



AXENON

**AVS Teknoloji
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USER HANDBOOK FOR

AXENON GSMR7H

REPEATER SERIES

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1.1. OBJECT

This manual has for objectives the following ones:

1. Describing the basic architecture of the repeaters AXENON GSMR7H designed by AVS.
2. Describing possible uses of the same ones.
3. Indicating the form of installing them appropriately.
4. Explaining the necessary software tools for their use and configuration.
5. Explaining their integration inside a supervision and control system.

1.2. SCOPE

This manual affects to all the equipments AXENON GSMR7H designed by AVS starting from its edition date. It will also be user handbook for repeaters manufactured previously and that they possess a modernized version of control software and compatible with the equipment. Approved by the Commercial department of AVS at Sep1 2002

1.3. RELATED DOCUMENTS

To supplement the information of this document they will be able to consult the following documents:

GSMR7H-XXX, DCSR14H-XXX, GSMR7H-XXXXA, DCSR14H-XXXXA, GSMR7H-XXXC, DCSR14H-XXXC, GSMR7H-XXXT, DCSR14H-XXXT. (XXX IS A NUMBER).

These documents are available in www.avs-technologies.com or they can be requested to the commercial department of AVS the e-mail: info@avs-technologies.com.

1.4. DOCUMENT REVISIONS

This is the second controlled edition of the document of code GSM-M-ENG elaborated by the production and commercial departments of AVS.

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2.1. DESCRIPTION OF THE AXENON GSMR7H

2.1.1. MAIN TOPICS

The AXENON GSMR7H Repeater's Family has been designed to cover at an inexpensive cost the areas with a very low level of coverage or no existing signal. These areas can be placed inside cellular networks with a high potential of locations where the level of signal is not strong enough. Such areas are very interesting due to the traffic which demands a full coverage in those locations (parking, tunnels, restaurants...etc). Some of the main remarkable advantages of the AXENON GSMR7H are:

Wide bandwidth repeater for GSM with small and medium coverage

“Full-duplex” configuration based on “heterodyne” structures over 70 MHz frequency

Bandwidth of 62, 34, 10 channels or designed to specific requirements of the operators

Gain greater than 70 dB

Output power between +23 dBm and + 33 dBm

Dynamic margins between 65 and 85 dB

ALC loops to suppress unwanted disturbing radio signals

Parametric digital control of the gain, ALC loops, bandwidth function, in / out levels by interface RS-232 (9600 baud) throughout computer or by using a modem.

Small dimensions and weight. Easy to install and operate.

Programmable under Windows®

All AXENON GSMR7H Repeaters are based on a full bandwidth conversion architecture in intermediate frequency of 70 MHz (for AXENON GSMR7H) and 140 MHz (for) to be filtered and modified (amplified and ALC). Later on, the signal is carried into the band with the same range of frequencies of the input signal. This processing mechanism has the below mentioned advantages:

- Easy adjust of the bandwidth (full bandwidth, medium bandwidth...)
- Ability to select the range of frequencies to be amplified
- Excellent linear response in bandwidth frequency

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- Easy and accurate dynamics margins and signal levels to avoid saturating and overload problems
- Excellent response in bandwidth frequency between operators

Differences in the usage of both models depend on the power supply to cover a specific area and also on the simultaneous carrying waves to be supported by the repeater.

The common characteristics of all GSM repeater's family are the ability to control the working frequency and the gain, in a digital manner (locally throughout RS-232 or remotely by using a 9600 modem). Using a PC the operator may update the parameters managed by the links in a friend-user application displayed in Windows® (versions 3.11, 95, 98 and NT).

Both models are powered with DC supply from 9 volts to 36 DC volts or through external adaptors to a line of 220 volts.

The GSM repeaters are introduced in a waterproof aluminum box (IP55 or IP65) with a size of 250x140x55 mm with N connectors for radio frequency and DIN connectors for power and control access.

The compact shape of the AXENON GSMR7H allows an easy installation on walls and poles.

The AXENON GSMR7H permits the local alarm treatment for power loss, high temperatures, etc. But in most cases these repeaters are provided with a system that manage the power supply or sun panels, and the device to control the battery charge.

Further explanations about this system are provided in the final pages of this manual.

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2.1.2. BLOCK DIAGRAM



Figure 1

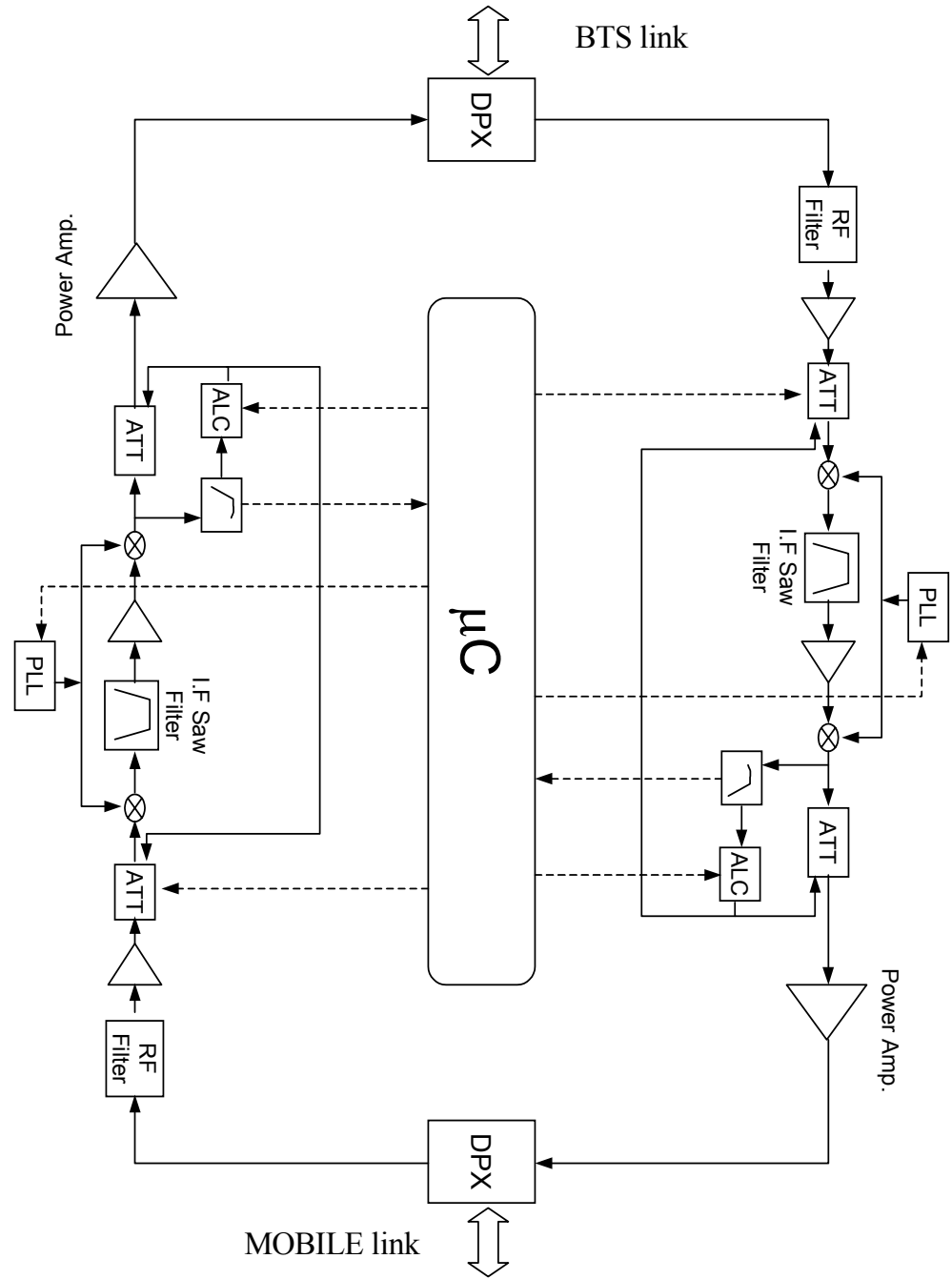


Figure 1 shows the architecture of the AXENON GSMR7H repeaters. According to this figure, three main sections can be distinguished:

- Amplifier stages
- ALC units
- Communications and control devices

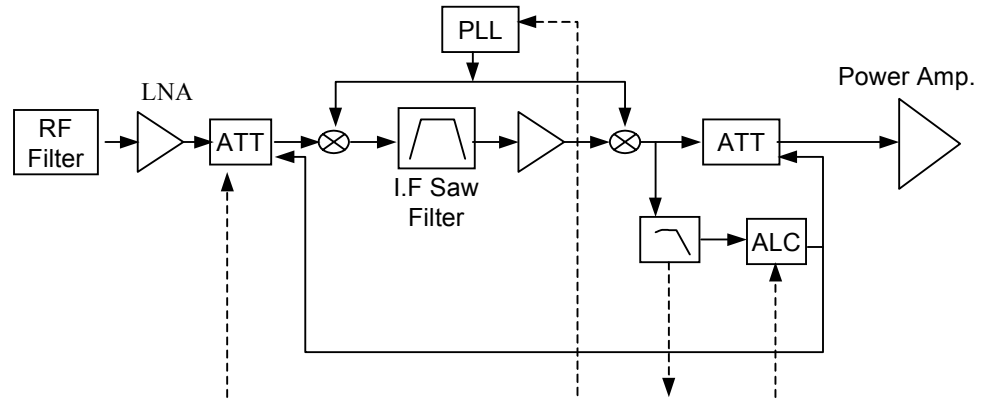
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Section of Amplifier Stages

Figure 2

Following figure 1, the signal issued by the input diplexer is guided into an attenuator of low loss, based into PIN diodes with a +40 dB input IP3 and an adjust margin of 35dB controlled by the input ALC loop.

