Theory of Operation Technical Description

1 Basic operation Theory Description

As shown in the schematics, the system includes four sub-systems: cellular, PCS, LTE, AWS, each are made up of uplink and downlink portion, with separate control circuits and RSSI detection circuits.

The uplink signal is received from the indoor antenna, and transmitted through the outdoor antenna after amplified by all stages of amplification block on the path.

The downlink is similar to the uplink.

2 Authorized Frequency Bands

Table: Authorized Frequency Bands

Authorized Frequency	**Value**
Cellular Downlink	869-894MHz
Cellular Uplink	824-849MHz
AWS Downlink	2110-2155 MHz
AWS Uplink	1710-1755 MHz
LTE Downlink	728-757 MHz
LTE-707 Uplink	698-716 MHz
LTE-781 Uplink	776-787 MHz
PCS Downlink	1930-1995MHz
PCS Uplink	1850-1915MHz

3 Hardware Operation Description

3.1 Hardware Block Diagram

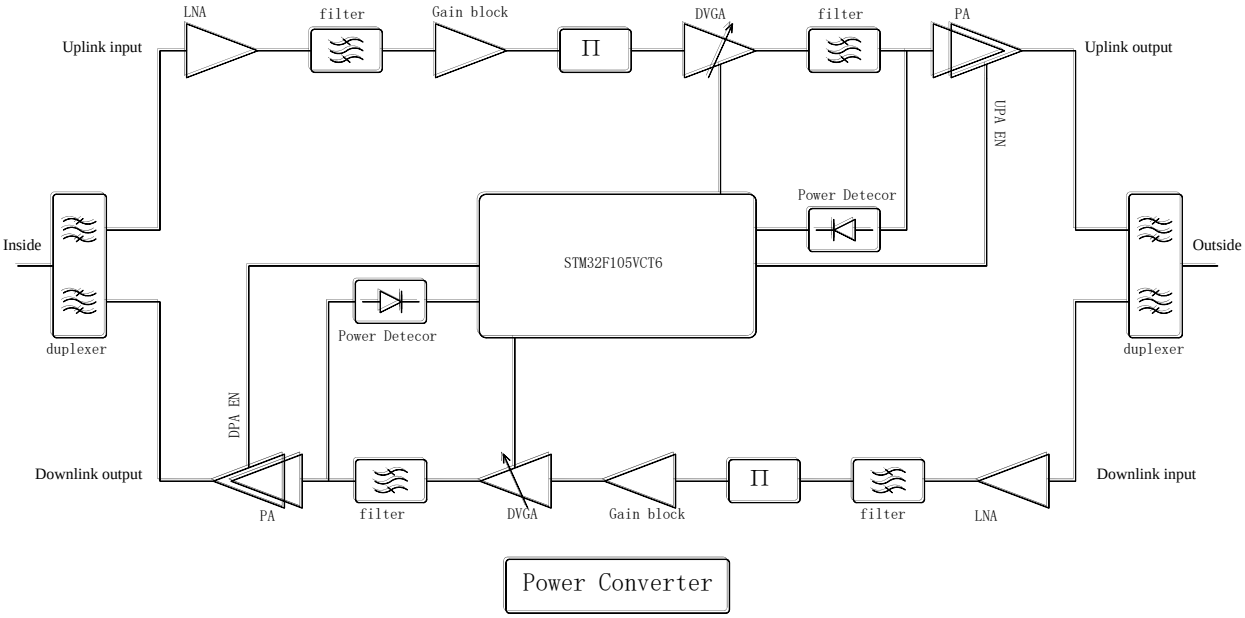

Figure 1 Block diagram for each band

The block diagram is composed of the following units:

Uplink input Power detector;

Uplink output Power detector;

Uplink PA switch integrated in PA;

Downlink input Power detector;

Downlink PA switch integrated in PA, and so on;

3.2 RF Hardware Operation Description

3.2.1 LNA provides good noise figure to meet the design requirements.

3.2.2 Gain block provides the link gain and a sufficient input level for PA.

3.2.3 PA provides the output power of the links to meet the design requirement.

3.2.4 Uplink inactivity Function: The booster determine that whether the input power level of uplink exceeds the limit using the uplink input power detector. When there is no user, uplink is turned off by uplink PA switch. Once the uplink is turned off, it will keep in the off state until a call is initiated.

3.2.5 AGC for uplink: The uplink output power detector is used to get the level of output. The MCU will control the attention of uplink and AGC works, when the level triggering the AGC limit.

