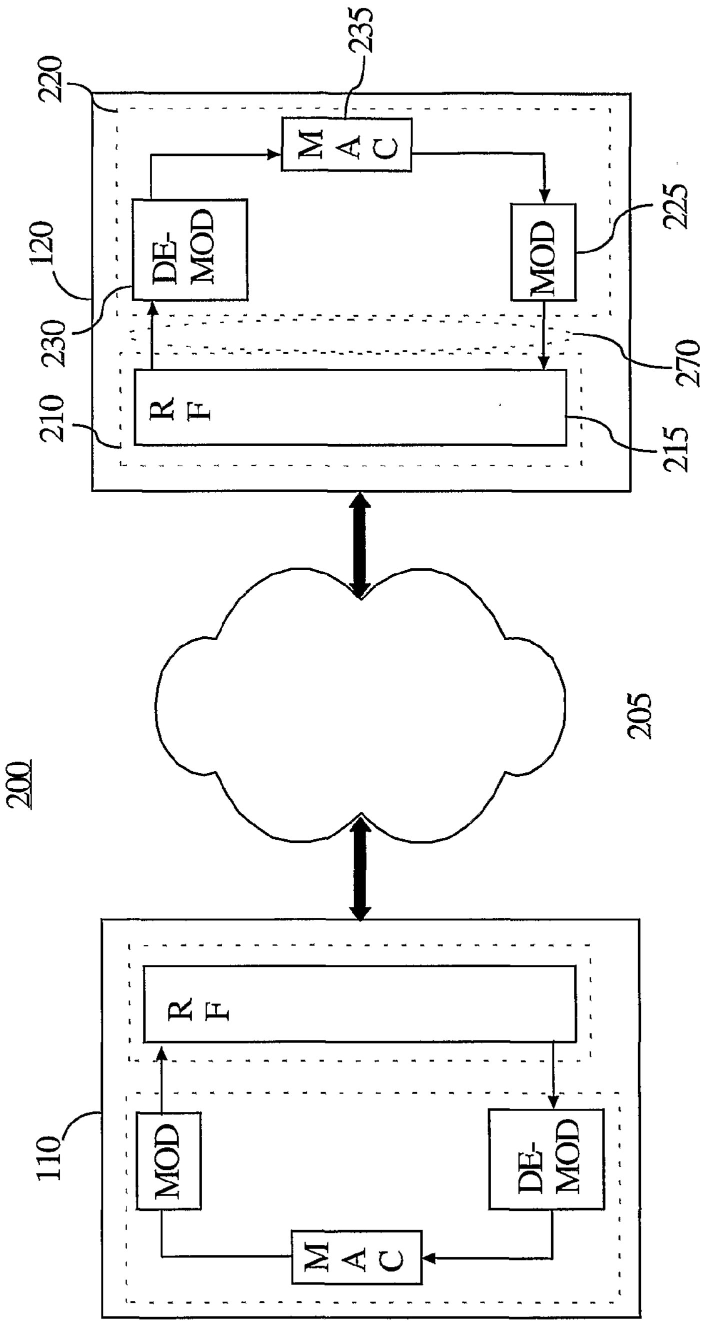

200
110
MOD
DE-
MOD
M
A
C
R
F
205
120
220
235
230
DE-
MOD
M
A
C
MOD
225
210
R
F
215
270

FIGURE 2

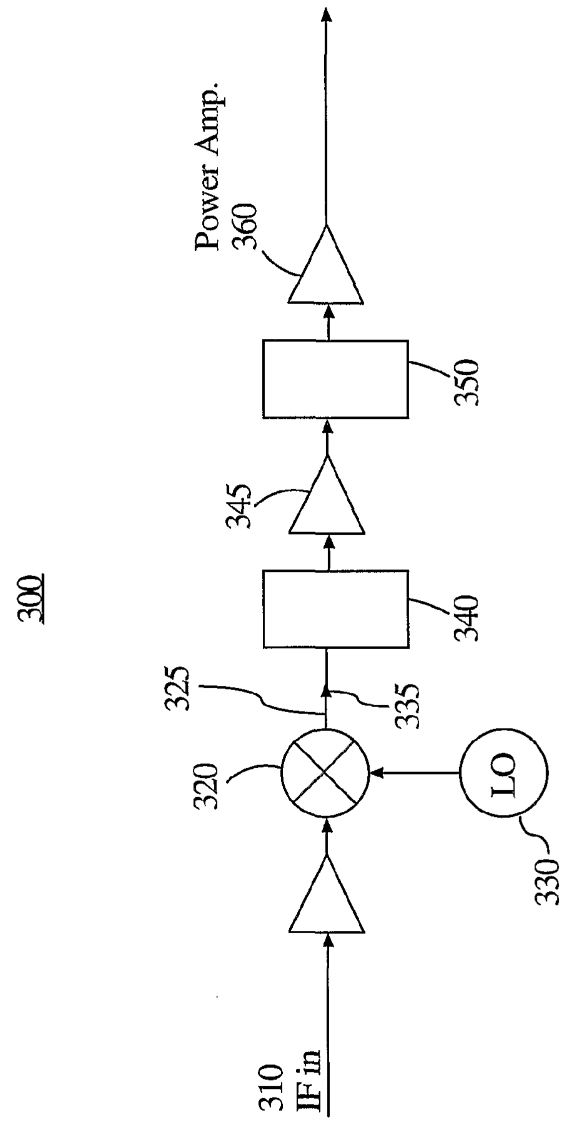


FIGURE 3

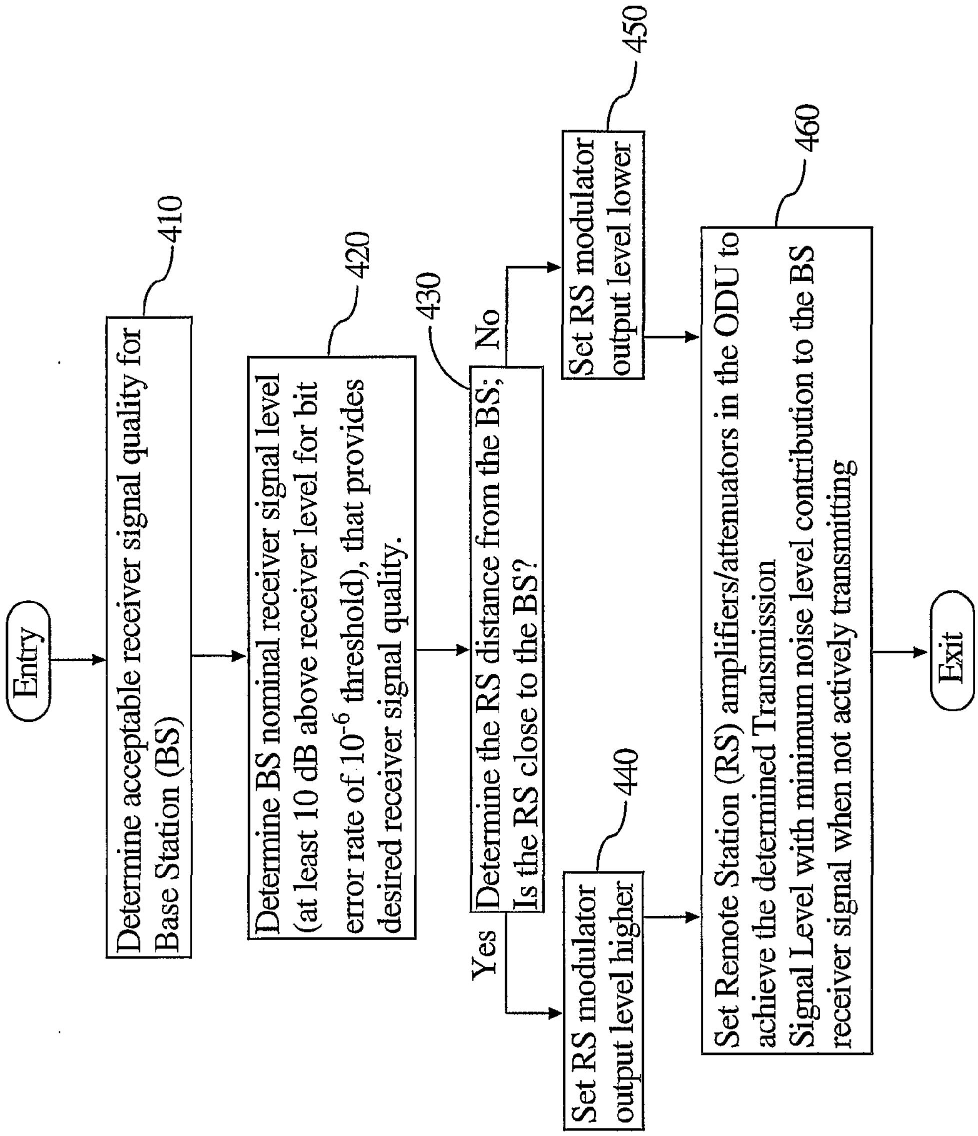

Entry
Determine acceptable receiver signal quality for Base Station (BS)
410
