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टीईसी 21000:2005

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STANDARD FOR GENERIC REQUIREMENTS

TEC 21000:2005

(Earlier No. TEC/GR/RDA-001/01.MAY 2005)

जीएसएम आरएफ ररपीटसस और ववतररत एंटीना प्रणाली

GSM RF REPEATERS & DISTRIBUTED ANTENNA SYSTEM

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This Generic requirement relates to the RF Repeater and Distributed Antenna system for the Digital cellular telecommunication system based on the GSM standards to be introduced in mobile networks based on GSM technology. This document covers briefly the concept of RF Repeaters, antenna system and distribution components. Features & functional requirements, Interfaces, Operation & Maintenance requirements, General requirements, etc. The Characteristics of RF Repeater shall be as per GSM 05.05 version 4.2.31 Release 1999 and the planning aspects shall be as per GSM 03.30 version 8.3.0 Release 1999 or any other higher version.

HISTORY SHEET

Sl. No.	Standard/Document No.	Title	Remarks
1.	GR / RDA-001/01.MAY 2005	GSM RF Repeaters & Distributed Antenna system	First Issue: May 2005
2.	TEC 21000:2005	Standard for Generic Requirements for a GSM RF Repeaters & Distributed Antenna system	Includes revised Numbering Scheme

Note:

1. The documents have been renumbered as per revised numbering scheme, kindly refer the Mapping-Listing Table pertaining to old and revised document number available on TEC website www.tec.gov.in/. In case of further clarification, please contact at email ID adgdoc.tec@gov.in

2. Inside the documents, General Requirements may be read as Standard for General Requirements, Interface Requirements as Standard for Interface Requirements, Several Requirements as Standard for General Requirements and Test Schedule & Test Procedure (TSTP) as TEC Test Guide.

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Chapter - 1

Introduction to Repeaters and Distributed Antenna system

1.0 Scope

This Generic requirement relates to the RF Repeater and Distributed Antenna system for the Digital cellular telecommunication system based on the GSM standards to be introduced in mobile networks based on GSM technology. This document covers briefly the concept of RF Repeaters, antenna system and distribution components. Features & functional requirements, Interfaces, Operation & Maintenance requirements, General requirements, etc. The Characteristics of RF Repeater shall be as per GSM 05.05 version 4.2.31 Release 1999 and the planning aspects shall be as per GSM 03.30 version 8.3.0 Release 1999 or any other higher version.

1.1 Definitions:

Repeater: Bi-directional Radio Frequency (RF) amplifier which can amplify and transmit a received Mobile Station (MS) signal in the GSM MS transmit band, simultaneously it can amplify and transmit a received Base Transceiver Station (BTS) RF signal in the GSM BTS transmit band

Broad Band Repeater: A repeater, which is designed for operation on any combination of ARFCNs (up to a specified maximum number) within the operating band of the repeater.

Channelised Repeater: A repeater, which is designed for operation on a specified subset of the ARFCNs within the operating band of the repeater. The subset of the ARFCNs is determined during the manufacture of the repeater or may be programmable.

Repeater system using frequency shift: A frequency-shifting repeater consists of two different elements, a master unit close to the BTS and at least one remote unit close to the area to be covered. The master unit amplifies the channel from the BTS and shifts them to different GSM channel. In the remote unit the shifted channels from the master unit will be transferred back to the original channels and amplified. This is valid for the downlink signals as well as for the uplink signals.

1.2 Concept of RF Repeaters:

Repeaters are used to enhance network coverage by extending the radio frequency (RF) coverage to areas, which either lack signal, or the required signal strength for adequate mobile phone performance. Insufficient wireless coverage can occur both indoors and outdoors and may include indoor areas such as office buildings, parking garages, apartment

buildings, shopping malls, and residential houses. Outdoors areas are degraded by geographic topologies such as mountains, valleys, dense foliage and high rise urban landscapes which can easily degrade or obstruct the cell site's signal from the mobile phone.

Repeater is a directional amplifier which receives, amplifies and transmits simultaneously both the radiated RF carrier in the down link direction (from the base station to the Mobile area) and in the uplink direction (from the Mobile to the base station).

The weak coverage problem can be solved by installing an active repeater system, designed for use in a multitude of installation configurations. Repeater systems provide an effective solution by redirecting, filtering and amplifying the available signal at the donor antenna, into the weak coverage area, through a properly selected interior coverage antenna. The illumination of the weak coverage area allows the user's handset to operate as intended within the building or weak coverage area, while maintaining the user's call clarity and quality, which reduces service complaints and potential subscriber churn.

These repeaters can be used to create effects on traffic distribution of large buildings such as office buildings, shopping malls, departmental stores and subway stations, etc. enhancing quality-service for in-building shadowed locations and degraded voice quality areas.

1.3 Applications for RF Repeaters

It shall be possible to use the repeaters for the following applications:

1.3.1 Extending coverage inside buildings.

Many buildings incorporate small windows, reinforced concrete and metal in their construction; therefore, act as an effective RF screen. By using distributed antennas or radiating feeders within these buildings (connected to the mobile port of the Repeater and a Yagi on the top of the building (connected to the base port) coverage can be extended within these buildings.

1.3.2 Filling propagation black spots.

Local topography such as hills, valleys, cuttings and embankments can cause propagation black spots. Coverage into such areas can be achieved using RF Repeater with a suitable antenna to cover the area and a Yagi mounted high enough to view the nearest base station.

1.3.3 Temporary coverage

Special events such as conferences, sporting events exhibitions and festivals can generate temporary demand that would not justify installation of a base station. In this case, a Rf repeater can be employed to "borrow" channels from a site with less traffic some distance away that would otherwise be out of range of mobiles at the event.

1.3.4 Optimising Radio traffic

If a site becomes very heavily congested with radio traffic whereas a neighboring site is under-utilised then a RF Repeater can be set up to make use of channels from the quiet site for use in the coverage area of the busy site.

In areas of low user density a base station can be under used. Often, however, it is not always possible to increase coverage from a central point which experiences limits on power levels, mast heights etc.; in these instances a Cell Enhancer placed some distance away from the base station can be used to extend the coverage in the desired direction.

1.4 Configuration

A repeater can be used to amplify the whole of the transmit RF band or just a part of the band. In the latter case the repeater can be either Broadband, with frequency band selective filtering, or canalised, with channel selective filtering.

The most basic form of a repeater-system is a stand-alone RF repeater. In this application the repeater is fed with signal through the air from a remote base-station. In order to receive this so-called donor-signal, the repeater has a donor-antenna connected to it. Because the BTS is at a known location, and in order to limit received interference, in general this shall be a highly directional antenna.

The RF-repeater amplifies the signal from the base-station and retransmits it using the service antenna connected to it. It does the same in the opposite direction, repeating and amplifying the signal from the MS towards the base-station.

The service antenna shall be chosen in such a way that the gain and opening angle is suitable for the area that shall be covered. Since the service-antenna is transmitting the same signal as the donor-antenna is receiving, special attention has to be given to the RF-isolation between the two.

Stand-alone RF-repeaters are typically used for providing coverage in shaded areas, short tunnels, mountain valleys, coverage holes, to extend cell-range, and a large number of other applications.

1.5 Indoor Repeater solutions

Indoor repeaters are used to compensate for the losses with the building attenuation for coverage of:

- Office buildings, Multi storied apartments, large basements,
- Parking garages, shopping malls, and
- Airports etc.

Many buildings, especially in rural and suburban areas, are simply covered though radio signal penetration from external outdoor cells. As long as the outdoor BTS can cope with the capacity demand, this is of course the easiest way to achieve in-building coverage.