Close to the attenuator is located an amplifier of low noise (LNA). This amplifier depending on the version allows gains between 15 and 25 dB and noise factor between 2.5 and 3.5 dB. A very low loss, high gain and control margin of 35 dB allows to the LNA and attenuator an adjustable gain from 24 to -10 dB, and an IP3 of +40 dB and a noise factor under 4 dB.

LNA output is used for the input of the first frequency converter (mixer) that carry out from a full GSM band (TX or RX) to an intermediate frequency centered in 70 MHz.

Since the complete band (for all operators) arrives to this point a sample of the full signal levels is rectified and its power is measured as well. This value is compared to the threshold power level. If this level is greater than the threshold this attenuation value is modified to avoid the ALC saturation.

It is very important that levels monitored will be for all operators. Otherwise, in the up link case, a different mobile telephone located close to the one who wants to be amplified, it may bring about the saturation of one input stage if the power sample selected is done after the signal has been filtered to select the operator.

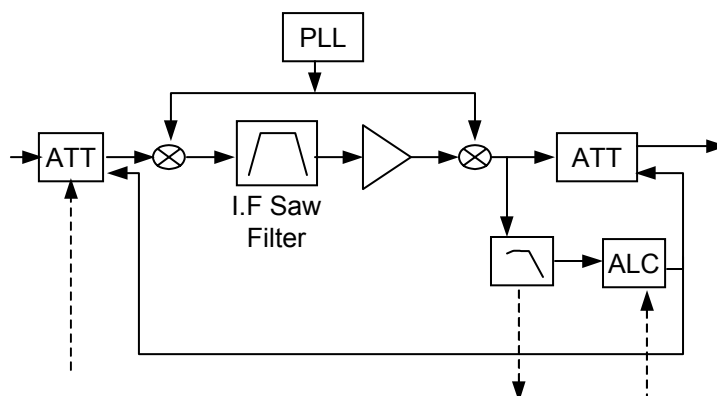


Figure 3

The output signal of the converter (IF) is filtered throughout a SAW, with the bandwidth required by the operator (the frequency of the local oscillator has been adjusted to allow the operator band to work in 70 MHz or 140 MHz).

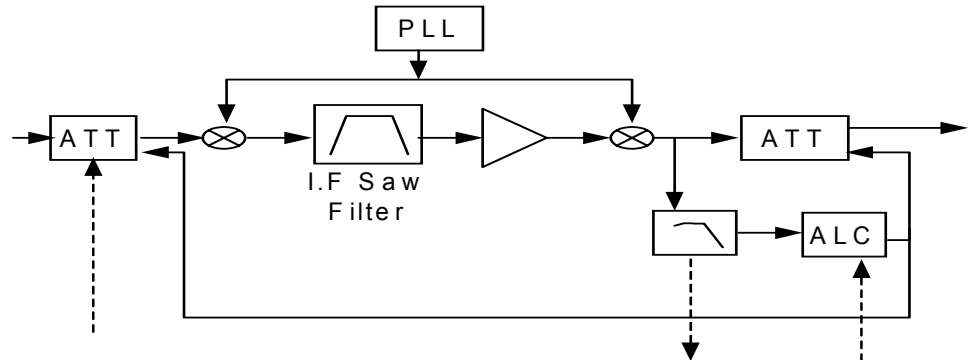
The characteristics of this filter of F1 allow a rejection of 25 dB for ± 400 KHz in the selected band. In this way the first channel of the closest operator will be always amplified up to 25 dB under the gain programmed value of the selected operator.

The filtered signal is amplified and it pass to the second frequency converter that carries out the filtered band (70 MHz or 140 MHz) to their initial position in GSM band.

An attenuator with the same characteristics is located in the second output converter.

The output of this attenuator passes through intermediate stages and them to the output stage.

Figure 4



Same as the case of the input ALC loop, a sample of the power displayed for the output stage to the diplexer is rectified and compared to the threshold reference. When the measured level is greater than the threshold, the attenuation of the attenuator located in the secondary converter output will be modified. In this way, the repeater avoids the saturation of the stage and the radiation of spurious.

ALC Units

The comparative and corrective processes of the attenuation levels of the input / output attenuators, makes an architecture of double ALC loop which presents the following properties:

The management of the ALC allows a full correction of 60 dB (a total deep of ALC).

The time passed from the detection of the overload-input signal to the correction of that signal is the "attenuation time of the ALC loop". This time must be smaller than that the "wake up time" of one slot times ($< 30 \mu\text{S}$).

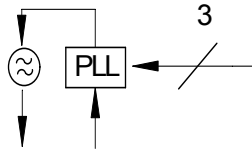
Altogether is equivalent to a second order loop (properties of stability and convergence)

All circuits associates to those sections above described are working to compare, amplify and filter the signals of measured and referenced with Communications and Control Devices

They serve to program the synthesators of frequency, input / output attenuators, input / output threshold ALC circuits...



Figure 5



Basically, these circuits are divided into the following units:

Microcontrol Unit

RS-232 Communications Series Unit

Attenuator Control Unit (DAC)

The microcontroller unit (UC) set up the parameters of the syntetizators of frequency generated by the local oscillators to convert the GSM band in intermediate frequency.

In the same way, the UC configures the attenuation values of the four attenuators (two per branch) and the threshold ALC control circuits as well.

The UC set up the voltage of the DAC (digital analogue converter) with eight outputs.

The communication is made throughout interface RS-232 that allows to the microcontroller to receive the configuration from a PC or 9600 bits per second modem.

The UC is also measuring the power levels managed by the ALC circuits and providing a validated reference to monitoring the power supply and the alarm generation.

All the information related to the configuration is saved in the EEPROM of the UC. In this way, the UC holds the instantaneous configuration when the power supply is over.

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2.2. REPEATER'S MODELS

2.2.1. STANDARD MODEL AXENON GSMR7H

The standard model of repeater consists of the repeater, a power supply, a power connector, and a RS232 cable for connecting to PC



This model can give power of +15 dBm, +23 dBm, +33dBm. The characteristics are detailed for each of the models in the datasheet corresponding to each of them.

REPEATER'S DIMENSIONS: 300 x 160 x 91 mm. **WEIGHT:** 4 Kg.

2.2.2. STANDARD MODEL IN A BLEAKNESS BOX:

The standard model in a bleakness box consists of all elements of the standard model wired up inside a bleakness box.



This model can give power of +23 dBm, +33dBm and +40 dBm. The characteristics are detailed for each of the models in the datasheet corresponding to each of them.

COMPONENTS: Repeater + power connector + RS232 cable + configuration and control software.

REPEATER'S DIMENSIONS: 400 x 300 x 200 mm **WEIGHT:** 12-15 Kg depending configuration.

The remotely controlled model consists of all the components of the standard model in a bleakness box but, besides, offers the possibility of being controlled remotely by a modem connected to the port serial of the repeater.

This model can give power of +23dBm, +33dBm and +40dBm The characteristics are detailed for each of the models in the datasheet corresponding to each of them.

COMPONENTS: Repeater + power connector + RS232 cable + GSM Modem + directional coupler + configuration and control software.

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2.3. GENERAL CHARACTERISTICS

In this paragraph the common characteristics are detailed for all the repeater's models. For more detailed characteristics the user should consult the datasheet of the concrete model.

2.3.1. CHARACTERISTIC COMMON ELECTRICITY

Parameters:	Minimum	Typical	Maximum	U
Gain (1 Db step)	30	70	85	dB
In band ripple		1.5	2	dB
Uplink excitability		-101		dBm
Downlink excitability		-101		dBm
Noise factor	6	10	11	dB
In / out impedance		50		Ω
Return losses		-12		dB
Group Delay		4	6	μ sec
Power supply AC levels	110	220	240	Vac

These characteristics can change subject to the concrete model.

Repeaters can be adapted for other power systems with direct current (solar panels, +12 Vdc, +24Vdc and +48 Vdc).

2.3.2. OTHERS CHARACTERISTICS

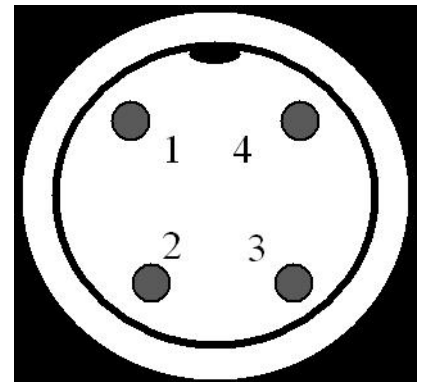
Operating temperature	-30 a 55 °C
Storage temperature	-40 °C a +70 °C
Relative humidity	< 95 %
MTBF	50000 Hours

2.3.3. PHYSICAL INTERFACES

Power Supply Input:

The equipment has a power supply of 12V ó 12 and 24V according to the version. The description of the connectors and the function of every PIN is shown below:

PIN	SIGNAL
1	+12V
2	+12V
3	+24V/NC s/model
4	GND



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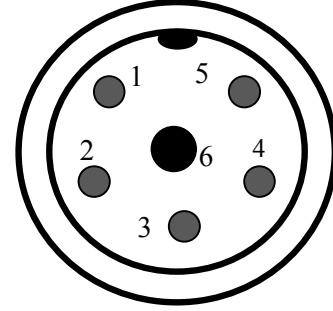
Input/Output of Radio frequency

Connector N Female.