Determine BS nominal receiver signal level (at least 10 dB above receiver level for bit error rate of 10^{-6} threshold), that provides desired receiver signal quality.
420
Determine the RS distance from the BS; Is the RS close to the BS?
430
Yes
No
Set RS modulator output level higher
440
Set RS modulator output level lower
450
Set Remote Station (RS) amplifiers/attenuators in the ODU to achieve the determined Transmission Signal Level with minimum noise level contribution to the BS receiver signal when not actively transmitting
460
Exit

FIGURE 4

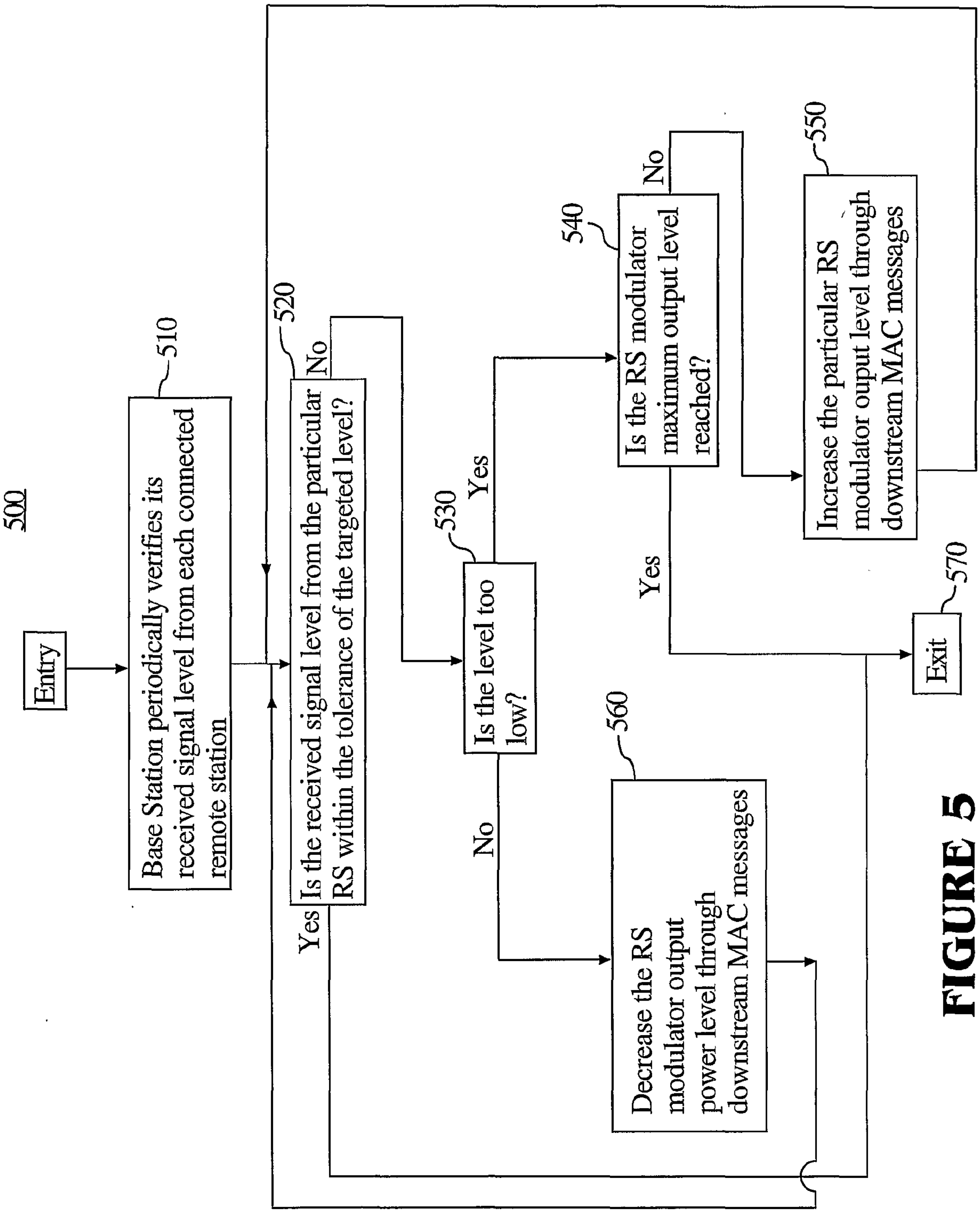
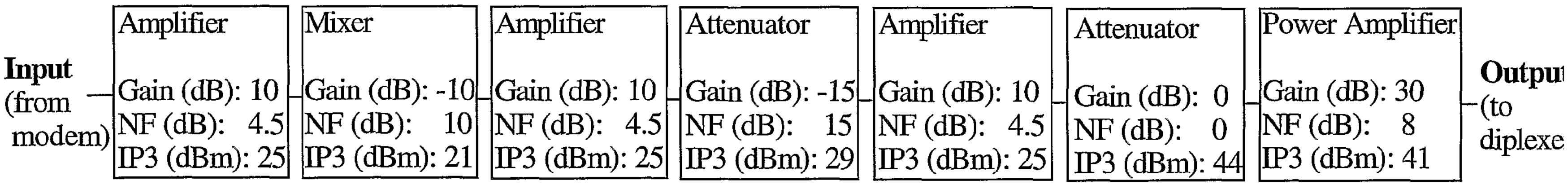

