Yealink

Yealink W90 DECT IP Multi-Cell System Deployment Guide

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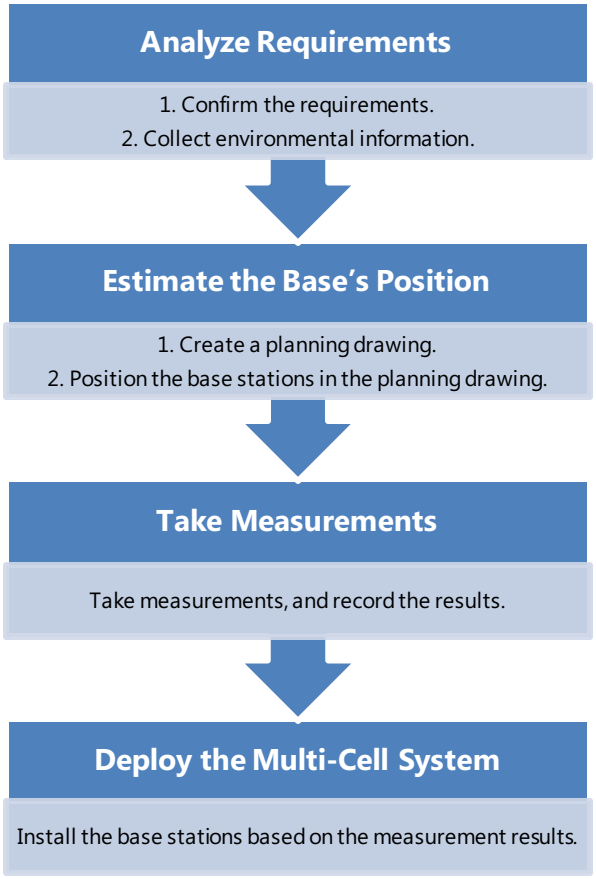
Introduction

This guide explains the necessary preparations for the installation of a DECT IP multi-cell system and how to take measurements for the optimum positions of the base stations. It also provides some technical and practical background information.

Key Tasks for Deployment



DECT Transmission Technology

DECT Transmission Glossary

LA (List Access)

All menus access by the handset that needs to interact with the base station.

WB (Wide Band)

One base station supports a maximum of four active handsets.

NB (Narrow Band)

One base station supports a maximum of eight active handsets.

Synchronization Technology

The base stations in a multi-cell DECT network must synchronize with each other. The synchronization can ensure a seamless handover and roaming for the LA and calls in the multi-cell system.

Base stations can be synchronized "over the air", meaning that they are synchronized via DECT. If the DECT connection between specific base stations seems to be not reliable enough, synchronization can also take place via LAN. To carry out the synchronization you will need the plan of the clusters with the synchronization level for each base station.

Cluster

A cluster comprises a number of base stations in the DECT IP multi-cell system that synchronize with each other to enable handover, roaming and load balancing.

Handover: The DECT connection of a handset is passed to another base station during a call.

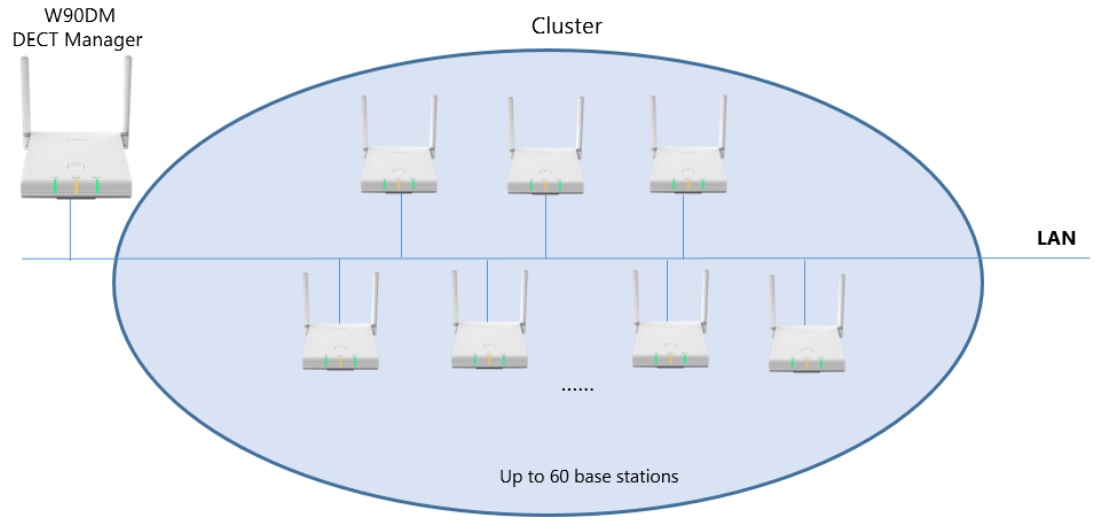
Roaming: A handset in the idle status is connected to the multi-cell system via a new base station.

Load Balancing: Because the current base station is overloaded with active DECT or media connections, the DECT connection is set up with a neighboring base station having free resources for a call.

Handover and load balancing take effects only when the base stations are synchronized with each other.

Single Cluster Only

All base stations in the multi-cell system belong to a cluster, where they can synchronize with each other.



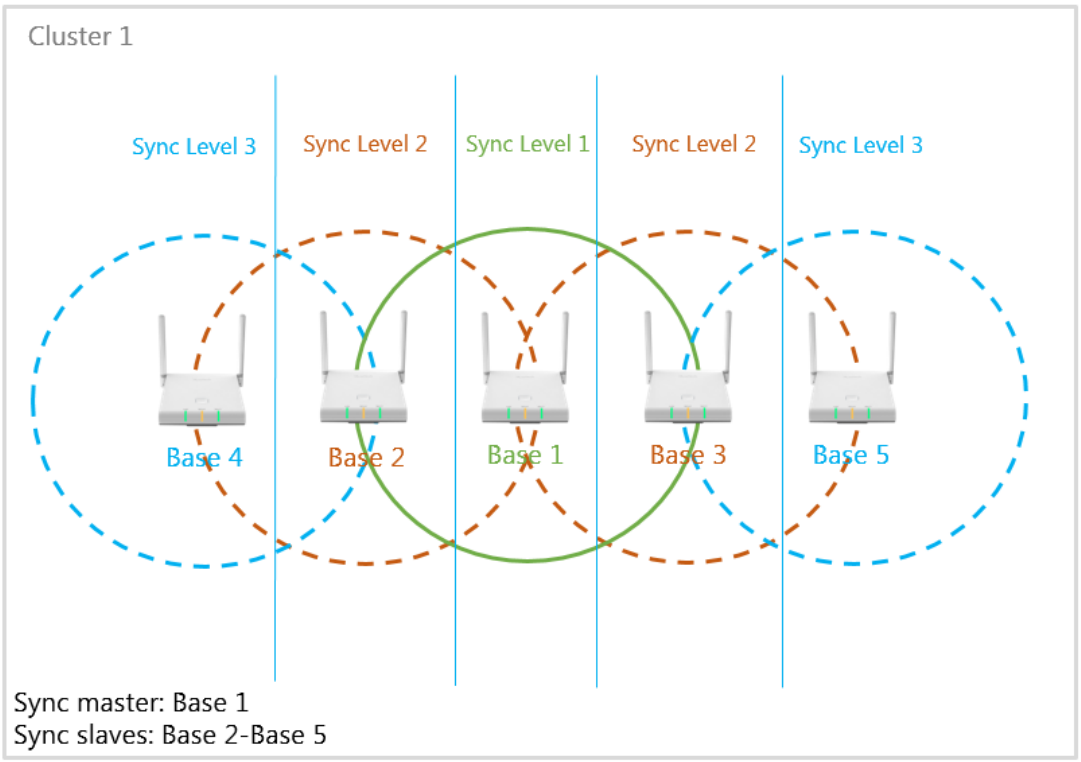
Multiple Clusters

Base stations that are far apart in the multi-cell system can be grouped into different clusters, where the synchronization is not required. So there is no handover between two clusters.