3.2.6 AGC for downlink: The downlink input power detector is use to get the level of output. The MCU will control the attention of downlink AGC works when the

level triggering the AGC limit.

3.2.7 Oscillation detection of uplink and downlink: The oscillation will produce a stable saturation level power. Therefore, we detect it through measuring saturated power level. Set a limit for the saturated power, if the level of the output power is higher than the limit for some time, CPU flags that the oscillation is detected. When oscillation is detected, the booster will shut down immediately by using PA Switch. After 68 second, the booster restarts automatically. If it still in the oscillation state after five starts, the booster will keep in shut down state until manually reset.

3.2.8 Noise limit: transmitted noise power in dBm/MHz of consumer boosters at their uplink and downlink ports shall not exceed the limit of (-103 dBm/MHz – RSSI). By controlling the ATT the MCU can properly control the noise of uplink and downlink if the RSSI level of the downlink input power detected exceeds the required limit.

3.2.9 Gain limit of uplink: The uplink gain in dB of a consumer booster referenced to its input and output ports shall not exceed -34 dB - RSSI + MSCL. Therefore, we use the same method as the downlink to control the gain of uplink to meet FCC's requirements.

3.3 Power Converter Description

Power convert circuit: The amplifier will be using the 6-12V DC power input. The DC to DC conversion (TPS65270) provided power to the gain block after converted any input voltage in the proper range to 4.2V.

3.4 Indication Light Description

When the output power is over the preset limit, the Alert light assigned to that link will be in red. When the booster is in oscillation state, the Alert light will be in Red yellow flashing. When the power supply connected to the amplifier, the POWER light will be in green. When the booster is in Uplink inactivity state, the Alert light will be in yellow.

4 Monitoring mechanism

4.1 Software Flowcharts and Description

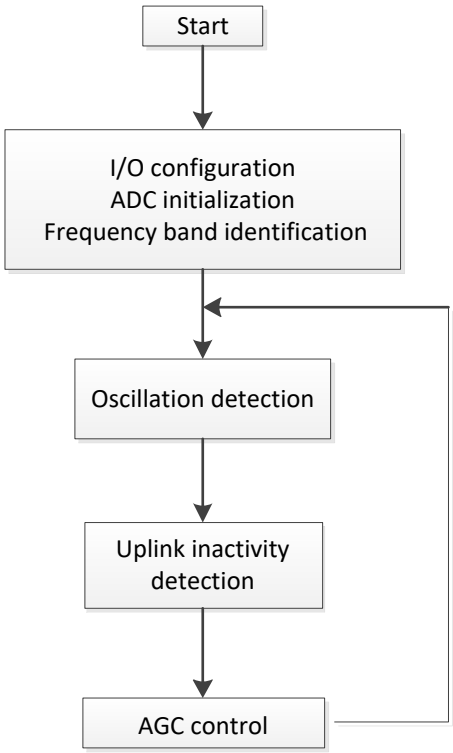

Figure 2 Software flowcharts

Description:

When the signal booster power on, the internal MCU begin to configure itself. The configuration procedure includes I/O configuration, ADC initialization and identifying frequency band, and so on. After configuration finished, The MCU continually performs cycle detection, like oscillation detection, uplink inactivity detection and AGC control functions.