Input/Output Data Access

Connector DIN male

PIN	SIGNAL
1	GND
2	RX
3	TX
4	NC
5	+12V
6	NC



SECTION 3. CONFIGURATION SOFTWARE

3.1. INSTALLATION AND CONFIGURATION

INSTALLATION

The control application of the repeater is given together with the repeater and . The application is designed for the execution on operative systems such as Windows 95®, Windows 98®, or Windows NT 4.0®.

This application is provided with a software auto installable that contains the following files: RepeaterNew.exe; RepeaterOld.exe; Repeater.cnf; Configuration.exe. All these files must appear in the same directory. These files can be accompanied by an additional one called Launcher.exe that selects automatically between the programs RepeaterNew.exe and RepeaterOld.exe.

The configuration of these files should be in one case:

..\AXENON	
Nombre	
! Configuracion.exe	
RepeaterNew.exe	
Repeater.cnf	
RepeaterOld.exe	

The configuration of these files should be in other case:

..\AXENON		..\AXENON\Bin	
Nombre		Nombre	
Bin		Repeater.cnf	
! Configuracion.exe		RepeaterNew.exe	
Launcher.exe		RepeaterOld.exe	

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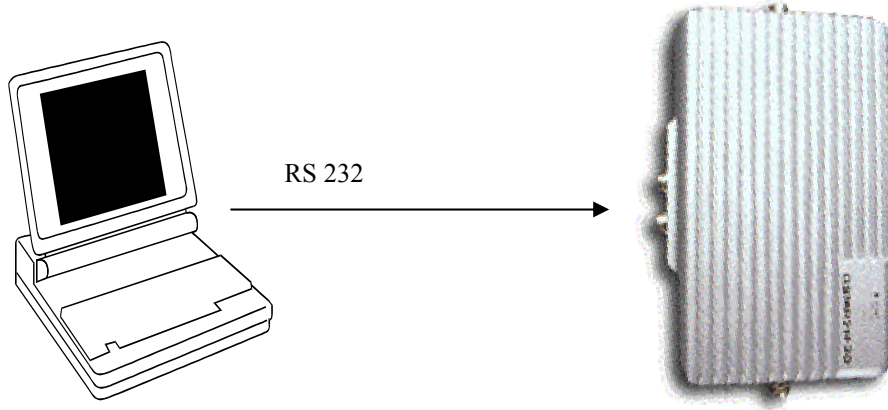
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NOTE: It is important to indicate the importance that the file Repeater.cnf is in the same directory that the configuration programs of the repeater. This file contains fundamental information for these programs to work well.

DIRECT CONECTION

It is necessary to connect the repeater to a port free series of the PC. The communication series is realized to 9600 bauds. The configuration of the port series must be 9600 Bauds, 8N1, without control of flow.



EXECUTION

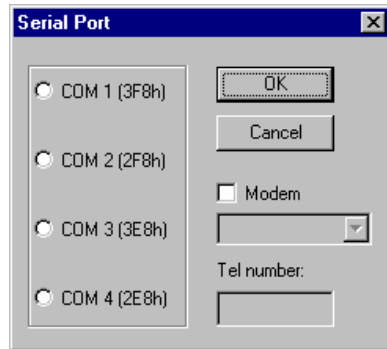
As soon as the repeater is connected to the suitable PC port, the sequence of execution of software is the following one:

It is necessary to execute the program “Configuration.EXE” or “Serial port selection”. When the port has been selected the configuration of the repeater can be started.

Launcher.exe, RepeaterNew.exe or RepeaterOld.exe. This is the configuration program mentioned before in order to control the repeater locally as well as remotely.

3.2. SERIAL PORT SELECTION. CONFIGURATION.EXE

3.2.1. LOCAL CONNECTION



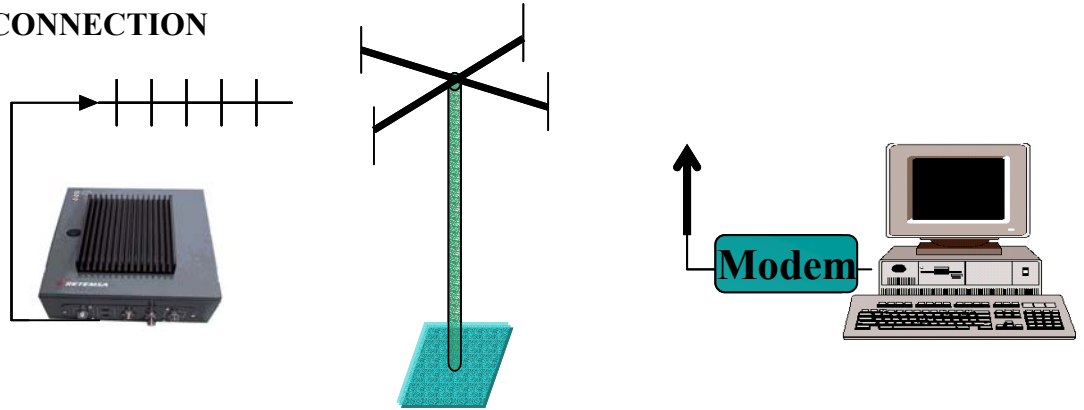
The program **configuration.exe** should be executed (as well as the corresponding direct access that normally is “Serial Port Selection”). During the execution appears the following window:

In this window the port of communication should be selected to connect the repeater. If this information is not known one option can be chosen and tried out if it is the correct one that execute the program repeater.exe. If this second program does not connect, the port should be changed until the connection is succeeded.

3.2.2. REMOTE CONNECTION VIA MODEM

IMPORTANT: For the remote connection with a repeater it is necessary to have of a modem radio (GSM, DCS, CDMA) connected to the port series of the PC. The repeater must be remotely controlled (or the modem should have connection to its port RS232).

CONNECTION



CONFIGURATION OF THE RADIO MODEM CONNECTED TO THE PC

Case of M1	Case of M20	Case of WAVECOM
>ATB13	>AT+IPR=9600	TO BE DEFINED
>ATN0	>AT+IFC=0,1	
>ATS0=1	>A+CBST=7,0,1	
>AT&D0	>ATS0=1	
>ATE0	>AT&D0	
>AT&W0	>ATE0	
	>AT&W0	

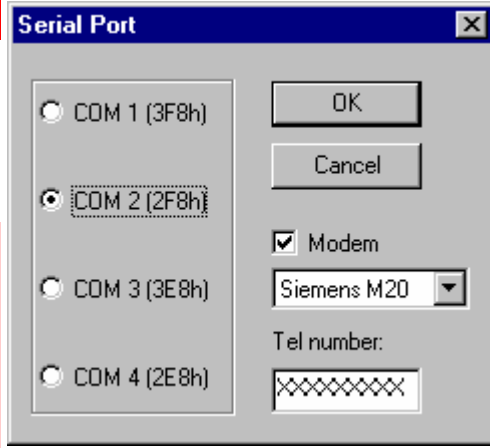
PROGRAM EXECUTION

The program **configuration.exe** should be executed (as well as the corresponding direct access that normally is “Serial Port Selection”). During the execution appears the following window where the option Modem is has to be selected.

The next steps for the remote communication with a repeater are the following ones:

Within the configuration program, select the port that is connected to the modem (COM1, COM2, COM3, COM4).

Select the checkbox Modem .



Once selected the checkbox you can select the type of connected modem to the COM of the PC (Siemens M1, Siemens M20, Wavecom,..). Select the connected modem.

When the modem has been selected, the telephone number should be introduced to the associated modem of the repeater to which one wants to call.

Click OK

The configuration is established until the modifications are made. This program does not need to be executed until the dates for the access to the repeater must be reconfigured again.

3.3. CONFIGURATION SOFTWARE. REPEATER.EXE

In order to configure the repeater, it must be correctly fed and loaded in its input/output of radio frequency. Furthermore the input RS232 of the repeater must be connected either to a port COM of a PC, or to a modem..

Before initiating the program one will be due to verify that the configuration of the communication with the repeater (by modem or directly) is correct.

EXECUTION

There are two identification numbers of users for the application, the **user PIN** and the **superuser PIN**, that establish two levels of control on the parameters of the repeater.

The **user PIN** offers the standard control of the repeater (power, gain and monitoring of values and alarms). The **superuser PIN** offers a calibrated control of the repeater and should only be used in the process of adjustment or by experienced users.