DECT-based Sync

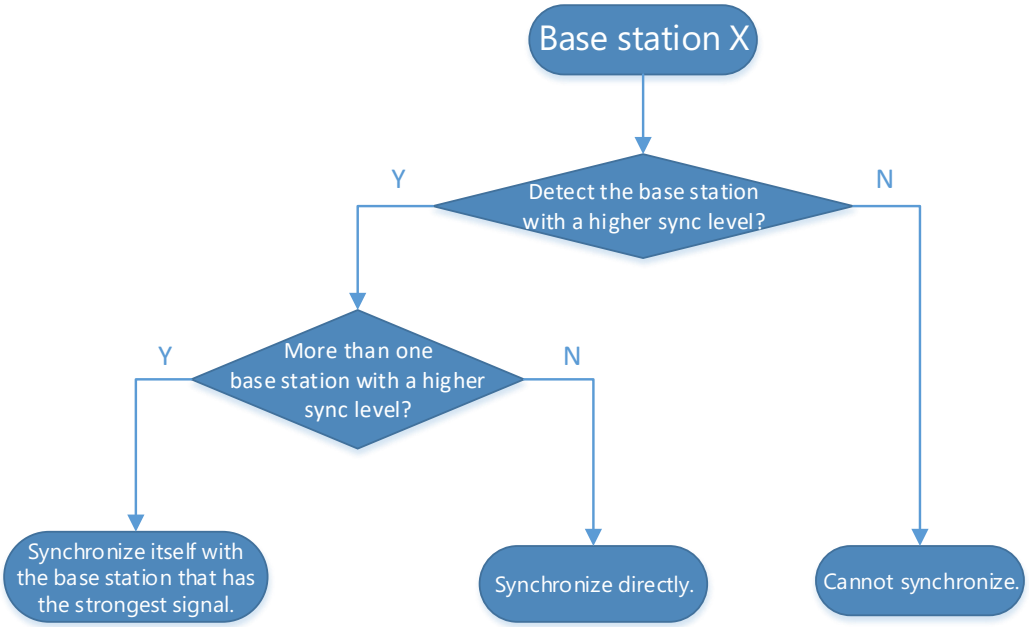
To ensure the synchronization, you should plan the level 1 base station in the center as much as possible, and place the next sync level's base stations around the center.

The following is an example of a synchronization scenario:

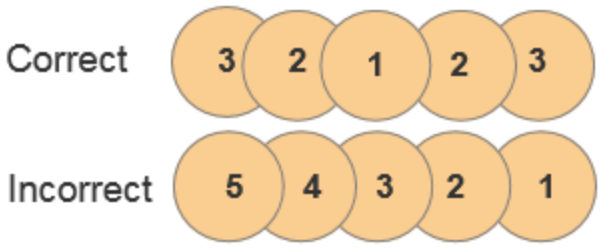


Each base station is assigned to a corresponding sync level. Sync level 1 is the highest level, which is the level of the sync master and appears only once in each cluster.

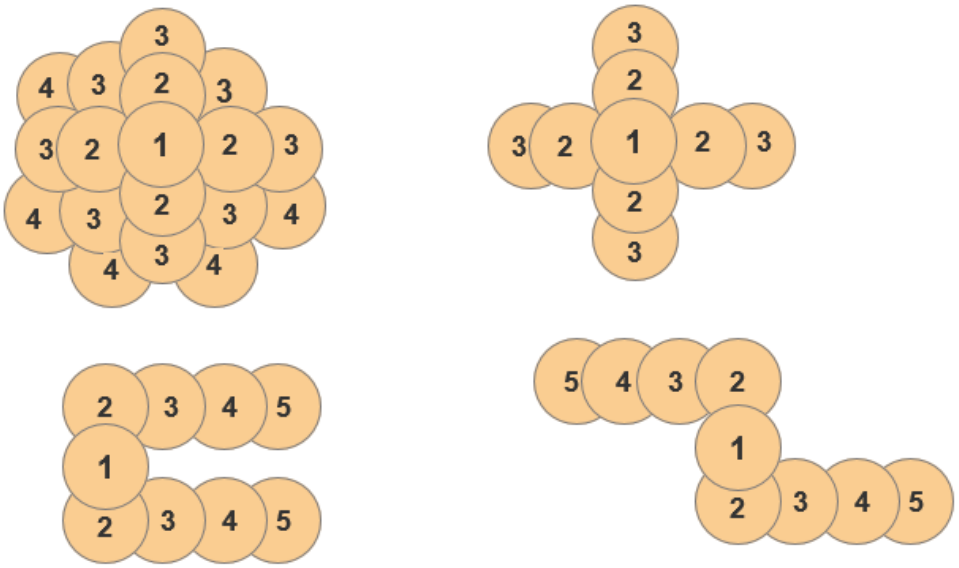
A base station always synchronizes itself with a base station that has a higher sync level. If it detects several base stations with a higher sync level, it synchronizes itself with the base station that has the strongest signal. If it does not detect any base station with a higher sync level, it cannot synchronize.



The more synchronization levels, the greater the possibility of synchronization loss. So select the base station that is in the center of your DECT network as the base station with sync level 1.



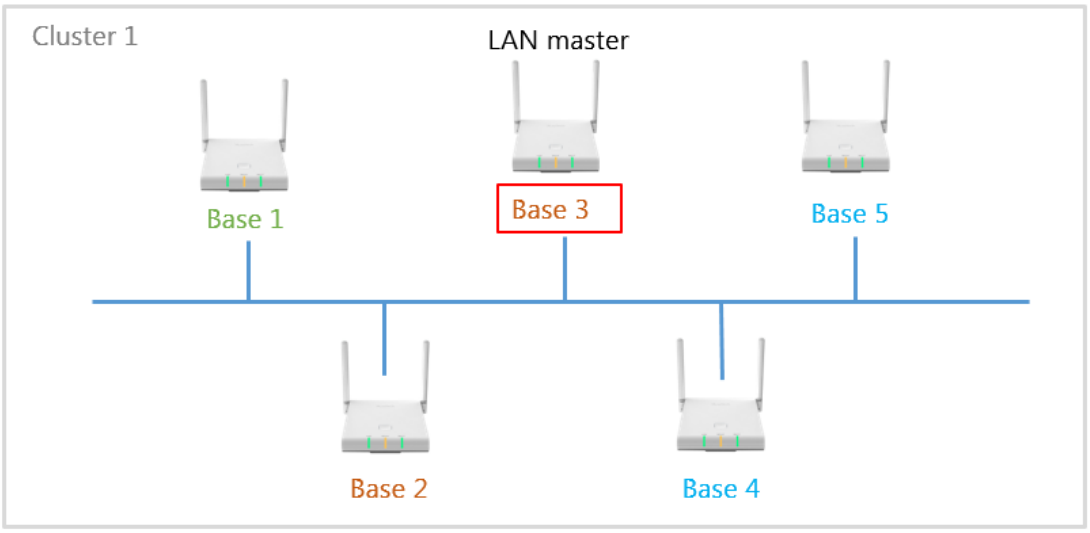
Your synchronization hierarchy could also look like as the following:



LAN-based Sync

The base station with the higher sync level will act as LAN master, the base with the lower sync level is a LAN slave. One base station must be explicitly defined as LAN master, and it must be on DECT sync level 1.

