



HUAPTEC

We Improve Your Mobile Signals

User's Manual

**Digital Repeater
DS20~27-5S**

Shenzhen Huaptec Co., Ltd

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Preface

This user's manual describes the installation, commissioning and maintenance of DS20~27-5S repeaters.

Please do read the user manual carefully before installing and maintaining DS20~27-5S repeaters.

The information in this manual is subject to change without prior notice.

Opinions are welcomed about the manual improvement.

1 Safety Warnings

Users must follow the below principles :



- I Repeater should follow system requirement of communication equipment, assure good groundings and lightning protection.



- I The power supply voltage of repeater should meet the standards of security requirement; any operation shall be carried out only after cutting off power in advance. Only the professional is authorized for the operation.



- I Do not dismantle machine, maintain or displace accessories by yourself, because in this way, the equipment may be damaged or even get an electric shock.



- I Do not open the repeater; touch the module of repeater, or to open the cover of module to touch the electronic component, the components will be damaged due to electrostatic.



- I Please keep away from heating-equipment, because the repeater will dissipate heat during operation. And do not cover booster with anything that influences heat-dissipation.

2 Why repeater

2.1 Reason

- 1) Blind or weak signal areas are formed if the buildings are too far away from BTS, or the buildings themselves shield or absorb the signals.
- 2) There are too many complicated signals in the higher part of the buildings, therefore ping-pong switching effect has been formed and the signals fluctuate a lot, there are annoying noises during phone calls and there are dropped phone calls accordingly.
- 3) Elevators and basements are well-known blind areas.
- 4) Downtown areas of the cities, congested with many high-rise buildings are usually the weak or blind areas.

3 Introduction

DS20~27-5S full duplex mobile communications repeater from Huaptec is the perfect solution for providing a wireless improvement in the cellular reception of a home, office, restaurant, VIP Room, apartment, building or shopping mall, in the quickest time possible. One repeater covers 5000 to 60000 square feet.

It is designed to improve the call quality of an area by receiving, amplifying and re-transmitting signals of the base station into a specified area via the server antenna of the repeater.

This repeater has Manual Gain Control (MGC) feature that enables engineers to reduce the gain of the repeater manually if oscillation is detected or too strong input power level during installation, this will help to get the best coverage effect without any interference back to mobile network.

And to maintain safe and specific output signal levels during the repeater's operation, this repeater has a built-in signal oscillation detection circuit to adjust the gain automatically so as to avoid interference to the cellular network, also it gets color changing LED's indicate its environmental status: the Alarm LED's located on the front of the unit (Alarm Low & Alarm High) will change color from green to orange or red, (depending on the input power level) if the system detects signal oscillation in either band or, if the input signal is beyond a safe limit.

Below diagram shows how simple and fast DS20~27-5S repeater system is installed and works effectively.

One donor antenna, has been installed at the top of the roof to pick up good mobile signals from outside, and send through a 5D-FB cable to a DS20~27-5S repeater to be amplified significantly, then the output signals are divided into two signals or more by splitters and couplers, sent a few indoor omni antennas and

finally transmitted into the coverage area. Very clear phone call or high speed mobile data services are immediately affected within the area.



4 System Characteristics

4.1 Features

- I Support quint systems
- I Has MGC and AGC function
- I Uplink noise suppression function
- I Excellent out of band rejection
- I Module structure, good reliability and easy maintenance
- I With Local and Remote monitor function
- I Good heat dissipation for longevity
- I Wide power supply range and low power consumption
- I High-integration (One board to contain low-noise amplifier, frequency selection module, power amplifier module, both uplink and downlink one for all)
- I Manual gain control provides a variety of applications
- I MTBF>50000h, low failure rate