The **user PIN** is "0000" and is possible to be changed once one access to the program. The **superuser PIN** will be facilitated to the owner or the person who exerts a control of a superior level on the apparatuses. It is formable and will be adapted to a secret number that only you know. The supersuser PIN can be changed also. When the application is sent, the screen shown appears on the left. If the repeater and the port of communications are configured correctly, the model and serial number of the repeaters should appear correctly in the display screen of the



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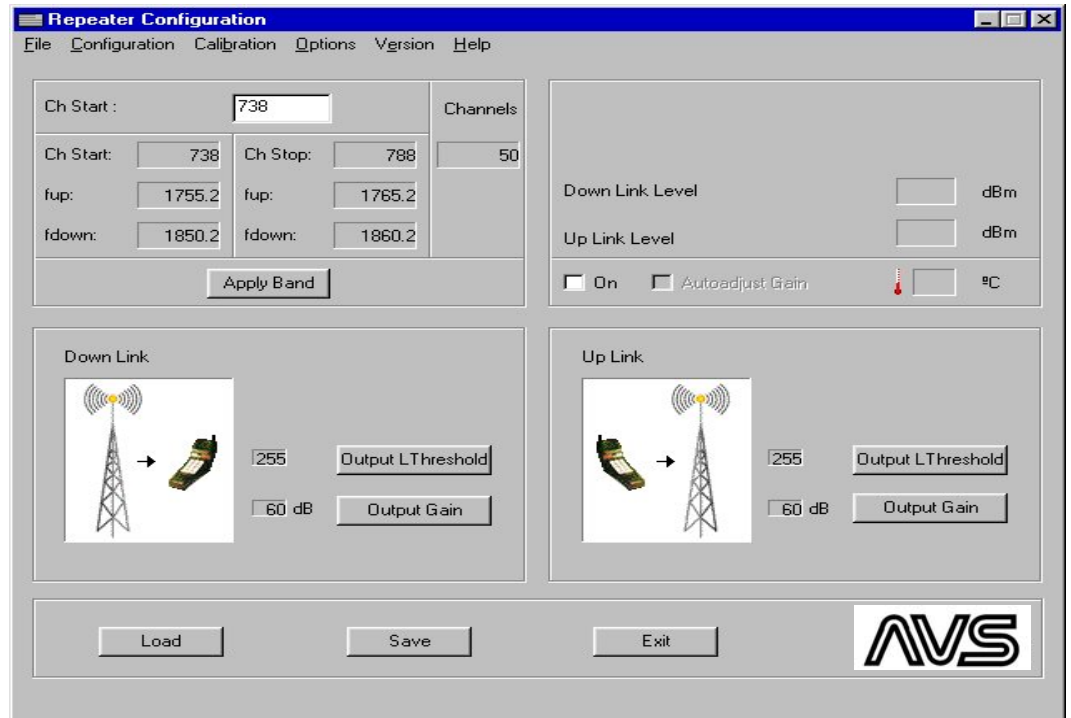
program.

In this screen the personal identification number (PIN) of the user is requested to give to access to the control of the repeater.

Once the user introduces his identification number he should press ENTER and wait until the communication is established correctly. If everything is right the user will enter in the configuration window of the repeater like standard user or "superuser".

3.3.1. USER CONFIGURATION

This window appears when the application starts.



For its usage the following process has to be done:

Move the repeater frequency band, or, select the channel that is desired to be amplified in the case of channel selective repeaters.

When modificate the gain of the repeater in both branches. It is important to select the suitable gain for each application, so that is makes the repeater work in linear zone and does not saturate it.

Monitor the repeater internal temperature, the level of output power of the Uplink and Downlink.

Associate to the alarm LEDs the incidences that indicate as well as the thresholds from which produce the alarms.

Change the user PIN.

Save all the changes in the static memory of the repeater

Below the window it you will find a description about how the operations can be made:

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TUNNING AMPLIFICATION BAND

One of the parameters configurable by the user is the number of the channel in the beginning of the band that is aimed to be amplified, leaving the final channel fixed by the bandwidth of the filter specified by the model.

Ch Start (1-124):	<input type="text" value="95"/>	Channels	<input type="text" value="60"/>
Ch Start:	<input type="text" value="95"/>	Ch Stop:	<input type="text" value="124"/>
fup:	<input type="text" value="909"/>	fup:	<input type="text" value="914.8"/>
fdown:	<input type="text" value="954"/>	fdown:	<input type="text" value="959.8"/>
<input type="button" value="Apply Band"/>			

In order to change the start channel of the band it should be introduced the desired channel in the beginning of the band and pressed the button “**Apply Band**”. Thus the new frequency will stay established in a provisional way. This frequency will be saved in the memory of the repeater like work parameter when the “**Save**” button is pressed and that it appears in the inferior part of the screen.

The final channel comes determined by the bandwidth of the repeater.

GSM FREQUENCIES AND CHANNELS		
CHANNELS (N)	1..124	
UP LINK (MOBILE-BASE STATION)		
	890 MHz - 915 MHz	
CARRIER FREQUENCY FOR UP LINK CHANNEL N	$890 + N * 0.2$ MHz	890.2;890.4;...
START FREQUENCY FOR UP LINK CHANNEL N	$890 + 0.1*(2*N-1)$ MHz	890.1;890.3;...
STOP FREQUENCY FOR UP LINK CHANNEL N	$890 + 0.1*(2*N+1)$ MHz	890.3;890.5;...
DOWN LINK (BASE STATION-MOBILE)		
	935 MHz - 960 MHz	
CARRIER FREQUENCY FOR DOWN LINK CHANNEL N	$935 + N * 0.2$ MHz	935.2;935.4;...
START FREQUENCY FOR DOWN LINK CHANNEL N	$935 + 0.1*(2*N-1)$ MHz	935.1;935.3;...
STOP FREQUENCY FOR DOWN LINK CHANNEL N	$935 + 0.1*(2*N+1)$ MHz	935.3;935.5;...

The equivalence (Channel number \leftrightarrow channel Frequency) can be calculated with the

DCS FREQUENCIES AND CHANNELS		
200 KHz CHANNELS (N)	512..885	
UP LINK (MOBILE-BASE STATION)		
	1710 MHz - 1785 MHz	
CARRIER FREQUENCY FOR UP LINK CHANNEL N	$1710 + (N-511) * 0.2$ MHz	1710.2;1710.4;...
START FREQUENCY FOR UP LINK CHANNEL N	$1710 + 0.1*(2*(N-511)-1)$	1710.1;1710.3;...
STOP FREQUENCY FOR UP LINK CHANNEL N	$1710 + 0.1*(2*(N-511)+1)$	1710.3;1710.5;...
DOWN LINK (BASE STATION-MOBILE)		
	1805 MHz - 1880 MHz	
CARRIER FREQUENCY FOR DOWN LINK CHANNEL N	$1805 + (N-511) * 0.2$ MHz	1805.2;1805.4;...
START FREQUENCY FOR DOWN LINK CHANNEL N	$1805 + 0.1*(2*(N-511)-1)$	1805.1;1805.3;...
STOP FREQUENCY FOR DOWN LINK CHANNEL N	$1805 + 0.1*(2*(N-511)+1)$	1805.3;1805.5;...

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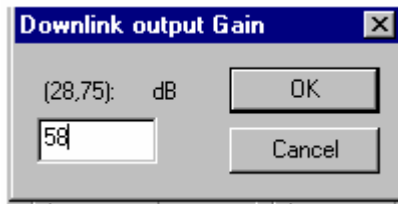
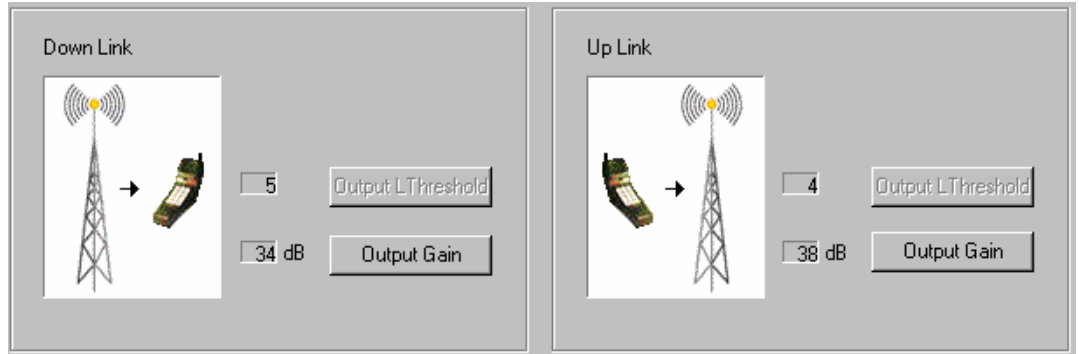
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formulas below.

GAIN ADJUSTMENT

The gain of each branch can be formed separately pressing the button **Output Gain** of the Uplink or Downlink.



When the button Output Gain is pressed this window appears which includes the possible limit of gain and a panel where the numerical value, in dB, should indicate it what is desired to be established. Once established press OK.

It is important to re indicate the value that will be provisional until the **Save** button is pressed.

NOTE: For the facilities in the field, it is very important that the user knows the signal level at the input of the repeater and with this data and the maximum power output that repeater can give, the gain will be configured in each branch. So the user should configure the repeater with a gain in such a form that it works in linear zone and not in saturation. Thus, if the levels of input signal are very high a low gain should be configured and if they are very low maximum gain needs to be configured.

MONITORING VALUE

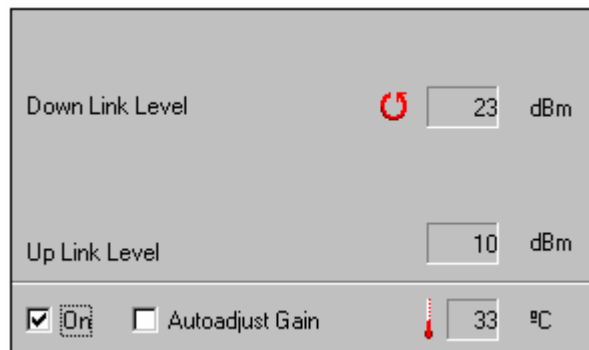
In normal operation of the repeater the program allows to visualize the following values:

The level of output power (dBm) of the Downlink. Repeater to the terminal power.