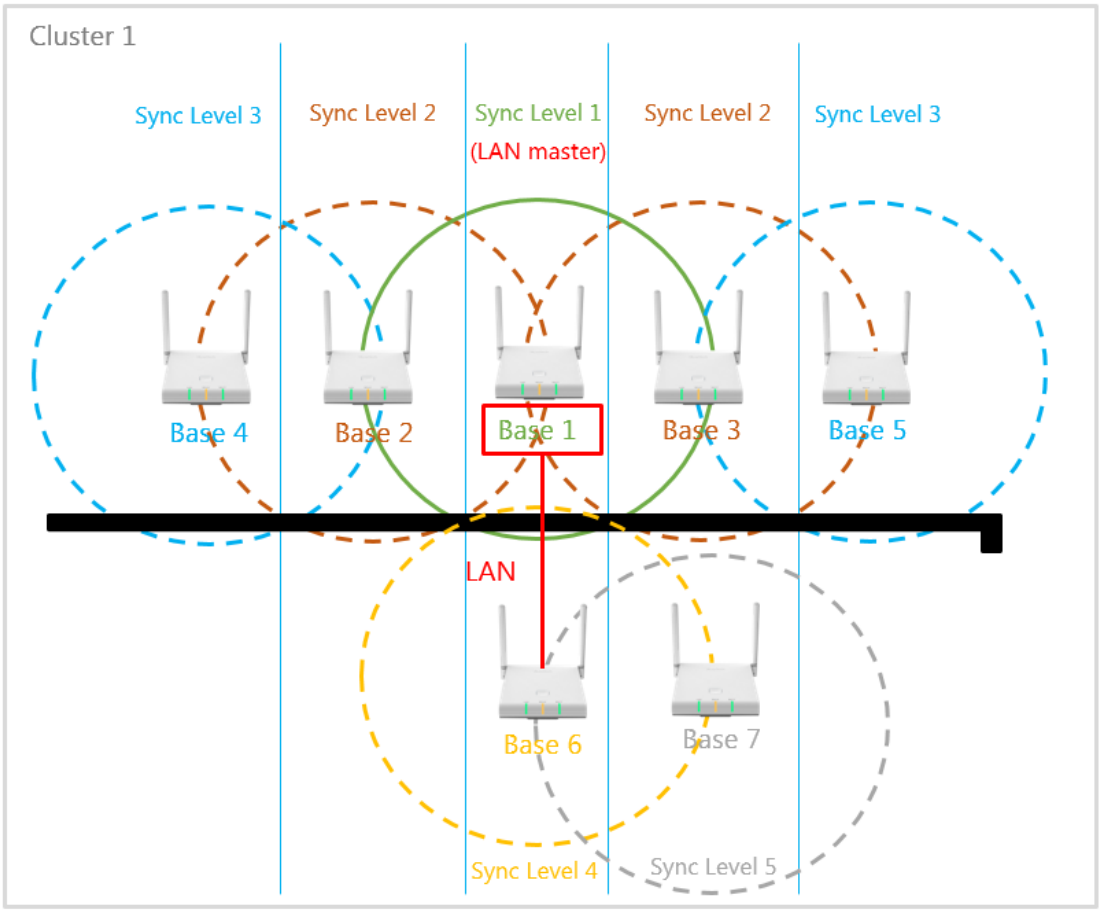
The following is an example of a synchronization scenario:



Mixed Sync

The synchronization between one base station on each side of the firewall can take place via LAN. The other base stations are synchronized via DECT.

The following is an example of a synchronization scenario:



Signal Transmission

The ideal signal transmission of a base station is omni-directional. All registered handsets can be the same distance away from the base station in all directions without the wireless signal being interrupted.

But the range is usually influenced by a variety of environmental conditions. You have to investigate the actual conditions by measuring the signal transmission of the base stations at the appropriate positions.

The following table gives some general guidelines on the degree to which certain materials will reduce signal strength:

Materials	Degree of Attenuation	Examples
Air	None	Open space
Wood	Low	Door, floor, partition
Plastic	Low	Partition
Glass	Low	Un-tinted glass, partition
Tinted glass	Medium	Tinted glass, partition
Living creatures	Medium	Crowds, plants
Bricks	Medium	Walls
Plaster	Medium	Partitions
Ceramic	High	Tiles
Concrete	High	Load-bearing walls, floors, pillars
Metal	Very High	Reinforced concrete, metal cabinet

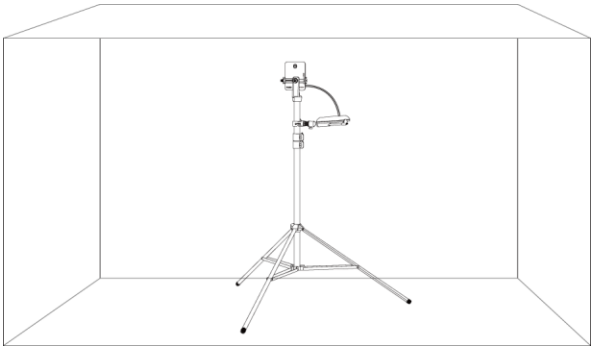
DECT IP Multi-Cell Deployment ToolKit

Yealink offers the DECT IP Multi-Cell Deployment ToolKit to help you plan and install your DECT IP multi-cell system.

You can use the measuring devices in the kit to determine the radio coverage at your position, establish all base stations required for a given installation and their optimal positions, and find sources of interferences in the DECT wireless network.

For more information on the kit, refer to *Yealink DECT IP Multi-Cell Deployment ToolKit Quick Start Guide*.

Using the ToolKit



1. Select the first measuring point, mount the base station to a proper position on the stand, and charge it using the mobile power.

   Note: The stand height can be adjusted from 3.28 feet (1.00 meter) to 9.19 feet (2.80 meters).

2. Enter the code *1234203# in the handset's idle screen to activate the metering mode. (By default, the measuring handsets are already in the metering mode out of the box.)

   Note: If there are no special measuring handsets, you can also activate the metering mode of the normal handset through the code *1234203#.

3. Set up communications between two handsets in the metering mode, and measure the radio coverage.

   You can connect headsets to the measuring handsets so that you can assess the quality of the sound transmitted from the measuring base station. It also means that your hands are free to enter the positions determined in the plan and you can read the LCD screen during the measurement.