4.2 Appearance of DS20-27-5S repeaters

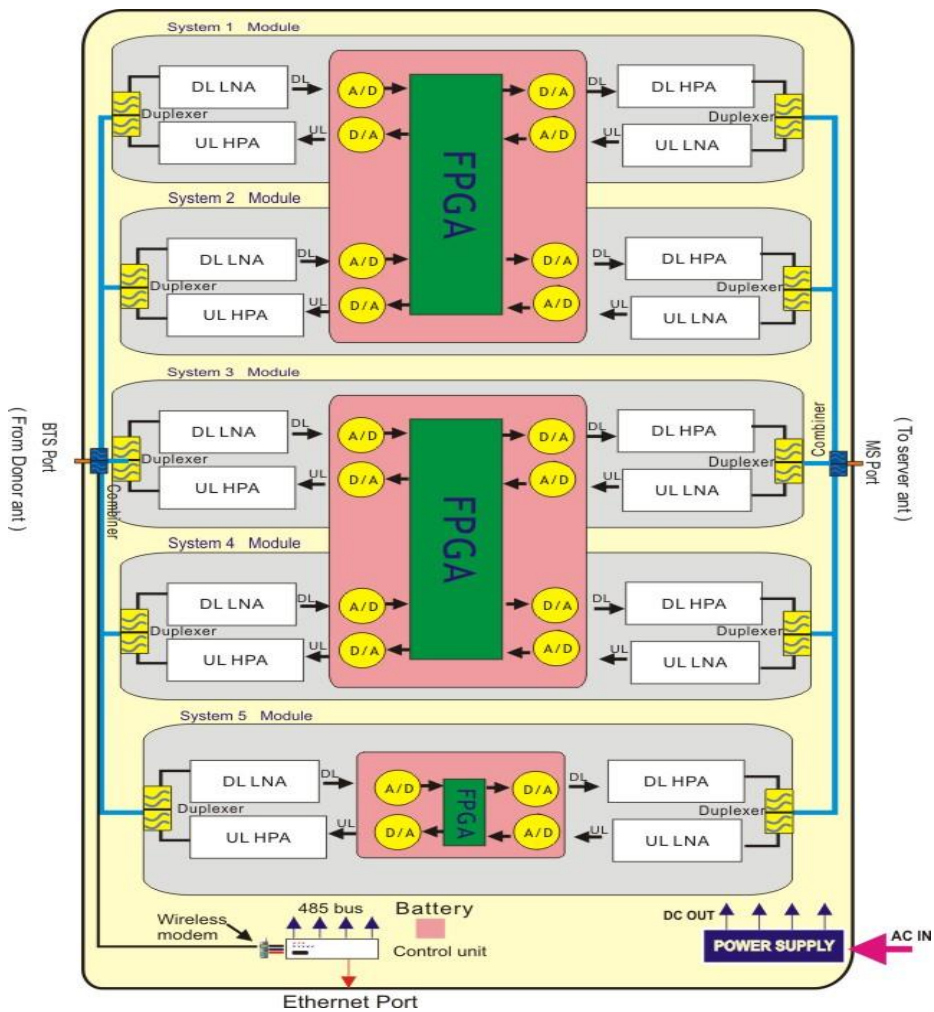


Figure 1 the front view (colors may differ from real products).

5 Block diagram and work principle

DS20~27-5S is basically a bi-directional amplifier, the downlink signals are received by the repeater from BTS by the donor antenna, filtered by its internal duplexers and FC unit, amplified by low noise amplifier (LNA) and downlink PA unit, and then sent via the server antenna to the coverage area. The bandwidth is operators' working frequency only.

The uplink signal of mobile terminal from the coverage area is input via the server antenna, then filtered by duplexers and FC unit, amplified by the uplink low noise amplifier (LNA) and the uplink PA unit and finally sent via the donor antenna to the BTS.



Modules in the system diagram:

- I **Combiner:** The main purpose of combiner is to combine quint system to share the same antennas.
- I **Duplexer:** The main purpose of duplexer is to combine downlink and uplink to share the same antennas, the duplexer is composted of one pair of band pass filter that can not only reject the spurious interference, but also increase the isolation of Uplink and Downlink.
- I **LNA:** LNA is the first active sub system of the repeater, of which low noise and high linearity is requested under strong input signals. LNA is the major sub system that determines the noise figure of the repeater system.
- I **FPGA:** Field—Programmable Gate Array, to process the digital signal transferred from analog signal.
- I **PA:** The power amplifier sub system helps the repeater to reach its targeted output power, linearity of which decides the linearity of the repeater.
- I **Power supply** is to supply power electricity to all repeaters' modules.

6 The repeater system



I Donor Antenna:

- Ø 5~7dbi outdoor panel or 7~9dBi wide band Yagi are recommended as donor antenna.
- Ø Function: Pick up donor signals from the BTS and send to the repeater by cable; the received signals' power level and quality influence a lot on the coverage effect. Donor antenna also transmits the uplink signals from the repeater to BTS.

I Server Antenna:

- Ø 2~3dBi indoor omni ceiling or 5~7dBi indoor panel are recommended.
- Ø Omni antenna (Indoor ceiling omni antenna or whip antenna), suitable to installed in the center and radiate all direction; It is better to use a directional panel antenna or Yagi when the coverage shape is long and narrow (corridors, long row of houses in two sides, tunnels or elevators or rural open space).

I Cables: LMR 300 or 400, 5D or 8D –FB coax cables are recommended.

I Splitters or couplers: when the building structure is too complicated or there is big loss due to thick walls, etc., splitters or couplers shall be used so that more antennas can be installed in more areas to distribute the signals to each corner of the coverage area.

I Power Box including electricity meter, air switch and groundings, some sites might need surge arrestors.

7 DS20-37-5S Main technical specification

Electrical specification		Uplink	Downlink
Frequency Range	CELL	824 ~ 849MHz	869 ~ 894MHz
	PCS	1850 ~ 1910MHz	1930 ~ 1990MHz
	AWS	1710 ~ 1755MHz	2110 ~ 2155MHz
	LTE(A+B)	704 ~ 716 MHz	734 ~ 746 MHz
	LTE C	776 ~ 787MHz	746 ~ 757 MHz
Max. Gain	DS20	$\geq 65\text{dB}$	$\geq 70\text{dB}$
	DS23	$\geq 70\text{dB}$	$\geq 75\text{dB}$
	DS27	$\geq 75\text{dB}$	$\geq 75\text{dB}$
Max. Output power	DS20	$\geq 15\text{dBm}$	$\geq 20\text{dBm}$
	DS23	$\geq 15\text{dBm}$	$\geq 23\text{dBm}$
	DS27	$\geq 20\text{dBm}$	$\geq 27\text{dBm}$
Band width	CELL	available upon request	
	PCS	available upon request	
	AWS	available upon request	
	LTE(A+B)	18MHz	
	LTE C	11MHz	
MGC (Step Attenuation)		$\geq 31\text{dB}$ / 1dB step by step software setting	
Automatic Level Control		$\geq 30\text{dB}$, Auto Gain Setting	
Gain Flatness	Typ	$\leq 3\sim 6\text{dB}$ (p-p) as per sub-band	
	AWS	$\leq 2\text{dB}$ / 3.84MHz	
Noise Figure		Typical $\leq 8\text{dB}$	
VSWR		Typical ≤ 2	
Group Delay		Typical $\leq 8\mu\text{s}$	
Frequency stability		$\leq 0.01\text{ppm}$	
Mechanical Specifications		Standard	
I/O Port		N-Female	
Impedance		50 ohm	

Operating Temperature	-25°C~+55°C
Environment Conditions	IP40
Dimensions	19*7.9*3.5inch/482*200*90mm
Weight	≤22lbs/10KG
Power Supply	Input AC90~264V

7.1 Requirements for adapters:

SN	Item	Minimum	Typical value	Maximum
1	Input Voltage Range	90 V	220 V	264 V
2	Output Voltage Range	47 Hz	50Hz	63 Hz
3	Total Power Consumption	60W		

8 Installation

DS20~27-5S repeater should be used to cover the area indoor and the humidity and temperature of working can affect the reliability of repeater. So, temperature, humidity, dust, interference, power, space requirements and other factors should be considered during installation of repeater.