500
Entry
Base Station periodically verifies its received signal level from each connected remote station
510
Is the received signal level from the particular RS within the tolerance of the targeted level?
520
Yes
No
Is the level too low?
530
Yes
No
Is the RS modulator maximum output level reached?
540
Yes
No
Increase the particular RS modulator ouput level through downstream MAC messages
550
Decrease the RS modulator output power level through downstream MAC messages
560
Exit
570

FIGURE 5

FIGURE 6a

Distance	15 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-10.0 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23



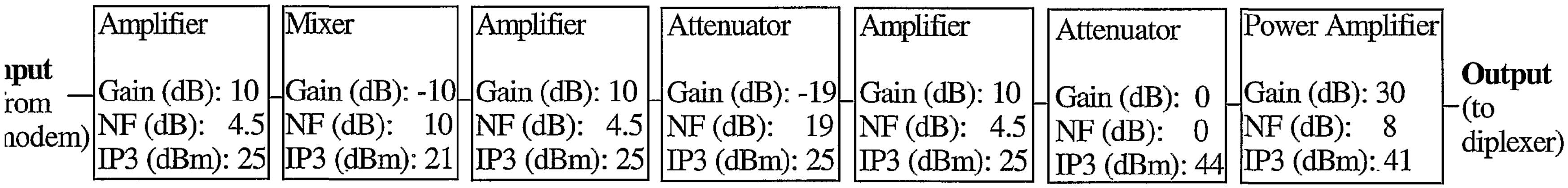
Cascaded Gain: 35.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	-10.0 (20.0)	0.0 (10.0)	-10.0 (20.0)	0.0 (10.0)	-15.0 (25.0)	-5.0 (15.0)	-5.0 -(15.0)	25.0 (15.0)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-154.9	-144.8	-144.8	-114.8	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	6.5 (6.5)	15.9 (15.9)	15.9 (15.9)	40.0 (40.0)	Output IP3: (dBm)
IMDS Products:		50.0 (70.0)	48.1 (68.1)	43.0 (63.0)	42.9 (62.9)	41.8 (61.8)	41.8 (61.8)	30.0 (50.0)	IMDS Products:

FIGURE 6b

Distance	10 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	- 9.5 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23