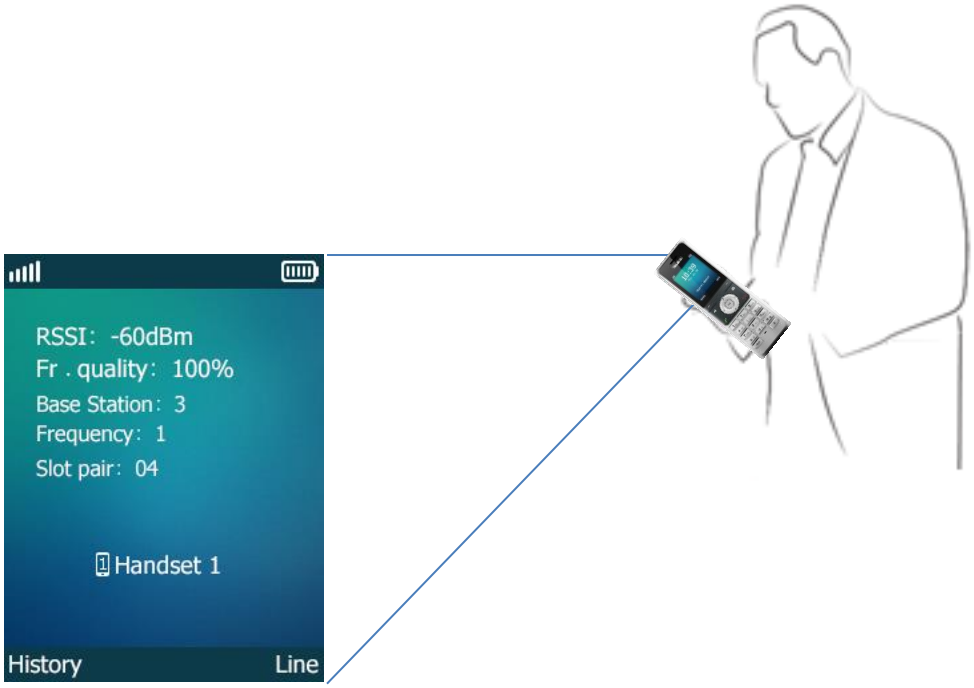
4. Check the current status values of the connection to determine the second position of the base station.

   The recommended RSSI value is between -27 dBm and -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm) (subject to actual call), and the Frame quality is 100%.

5. Move the base station to the second position, and adjust it to a proper position of the stand.

6. Repeat the above steps to determine more positions of the base station.

Display in Metering Mode



RSSI: Received Signal Strength Indication. Base station signal reception strength with the best reception in dBm.

Recommended value: -27 to -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm). (subject to actual call)

Note: The RSSI value is displayed in dBm as standard, you can change it into a percentage value.

Fr. quality: Frame quality. Percentage rate of the packages received without error in the last measuring interval.

Recommended value: 100%.

Base Station: RPN (Radio Fixed Part Number) of the base station. Identifier for the base station to which the handset is connected.

Frequency: Carrier frequency of the signal received.

Value range: 0-30.

Slot pair: Time slot for the reception channel on which the measurement was performed.

Duplex Slot pair used (0-11).

Deployment Guidance

Data References

Number of Simultaneous Calls

The following table shows the maximum number of simultaneous calls in relation to the number of W90B:

Number of W90B	Maximum Number of Simultaneous Call		Maximum Number of Active Handset	
	Wide Band	Narrow Band	Wide Band	Narrow Band
1	8	8	4	8
2	16	16	8	16
3	24	24	12	24
4	32	32	16	32
5	40	40	20	40
6	48	48	24	48
…29	232	232	116	232
30	240	240	120	240
31	248	248	124	248
32	250	250	128	250
…60	250	250	240	250

System Capacity

The capacity of the DECT multi-cell system must be high enough to guarantee that subscribers can be reached in high-density traffic. Both the capacity of the entire DECT system and the capacity of the individual wireless cells must be taken into account.

The capacity of the DECT multi-cell system is determined by the following factors:

- Number of connection channels available

  The number of connection channels available defines how many connections can be managed simultaneously.

  Note: A connection channel is not only needed for phone calls. All LA actions occupy a connection channel, such as the access to the history or remote phone book.

- Grade of service (GoS)

  The GoS determines the number of connections that may not be achieved due to the system being at full capacity.

Loss of Range

The wireless range of a base station for handsets is (guideline values):

- In the building: radius < 50m
- In the open air: radius < 300m

These two values do not apply to the maximum possible distance between two base stations. To ensure a seamless handover from the wireless cell of one base station to the one of another, the overlap zone is necessary. Fewer obstacles between two base stations increase the possible distance between them.

Different building materials (common building) for the signal attenuation can refer to the following table:

Insertion	a (dB)	Range Loss (%)
Brick wall, 10 to 12 cm	2.5	~ 43.5
Brick wall, 24 cm, small windows	4	~ 60
Brick wall, 63 to 70 cm	4.0 to 4.5	~ 60 to 64
Drywall	1.3 to 2.3	~ 26.5 to 41
Gaseous-concrete wall	6.6	~ 78
Glass wall	2	~ 37
Wire-reinforced glass wall	8	~ 84
Reinforced concrete ceiling (residence)	6 to 9	~ 75 to 87
Two reinforced concrete ceilings	26	~ 99.5
Three reinforced concrete ceilings	46	100

The capacity must always be adjusted to the highest possible traffic volume if capacity bottlenecks are to be excluded.

Traffic Volume

The traffic volume is expressed in “erlangs (E)”. One erlang corresponds to the continuous full capacity utilization of a connection channel in one hour. It can be used to calculate the number of base stations.

For example, 300 calls (of 5 minutes each) would be necessary in one hour

Calculation: **300 x 5min/60min = 25 E**

So for the volume of traffic accepted, at least 25 connection channels would be necessary. So at least 4 (3.13) base stations are needed when choosing to use the narrow band.

With a grade of service of 5%, it is permissible for 5% of 300 calls (15 connections) not to be established. This means that only 285 connections have to be achieved.

Note: Grade of Service (GoS) determines the number of connections that may not be achieved due to the system being at full capacity. For example, the line is engaged. A grade of service of 5% means that

out of 100 calls, 5 cannot be connected for capacity reasons.

Calculation:**300 x (1-5%) x 5min/60min = 23.75 E**

So for the volume of traffic accepted, at least 24 connection channels would be necessary. So at least 3 base stations are needed when choosing to use the narrow band.

Since the traffic volume is not normally evenly distributed over the site to be covered, the traffic volume must be calculated for each area (for example, offices, hotspots, stairwell) in order to determine the relevant number of base stations that need to be installed.

Limit Values

During the measurement, the measuring handsets receive wireless signals from the measuring base station and display various characteristics for the reception quality. The following are relevant for the reception quality.

- Reception power
- Connection quality

Limit values for normal, interference-free conditions are:

1. Limit value for synchronization: –85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm)

   This is the value at which a base station must receive another base station signal to ensure synchronization.

   Note: The recommended value is only a theoretical value, which can be adjusted according to different deployment environments. If it is a relatively empty environment, you can try to move to a farther location. If it is a building with more blocks, it is recommended to keep it at -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm). The final position can be based on the actual call, which can ensure the stability of the system and improve the coverage of the base station. If you do not use a professional deployment tool, you need to take the actual synchronization effect as the standard.