The level of input power (dBm) of the Uplink. Repeater to BTS power.

The internal temperature of the repeater air.

All these parameters will show at the moment that the checkbox **On** is selected. After some seconds the values begin to visualize.



IMPORTANT: It is advisable to visualize only the previous values **during the necessary time**. When the checkbox On is activated, the repeater enters in a state of continued measurements and the control of other parameters slows down

considerably. For this reason it is advisable to inactivate this option when the values are verified.

Autoadjust Gain. This option allows the repeater to auto configure the gain for the first time that it is put into operation. However, with this option, the repeater will probably only work well in a special situation, so it is recommended that the user configures the gain manually having all the necessary data. It is not advisable to use this possibility.

CHANGE OF USER PIN

ACCESS MENU: Option > Change PIN

When Change PIN is pressed in the menu the window on the right appears.



It is recommended that the PIN is changed and substituted by one that only you know. From this window the new desired PIN will be requested and asked to be verified. If everything worked well the program will inform you that the PIN has been changed correctly.

NOTE: It is important to remember the new PIN well, it could also be convenient if you keep it in a safe place. If in any circumstance you forget the PIN you will not be able to enter the application. Please contact the provider of the software to provide you with a new PIN.

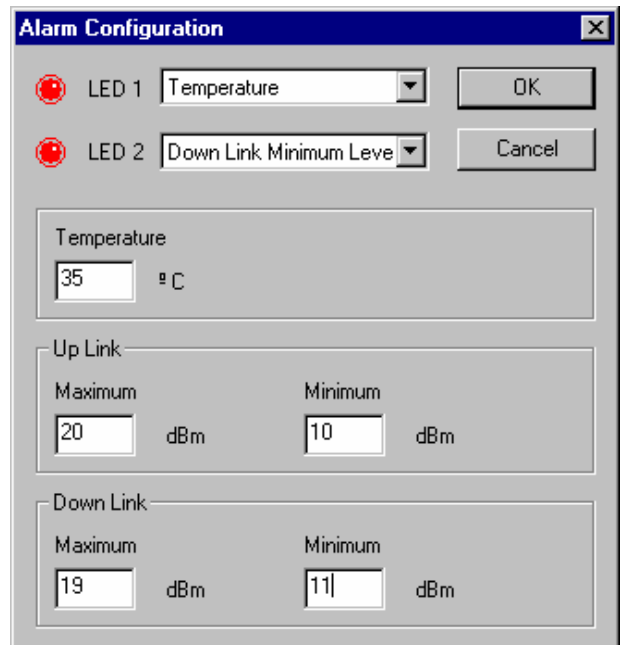
CONFIGURATION OF ALARMS

ACCESS MENU: Configuration > Alarms



In the standard repeater the alarms can be associated to one of the LEDs that appear in the frontal. In the remotely controlled repeater with OMC, these are sent to the server of maintenance of the network.

When **Alarms** is pressed the window on the right appears. In this window it is possible to associate to each led of the repeater a different alarm.



Temperature refers to the temperature that informs the associate alarm. In Uplink and Downlink the thresholds of warning by excess and defect are established.

The Alarms available appear in the associated menus to LED1 and LED2 and are the following ones:

None: LED inactivated
Feedback in mobile branch – Base

Maximum level exceeded in mobile branch – Base

Level below minimum in mobile branch – Base

Feedback in base branch – Mobile

Maximum level exceeded in base branch – Mobile

Level below minimum in base branch – Mobile

High temperature

Aux 1: Configurable exterior alarm based on the necessities of the client.

Aux 2: Configurable exterior alarm based on the necessities of the client.



GENERAL MENU

ACCESS FROM MENU: File

Load: Load in the window the parameters that the repeater has in static memory (operative configuration).

Save: Save in static memory the configuration that appears. It is important to be sure that the configuration that is saved is the desired operative.

Exit: Leave the program.

3.3.2. CONFIGURATION IN “SUPERUSER” OPTION.

When one enters the Repeater.exe program with the superuser PIN appear all activated menus and options of the program appear, this does not happen if one enters with the PIN.

The functionalities available in the superuser option are all available in the user option as well as the following ones:

Option of calibration of the repeater. This is the adjustment process that is made in factory and that is the reason for which gain has its real correspondence associated. This operation can only be made in factory and it's not explained in this manual.

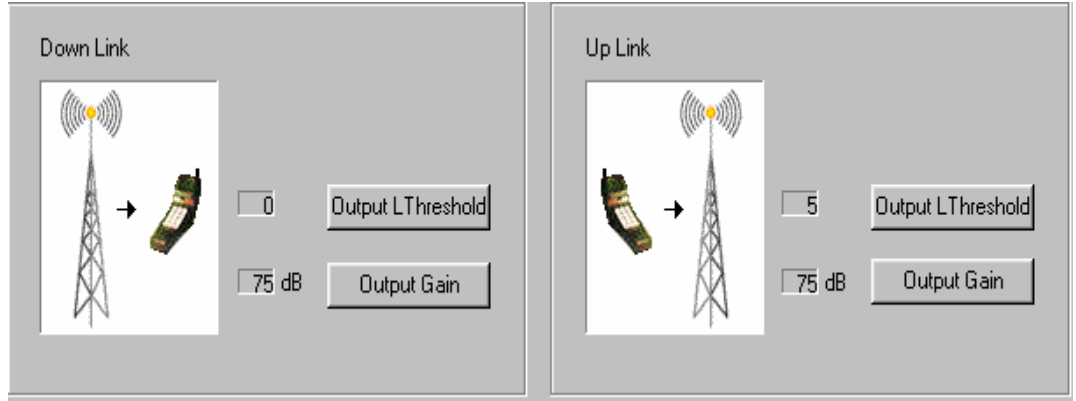
Selection of the level of power output when the automatic control of gain (CAG) begins to act. This has to be made to prevent that a repeater produces products of greater intermodulations than the established ones by the norm (greater than -36 dBm).

Change of the PIN and superuser Operation similar to the change of user PIN.

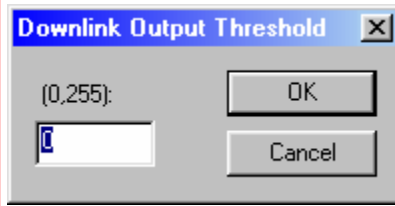
SELECTION OF THE LEVEL OF PERFORMANCE OF THE CAG

This operation is realized through the button of “Output Lthreshold” located next to “Output Gain” and it is made independently for each branch.

When the button is pressed a window appears in which you should introduce



a number between 0 and 255. Each number selects a level of performance of the CAG. The calibration of the CAG is not linear for that reason you should dispose of an analyzer of phantoms or an analyzer of networks to associate to each value the level of performance.



VERY IMPORTANT

This function is used in 33 dBm wideband repeaters with only one channels for amplifying. When some carriers arrive at the repeater with the same level the output level can reach 30 dBm for each one, and intermodulation products can be out of normative (since the IP3 of such is 45-48 dB). For that reason the repeater should be adjust for an output power of 23 dBm.

Thus, wideband repeaters should be configured in the following way:

CASE A: “Repeater that amplifies more than one carrier that can leave a power higher than 20 dBm”. In this case, for the specific location, CAG MUST BE REGULATED TO 23 dBm. Because of this a value between 0 and 10 should be entered in the square corresponding to this function. For the correct selection of the value one should have the suitable instruments of measurement. This is the configuration that leaves the factory by defect.

CASE B: “Repeater that mainly amplifies one ONLY carrier” (the rest leaves with a very low level). In this case, for specific location, IT IS NOT NECESSARY TO TRIM THE CAG TO 23 dBm. For this reason a value of 255 is due to be entered in the text box corresponding to this function.

SECTION 4. INSTALLATION & MEASUREMENTS

4.1. INSTALLATION

4.1.1. INSTALATION OF STANDARD AND COMPACT REPEATERS

To hold the repeater in a wall or in a pole, it is necessary to use the metallic base provided with the repeater. This metallic base is fastening by four screws. When the base is held, you must place the sideburns of the repeater by pushing them into the holes of the base. See below figures)

4.1.2. INSTALATION OF REPEATERS INSIDE A BLEAKNESS BOX

4.1.4. EXAMPLE OF AN INSTALATION

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Usually when connecting a repeater, you set up the installation by using the power level of the base station. This signal level will set up the gain to be programmed and the isolation levels between the base station and the antennas of coverage. Previously you have to define the antennas gain and the area that should be covered.

I.e.:

Define the installation

A parking lot of 10.000 m² (125 m x 80 m)

Requirements

Level of signal over -85 dBm

Antenna placed in a central position

Therefore;

$$P_t = P_r - G_{tx} - G_{rx} + L_{bf} + L_a$$

[1]

P_t = Desired Power level in the worst scenario

G_{tx} = Transmission antenna gain in the worst scenario

G_{rx} = Reception antenna gain in the worst scenario

L_{bf} = Free space losing propagation in the worst scenario

L_a = Additional losses (cables, obstacles, movements,...)