8.1 Installation Location Requirement

- 1) It is appreciated that the repeater is installed in a cool, dry and ventilated room without erosive gas and smoke and without leakage on its proof.
- 2) Besides above, a cool and ventilated wall of which sun-proof and waterproof is expected.
- 3) Besides above, common wall, tower or high pole is ok.
- 4) Installation height should be easy for RF cable wiring, heat dissipation, security and maintenance.
- 5) Have a set of independent and stable power supply.
- 6) Have lightning conductor in the building, tower or high pole with enough strength or stability.

8.2 Power requirement

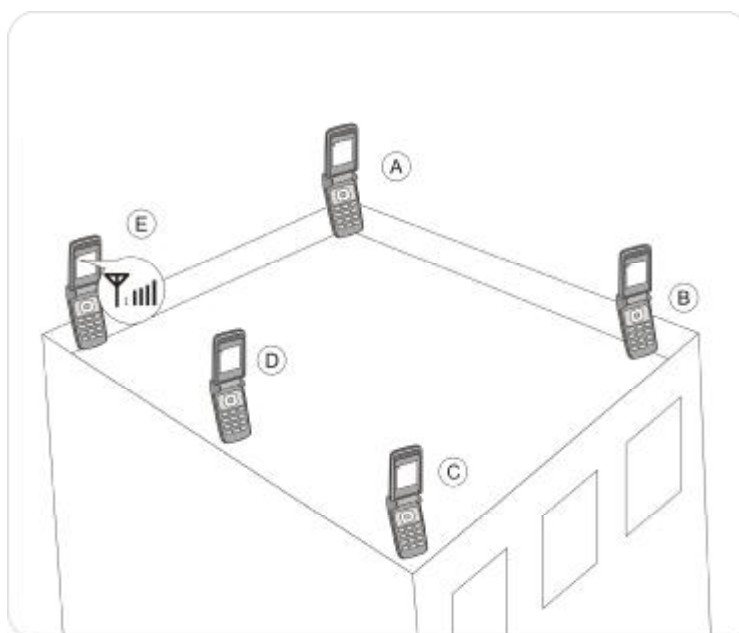
Generally it is AC power supply, and the requirement of AC is $90\sim 264\text{VAC}/50\pm 5\text{Hz}$.

8.3 Installation tools and accessories

No.	Name	Specification	Quantity	Remark
1	Plastic Expansion Bolt	M5*24	6	Standard accessories
2	Tapping screw	M3*30	4	Standard accessories
3	Hanging folder		1	Standard accessories
4	reciprocating drill		1	Engineering-owned, punch the wall
5	Shot bit	M3	1	Engineering-owned, punch the wall

8.4 Installation of donor antenna

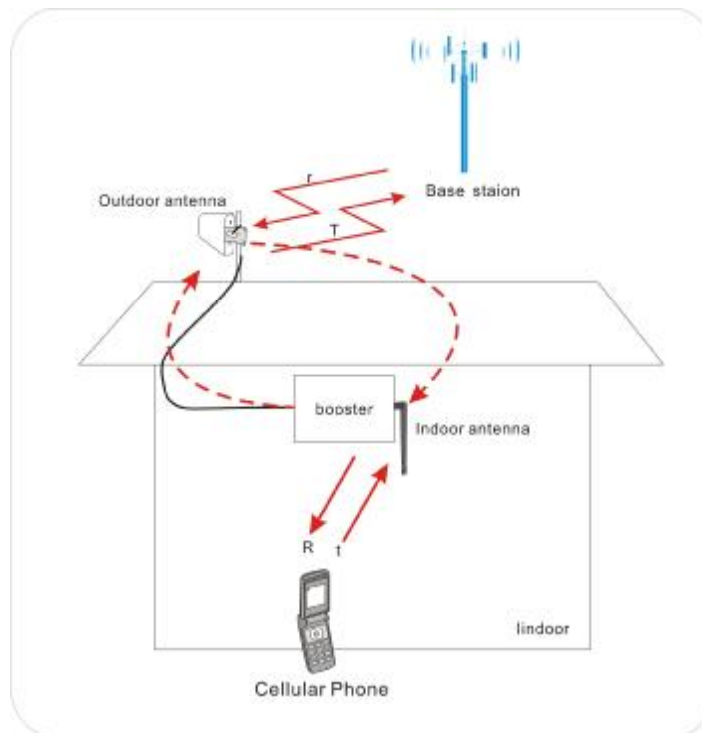
The repeater's main function is to improve weak RF signals to an area. A simple formula: Input power+ Gain= Output power. The signal strength from the outdoor antenna directly affects the efficiency of the indoor coverage. It is very important to choose the location of the outdoor antenna carefully. With this in mind, it is not recommended the donor antenna to be installed in an attic.