In principle, the measurement of the field strength should always be supplemented by checking the connection quality (frame quality). Interference, for example, through reflection or external systems that influence the voice quality, can occur with good reception power as well.

The **Frame quality** indicates the percentage of packages received without errors in a measurement interval.

Reception Power	RSSI	Frame Quality	Quality Evaluation (W80)	Quality Evaluation (W90)
-48 dBm < x < -28 dBm	0xA8 < x < 0xD8	100%	Good	Good
-58 dBm < x < -48 dBm	0x90 < x < 0xA8	100%	Satisfactory	Good
-66 dBm < x < -58 dBm	0x78 < x < 0x90	100%	Adequate	Satisfactory
-80 dBm < x < -66 dBm	0x50 < x < 0x78	100%	Weak	Adequate
-95 dBm < x < -80 dBm	0x30 < x < 0x50	100%	Poor	Weak
-xx dBm < x < -95 dBm	0x00 < x < 0x30	100%	Disconnected	Poor

Installation Height of the Base

The recommended installation height for a base station is between 1.80 meters and 3 meters depending on the room height. There should be a minimum clearance of 0.5 meters to the ceiling.

Estimating the Number of the Base Stations

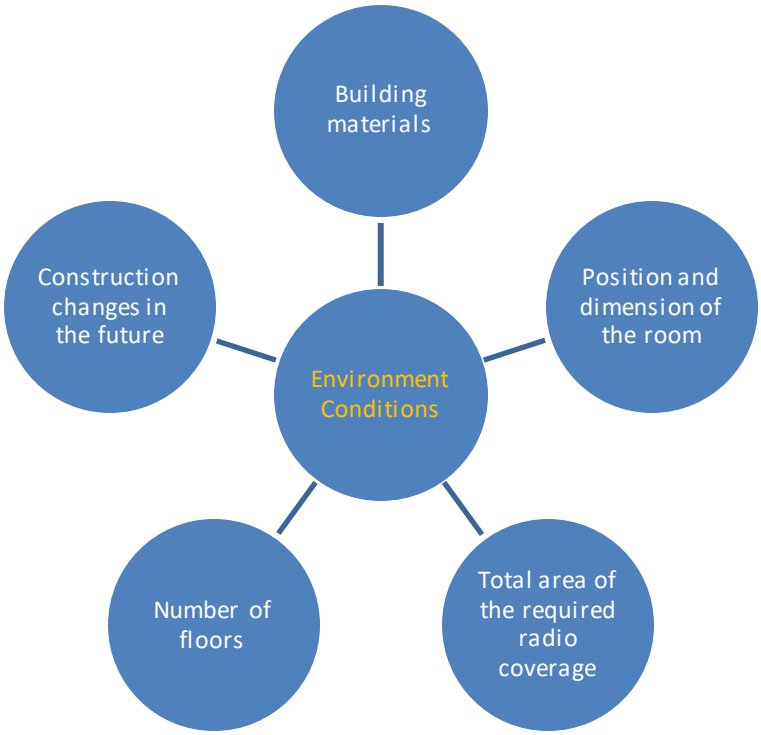
The following requirements must be considered when estimating how many base stations are required and deciding where they should be placed:

- Sufficient DECT radio coverage of the entire site so that each subscriber can be reached.
- Sufficient wireless channels (DECT bandwidth), particularly in “hotspots”, to avoid capacity bottlenecks.
- Sufficient overlap of wireless cells to enable synchronization between base stations and to guarantee the free movement for subscribers when making calls.

Estimation Based on the Total Coverage Area

Estimate the approximate number of base stations according to the total area of expected radio coverage.

Request the building plan and confirm the following:



The calculation can be the following:

Number of the base stations = [the size of the coverage area (in square meters)] / 800

The suggested distance between two base stations depends on the physical path between the base stations.

The following table lists the recommended distance between two base stations:

Area	Distance between two base stations
Office areas	Up to 40 meters
Office areas with obstacles like elevator shafts, stairwells or metal walls	Up to 10 meters
Shop floors	Up to 60 meters
Exhibition halls or production areas without obstacles	Up to 100 meters
Underground garages	Up to 20 meters

As the base stations can interfere with each other, you should maintain sufficient distance between two base stations. The minimum distance depends on the circumstance. If there are no obstacles between them, the required distance can be 5 to 10 meters. If there is an absorbent wall or absorbent furniture between them, 1 to 2 meters may be sufficient.

Estimation Based on the Total Number of Handsets

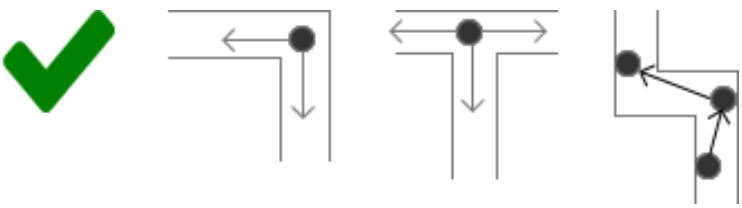
Confirm the following:

1. How many employees need to make phone calls and how many subscribers may make simultaneous calls?
2. How many calls will be made?
   - How long is the average call?
   - Where are the hotspots, that is, where do a lot of subscribers gather simultaneously (office area/meeting room/canteen)?
   - Where are telephone conferences held? And how many telephone conferences are held?

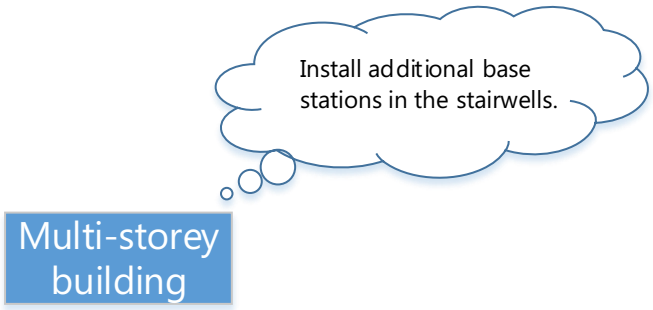
Placement Strategies of Base Stations

The following tips you need to know when selecting a position for the base station:

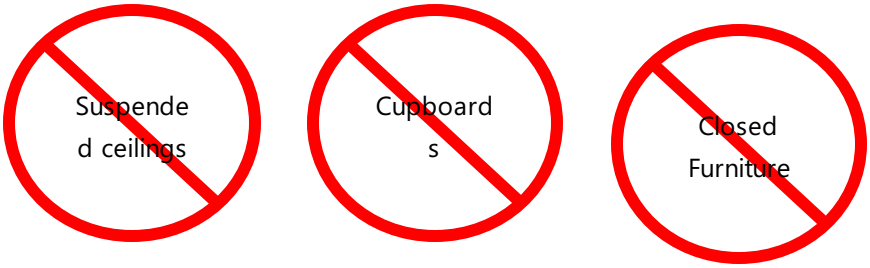
- Considering the coverage of wireless signals in the building, it is better to install the base stations at the corridor intersection.