By using an off-air radio repeater, basically a bi-directional amplifier with a high-gain and narrow beam BTS facing donor antenna and an antenna facing the mobiles, the geographical coverage can be extended into in-building areas. Both channel and band-selective radio repeaters can be used, depending on applications.

In a simple implementation for the in-building coverage, a donor antenna with a radio repeater is mounted at the upper building floor and the coaxial distribution network is used to extend the coverage in the different locations inside the building.

These passive distribution systems have the limitation of coverage because of high loss and also cannot handle the multi-frequency-band systems because of the non-availability of frequency equalisation. By implementing the Bi-directional amplifiers in the coaxial distribution network, the coverage can be extended. For the longer links bi-directional optical links can also be used

1.6 Outdoor Repeaters solutions

Outdoor repeaters are used to enhance area of poor coverage due to terrain limitation for applications such as:

- Rural area coverage
- Covering black spots
- Optimising Radio traffic

Chapter - 2

General Requirements

2.1 Engineering Requirements

2.1.1 The equipment shall adopt state of the art technology.

2.1.2 The equipment shall be compact and lightweight. The manufacturer shall furnish the actual dimensions and weight of the equipment.

2.1.3 All connectors shall be reliable and of standard type to ensure failure free operation under environmental conditions specified in this document.

2.1.4 All connectors and the cables used shall be of low loss type and suitably shielded.

2.1.5 The equipment shall have necessary self-cooling arrangement with or without in-built fan.

2.1.6 The plug-in units, if any, shall be hot swappable to allow their removal/insertion while the equipment is in energised condition.

2.1.7 The mechanical design and construction of each card/ unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport and conforming to para-12 of BSNL QA document No. QM 333 (Latest issue) "Specification for environmental testing of electronic equipments for transmission and switching use".

2.1.8 Each sub-assembly shall be clearly marked with schematic reference to show its function, so that it is identifiable from the layout diagram in the documents provided by supplier.

2.1.9 Each terminal block and individual tags shall be numbered suitably with clear identifying code and shall correspond to the associated wiring drawings.

2.1.10 All controls, switches, indicators etc. shall be clearly marked to show their circuit designation and functions.

2.2 Operational Requirements

2.2.1 The manufacturer shall guarantee the satisfactory performance of the equipment without any degradation at an altitude up to 3,000 metres.

2.2.2 The equipment shall be able to work without any degradation in saline atmosphere near coastal areas and shall be protected against corrosion.

2.2.3 Extreme environmental conditions under which the system is capable of short-term emergency operation without permanent damage may be indicated.

2.2.4 Visual indication to show power ON/OFF status shall be provided.

2.2.5 Suitable visual indications shall be provided. It is desirable that green colour for healthy, red colour for unhealthy conditions and amber colour for non urgent alarms may be provided.

2.2.6 The software / hardware in equipment shall not pose any problem due to changes in date and time caused by events such as leap year etc. in the normal functioning of the equipment.

2.2.7 The power amplifier shall have protection, which prevents PA exceeding the predetermined max power level.

2.3 Quality Requirements

2.3.1 Components

(a) All the components used shall have to be approved and qualified as per procedure specified in QA BSNL document No. QM-324. The source of procurement of components shall also have to be submitted by the manufacturers. Alternatively, the supplier may indicate whether the components are approved by any international authority.

(b) List of all the components for which second source is not available, shall be provided.

2.3.2 Quality Standards

(a) The equipment shall be manufactured in accordance with the International Quality management system ISO-9001:2000 for which the manufacturer shall be duly accredited. The quality plan describing the quality assurance system followed by the manufacturer shall be submitted.

(b) The equipment shall be manufactured as per the latest BSNL QA Guidelines indicated in Quality Manuals QM 118 {Quality and Reliability in Product Design.}, QM 205 {Guidelines for Standard of Workmanship of Printed Boards}, QM 206 {Guidelines for Standard of Workmanship for Printed Board Assemblies}, QM 210 {Guidelines for Standard of Workmanship for Surface Mounted Devices} and QM 301 {Transmission Equipment General Documentation}.

(c) The product shall conform to the QA requirements stipulated in QM-351 (QA Requirement for Switching equipment).

2.3.3 **Lightening Protection**: The equipment including antenna, feeder etc. shall have adequate protection against lightening & power surges. All equipment shall have provision for grounding.

2.3.4 Redundancy :

The Power Supply as well as the OMC shall be provided in full redundant mode. The reliability of the system shall be 99 %.

2.3.5 Environmental Specifications:

The equipment shall be capable of working in an environment as specified for given category in the QA, BSNL document QM-333.

(ii) Indoor Equipment : Category B2
(ii) Outdoor equipment : Category D

2.4 Maintenance Requirements

Maintenance philosophy is to replace faulty units/ sub-systems after quick on-line analysis through monitoring sockets, alarm indications and Built-in Test Equipment or hand held terminal or lap top/ PC. The corrective measures at site shall involve replacement of faulty units/sub-systems. The actual repair shall be undertaken at centralised repair centres. The supplier shall have maintenance/repair facility in India.

2.4.1 The equipment shall have easy access for servicing and maintenance.

2.4.2 Suitable alarms shall be provided for identification of faults in the system and faulty units.

2.4.3 Any update in the software at a later stage to overcome deficiencies of the system due to bugs, compatibility etc., shall be provided free of cost by the equipment supplier. The equipment supplier shall undertake to supply, on continuing basis, all software updates. These updates shall include new features and services and other maintenance updates. The software up-gradation shall be possible with minimum interruption to the service.

2.4.4 Ratings and types of fuses used shall be indicated by the supplier.

2.4.5 The manufacturer/supplier shall furnish the list of recommended spares for maintenance.

2.5 Accessories

2.5.1 The supplier shall provide one complete set of:

a) All the necessary interfaces, connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment. Types of connectors, adopters to be used and the accessories, of the approved quality, shall be clearly indicated in the operating manuals, which shall be in conformity with the detailed list in the GR;
b) Software and the arrangement to load the software at site.

2.5.2 Special tools, extender boards, extender cables and accessories essential for installation, operation and maintenance of the equipment shall be clearly indicated and supplied along with the equipment.

2.6 Documentation

2.6.1 Hard & Soft copy of all documents shall be provided in English by the equipment supplier. The documents shall comprise of:

(i) System Description Documents

The following system description documents shall be supplied along with the system:

(a) Overall system specification and description of hardware and software.
(b) Installation manuals and testing procedures. Installation manuals shall contain step-by-step process of system installation.
(c) Equipment layout drawings.
(d) Cabling and wiring diagrams.
(e) Detailed specification and description of all I/O devices.
(f) Adjustment procedures, if there are any field adjustable units.
(g) Spare parts catalog including information on individual component values, tolerances etc. enabling procurement from alternate sources.
(h) Detailed description of software describing the principles, functions, interactions with hardware, structure of the program and data.
(i) Programming language (s) manual.
(j) Planning and system engineering documents.

(ii) System Operation Documents

The following system operation documents shall be provided by the equipment supplier:

a) Operating manual of the system
b) Maintenance manual.
c) Man-machine language manual.
d) Operation and maintenance manual for all I/O devices and auxiliary equipments.
e) Faulty location and trouble shooting instructions including fault dictionary.
f) Test procedures with auxiliary test equipments.
g) Emergency action procedures and alarm dictionary.

(iii) Training documents

Training manuals and documents necessary for organising training in installation, operation & maintenance and repair of the system shall be made available.

2.6.2 In addition to the printed documentation, all documents shall be provided in CD-ROM alongwith suitable means of retrieval i.e. IBM PC compatible machine with CD-ROM drive for each site.