- n** Testing the signal strength received from donor antenna mounted in site by mobile phone:
 - l** Please select the top of the building to install the donor antenna if the total floors are less than 7, and must select a place like balcony or platform lower than 7th floor for the donor antenna if the buildings are over 7 floors.
 - l** The mobile phone shall display full bar signals in location where the donor antenna is installed
 - l** The phone calls or data transmission are smooth and stable by 3 times testing in location where the donor antenna is to be installed.
 - l** As shown from the above illustration, testing the signals from A to E, and select a best place that displays full bar signals to install the donor antenna.
- n** Selection the installation direction of donor antenna.
 - l** The donor antenna shall point to the direction of the tower, and it would be much better to keep line of sight.
 - l** Please select the opposite directions for donor antenna and server antenna. If donor and server antennas have to be installed in the same direction, please install them only after the signal quality is tested and the self-oscillation is avoided. If the directional antenna is selected, the main directional angle should point to the tower antenna.
 - l** If the performance is poor due to weak signals or poor phone call quality after installation, please adjust the direction of donor antenna or change its installation position in order to obtain the best calling effect.
- n** Donor antenna installation ---Notes:
 - l** Do not install the donor antenna during the rainy day with lightning.
 - l** Please follow the instructions to install the donor antenna.
 - l** It is a must that the waterproof shall be done to connectors of donor antenna and feeder lines.
 - l** In order to avoid interference, please note that the donor antenna should be far away from the following objects.
 - ² Metal
 - ² High-voltage line
 - ² RF antenna
 - ² High-voltage transformer
 - l** Repeater is a two-way signal amplifier. So proper isolation between donor antenna and server antenna is necessary in order to avoid self-oscillation. About the definition for self-oscillation, take MIC and loudspeaker for example; if it is too close for each other, it could make big noise. So the repeater can run smoothly if the isolation between donor antenna and server antenna is 15 dB higher than the gain of booster. For example, if the repeater gain is 60 dB, then the isolation between donor antenna and server antenna should be 75 decibel.

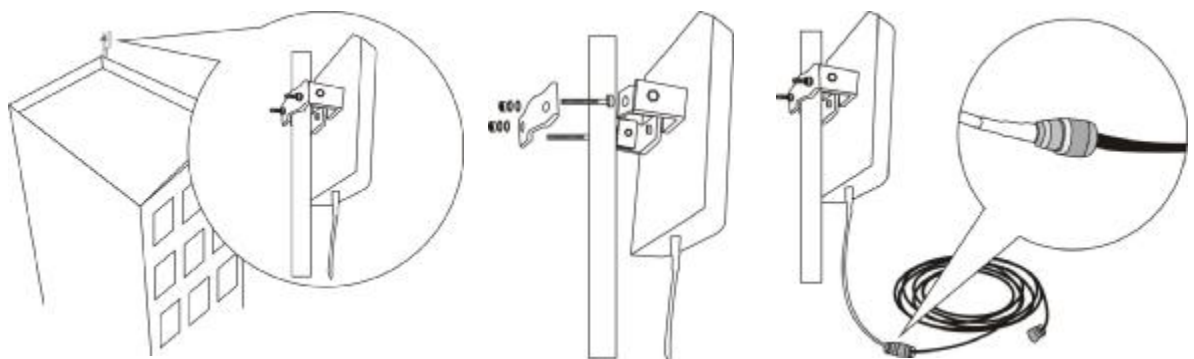
- n The minimum distance between donor antenna and server antenna is 10 meters; again the direction of donor and server antennas shall be opposite.

As shown in the below illustration, the booster amplifies the signal R and signal T from the tower at the same time. If the distance between donor antenna and server antenna is less than the required distance, then the amplified signal R (T) will back to server antenna (donor antenna). So it will lead to self-oscillation and reduce the coverage area, also the bad calling quality could happen at the same time.

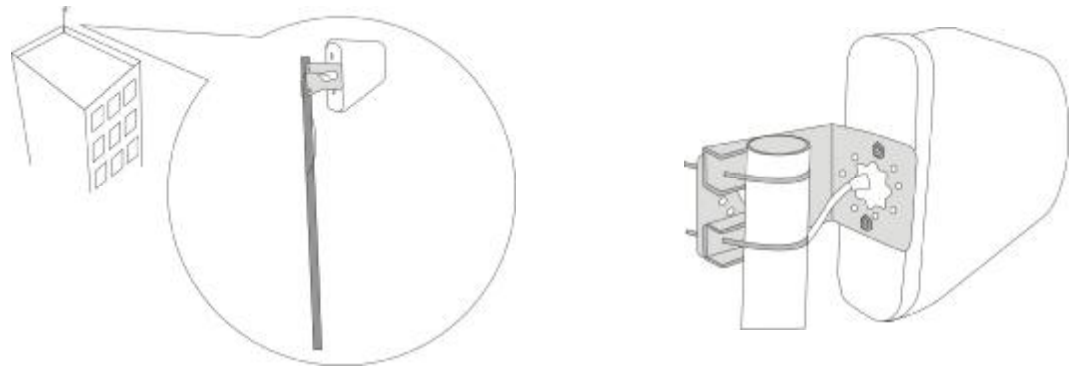


If isolation can't be achieved by the limited distance, the roof of the building or other barriers can be used to increase isolation.

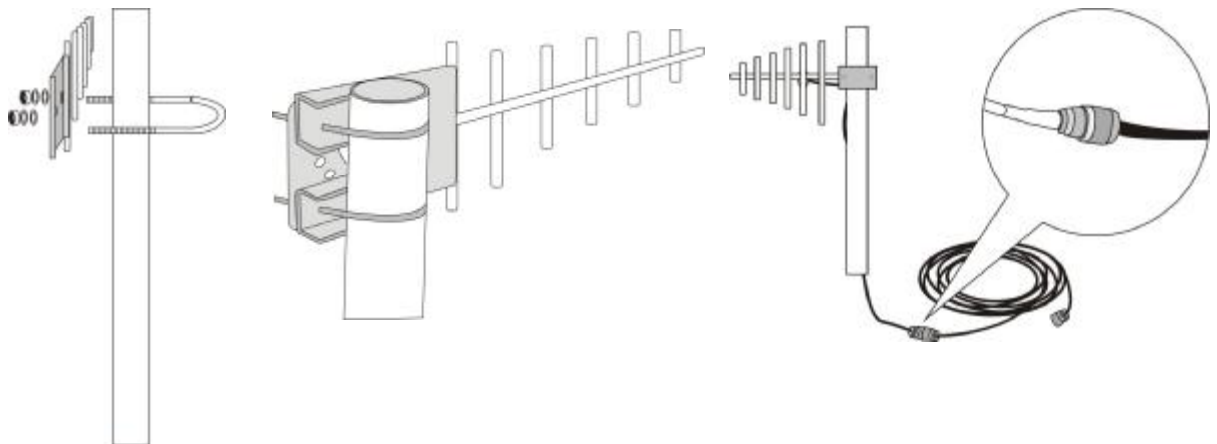
- n Installation of panel antenna as donor antenna