4.2 Uplink inactivity flowcharts and Description

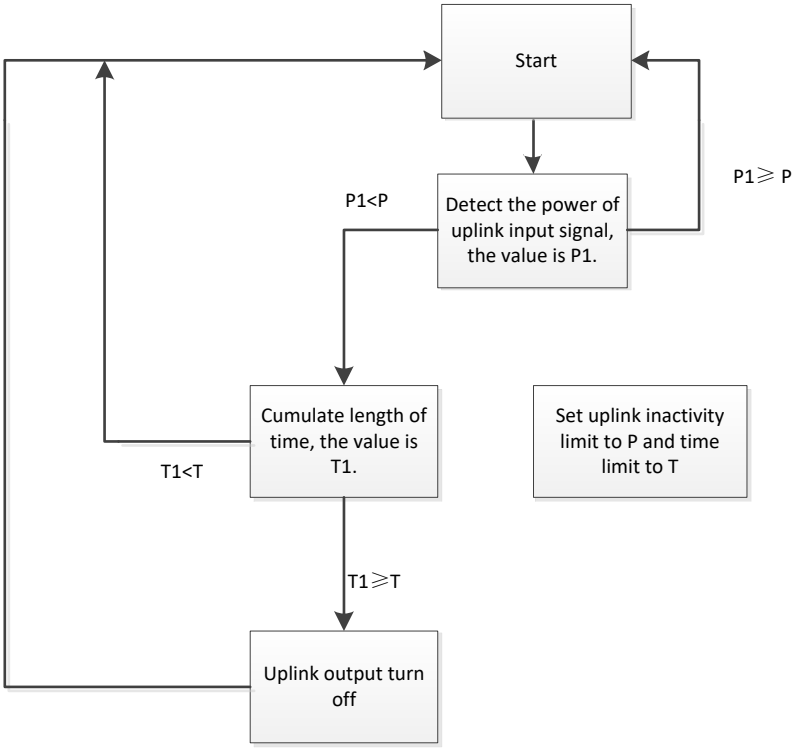

Figure 3 Uplink inactivity flowcharts

Description:

When a wireless signal at uplink band exceeds the inactivity limit, whatever CDMA modulation or GSM modulation, the signal booster opens the uplink circuit and amplifies the wireless signal. If the wireless signal at uplink band is lower than the inactivity limit for a short time, normally less than 5 minutes, the booster will work in an inactivity state ,(Noise figure is < -70dBm/M and Gain is < 23dB). In this state, the output PA will turn off and the attenuation will be set to maximum value to meet FCC uplink inactivity requirement. The booster will keep in this state until it detects a wireless signal exceeding the inactivity limit.

4.3 Oscillation detection flowcharts and Description

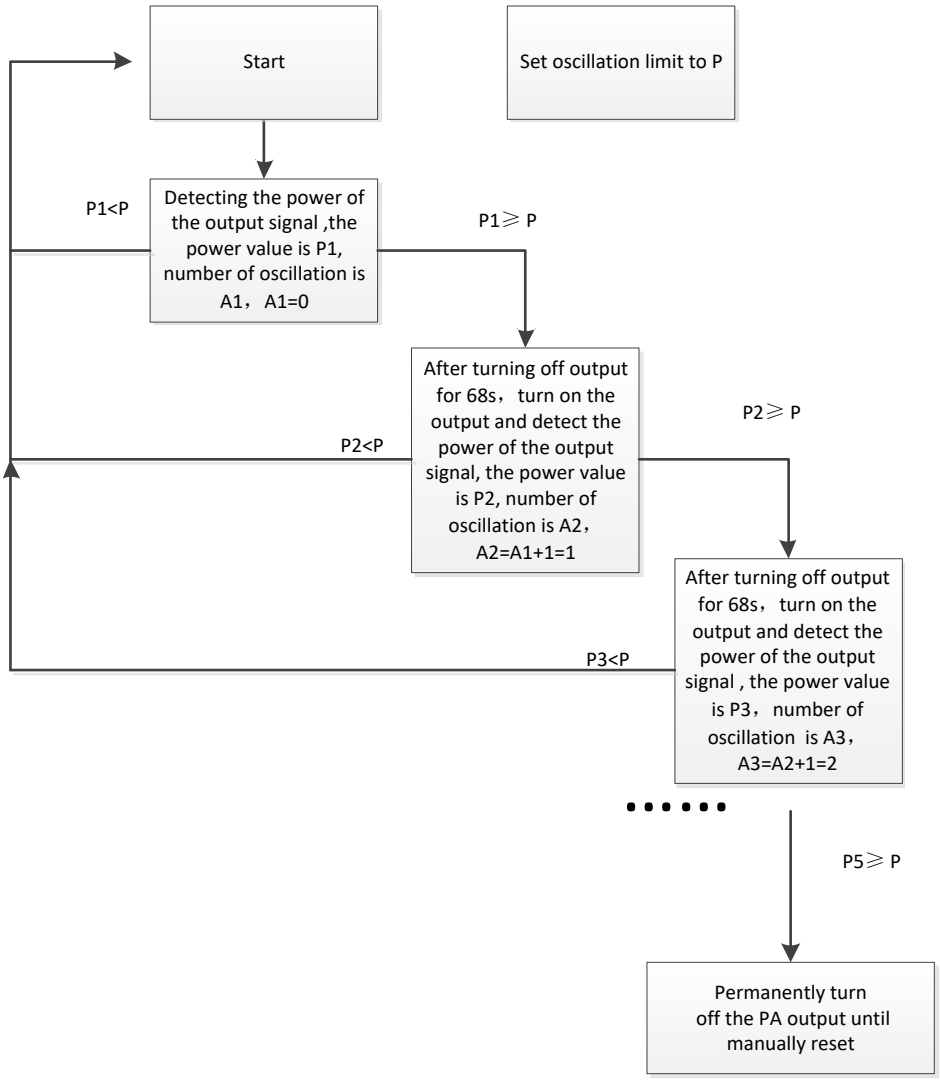

Figure 4 Oscillation detection flowcharts

When oscillation happens, the booster will generate a stable near saturation level power signal. So the booster can detect it easily. If it exceeds the power level limit, it means oscillation is happening and the booster will shut down immediately. After 68s, the booster restarts. If it still in the oscillation state after five such restarts, the booster will not resume operation until manually reset.