2.6.3 Any provisional document, if supplied, shall be clearly indicated. The updates of all provisional documents shall be supplied immediately following the issue of such updates.

2.6.4 The structure and scope of each document shall be clearly described.

2.6.5 The documents shall be well structured with detailed cross-referencing and indexing enabling easy identification of necessary information.

2.6.6 All diagrams, illustrations and tables shall be consistent with the relevant text.

2.7 Protection Requirements

2.7.1 The equipment shall have a terminal for grounding the rack.

2.7.2 Protection against short circuit/ open circuit in the accessible points shall be provided.

2.7.3 All switches/controls on front panel shall have suitable safeguards against accidental operation.

2.7.4 The equipment shall be adequately safeguarded to prevent entry of dust, insects and lizards.

2.8 Safety Requirements

2.8.1 The operating personnel shall be protected against shock hazards as per IS 8437 {1993} "Guide on the effects of current passing through the human body" [equivalent to IEC publication 60479-1 {1984}].

2.8.2 The equipment shall conform to IS 13252 {2003} "Safety of information technology equipment including electrical business equipment" [equivalent to IEC publication 60950 {2001}] and IS 10437 {1986} "Safety requirements of radio transmitting equipments" [equivalent to IEC 60215].
The manufacturer/supplier shall submit a certificate in respect of compliance to these requirements.

2.9 Electromagnetic Compatibility (EMC)

The equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished:

a) Conducted and radiated emissions: To comply with Class-B of CISPR 22 {2003} "Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment";
b) Electrostatic discharge: To comply with IEC 61000-4-2(2001) "Testing and measurement techniques of Electrostatic discharge immunity test" under following test levels:
   Contact discharge level-2 {$\pm$ 4 KV}
   Air discharge level-3 {$\pm$ 8 KV};
c) Fast transients common mode (burst): To comply with IEC 61000-4-4 {1995 with Amendment-1 (2000) and Amendment-2 (2001)} "Testing and measurement techniques of electrical fast transients/burst immunity test" under Level-2 {1KV for DC power lines; l KV for signal control lines};
d) Immunity: IEC 61000-4-3{2002} "Radiated RF Electromagnetic Field Immunity test under test level-2 (test field strength 3 V / m) for general purpose in frequency range 80 MHz to 1000 MHz and under test level-3 (10 V/ m) for protection against digital radio telephones in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 2.0 GHz";
e) Surges Common and differential mode : To comply with IEC 61000-4-5 {2001} "Test & Measurement techniques for Surge immunity tests" under test levels of 0.5KV for differential mode and 1 KV for common mode;
f) Radio frequency common mode: To comply with IEC 61000-4-6 {2001} "Immunity to conducted disturbances induced by radio frequency fields" under the test level-2 {3 V r.m.s.}; clamp injection method for DC lines and Signal Control lines.

Note: - For tests for checking compliance to above EMC requirements, the method of measurement shall be in accordance with TEC Standard No.SD/EMI-02. and the references mentioned therein.

2.10 MTBF/MTTR

The MTBF and MTTR (predicted and observed values) figures shall be worked out by the equipment supplier as per QA document QM-115 and based on these figures, the maintenance spares for three years or for the period as specified by the tendering authority, shall have to be specified by equipment supplier.

Part-2

Chapter - 3

Repeater System Specifications

This chapter describes the system specifications for various types of Repeaters

3. **System Specifications**:

3.1 The repeater may of the following types:

a) Channel selective: atleast 2 channels
b) band selective: low power / high power
c) Multi-sub band repeater
d) Frequency converting
e) Fibre Optic Repeater

The repeater may also be classified based on its place of use i.e. indoor repeater and outdoor repeater.

3.1.1 Channel selective repeaters:

A Channel selective repeater amplifies and repeats multi-channel signals within the specific frequency band. The channel selective repeater shall be programmable to select the channel frequency (ies) out of the frequency band. The various options shall include channel selection of at least 2 channels in 900 MHz band or dual band (900 MHz & 1800 MHz).

3.1.2 Band selective repeaters:

A band selective repeater amplifies and repeats the entire band within the specific frequency band. The band of the repeater shall be selectable at the time of deployment out of the frequency band ranging from 2 TO 15 MHz band in 900 MHz or dual band (900 MHz & 1800 MHz). Following options shall be available to select according to power levels:
Indoor:

i) Low Power : atleast 10 dBm
ii) High power: atleast 20 dBm

Out door

i) Low Power: atleast 20 dBm
ii) High power: atleast 33 dBm

3.1.3 Multi-sub band repeater:

Multi-sub band repeater amplifies and repeats multi sub-bands out of a frequency band. Multi sub-band upto 2 shall be possible.

3.1.4 Frequency Converting repeater:

The Frequency Converting repeater provides output power levels comparable to GSM base stations. The frequency translating technology used in repeaters permits high gain of upto 105 dB without the high antenna isolation requirements of conventional repeaters. The Frequency Converting repeater consists of two units, a Donor unit placed close to the BTS and a Remote unit at the selected site. The Frequency Converting repeaters shall be configurable for 1 or 2 GSM-carriers. The power output shall be 40 dBm (10 watts) / 37 dBm (5 watts) at antenna port of each channel. Built in Spurious Detection Circuit shall be available. Manual, Local RS 232 & remote NMS available with easy GUI interface shall be available. Frequency Range shall be in 900Mhz or 1800Mhz.

3.1.5 Fibre Optic repeaters:

I. Indoor optical repeater: Indoor optical repeater is used for providing indoor coverage in medium size office buildings, hospitals, convention centres etc. up to a distance of 20 kms. It is deployed in places where only one band signal is required to be enchanced. Single Master Optical Unit (MOU) shall be able to connect up to atleast six (ROU) Remote Optical Units (each using one / two fibers). There shall be built in Spurious Detection Circuit. Wavelength Division Multiplexing (WDM) technique shall be used to enhance the optical fibre utilisation and only single fibre is used for uplink and downlink signal.

Specifications:

i)	Power output	+16 dBm	
ii)	Frequency Range:	900MHz / 1800MHz	
iii)	Gain:	65 dB (minimum)	
iv)	Optical Link Wavelength	Forward Link : 1310 nm	Reverse Link : 1550 nm
v)	Fibre cable	Single mode	
vi)	Fibre Connector	FC / APC	
vii)	Optical output power	-6 dBm	
viii)	Manual, local RS 232 & remote NMS shall be available with easy GUI interface.		

II. Outdoor optical repeater: Specifications same as above with power output of +37 dBm (5 Watts) / +40 dBm (10 Watts) / +43 dBm (20 Watts)

III. Dual band GSM 900 MHz and 1800 MHz optical RF repeater for point-to-point indoor Distributed Antenna System: It uses single-mode fibre and is suited for applications where large signal coverage is required, such as high-rise office buildings, hotels, shopping malls, underground tunnels, airports and convention centres.

The BTS Interface Unit (BIU) is connected to the antenna port of the BTS through a directional coupler. This BIU interfaces with Optical Interface Units (OIU) which corresponds to multiple Remote Optical Units (ROU) using two expansion shelves of OIU. The Optical Interface Unit (OIU) converts the downlink RF signals to optical signals, and vice-versa for the uplink signals.