In this case:

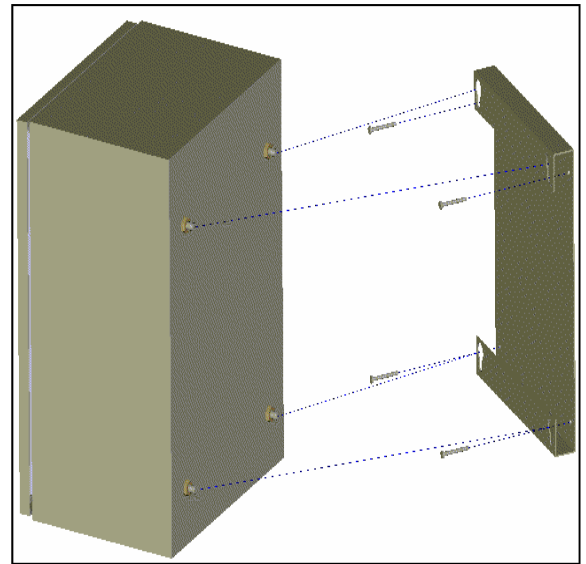
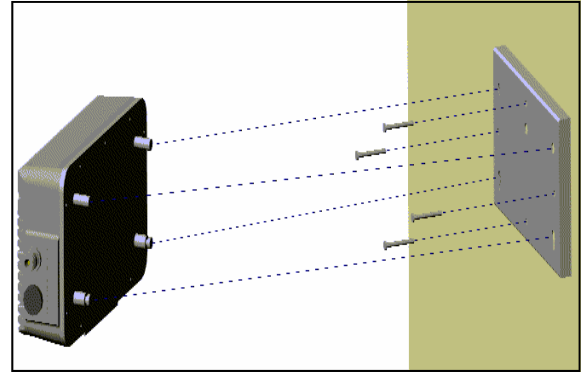
$$L_{bf} \text{ for } 62 \text{ m} = 68 \text{ dB}$$

$$G_{rx} = 0 \text{ dB}$$

$$G_{tx} = 5 \text{ dBi}$$

$$L_a \cong 30 \text{ dB}$$

$$P_t = -85 - 5 - 0 + 68 + 30 = +8 \text{ dBm}$$



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Therefore, the repeater must have an output power level of + 8 dBm. It is necessary to know the signal level of the base station in the point where the base antenna will be placed. If the value obtained in the measurement is 70 dBm and the model of the antenna to link with the repeater of the base station is a Yagui; the gain for the repeater should have the following value:

$$G_{rep} = + 8 \text{ dBm} - (G_{yagui} - 70 \text{ dBm}) = 68 \text{ dB}$$

Installation

In this case it will be necessary to link an antenna Yagui of 10 dBi with the base station and a panel antenna of 5 dBi to cover the parking lot.

The repeater may be placed between both antennas and connected to a power supply of 220 volts.

After this, it will be installed the power supply and the cable from the antennas to the repeater:

ANTENA BASE (for the base station antenna)

ANTENA COBERTURA (for coverage of the parking lot)

ANTENA BASE ↔ YAGUI

ANTENA COBERTURA ↔ PANEL

Previously to make the connection of the repeater, it is very important to measure the isolation between both antennas:

You will need a spectrum analyzer with tracking generator

Connect the output of the generator to anyone cable of the antennas

Connect the other cable to the input of the spectrum analyzer

Program a sweeping between 890.0 and 960.0 MHz with an output level of + 0 dBm

Make a direct measure of the isolation in the spectrum analyzer as the power level is received by the other antenna

The measured value must be 10 dB greater than the programmed gain to avoid the feedback between antennas

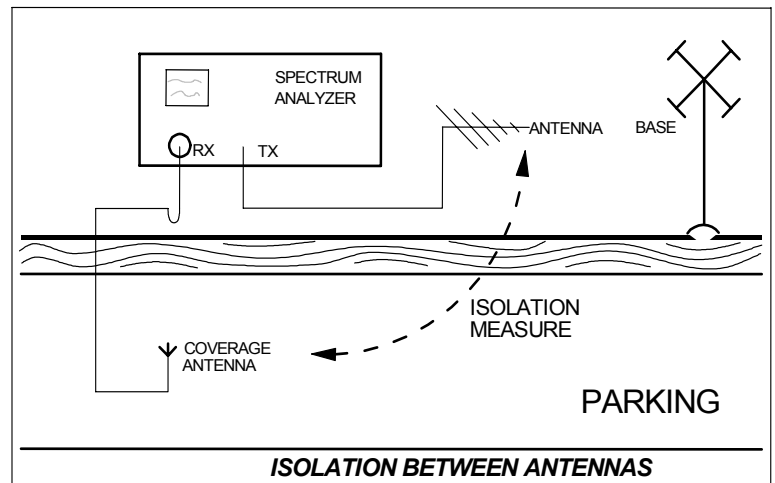
Figure 3:

In this example, we can measure the antenna of coverage when + 0 dB are injected into the antenna of the base station. If the result were - 85 dBm, this means that the isolation is 85 dB, therefore:

$$85 - 68 = 17 \text{ dB}$$

We have more isolation than the programmed gain; therefore, the system will work without problem.

Usually the isolation is so strong that



Starting up

When the previous steps have been fulfilled, it is time to activate the repeater.

First, you must:

To connect the cables of the antennas to the repeater.

To verify that the power supply is close to the repeater and provides the voltage according to the requirements: + 12 volts for AXENON GSMR7H 20 models and + 12 volts and 24 volts for AXENON GSMR7H 30 models.

To connect the control serial cable RS-232 to a PC. (We recommend using a portable PC).

Repeaters use to be configured by default with 70 dB of gain

Turn on the power supply of the repeater. The red led must be lighted

Run the application "CONTROL SOFTWARE" provided with the repeater. This program should be previously installed in your computer.

Introduce the PIN and the serial number of repeater. If a failure is occurred, this screen will show a series of "x"

A failure may be produced by the following reasons:

The repeater is not working

The cable connections are not working

The application "CONTROL SOFTWARE" is not properly configured

If the device is working, a dialog box will display the serial number and model series.

Now you should introduce the PIN ("0000" by default")

You can access to the programmed gains. In the above example, we need 68 dB, but the setting default is 70 dB. We can now modify the output gain to 68 dB. Save the changes to update the system.

The repeater incorporates sensors for the power stages of the output signal levels. In the menu "Signal Levels" you can find out the output levels of the uplink and downlink.

There is not feedback between antennas when none level is indicated (less than + 10 dBm). In this case, we cannot verify if the signal levels are suitable.

In these cases, we will use a spectrum analyzer:

Disconnect the cable of the antenna for coverage

Connect the COVERAGE ANTENA port to the spectrum analyzer



Set the amplitude reference level in + 30 dB

Set the span in 25 MHz and centered in 947.0 MHz

Measure the level of the amplified carriers

If everything is OK, the level must be around + 8 dBm

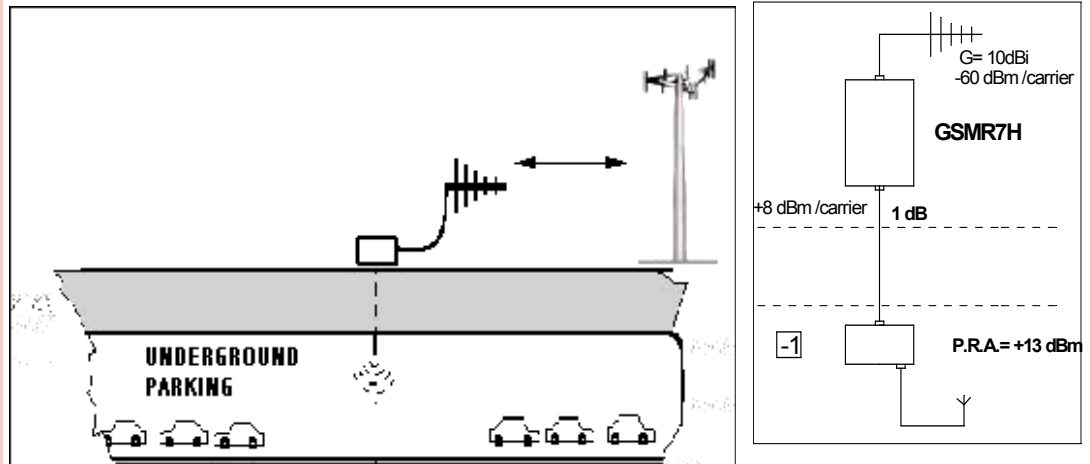
The gain maybe modified by using the program installed in your computer.

First change the value for the downlink and then for the uplink

After this, the repeater should be working in the downlink mode. Disconnect the spectrum analyzer and connect the repeater to the coverage antenna.

4.1.5. Quality and working measures

When connected the coverage antenna, you can make the test of quality using a mobile phone equipped with an engineering module (we recommend the ERICSSON GH-688).



Move the mobile around the parking to measure the different quality levels. After this, the installation process is finished.

Please be sure that you have saved the changes made in your computer during the installation.