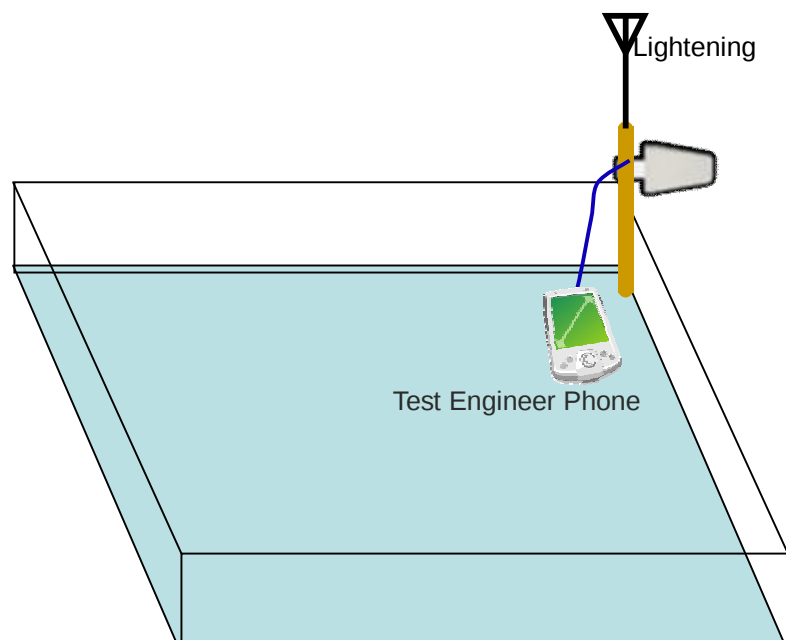
- n Installation of wide directional antenna as donor antenna



n Installation of YAGI antenna as donor antenna



n Test the call quality of donor antenna



Fix the donor antenna after selecting the best position, and adjust slightly its height or angles in order to get the signals with suitable input power level and calling Quality.

I System Requirement of LTE(A+B), LTE C, CDMA, PCS, and AWS

- 1) The total input power level shall be around -50dBm, lowest shall be more than -80dBm
- 2) Test by mobile phone or data card by 3~5 times to make sure the calling quality is good in 95% of the time, and no handovers.
- 3) It is requested that the leading BCCH shall be 6dB higher than the second (for professional engineering reference only).

Cable layout and connector assembly:

- 1) Keep the type, specifications, routing direction, location, and curvature radius of cables in compliance with the design requirement. Place cables in good order, bend them smoothly, and protect the outer skin against any damage.
- 2) Bind cables in good order when laying them on cable racks. Keep cables within cable troughs, without any cross, when you do not bind them. When leading cables in or out of troughs, use a hole-opener to open cable troughs and then install PVC lock-nuts to protect them.
- 3) Keep horizontal cables straight and fasten them stably with a fixing clip every 1 to 1.5 meters, with a proper stress.
- 4) Bind and fasten vertical cables every two to three meters to avoid damaging cables or connectors owing to their own heavy weight. Take back the cables and re-lay them when you have difficulty in pulling them, and avoid using a strong force to pull them.
- 5) Separate RF cables from power cables. Take proper isolation measures if they have to be placed on the same cable racks owing to the site condition restriction.
- 6) Correctly fasten all connection parts of the whole system, from the antenna to active interfaces to passive interfaces, and keep electrical interfaces well contacted. Give waterproof treatment to outdoor connection parts.
- 7) Take lightning protection measures for the antenna and feeder system in accordance with the design requirement. Avoid deforming the antenna feeder where grounding clips are placed, and give waterproof treatment to the feeder.
- 8) Keep exposed indoor cables in good order. Install PVC troughs or tubes if the exposed cables are more than 1 meter long. Place small passive RF parts such as power splitter in cable troughs.
- 9) Process both ends of RF coaxial cables as follows:

Keep the same redundant cable length and keep the length of stripped cables to agree with the corresponding connectors.

Use a proper force to cut the jacket layer or insulation layer and avoid damaging the braid shielded net and cores.

Weld cores firmly and smoothly with a proper amount of solder, without solder projections or nodules. Assemble coaxial cables strictly in accordance with the installation specifications.

Keep a moderate length of heat-shrinkable tubes and heat-shrink the tubes evenly when adding

heat-shrinkable tubes to the end of cables.

Protect the ends of cables against water and dampness. Use waterproof tape to give waterproof treatment to exposed cable ends. Cut off the end if it is dampened or water-soaked.

8.5 Indoor antenna installation

Proper antennas shall be selected according to the site conditions and the requirement.

- 1) Indoor panel antenna, suitable to be installed in the corner and radiate to other side.



- 2) Omni antenna (Indoor ceiling omni antenna or whip antenna), suitable to be installed in the center and radiate all directions.



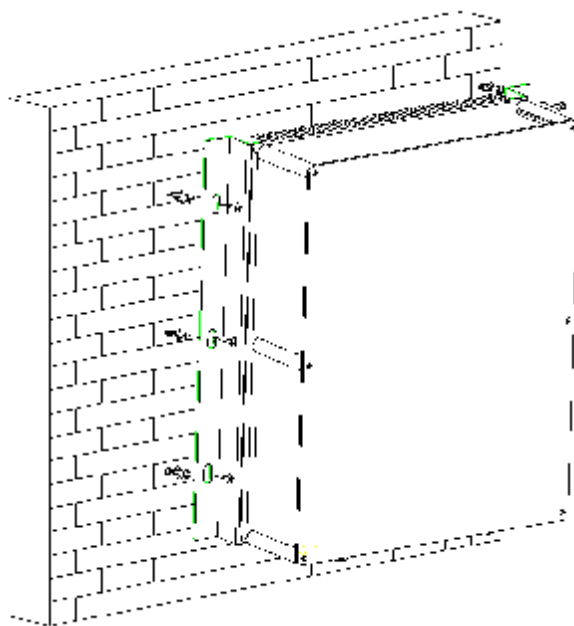
- 3) It is better to use a directional panel antenna or Yagi when the coverage shape is long and narrow (corridors, long row of houses in two sides, tunnels or elevators or rural open space).