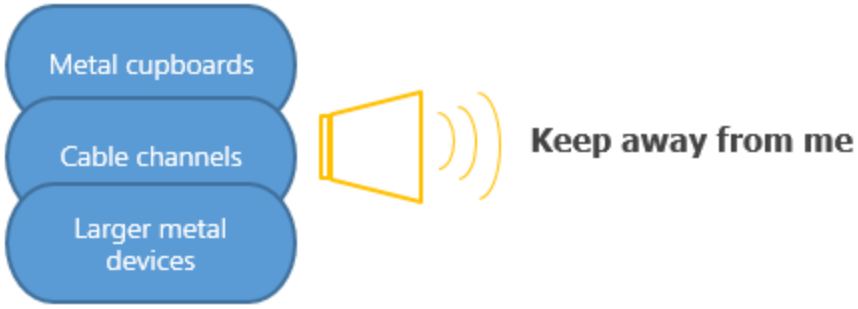
- In a multi-storey building, we recommend that you install additional base stations in the stairwells.



- Do not install the base stations in suspended ceilings, cupboards or other closed furniture. The radio coverage will be significantly reduced, depending on the materials used.



- Avoid installing the base stations in the direct vicinity of cable channels, metal cupboards or other larger metal devices. They can reduce the radiation and couple into interfering signals.



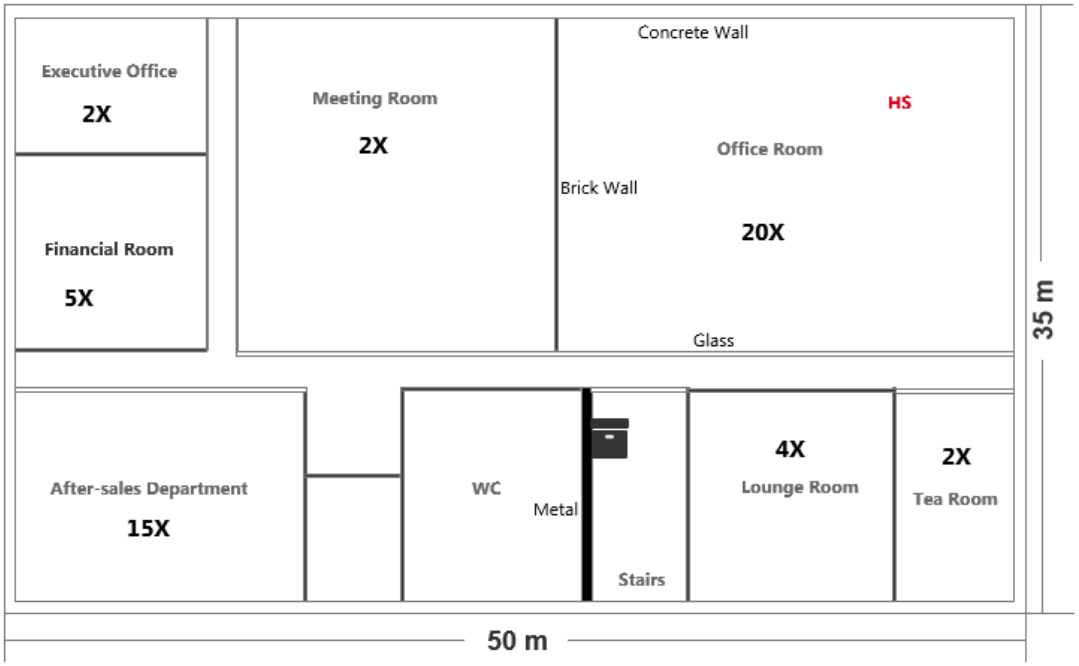
Preliminary Determination of the Positions of the Base Stations

After estimating the number of the base stations, you can create a planning drawing and position the base stations in the planning drawing now.

Creating a Planning Drawing

Create a planning drawing from the information you have collected in the preliminary examination of the position. Enter building dimensions, hotspot areas and any sources of interference already identified.

Example:



- The different lines indicate different building materials.

  Loss of radio coverage range of the base stations through building materials:

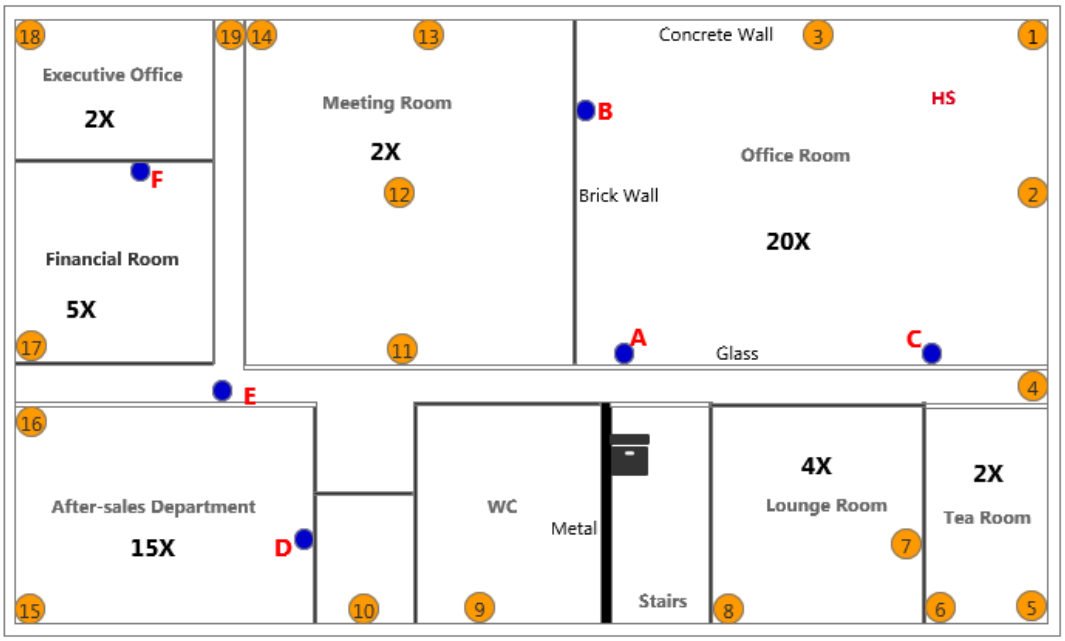
Building Materials	Degree of Attenuation
Metal	Very High
Brick walls	Medium
Glass	Low
Concrete walls	High **Note**: There is no need to consider these exterior walls.

- The numbers in the rooms reflect the **traffic volume** of the DECT phones.
- Areas with high-density traffic are marked as hotspots (**HS**).

Positioning the Base Stations in the Planning Drawing

After creating a planning drawing, position the preliminary position in the planning drawing.

Example:



- The example shows six preliminary positions of base stations (A, B, C, D, E, and F).

  You need to set a corresponding sync level for each base station according to the preliminary positions. Generally, start with the base station for which a subsequent change would mean the greatest effort. This is the base station with sync level 1. And then move outwards from sync level to sync level.

  Here, we set the following:

  Sync Level 1: Base station A

  Sync Level 2: Base station B, base station C, base station E

  Sync Level 3: Base station D, base station F

  Note: For LAN-based sync or DECT automatic sync, you do not need to pre-configure the sync level and measure according to the sync level. You only need to ensure that the signals between bases can cover each other during the measurement process.

- The example shows nineteen measuring points (1 to 19).