3.1.6 RF

Specifications

Common Parameters

a) Frequency Range

GSM 900 Band	i) 890 – 915 MHz (Uplink)
	ii) 935 – 960 MHz (Downlink)
GSM 1800 Band	i) 1710 – 1785 MHz (Uplink)
	ii)1805 –1880 MHz (Downlink)
b) TX RX separation	i) 45 MHz in 900 MHz Band
	ii)95 MHz in 1800 MHz Band
c) Adjacent channel spacing	200 KHz
d) Total system Gain	
(The total gain in receive and transmit path for forward and reverse link) in both Directions (Other than optical and frequency repeaters)	
	i) 70 dB (Indoor)
	ii) 90 dB (Outdoor)
e) Auto Power Control range	20 dB
f) Gain Adjustability	Min 30 dB, in steps of 1 dB
g) Group Delay	9 μs max
h) Input and output Impedance	50 ohms (nominal)
i) VSWR of I/O port	1.5 Max
j) Type of Circuits	Fully Solid-State

3.1.7 System Parameters

a) System (Average) Gain - (dB)	+ < 20
b) Gain Flatness and Variation - (dB)	< 4
c) Output ROU power Downlink - [dBm]	+20
d) System Noise Figure Uplink - [dB]	6
e) System Noise Floor Downlink - [dBm]	-101
f) Spurious & intermodulation - [dBm]	-36 upto 1 GHz, -30 upto 12GHz
g) System Group Delay [μSec] (Excluding Cable)	< 5
h) System Input Power, DL - [dBm]	+10
i) At BIU RF input w/o 40 dB coupler	+50
j) Maximum Input Power, Uplink - [dBm) (At ROU RF input)	-10
k) Attenuation Adjustment, Independent, Uplink/Downlink	0 - 3 0, in 1 dBm step

3.1.8 BTS Interface Unit (BIU)

a) RF Connectors	SMA (Female)
b) Input Power Level	0 to +10 dBm
c) Input Signal Interface	Duplexer

3.1.9 Optical Interface Unit (OIU)

Optical Loss - [dB]	< 2.0
Fibre Distance - [Km]	< 4
RF Connectors	SMA-Female
Single-Mode Fibre, Connectors	1 pair, FC / APC
LED Alarm and Status Indicators	Status for each port

3.1.10 Supervisory Module

RS-232 Interface	DB-9 connector
Remote Alarm Connector	RJ-11, RJ45
Status Indicators	VFD Display

3.1.11 Remote Optical Unit (ROU)

RF Connectors	2 x N-Female
Single-Mode Fibre, Connectors	1 pair, FC / APC

3.2 Transmitter Specifications

3.2.1 Frequency stability of Carrier $\pm$ 10 ppm or better

3.2.2 Spurious Emission

The average power of any single spurious measured in a 3 KHz bandwidth shall not be greater than:

250 nW (-36 dBm) in the relevant MS and BTS transmit frequency bands for a GSM 900 MHz repeater at offsets of >100 KHz from the carrier.

1μW (-30 dBm) in the relevant MS and BS transmit frequency bands for a GSM 1800 MHz repeater at offsets of >100 KHz from the carrier.

Outside of the relevant transmit bands, the power measured in the bandwidths according to table E.1 below, shall not be greater than:

250 nW (-36 dBm) in the frequency band 9 KHz – 1 GHz.

1μw (-30 dBm) in the frequency band 1 – 12.75 GHz.

Table: E.1

Band	Frequency offset	Measurement bandwidth
100 kHz – 50 MHz	-	10 KHz
50 MHz – 500 MHz	-	100 KHz

above 500 MHz outside the relevant BS Transmit band or MS Transmit band	(Offset from edge of the relevant above band) > 0 MHz ≥ 2 MHz ≥ 5 MHz ≥ 10 MHz ≥ 20 MHz ≥30 MHz	10 KHz 30 KHz 100 KHz 300 KHz 1 MHz 3 MHz

3.2.3 Intermodulation products

At maximum repeater gain, with two continuous static sine wave input signals in the operating band of the repeater, at equal levels which produce the maximum rated power output per carrier, the average power of any intermodulation products measured in a 3 kHz bandwidth shall not be greater than:

a) For repeaters with output power of upto 20 dBm
   250 nW (-36 dBm) in the frequency band 9 KHz – 1 GHz.
   1μW (-30 dBm) in the frequency band 1 – 12.75 GHz.
b) For repeaters with output power > 20 dBm : -16 dBm

When the two input signals are simultaneously increased by 10 dB each, the requirements shall still be met. The requirement applies to all ports of the repeater

3.2.4 Out of band gain

The following requirements apply at all frequencies from 9 KHz to 12.75 GHz excluding the relevant transmit bands.
The net out of band gain in both directions through the repeater shall be less than +50 dB at 400 KHz, +40 dB at 600 KHz, +35 dB at 1 MHz and +25 dB at 5 MHz offset and greater from the edges of the BTS and MS transmit bands.

3.2.5 Protection — Tx shall be protected against infinite VSWR

3.2.6 Cooling of the Transmitter — Natural

3.2.7 Output RF Connector — N Type

3.3 Receiver Specifications:

3.3.1 Receiver Noise Figure — 6.0 dB Max

3.3.2 Receiver Overload — - 30 dBm

3.3.3 Intermediate Frequency — 70 MHz (For GSM 900 MHz band)
70/140 MHz (For GSM 1800 MHz band)

3.3.4 LO frequency stability	$\pm$ 10 ppm or better
3.3.5 IF bandwidth	Based on the number of channels

3.4 Power Supply

3.4.1 Input supply:	Nominal power supply is 220 V AC. The Equipment shall work without any degradation in performance over the AC variation from 160 – 270 V (50 $\pm$ 2 Hz) Secondary DC voltages may be derived as per the equipment requirement.
3. 4.2 **Protection**	The derived DC voltages in the equipment shall have protection against over voltage, short circuit and overload.
3. 4.3 **Visual alarm**	There shall be visual indication for output under Voltage.
3. 4.4 **Power consumption**	Power consumption shall be minimal. Actual power consumption shall be furnished by the supplier.
3. 4.5 **Back up battery (Indoor as well as outdoor)**	The **Outdoor RF repeaters** shall be provided with a maintenance free battery in a separate enclosure which is to be mounted outdoor on the same mast on which the repeater is to be mounted. It shall form the integral part of the repeater system. It shall be capable of providing 4 hours of continuous backup in absence of AC power source. Battery shall be of VRLA type.
3. 4.6 **Battery Charger (Optional)**	The battery charger shall operate from 160 -270 V AC source and shall be supplied along with the equipment. It shall be possible to charge the battery to 90% capacity with a charging time not exceeding 10 hours.

3.5 Alarms & Monitoring

3.5.1 Local Supervision for Indoor and outdoor repeaters.

Built-in Test Equipment (BITE) for monitoring parameters such as Transmit power, Receive RF level and health of TLO and RLO shall be provided. The details of all parameters monitored and methodology of measurement shall be indicated.

3.5.2 Visual Indications for medium power Indoor repeaters and all outdoor repeater.

Visual indication shall be provided for parameters such as equipment failure, DC failure, AC failure, Transmit power low, TLO and RLO unhealthy. The explanation of alarms provided shall be given. Individual alarm or grouping of alarms may be provided. If grouping of alarms is done, it shall be possible to isolate alarm though BITE.

3.6 Remote Configuration & Monitoring Console (Outdoor Repeater system).

The system shall perform centralised remote management of all the repeaters under its network. It shall have capability to configure and monitor all the repeaters remotely via GSM modems built into the RF Repeaters from a distant Repeater Management Station (RMS). Alarm events shall be recorded at RMS using SMS mode and parameter monitoring and configuration shall be done through dial-up mode of GSM Modem. Each repeater shall be monitored within 5 seconds maximum. The system shall have instant alarm recording capability. It shall also have routine alarm monitoring facility in a regular interval. There shall also be RS232 interface availability in the repeater for the user to communicate locally.