8.6 Repeater Installation

8.6.1 Installation Steps

- 1) Drill holes on the selected place and install expansion bolts.
- 2) Align the holes on the installing support with the expansion bolts, keep the installing support vertical, place flat washers, spring washers, and nuts in turn, and tighten the nuts to fasten the installing support.
- 3) Place the repeater on the support and fasten it.
- 4) Connect cables and power cables to the repeater respectively.
- 5) After installing the repeater as described as above, power on the repeater to check the operation status.



8.6.2 Repeater's ports description

- 1) BTS port: connected with the BTS sector by cable.
- 2) MS port: connected with server antenna directly or by cable.
- 3) AC IN: connected with power supply.



8.6.3 Accessories selection

Please pay attention to the two points of “frequency” and “impedance” during the selection of the accessories. All accessories shall support the repeater’s frequencies from feeder line, antenna and splitter to combiners etc. For example, the repeater’s frequency is GSM900, so all the accessories must support the GSM900 frequency. And the repeater’s impedance is 50ohm, so the accessories shall all be 50ohm. To use any other impedance of coax will put an extra load on your repeater, shorten its life span and decrease the system performance.

8.7 Repeater Settings

Please check very carefully all cable connections are correct and firm before running operation test and then carry out following tests

8.7.1 Switch on power

After power is on, check firstly the alarm and power LED.

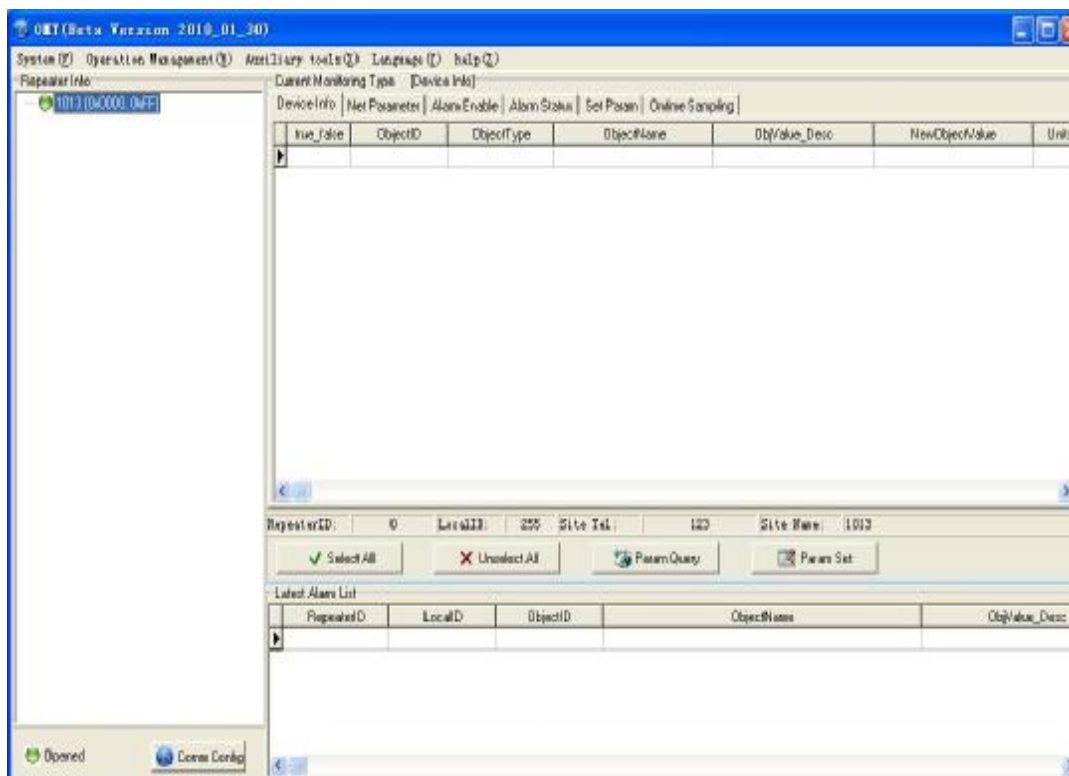
I Status and definition of POWER indicators:

Status	Definition
Green	Normal
Off	DC power problem

I Status and Definition of ALARM indicators,

Status	ALARM
Green	It is working in linearity
	attention: Input signals may be not enough
Red	There are overloading or self oscillation, strong input signals, measures shall be taken
Orange	It is working in linearity
	Attention: Please adjust MGC to increase the attenuation value, till you find the “edge point” (I.E. the Alarm LED shall stay at green color, with intention of turning Orange), and let the repeater work at this point.
Off	Repeater break down