  These measuring points should be selected in the corner and where are not easily covered by the signal theoretically.

- For the hotspot in the office room, two additional base stations are planned in parallel.
- You should also check whether the base stations planned are sufficient for the second hotspot (after-sales department).

Check these preliminary estimations later by Taking Measurements.

Taking Measurements

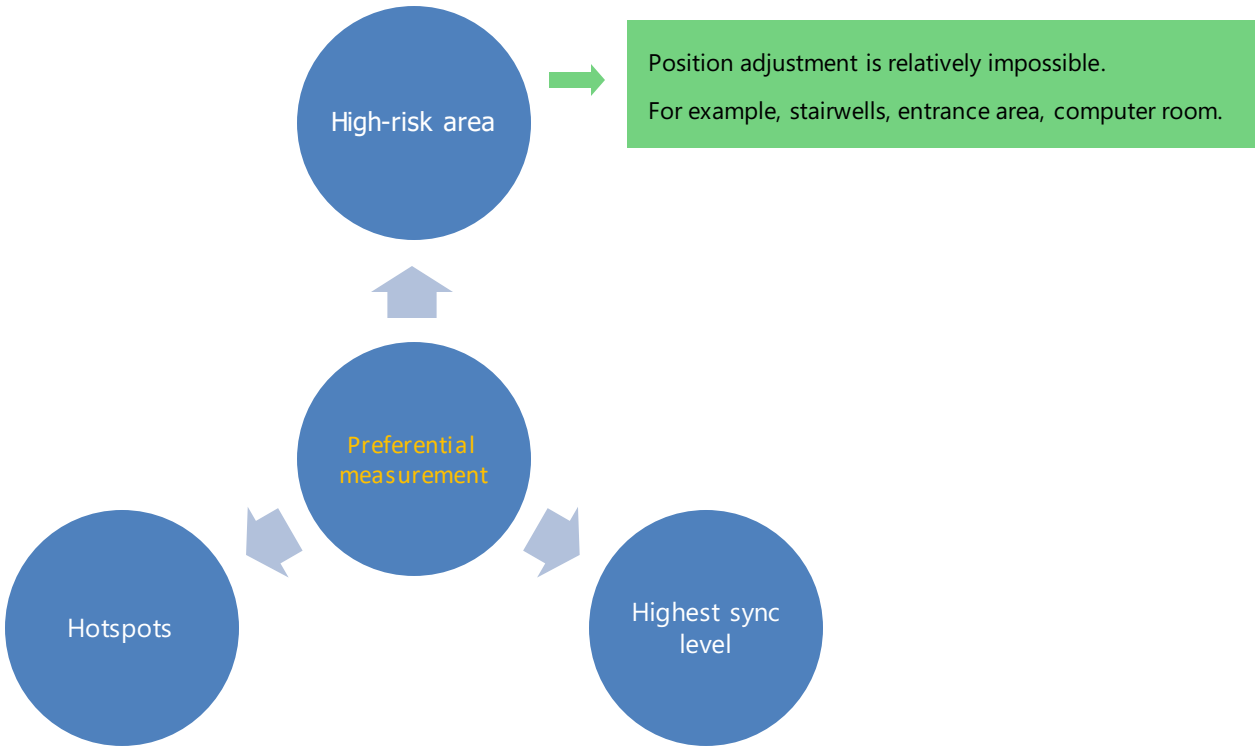
For actual measurement, we need to make sure the following three aspects meet the deployment requirements.

- Are sufficient radio coverage and a good voice quality guaranteed everywhere in the planned network?
- Is synchronization of the base stations ensured in the planned positions?
- Is a roaming or a handover possible in the multi-cell system?

Recommendations for Measurement Sequence

You may need to fine-tune the position of the base station as there is some error between the estimation and measurement.

In order to adjust as little as possible, you should follow the following measuring principles:

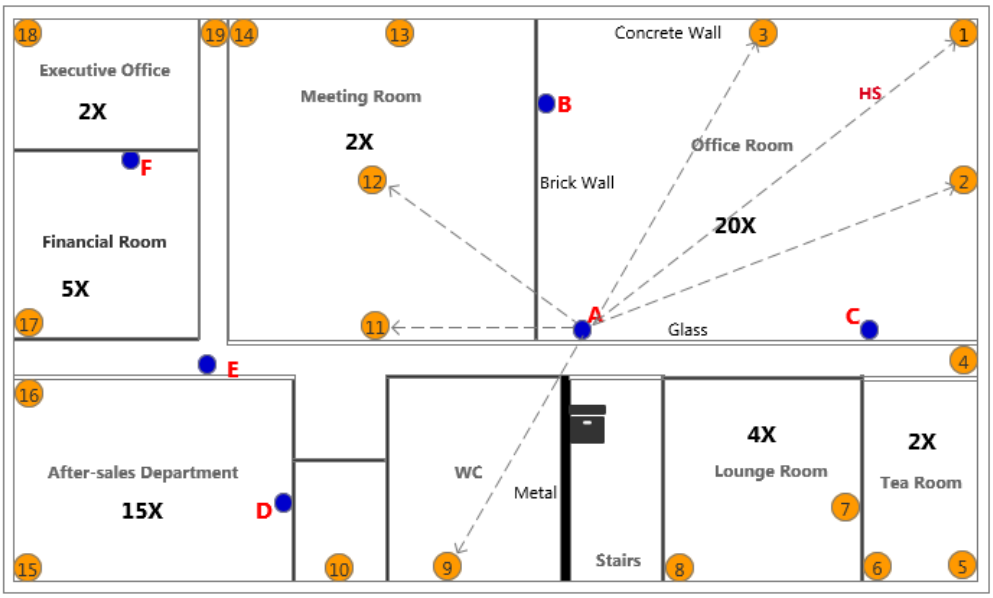


Measuring the Voice Quality at the Measuring Points

Measure the voice quality transmitted from the measuring base station in the wireless cell. It is used to ensure that excellent voice quality is guaranteed at every position in the required coverage area. Taking the same measurement for the neighboring base station that produces the overlap area required for a handover.

Procedure

1. Temporarily fix the measuring base station in the planned position where it will be installed.
2. Establish a phone connection between the two measuring handsets, observing the display and the signal in the headset, until the limit value of -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm) is displayed or a wireless transmission boundary is reached. Transfer this point to your plan and record the value in the measurement log.
3. Check the voice quality in the limit areas using the connection to the second measuring handset.
4. Record the deviations in the reception signal measurement of the voice quality in the measurement log.



Example of a measurement log for the cells of multiple base stations:

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
1	√	√	√			
2	√	√	√			
3	√	√	√			
4			√	√		
5			√			
6			√			
7			√			
8			√			
9	√					

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
10					√	
11	√	√				
12	√	√				
13		√				
14		√				
15				√	√	
16				√	√	
17				√		√
18						√
19				√		

The measuring results may look like this, for example:

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
1	-55dBm/100%	-52dBm/100%	-49dBm/100%			
2	-50dBm/100%	-54dBm/100%	-35dBm/100%			
3	-47dBm/100%	-30dBm/100%	-50dBm/100%			
4			-50dBm/100%	-50dBm/100%		
5			-62dBm/100%			
6			-61dBm/100%			
7			-57dBm/100%			
8			-64dBm/100%			
9	-63dBm/100%					
10					-52dBm/100%	
11	-57dBm/100%	-59dBm/100%		-55dBm/100%		
12	-60dBm/100%	-50dBm/100%				
13		-53dBm/100%				
14		-58dBm/100%				
15				-52dBm/100%	-35dBm/100%	
16				-50dBm/100%	-34dBm/100%	

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
17				-53dBm/100%		-40dBm/100%
18						-52dBm/100%
19				-40dBm/100%		

Note: During the measurement, it is necessary to focus on the measuring point that only be covered by one base station. For example, point 9, 10 and 19. Once the DECT signal fails to meet the requirements at a certain test point, the position of the preset base should be adjusted in time.