3.6.1 System features

The system shall have following features

1. It shall provide easy GU interface between the user and the repeater.
2. Shall have the Configuration and monitoring capability remotely as well as locally.
3. Configuration ability: Setting of different repeaters parameters for the proper operation of the repeater i.e.
    a. Setting/ reading of RF parameters
    b. Setting of real time clock.
4. It shall have the capability to configure the following parameters:
    a. Repeater Identity Number: User shall be able to assign unique number to repeater for their reference.
    b. Repeater site address: User shall be able to assign complete address of location (maximum 30 characters) where repeater is installed.
    c. Start channel of sub-band: Lower edge frequencies of a sub-band.
    d. Stop Channel of sub-band: Upper edge frequency of a sub-band.
    e. Attenuation: User shall be able to adjust the system gain by setting the attenuation.
    f. Maximum system output Power: As desired by the user
    g. PA ON/OFF: User shall be able to set the PA as 'ON' and 'OFF' for testing at the time of installation
    h. RMS phone Number: The phone number of the central station where the repeater shall send all alarms and status to Repeater Management system.
    i. Real time clock: For the synchronisation with the user computer RTC.
    j. SMS alert: Service engineers mobile number shall be programmed for SMS alert for alarms from the repeater.
    k. Oscillation 'ON/OFF': Repeater shall detect oscillation problem and correct it by this feature.

5. It shall have the capability to monitor parameters status/alarms as follow:

Status	
Channel	Configured Start & stop channel number of a sub-band
Frequencies	Frequencies corresponding to Channel Numbers
Attenuation	Attenuation configured by the user
Used Gain	Used gain of the system
Output Power	PA output power
Output Power Limit	Alarm shall be generated if output power exceeds output power limit set by user.
Minimum RSSI	Minimum signal received so far.
Present RSSI	Present signal level received.
Maximum RSSI	Maximum signal received so far.
PA Temperature	Current temperature of down link PA.
System Temperature	Current temperature of the system.

ALARMS	
Alarm	**Event**
PA off (manual)	When the PA is switched off by the user
PA off (auto)	When the PA switches off automatically if temperature exceeds ***configurable value***
PA power high	When PA power exceeds output power limit set by the user.
PA temperature High	When PA temperature exceeds ***configurable value***
LO fail	When LO synthesiser fails/unlock
AC Fail	When AC supply fails
DC Fail	When DC supply fails
Battery Low	When battery goes low
System temperature High	When the system temperature exceeds ***configurable value***
Door Open	Whenever Repeater door is open
LNA Fail	When LNA fails
VSWR Alarm	When reflected power is higher than the stipulated value.

Chapter-4

Distribution Components Specification

4.0 This section defines the detailed specification of various passive components, which may form the required network of Distributed Antenna System

4.1 Specifications for Antenna

4.1.1 Indoor Antenna

Sl. No.	Parameters	Ceiling Omni Antenna - Dual Band	Ceiling Directional Antenna Dual Band	Panel Antenna Dual Band	Ceiling Strip type Antenna Dual Band
1	Frequency Range	800~960 MHz, 1710-1900 MHz	800~960 MHz, 1710-1900 MHz	800~960 MHz 1710-1900 MHz	800~960 MHz, 1710-1900 MHz
2	VSWR	<1.5	<1.5	<1.5	<1.5
3	Input Impedance	50 Ohms	50 Ohms	50 Ohms	50 Ohms
4	Typical Gain (dBi)	2dBi	2 /4/5.2/ 5.5 dBi	7.5 dBi / 8.5 dBi	6 dBi
5	Polarization Type	Vertical	Vertical	Vertical	Linear
6	Horizontal Bandwidth	To be Specified by the Supplier	To be Specified by the Supplier	To be Specified by the Supplier	To be Specified by the Supplier
7	Vertical Bandwidth	To be Specified by the Supplier	To be Specified by the Supplier	To be Specified by the Supplier	To be Specified by the Supplier
8	Max. Input Power (W)	50/100	50/100	100	50
9	Connector Type	N Female with 35 cm jumper cable	N Female with 35 cm jumper cable	N Female with 35 cm jumper cable	SMA female
10	Ground Type	DC Ground	DC Ground	DC Ground	DC Ground

4.1.2 Outdoor Antenna

SL. No.	Parameters	Omni Directional Antenna Dual Band	Directional Parabolic Antenna Dual Band	Direction Panel Antenna Dual Band	Yagi Dual Band Antenna
1	Frequency Range	800~960 MHz, 1710-1900 MHz	800~960 MHz, 1710-1900 MHz	800~960 MHz, 1710-1900 MHz	800~960 MHz, 1710-1900 MHz
2	VSWR	<1.5	<1.5	<1.5	<1.5
3	Input Impedance	50 Ohms	50 Ohms	50 Ohms	50 Ohms
4	Typical Gain (dBi)	8/11 dBi	18dBi	17 dBi	8/10/12 dBi

SL. No.	Parameters	Omni Directional Antenna Dual Band	Directional Parabolic Antenna Dual Band	Direction Panel Antenna Dual Band	Yagi Dual Band Antenna
5	Polarization Type	Horizontal	Vertical	Vertical or Horizontal	Vertical or Horizontal
6	Horizontal Beamwidth		< 20.4 degree	<25 degree	To be Specified by the supplier
7	Vertical Beamwidth	6.5 degrees	< 20.4 degree	-	To be Specified by the supplier
8	First Upper Side Lobe Suppression	-	< -18dB	< -17dB	-
9	Front to Back Ratio	-	25dB	30dB	-
10	Max. Input Power (W)	50 W	100W / 200 W	200W	100W
11	Connector Type	N Female	N Female	N Female	N Female
12	Lightning Protection	DC Ground	DC Ground	DC Ground	DC Ground
13	Ground Type	DC Ground	DC Ground	DC Ground	DC Ground
14	Azimuth , Elevation	-	± 5 degree	-	-

4.2 Power Dividers and Couplers

Sl. No.	Parameters	Power Divider		Broad Band Power Couplers	High Power Broad Band Power Couplers
1	Type	2, 3, 4 Way		7db,10db,15db,20dB	15/20/25/30/35/40/45/50/70 dB
2	Frequency	800~960 MHz, 1710-1900 MHz		800~960 MHz, 1710-1900 MHz	800~960 MHz, 1710-1900 MHz
3	Insertion Loss 2 Way 3 Way 4 Way	**Without Power Distribution losses** 0.25 dB 0.40 dB 0.50 dB	**With Power Distribution losses** 3.5 dB 5.0 dB 6.5 dB	< 0.1 dB	< 0.1 dB
4	VSWR	<1.5	<1.5	< 1.5	< 1.5
4	Impedance	50 Ohms	50 Ohms	50 Ohms	50 Ohms
5	Connector	N-Female	N-Female	N-Female	N-Female
6	Max Power Handling	100 W	100 W	100W	200W

Chapter - 5

Tendering Information

5. At the time of tendering the equipment, the tendering authority may take a decision on the following issues/points:

5.1 The tendering authority may ensure that repeaters are deployed only to provide coverage in areas as envisaged in this document. It shall not be used as a substitute for BTSs. The detailed Link budget calculations shall be done along with that for the BTS. It shall be clearly shown that there will be no adverse effect on cell coverage / capacity by deploying repeaters, and if any effect is there, it is taken into consideration in overall planning. The typical examples of link budget calculations for 900 MHz repeater, optical repeater along with uplink and down signal flow diagrams are enclosed as annexure-I. Further, a typical example of indoor coverage enhancement, depicting the signal levels and attenuation at various stages, is enclosed as annexure-II. Actual calculations need to carried out as per site/field conditions and requirements.