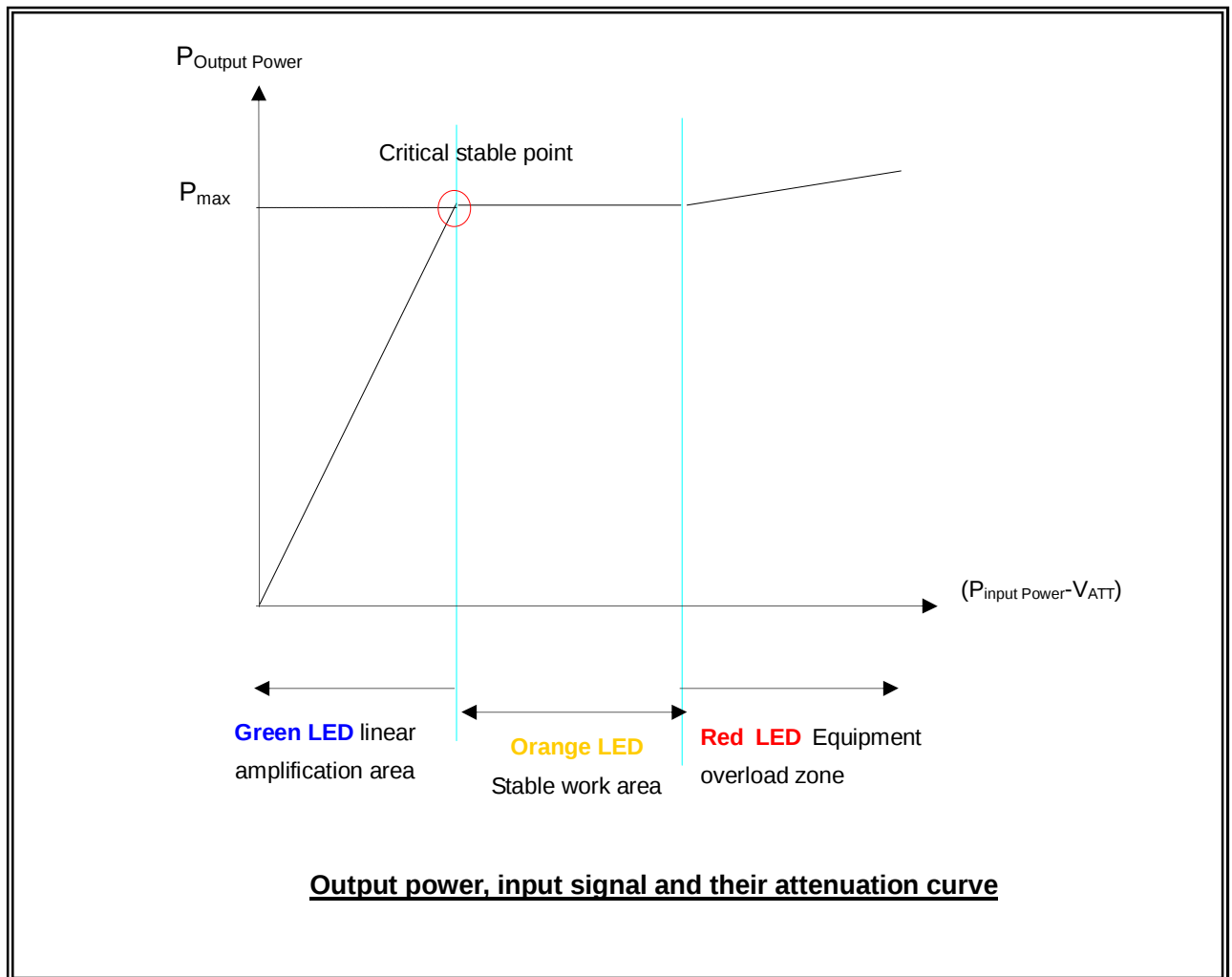
8.7.2 Parameters setting



Parameters setting refer to OMT in detail

8.7.3 Repeater Commissioning

I The curve about device working status



$P_{\text{Output Power}}$: Output Power

$P_{\text{Input Power}}$: Input Power

V_{ATT} : Attenuation value of attenuator

$P_{\text{Input Power}} - V_{\text{ATT}}$: Input Power — Attenuation value of attenuator

P_{max} : Rate output power

I **Downlink gain setting**

First the alarm LED only indicates the downlink input power level, here we use color of Alarm LED to adjust the gain of the repeater. As for the downlink working performance, Alarm LED of "Green" color and with the intention of turning orange is a good working point; here we refer as "edge point". At this time, downlink output power and coverage effect are stable.

And the equipment must be as far as possible away from overloading status of "red" (the equipment would hold higher interference and depression ability at this stage). So we try our best to set the equipment near "edge point" of green and intention of turning orange during engineering.

I **Setting of "edge point":**

Switch on the power supply after connection with donor antenna and server antenna, and observe ALARM LED.

- n** If it shines “orange”, use 1dB as step to reduce the gain until “green” turns on, then increase the gain 1~3dB attenuation value until “orange” starts to turn on, then brings back 1~2dB till “green” is on, then fix the gain and the repeater’s downlink output power reaches the perfect status.
- n** If it shines “green”, then:
 - u** To check whether the attenuation value has been set, if it is, use 1dB as step to increase gain until the “orange” turns on, then brings back 1~2dB till “green” is on again , then the repeater’s downlink output power reaches the perfect status.
 - u** But if attenuation is not set, it indicates that the input power is not enough.
 - ² Then please check coverage effect first, if the coverage effect is good, the engineering has reached expecting target.
 - ² But if the coverage effect is not good, the donor antenna should be adjusted to get a stronger signal until “orange” intends to turn on or the effect reaches the target. At this stage, please make sure “Orange” color is not generated by self oscillation. Please take off the server antenna to test if it is self oscillation or not: if the Orange turns to be Orange, it is self oscillation; if it stays as Orange, it is not self oscillation.

I Uplink gain setting

Standard: uplink attenuation values =downlink attenuation values

Remark: Keep in mind that you do not want to have more than a 5dB difference between the uplink and downlink values for optimum system performance, and it is better to keep the same attenuation value of Uplink with that of Downlink.