4.2. TESTING MEASURES

4.2.1. MEASUREMENT OF THE GAIN

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Measurement Conditions

Powered the repeater with a suitable voltage

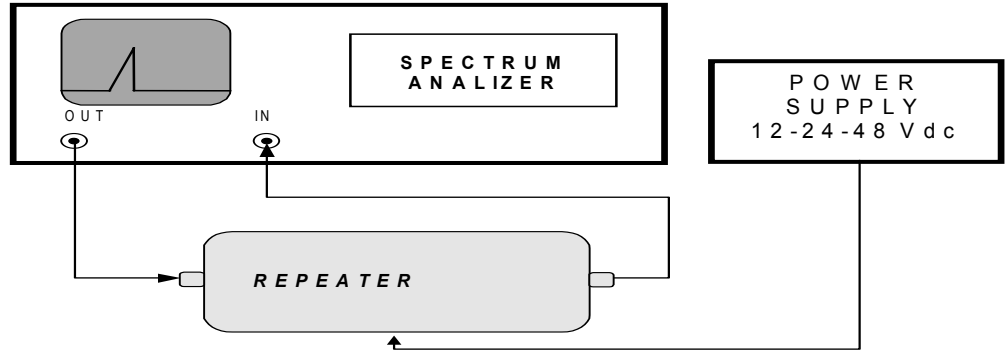
Adjust the gain to the maximum (input/output) over the link that you want to measure

Inject a tone of - 50 dBm in the passband of the repeater

Measure the output value by the other port

Measurement Values

LINK	TESTING FREQUENCY	OUTPUT LEVEL	CABLE LOSSES	GAIN	V. Min.
UP					65 dB
DOWN					65 dB



4.2.2. MEASUREMENT OF THE OUTPUT POWER LEVEL FOR ONE CARRIER

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Measurement Conditions

Powered the repeater with a suitable voltage

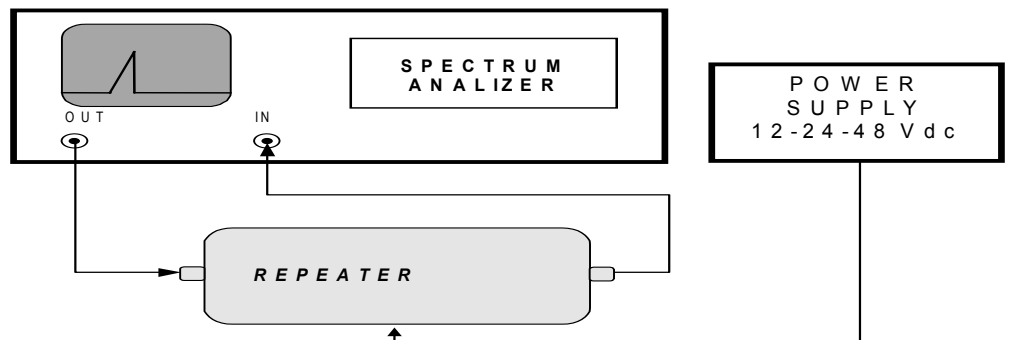
Adjust to the maximum the gain (input/output) over the link that you want to measure

Inject a tone of $-X$ dBm in the passband of the repeater

Measure the output value by the other port

Measurement Values

LINK	TESTING FREQUENCY	OUTPUT LEVEL	INPUT LEVEL	V. Min (AXENON GSMR7H X)
UP				23,33 dBm
DOWN				23,33 dBm



4.2.3. MEASUREMENT OF THE FREQUENCY REPLY

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Measurement Conditions

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Powered the repeater with a suitable voltage

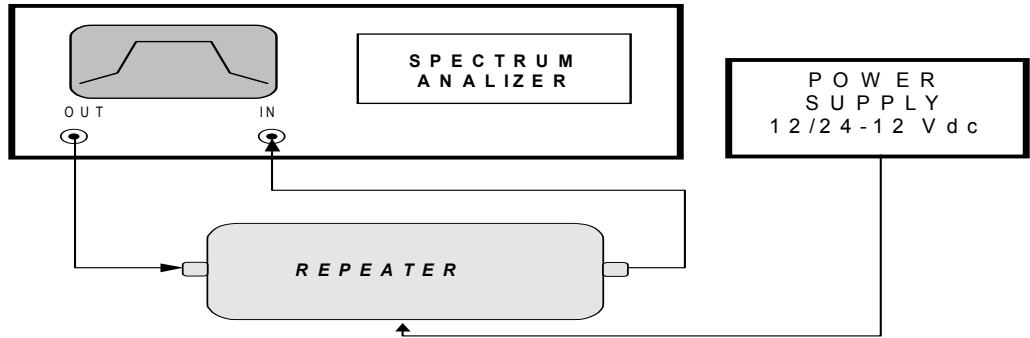
Adjust to the maximum the gain (input/output) over the link that you want to measure

Generate a sweeping of – 50 dBm in the passband

Measure the vertical scale in 1 dB step

Measurement Values

LINK	IN BAND RIPPLE	TOLERANCE
UP		± 1.5 dB
DOWN		± 1.5 dB



4.2.4. MEASUREMENT OF THE OUTPUT POWER LEVEL FOR TWO CARRIERS

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Two tones generator

Measurement Conditions

Powered the repeater with a suitable voltage

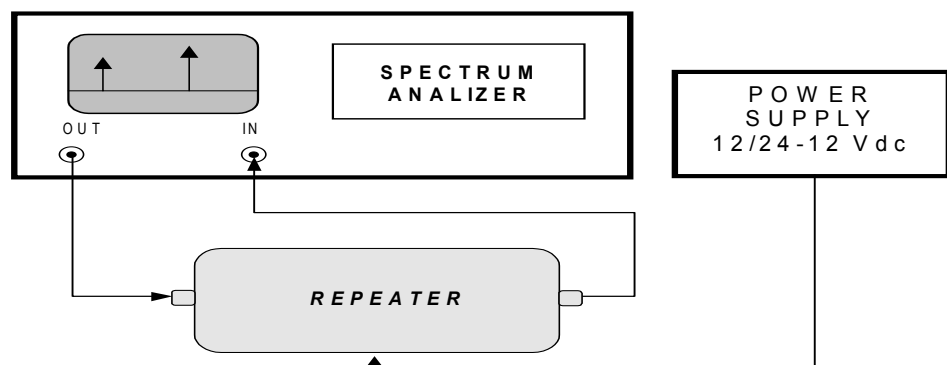
Adjust to the maximum the gain (input/output) over the link that you want to measure

Inject two tones of – X dBm in the passband of the repeater separate by X KHz

Measure the output value by the other port and increase the input value to the level of the inter - modulation ($f_1 - \Delta f$) and ($f_2 + \Delta f$) up – 50 dB over f_1, f_2 .

Measurement Values

LINK	f_1, f_2	OUTPUT LEVEL (-45)	OUTPUT LEVEL (-45)	V. Min. (AXENON GSMR7H 30)	V. Min. (AXENON GSMR7H 20)
UP				20 (-50), 23 (-40) dBm	10 (-56), 13 (-47) dBm
DOWN				17 (-30), 22 (-20) dBm	7 (-30), 12 (-20) dBm



4.2.5. MEASUREMENT OF THE REJECTION FOR UNDESIRED BANDS

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Measurement Conditions

Powered the repeater with a suitable voltage

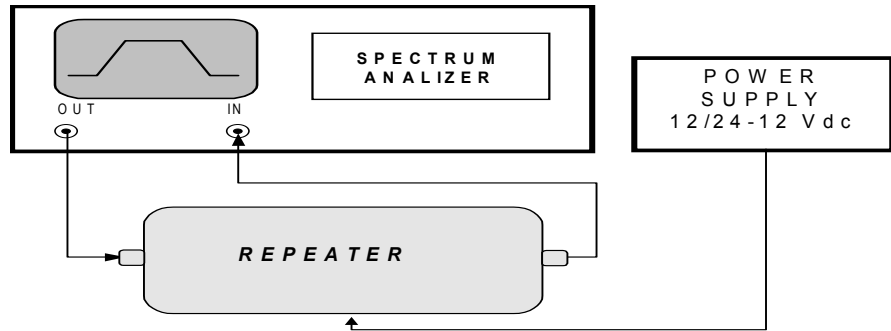
Adjust to the maximum the gain (input/output) over the link that you want to measure

Generate an input sweeping of – 50 dBm

Measure the bandwidth value to –3, -10, -20 and –30 Db

Measurement Values

LINK	Δf to – 3 dB	Δf to – 10 dB	Δf to – 20 dB	Δf to – 30 dB
UP				65 dB
DOWN				65 dB
62-30-10 Ch	12.5-7-2	14-7.5-2.4	14-7.5-2.4	14.3-7.7-2.6



4.2.6.

MEASUREMENT OF MATCHED PORTS

Control Devices

Spectrum analyzer with sweeping generator of 1 GHz

Directional coupler

Measurement Conditions

Powered the repeater with a suitable voltage

Adjust to the maximum the gain (input/output) over the link that you want to measure

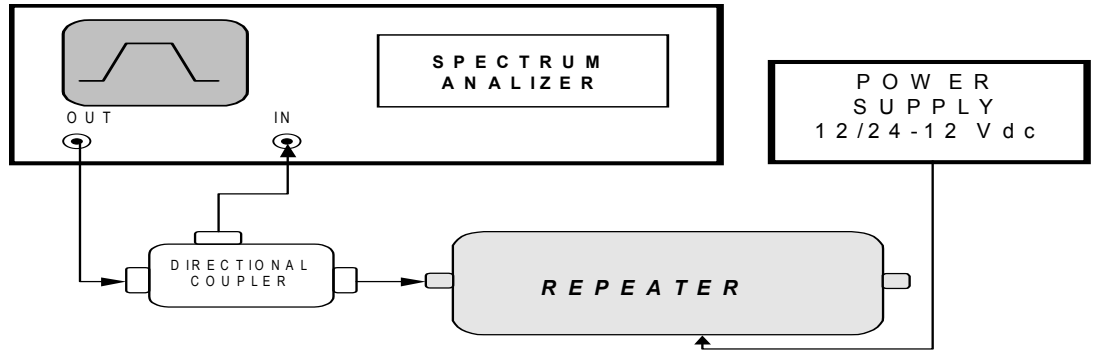
Generate an input sweeping of – 20 dBm with the directional coupler