5.2 Tendering authority may get the actual RF survey and planning conducted prior to system planning for each site and may also identify the sites likely to cause interference with the already working wireless networks. It may also be indicated whether repeaters are required to be provided for coverage to the shadow regions/dark spots.

5.3 In NFAP the frequency band 890-915 MHz paired with 935-960 MHz in 900 band and 1710–1785 MHz paired with 1805-1880 MHz in 1800 band have been allocated at present. Any other frequency band, allocated by WPC, may be specified, if required. Tendering authority shall also specify the RF carriers, which may not be contiguous, for which the repeater shall operate.

5.4 The tendering authority may indicate type of repeater required out of the following:

a) Channel selective: up to atleast 2 channels
b) band selective : low power/ high power
c) Multi-sub band repeater
d) Frequency converting
e) Fibre Optic Repeater

The variable parameters such as power, frequency band, gain etc. shall also be specified according to need or allow the defined parameters in case of turnkey solution.

It may not be advisable at present to use Multi-sub band repeater for more than three sub-bands due to complexity, size and economy. The tendering authority may indicate whether Multi-sub band repeater is required for 2/3 sub-bands.

5.5 The tendering authority may also indicate type of Antenna, Power coupler, Divider etc. and choice of variable parameters of the GR or allow the defined parameters in case of turnkey solution.

5.6 The tendering authority may indicate the type of power supply on which the equipment shall operate. It may also indicate whether any external power plant, if required, will be part of it or not and its technical requirements. It may also indicate detailed requirements for backup battery & Battery charger, like backup period, provision of charging from SPV, charging time etc., as per the actual requirements.

5.7 Provision for Built-in Test Equipment (BITE) for monitoring and visual indications may not be available/required in case of indoor type of repeater hence the tendering authority may specify if such a requirement is there.

5.8 If required, the tendering authority may specify the type of north-bound interface, (e.g. SNMP, CORBA, TCP / IP, CMIP etc.), the OMC should support to enable it to work with a remote NMS.

5.9 Field Proveness: The tendering authority may mention the requirement of equipment being deployed in multiple countries and networks & period of deployment. This may be mentioned as, "The equipment should have been field deployed commercially across multiple countries and networks & for a reasonable period of time at least six months".

5.10 Interference to existing networks: Tendering authority may ask the vendor to provide details of provisions made by them to ensure that there is no interference with the existing systems, wherever necessary.

5.11 The versions of all the documents mentioned in this GR may be reviewed and updated, if necessary.

5.12 The tendering authority at the time of tendering may specify if there is any requirement for repeaters with optical fibre in the distribution network.

5.13 The period for which the maintenance spares have to be quoted by the supplier may be specified by the tendering authority.

5.12 For testing the performance of Repeaters, the requirement of the test instruments may be indicated. It shall be a compact portable unit, operated with internal rechargeable battery for minimum 2 hours. It should have following testing capabilities / features:

- Compatible to GSM Phase 2+
- Testing of interfaces.
- The measurement of GSM parameters shall be possible without interrupting the network operation.
- Measurement of Antenna Gain, Feeder cable attenuation, VSWR, Return Loss etc.
- Power Meter with Sensor, for power measurement.
- Functionality of Spectrum Analyser
- Functionality of CW Signal Generator

NOTE : *TEC validation of the equipment is done under test/simulated conditions. Field Trial also is done with partially installed system and with limited number of test subscribers. It may not truly reflect the performance of the system in the field. Hence, the network (of which the equipment covered under this GR is a part) shall be retested for its performance after its complete commercial deployment under loaded condition, for a suitable time period. Accordingly, necessary provision may be made in the tender.*

Abbreviations

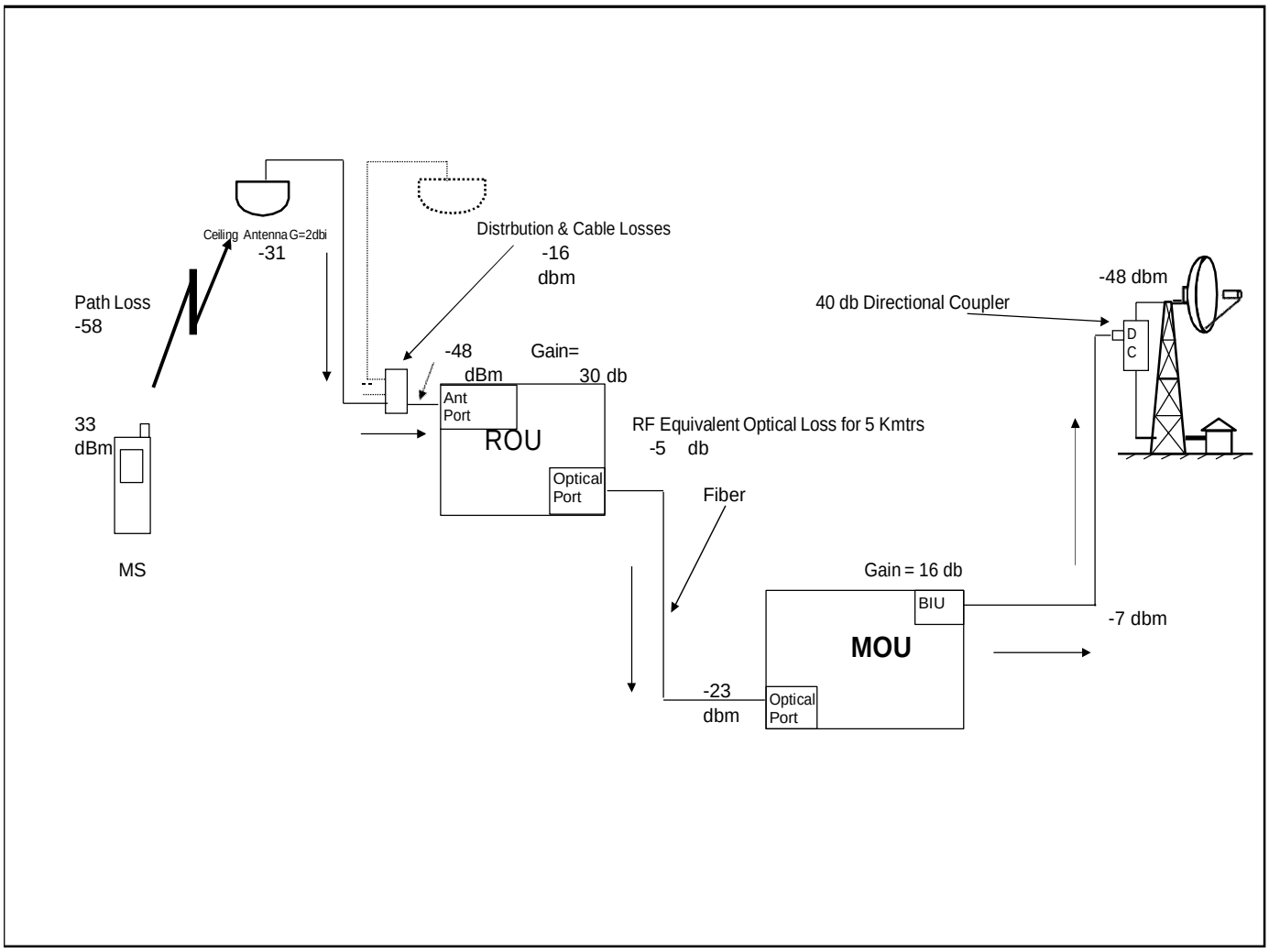
RF	Radio Frequency
GSM	Global System for Mobile Communication
MTNL	Mahanagar Telephone Nigam Limited
BSNL	Bharat Sanchar Nigam Limited
MS	Mobile Station
BTS	Base Transceiver Station
MTBF	Mean Time Between Failures
OMC	Operation & Maintenance Centre
EMC	Electromagnetic Compatibility
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
MOU	Master Optical Unit
WDM	Wavelength Division Multiplexing
ROU	Remote Optical Units
OIU	Optical Interface Units
BIU	BTS Interface Unit
BITE	Built-in Test Equipment
RMS	Repeater Management System
RSSI	Received Signal Strength Indicator
RTC	Real time clock
SNMP	Simple Network Management Protocol
TCP/IP	Transmission Control /Internet Protocol
NMS	Network Management System