8.8 System Test

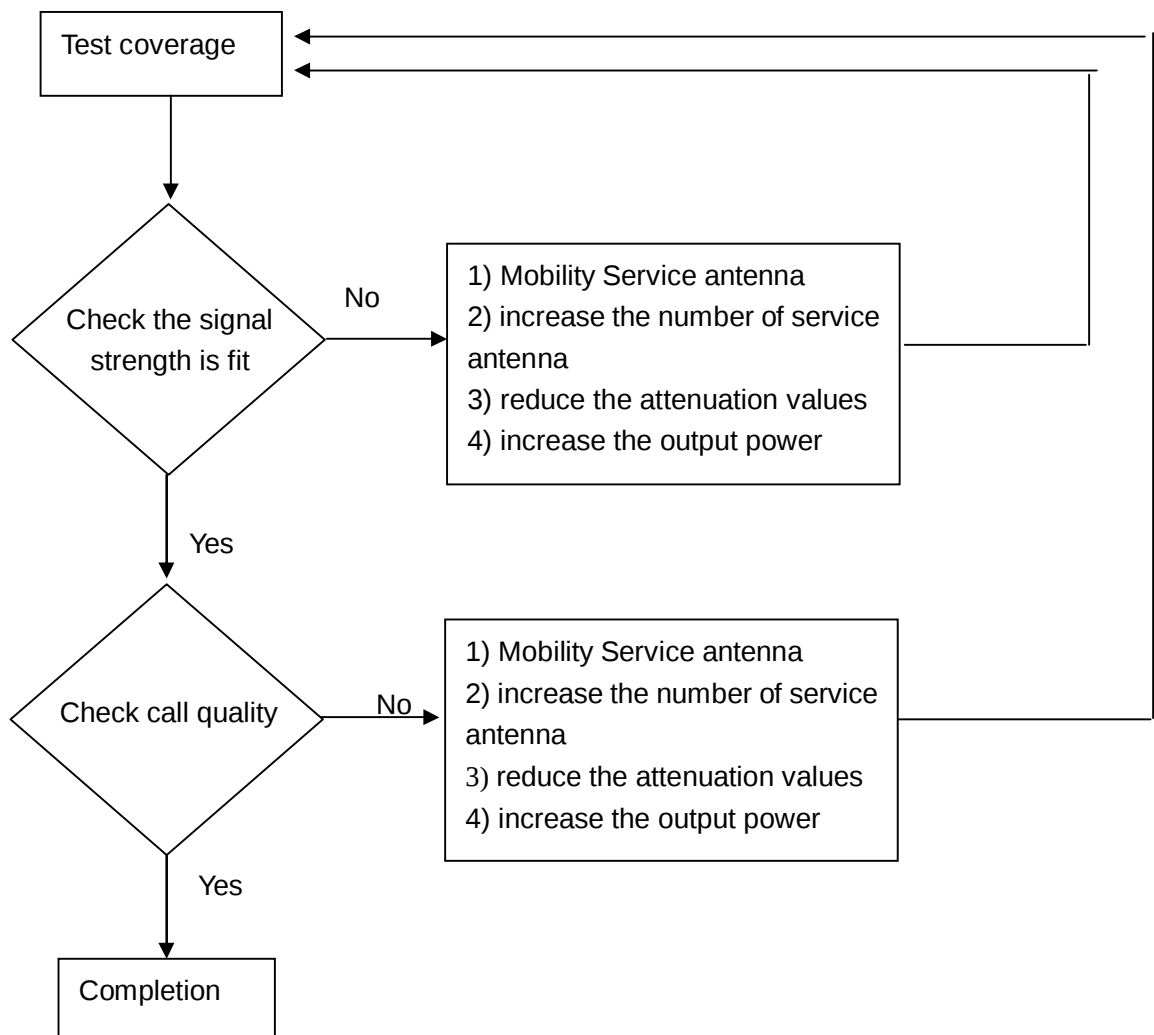
8.8.1 Check whether the coverage is good

- 1) Have a test with mobile phone or data card (engineering mobile phone is preferred). If the signals in most areas have not been improved, please check below again:
 - u** The weak input signal leads to the low output power. Change the direction of donor antenna or its installation position or replace donor antenna with higher gain to increase input signal power level.
 - u** Check whether it is necessary to add more server antennas due to barriers, whether the repeater’s

- u Power is enough; please install more server antennas or change with a repeater with higher power level.

2) If the signals in small part of the areas have not been improved, please check below:

- u Check whether the service antenna is installed correctly or not, you may try to move the antenna location improve coverage.
- u Check if it is necessary to use a directional antenna.
- u Check whether it is necessary to add one or more antenna to enhance the coverage of special areas.



- u Remark:

- ² **Reduce the attenuation values**---at the same time must ensure the isolation.
- ² **Increase the output power** ---recommended ways: adjust the donor antenna; increased input signal strength.

8.8.2 Repeater can not communicate in Power-ON status

The power is on but there is signal fluctuation

- 1) The power is on but it has a signal fluctuation or a flash signal. The phone call can not achieve.

It shall be caused by the insufficient isolation between donor antenna and serve antenna.

Please take below measures:

- Ø Firstly check whether the alarm LED becomes red. The red light shows the insufficient isolation.
 - Ø Secondly adjust the antenna directions or locations or enlarge the distance between them.
 - Ø Thirdly reduce the repeater's gain by ATT DIP if the above methods don't work.
- The best minimum distance between donor antenna and serve antenna should be more than 10 meters.

The following measures can also be tried:

- Ø Use the roof of the building to enlarge the isolation (Please try to place the donor antenna and server antenna in different floors).
- Ø Use some obstacles.(Such as wall).

- 2) The repeater's power is on but the phone is not connected into the network and still can not communicate.

- Ø **Reason 1:** There are loose or wrong connections in the repeater system.

² **Solution:** Please try to fasten the connections between the different parts of the system.

- Ø **Reason 2:** The signals received by donor antenna of other operators nearby are too strong. (For example, the other operators' signals are 10 dB stronger than the needed signals.)

² **Solution 1:** Change the direction of donor antenna or its installation position, so that the gap of signal strength between operators is reduced.

² **Solution 2:** Use barriers (like buildings) to block signals of other operators.



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