Measure the value in both input ports and take note of the maximum (minimum relation $P_{in} \leftarrow \rightarrow P_{ref}$)

Measurement Values

LINK	MEASURED VALUE	V. Min.
UP		12 dB
DOWN		12 dB

4.3. EXAMPLES OF USAGE



4.3.1. COVERAGE IN A PARKING

It is possible to create a structure of coverage inside of a parking lot just by combination of internal antennas and the AXENON GSMR7H 30 repeater ($G > 70$ dB and Power $> +33$ dBm)

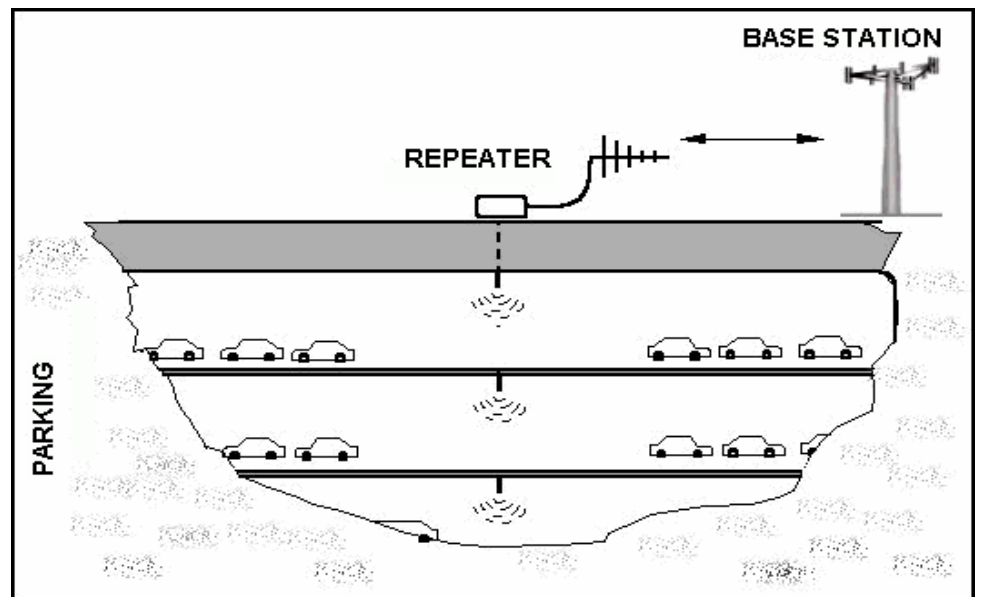
We propose a solution for a parking lot with four floors and 10.000 m² each floor

A direct link (base station to repeater) between the antenna of the base station and the repeater must allow an output level for the repeater of +20 dBm per carrier (for 70 dB of gain this should be -60 dBm in the surface of the parking).

The signal of +20 dBm per carrier is injected into the cable. Every floor is divided throughout accopulators of 3 dB. A half of the signal is applied to the antenna and the other half follows to the next floor.

The same scheme is applied in the reverse link (mobile to repeater).

Figure 9



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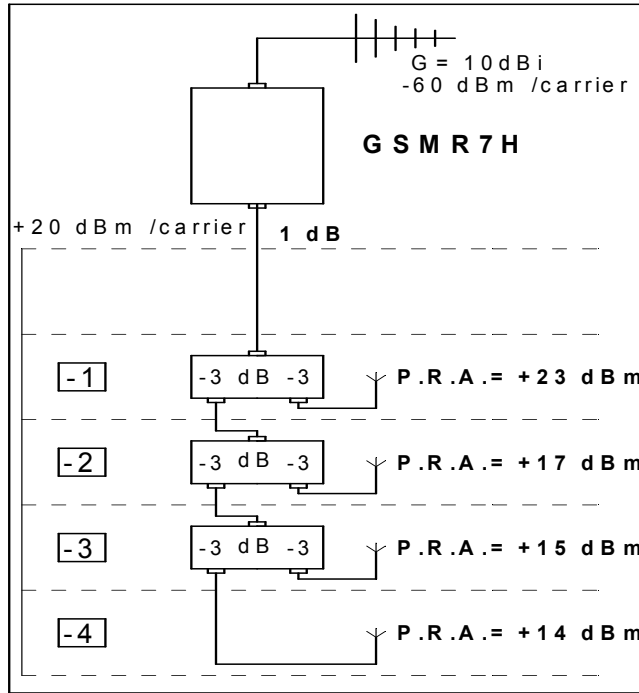
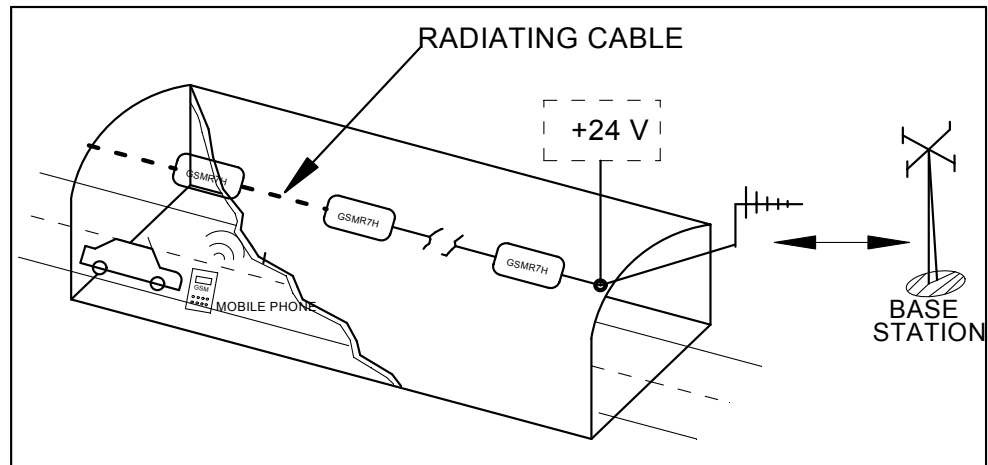


Figure 10

Figure 10 represents the signal levels from the surface to the deepest floor

4.3.2. COVERAGE IN TUNNELS

There is a possibility to create a structure of coverage inside a tunnel. It is based on the combination of radiating cable and the AXENON GSMR7H 30 repeaters.



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Therefore, we propose a solution for a tunnel with 4 Km of length. The results are valid for underground installations such mining, subway, etc.

Select the access of the tunnel with a higher level of signal coming from the base station. The chain of coverage will be implemented as in the below figure: Figure 11

The building elements will be displayed in the following manner.

1 repeater every 600 or 1.000 meters, depending on the cable type

Transportation of the power supply for every repeater using the radiating cable

For this case we will need:

6 Repeaters GSMR7 30

4.000 radiating cable (4 dB / 100 meters, coupling loose of -80 dB to 6 m)

Power supply of 24 volts and 10 A

4.3.3. COVERAGE IN RURAL AREAS

In small towns located in isolated areas is necessary to minimize the investments to design the coverage. Also, some professional applications need small investments for supervision and remote control tasks.

Both samples needs systems of independent power supply sources based on sun panels or batteries. For instance, a small town of 5.000 people with a very low signal level (< -90 dBm) coming from a location placed 20 km away.

Select the highest location around the town (in a radio of 2 Km away)

We are looking for a signal level between -80 and -70 dBm

In these conditions the system profile will be:

Antenna for repeater / base link	Yagui 14 dBi
Coverage antenna	Sectorial panel 14 dBi
Repeater	AXENON GSMR7H 20

The parameters will be:

P.R.A. to the coverage area	+23 dBm / carrier
Consumption	12 W
Coverage area (Prx > -85 dBm)	19.000 km ²

Photovoltaic power supply sub-system:

Sun panels power	140 W
Capacity of the accumulator	200 Ah

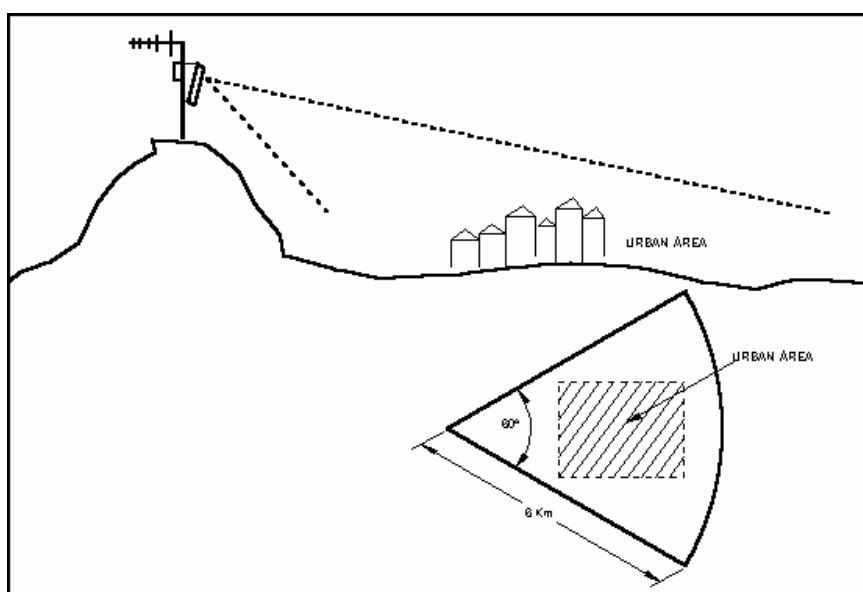


Figure 12



AXENON

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