Typical Link Budget for Optolink - ROU 16 with 0 dBm Omni Antenna (no ALC in Uplink) 900MHz

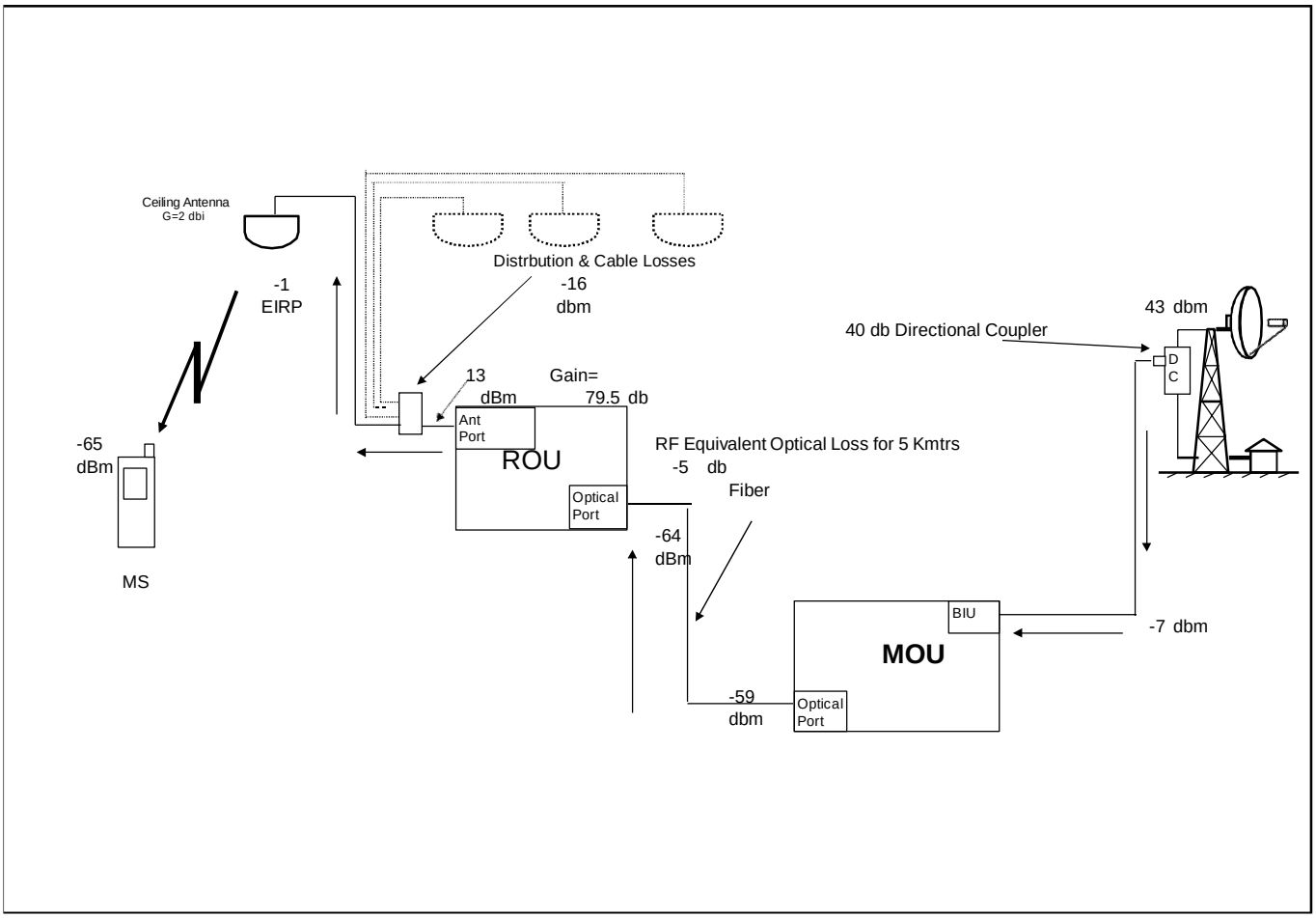
DL LINK (desired)			UP LINK (desired)		
S.No.	**Description**	**Value**	**S.No**	**Descriptipn**	**Value**
1	BTS out put power (dBm)	43	1	MS TX Output Power (dBm)	33
2	BTS Coupler (dB)	-40	2	Interference Degradation Margin (dB)	-3
3	Cable Loss from MOU to Directional Coupler	-1	3	Head Loss (dB)	-3
4	Manual Attenuator (dB)	-10	4	Path Loss (dB) @ 915 Mhz for a distance in mtrs = 20	-58
5	Gain in BIU (dB)	-3	5	Received EIRP -31	
6	Gain in RF MB (dB)	-30	6	Repeater Coverage Antenna Gain (dBi)	2
7	Gain in OIU (dB)	-18	7	Cable Loss (dB)	0
4	Out put from MOU (Loss=61db) (dBm)	-59	8	Distribution Loss (Cables +splitters etc)	-16
5	Optical loss (dB)	-5	9	Input to ROU16 from MS Power Per Carrier (dBm)	-48
6	Input to ROU16 from BTS side (dBm)	-64	10	No. of Carriers = 2	
7	Over all ROU Gain =80 db	80	11	ROU Gain (dB)	30
8	**ROU16 O/P Power Per Carrier PPC (dBm)**	**13**	12	Optical loss (dB) for 5 K mters i.e RF Loss)	-5
9	**No. Of Carrier = 2**		13	Input at MOU (dBm)	-23
10	Ditribution Loss	-16		Gain in OIU (dB)	25
11	Cable Loss (dB)	0		Gain in RF MB (dB)	-30
12	Repeater Coverage Antenna Gain (dBi)	2		Gain in BIU (dB)	31
13	EIRP	-1		Manual Attenuator (dB)	-10
14	Path Loss (dB) @ 960 Mhz for a distance (mtrs) = 20	-58	14	MOU out in dBm (Gain=14db)	-7
15	Head Loss (dB)	-3	19	BTS Coupler (dB)	-40
16	Interference Degradation Margin (dB)	-3	20	Cable Loss from MOU to Directional Coupler	-1
17	**MS RX Input Power (dBm)**	**-65**	21	**UP Link Signal into BTS dBm**	**-48**