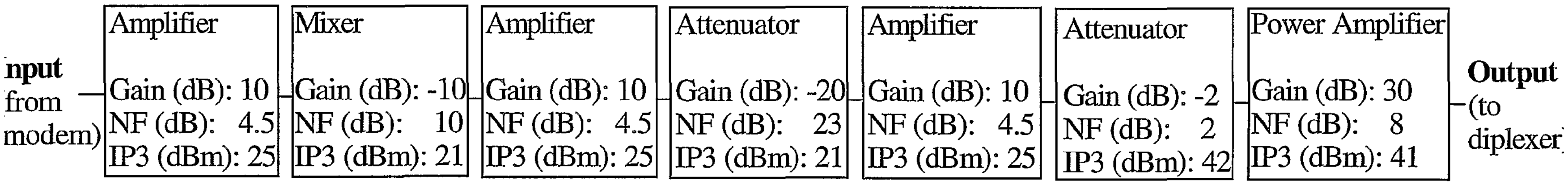
Cascaded Gain: 31.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	- 9.5 -(19.5)	0.5 -(9.5)	-9.5 -(19.5)	0.5 -(9.5)	-18.5 -(28.5)	-8.5 -(18.5)	-8.5 -(18.5)	21.5 (11.5)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-158.9	-148.7	-148.7	-118.6	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	2.5 (2.5)	12.2 (12.2)	12.2 (12.2)	38.7 (38.7)	Output IP3: (dBm)
IMDS Products:		49.0 (69.0)	47.1 (67.1)	42.0 (62.0)	41.9 (61.9)	41.4 (61.4)	41.4 (61.4)	34.4 (54.4)	IMDS Products:

FIGURE 6c

Distance	5 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-9.5 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23



Faded Values: xx
Clearsky Values: (xx)

Cascaded Gain: 35.0 dB

Signal Out: (dBm)	-9.5 -(19.5)	0.5 -(9.5)	-9.5 -(19.5)	0.5 -(9.5)	-22.5 -(32.5)	-12.5 -(22.5)	-14.5 -(24.5)	15.5 (5.5)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-162.9	-152.4	-154.4	-124.1	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	-1.5 -(1.5)	8.4 (8.4)	6.4 (6.4)	35.1 (35.1)	Output IP3: (dBm)
IMDS Products:		49.0 (69.0)	47.1 (67.1)	42.0 (62.0)	41.9 (61.9)	41.7 (61.7)	41.7 (61.7)	39.3 (59.3)	IMDS Products:

FIGURE 6d

Distance	2 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-9.5 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23

nput from nodem) —

Amplifier	Mixer	Amplifier	Attenuator	Amplifier	Attenuator	Power Amplifier
Gain (dB): 10	Gain (dB): -10	Gain (dB): 10	Gain (dB): -23	Gain (dB): 10	Gain (dB):-10	Gain (dB): 30
NF (dB): 4.5	NF (dB): 10	NF (dB): 4.5	NF (dB): 23	NF (dB): 4.5	NF (dB): 10	NF (dB): 8
IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 34	IP3 (dBm): 41

— **Output** (to diplexer)

Cascaded Gain: 35.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	-9.5 -(19.5)	0.5 -(9.5)	-9.5 -(19.5)	0.5 -(9.5)	-22.5 -(32.5)	-12.5 -(22.5)	-22.5 -(32.5)	7.5 -(2.5)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-162.9	-152.4	-162.4	-131.0	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	-1.5 -(1.5)	8.4 (8.4)	-1.6 -(1.6)	28.1 (28.1)	Output IP3: (dBm)
IMDS Products:		49.0 (69.0)	47.1 (67.1)	42.0 (62.0)	41.9 (61.9)	41.7 (61.7)	41.7 (61.7)	41.3 (61.3)	IMDS Products:

FIGURE 6e

Distance	1 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-8.5 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23

Input (from modem) —

Amplifier	Mixer	Amplifier	Attenuator	Amplifier	Attenuator	Power Amplifier
Gain (dB): 10	Gain (dB): -10	Gain (dB): 10	Gain (dB): -23	Gain (dB): 10	Gain (dB):-17	Gain (dB): 30
NF (dB): 4.5	NF (dB): 10	NF (dB): 4.5	NF (dB): 23	NF (dB): 4.5	NF (dB): 17	NF (dB): 8
IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 27	IP3 (dBm): 41