4.4 AGC flowcharts and Description

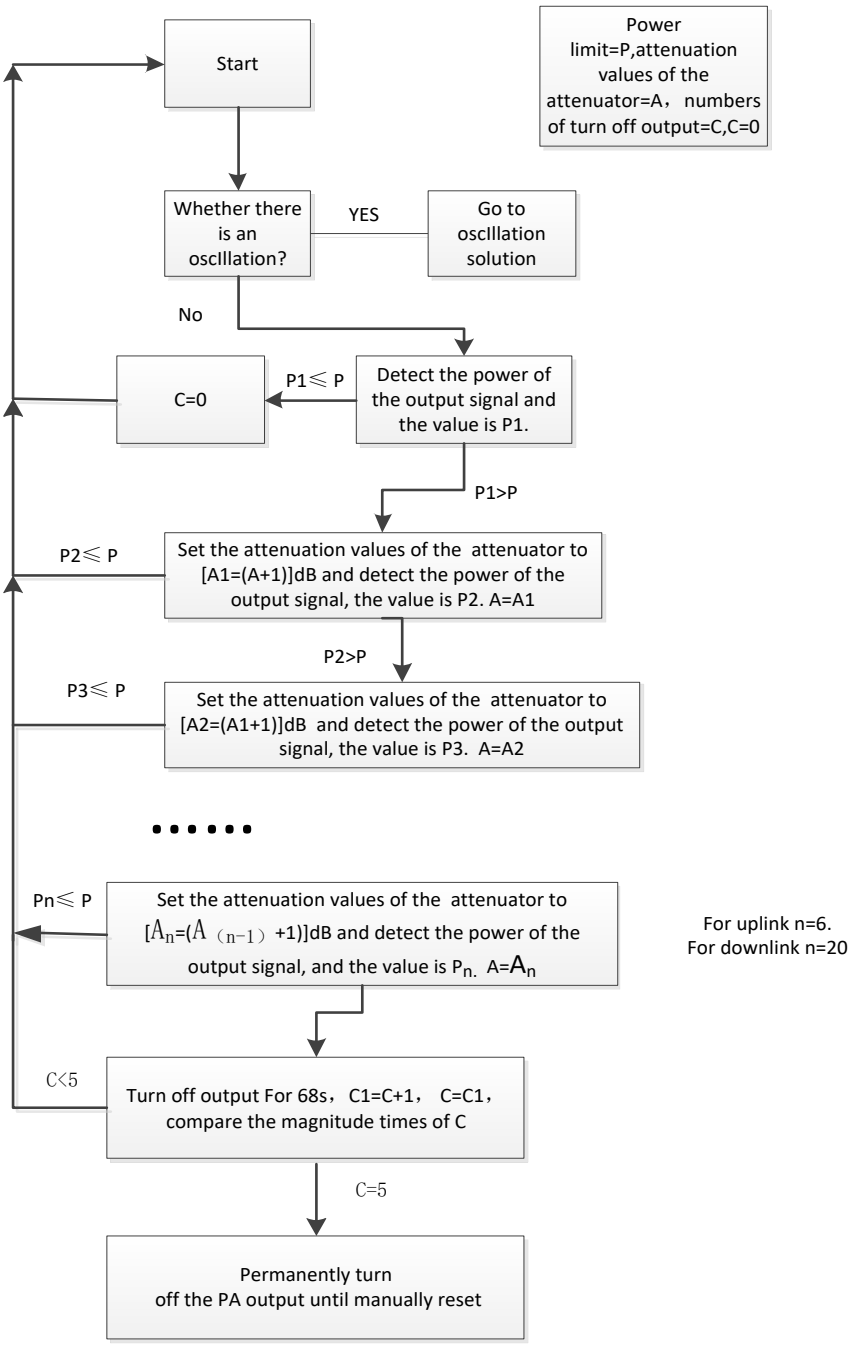

Figure 4 AGC flowcharts

When the output power rises up to the preset AGC power level, the AGC will start working and keep on adjusting gains of that particular link to keep the output power and noise etc. at the desired level allowed by FCC.