Measuring the Signal Strength between two Base Stations

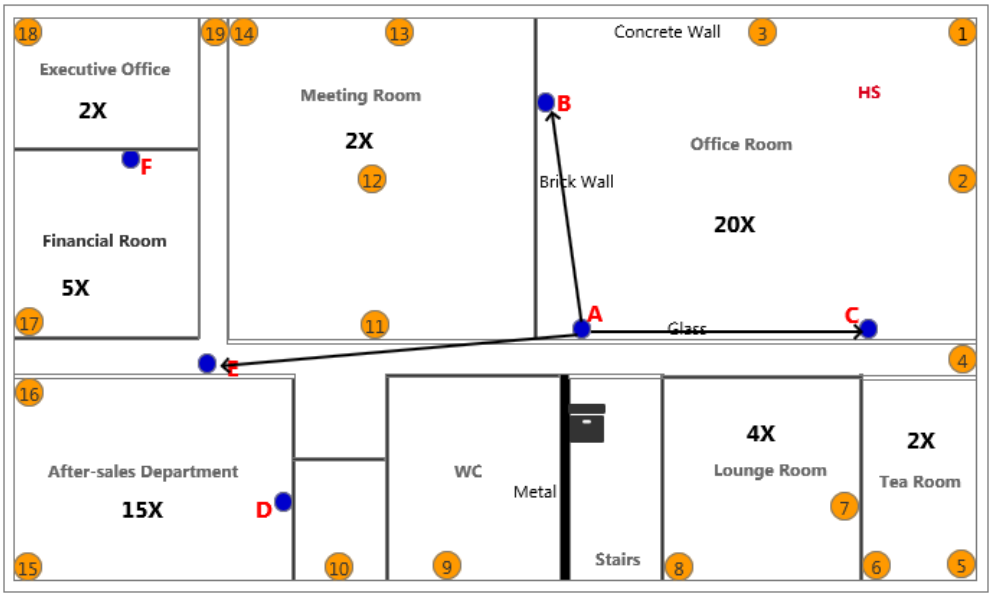
Measure the signal strength transmitted from the measuring base station that you receive at the planned position of the neighboring base station. It is used to ensure that sufficient synchronization overlap is guaranteed.

For the base stations to be able to synchronize, we recommend that the signal value between two neighboring base stations be kept above -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm).

Procedure

1. Leave the first-level base station at the planned position and place the measuring handset to the planned position of a second-level base station that is to synchronize with the first base station.
2. Check whether the signal is within the limit of -85 dBm (W90B DECT sync: -90 dBm, W90B LAN sync: -95 dBm) at 100% frame quality.
3. Record the results in the measurement log.
4. Take this measurement for all planned positions.

Note: In order to keep measurement results correct, the measuring handset should be placed at the exact position of the planned base station.



Example of a measurement log for the synchronization overlap of neighboring base stations:

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
A		√	√	√		
B	√		√			
C	√	√		√		
D				√		
E	√	√	√		√	√
F				√		

Measuring Point	Base A	Base B	Base C	Base E	Base D	Base F
A		-37dBm/100%	-39dBm/100%	-61dBm/100%		
B	-35dBm/100%		-47dBm/100%			
C	-40dBm/100%	-45dBm/100%		-68dBm/100%		
D				-53dBm/100%		
E	-60dBm/100%	-70dBm/96%	-66dBm/100%		-50dBm/100%	-60dBm/100%
F				-60dBm/100%		

The result of the measurement is that the signal strength is sufficient for synchronization everywhere. Base station F and D can only receive base station E with sufficient quality, and base station B, C and E can only receive base station A with sufficient quality.

Here, a sensible synchronization hierarchy would be:

Sync Level 1: Base station A

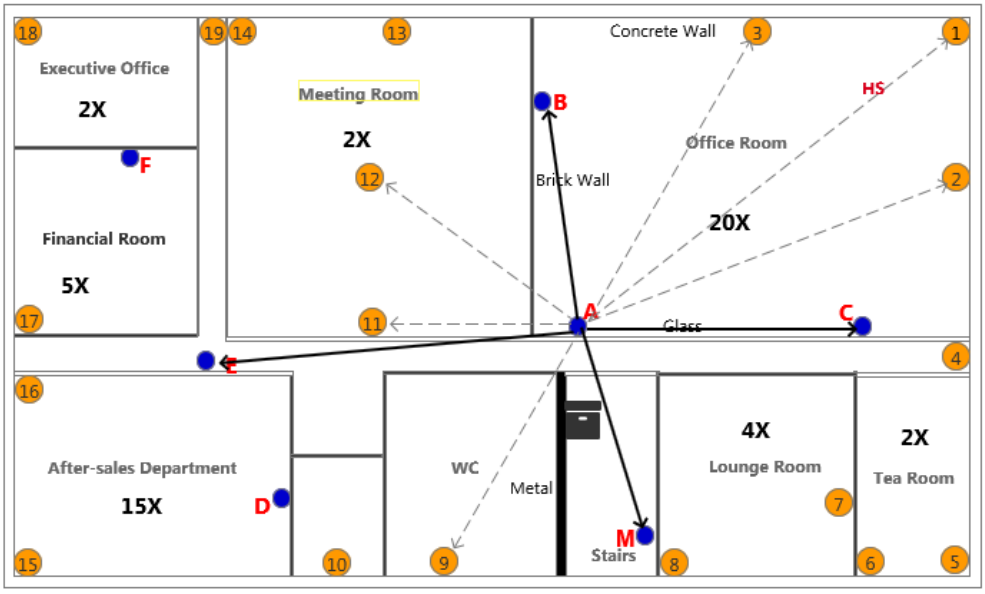
Sync Level 2: Base station B, base station C, base station E

Sync Level 3: Base station D, base station F

Deployment in a Multi-Storey Building

If a handover must be guaranteed among the floors in a building, you need to consider installing a dedicated base station in the stairwells.

As is shown, the seventh base station (point M) should be added in the planning:



In this case, guarantee the synchronization among floors first, and then on the floor. So you need to measure the radio coverage of the base stations in the stairwells.

Installing the W90DM/W90B

Once you complete the measurements, and the positions of the base stations have been determined, you can install the W90B. Refer to the Quick Start Guide for more information about the installation.

The following points require additional attention:

1. After the installation, the multi-cell system will be synchronized soon. You should check the voice quality, roaming, and handover again.
2. For each position please note down the MAC address of the device you are going to install.

   The MAC address can be found on the rear of the device.
3. We recommend that you place W90DM in a protective position.