— **Outp** (to diplex

Cascaded Gain: 35.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	-8.5 -(18.5)	1.5 -(8.5)	-8.5 -(18.5)	1.5 -(8.5)	-21.5 -(31.5)	-11.5 -(21.5)	-28.5 -(38.5)	1.5 -(6.5)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-162.9	-152.4	-169.4	-134.8	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	-1.5 -(1.5)	8.4 (8.4)	-8.6 -(8.6)	21.3 (21.3)	Output IP3: (dBm)
IMDS Products:		47.0 (67.0)	45.1 (65.1)	40.0 (60.0)	39.9 (59.9)	39.7 (59.7)	39.7 (59.7)	39.6 (59.6)	IMDS Products:

FIGURE 6f

Distance	0.5 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-6.5 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23

Input (from modem) →

Amplifier	Mixer	Amplifier	Attenuator	Amplifier	Attenuator	Power Amplifier
Gain (dB): 10	Gain (dB): -10	Gain (dB): 10	Gain (dB): -23	Gain (dB): 10	Gain (dB): -25	Gain (dB): 30
NF (dB): 4.5	NF (dB): 10	NF (dB): 4.5	NF (dB): 23	NF (dB): 4.5	NF (dB): 25	NF (dB): 8
IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 19	IP3 (dBm): 41

→ Output (to diplexer)

Cascaded Gain: 35.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	-6.5 -(16.5)	3.5 -(6.5)	-6.5 -(16.5)	3.5 -(6.5)	-19.5 -(29.5)	-9.5 -(19.5)	-34.5 -(44.5)	-4.5 -(14.5)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-162.9	-152.4	-174.0	-136.0	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	-1.5 -(1.5)	8.4 (8.4)	-16.6 -(16.6)	13.3 (13.3)	Output IP3: (dBm)
IMDS Products:		43.0 (63.0)	41.1 (61.1)	36.0 (56.0)	35.9 (55.9)	35.7 (55.7)	35.7 (55.7)	35.7 (55.7)	IMDS Products:

FIGURE 6g

Distance	0.25 Km
Tx Frequency:	3450 MHz
Flat Fade Margin:	10 dB
Modem Output Level:	-4.6 dBm
Modem Muted Output Noise:	-150.0 dBm/Hz
Thermal Noise Floor:	-174.0 dBm/Hz
Boltzman's Constant:	1.374E-23

Input (from modem) →

Amplifier	Mixer	Amplifier	Attenuator	Amplifier	Attenuator	Power Amplifier
Gain (dB): 10	Gain (dB): -10	Gain (dB): 10	Gain (dB): -24	Gain (dB): 10	Gain (dB):-32	Gain (dB): 30
NF (dB): 4.5	NF (dB): 10	NF (dB): 4.5	NF (dB): 24	NF (dB): 4.5	NF (dB): 32	NF (dB): 8
IP3 (dBm): 25	IP3 (dBm): 21	IP3 (dBm): 25	IP3 (dBm): 20	IP3 (dBm): 25	IP3 (dBm): 12	IP3 (dBm): 41

→ **Output** (to diplexer

Cascaded Gain: 35.0 dB

Faded Values: xx
Clearsky Values: (xx)

Signal Out: (dBm)	-4.6 -(14.6)	5.4 -(4.6)	-4.6 -(14.6)	5.4 -(4.6)	-18.6 -(28.6)	-8.6 -(18.6)	-40.6 -(50.6)	-10.6 -(20.6)	Signal Out: (dBm)
Muted Noise Out: (dBm/Hz)	-150.0	-140.0	-150.0	-139.9	-163.9	-153.2	-174.0	-136.0	Muted Noise Out: (dBm/Hz)
Output IP3: (dBm)	100.0 (100.0)	25.0 (25.0)	14.0 (14.0)	21.5 (21.5)	2.5 -(2.5)	7.4 (7.4)	-24.6 -(24.6)	5.4 (5.4)	Output IP3: (dBm)
IMDS Products:		39.2 (59.2)	37.3 (57.3)	32.2 (52.2)	32.1 (52.1)	32.0 (52.0)	32.0 (52.0)	31.9 (51.9)	IMDS Products:

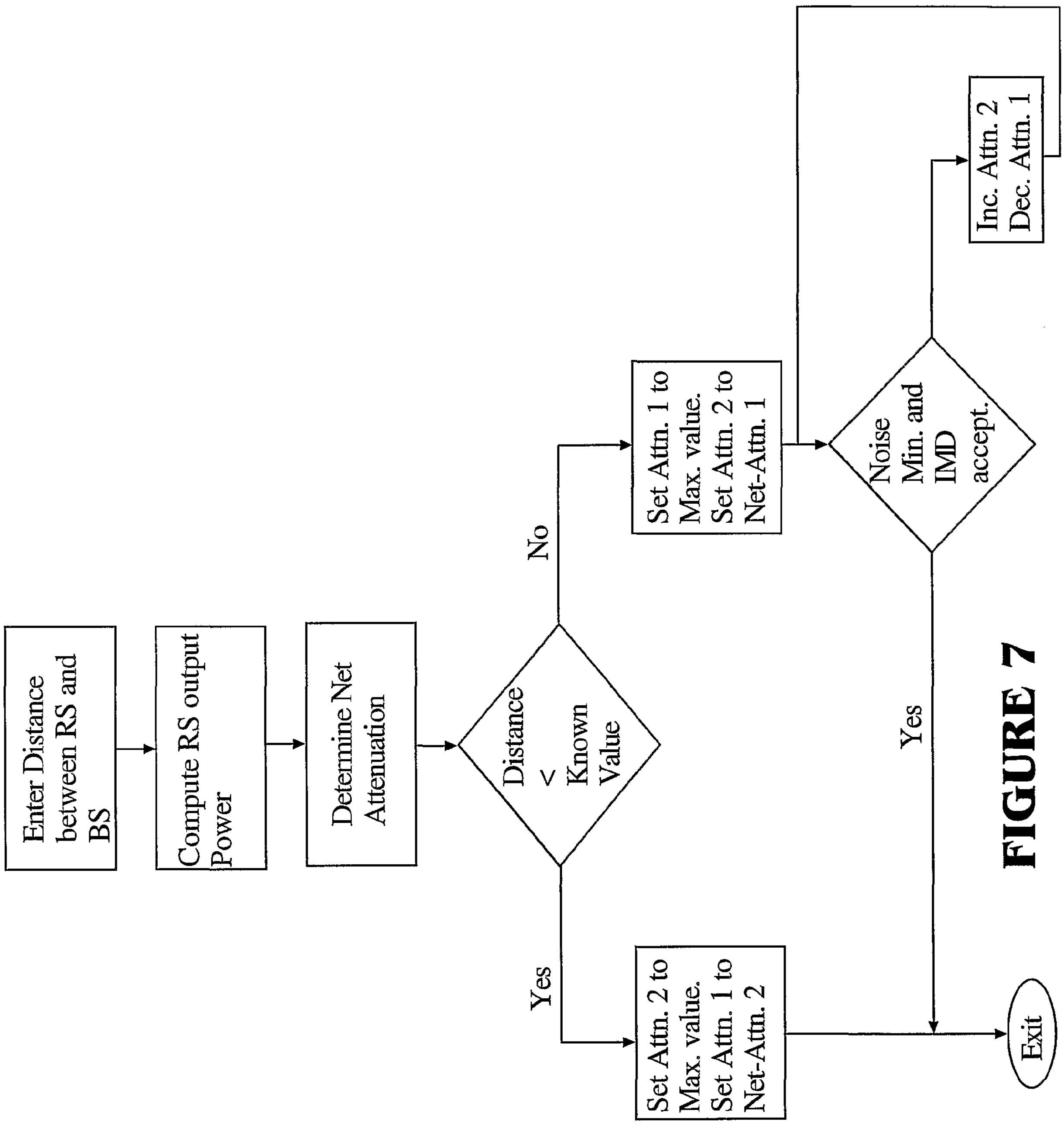

Enter Distance between RS and BS
Compute RS output Power
Determine Net Attenuation
Distance < Known Value
Yes
No
Set Attn. 2 to Max. value. Set Attn. 1 to Net-Attn. 2
Set Attn. 1 to Max. value. Set Attn. 2 to Net-Attn. 1
Noise Min. and IMD accept.
Yes
Inc. Attn. 2 Dec. Attn. 1
Exit

FIGURE 7