When the RSSI rises up and is in region of adjusting uplink gain and noise, AGC works in same theory.

5 Interference avoidance scheme

The booster has AGC scheme. The AGC protect against excessive input signals that would cause output power and emissions in excess of that authorized by FCC.

The booster can adjust noise base on RSSI. When the detected RSSI rise up to the pre-defined power level, the AGC will also start adjusting gains to keep uplink gain and noise etc.at the level allowed by FCC.

The booster have Anti-Oscillation fusion, which is be able to detect oscillations in uplink and downlink bands and shut down within the FCC required time.

6 Saturation or over-modulation is prevented for pulsed signals

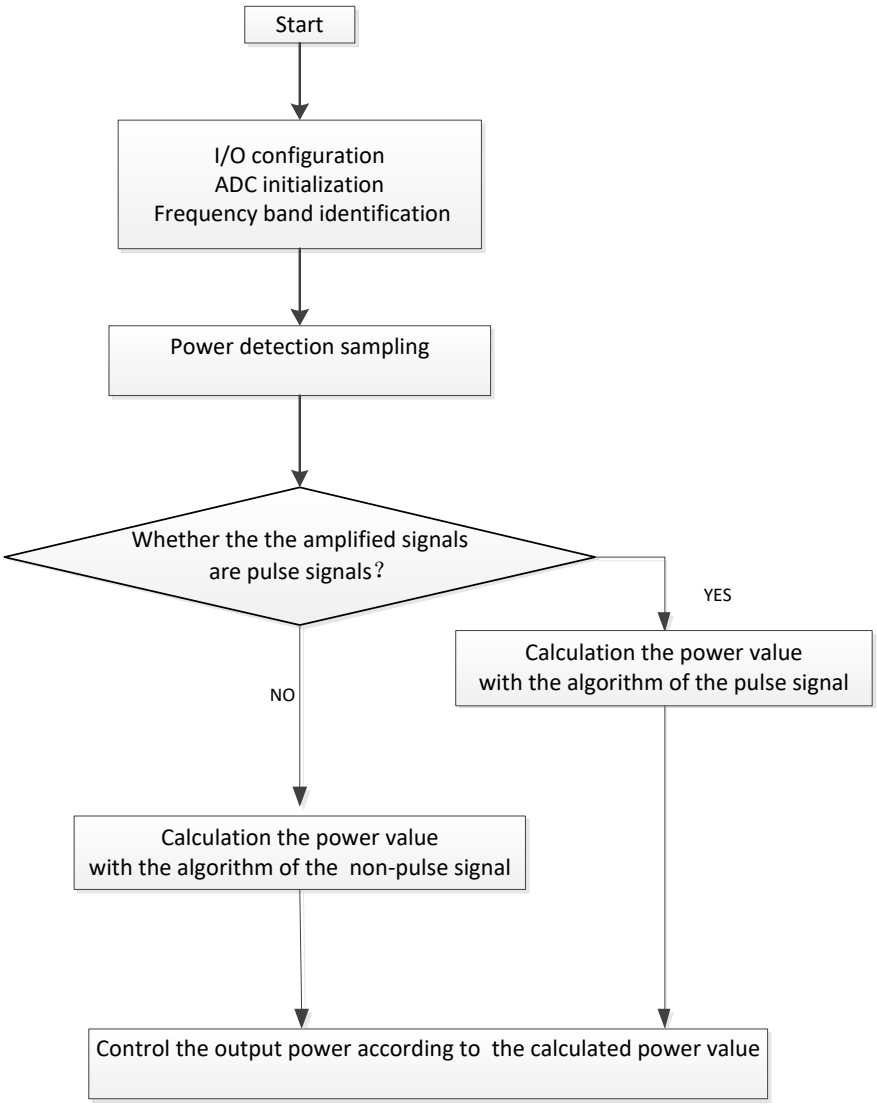

Figure 7 flowcharts for dealing with pulsed signals

In the software control algorithm, the software will judge whether the amplified signals are pulse signals through the multiple power sampling. If the amplified signals are pulse signals, the power value will be calculated with the algorithm of the pulse signal. So we can get the power value of the pulse signal (in fact it is the peak power of the pulse signal). When the

output power (the peak output power)of the pulse signal rises up to the preset AGC power level, the AGC will start working and keep on adjusting gains of that particular link to keep the output power at the desired level. The preset AGC power level shall make sure that saturation or over-modulation is prevented for pulsed signals.