TYPICAL UP LINK Signal Flow Diagram

Annex I



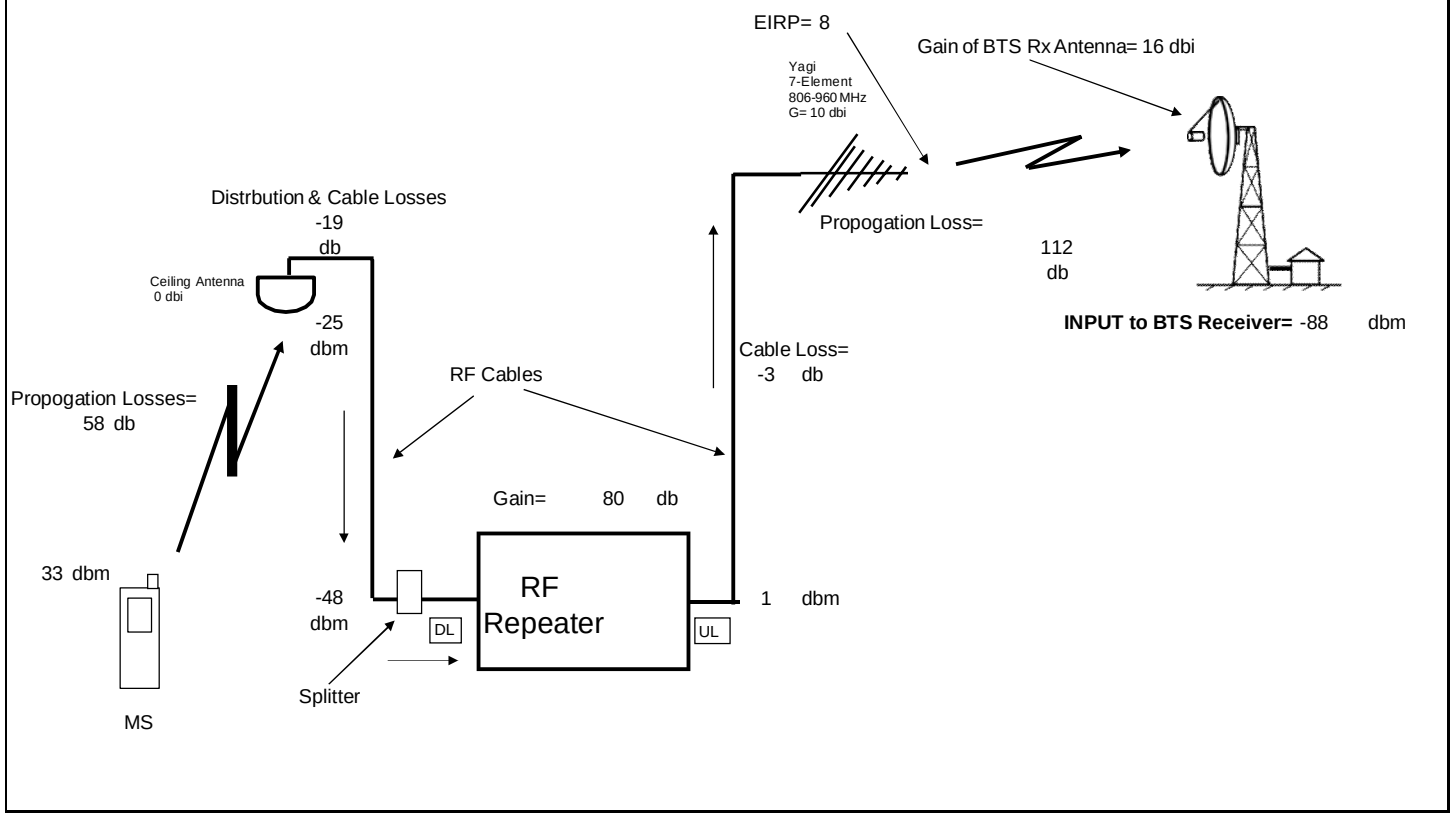
TYPICAL Down LINK Signal Flow Diagram



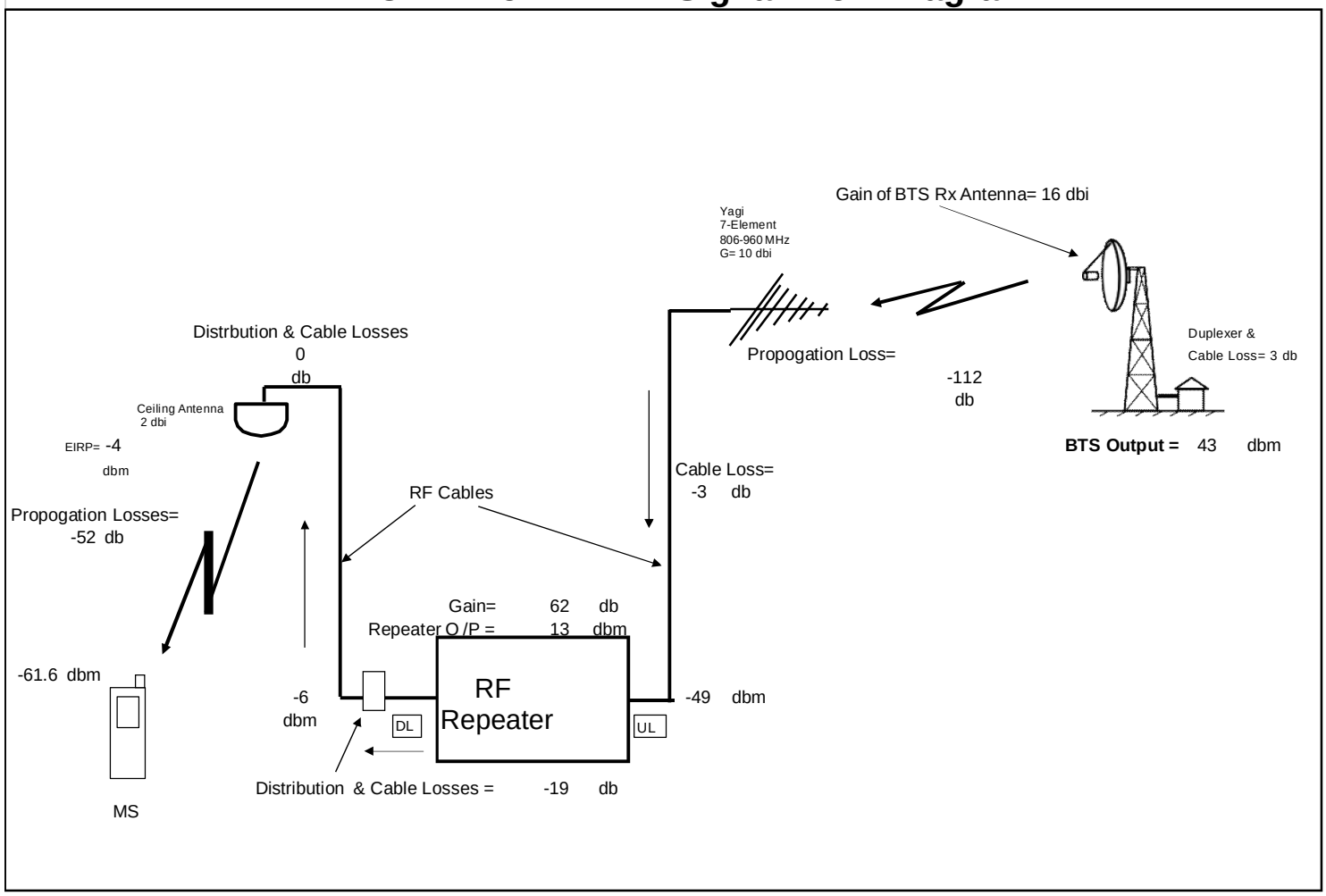
Typical Link Budget for GSM-900 Repeater

DOWN LINK				UP LINK			
S.No.	Description		Value	S.No	Descriptipn		Value
1	BTS Tx Output Power (dBm)		43	1	MS TX Output Power (dBm)		33
2	BTS Cable & Duplexer Loss (dB)		-3	2	Interference Degradation Margin (dB)		-3
3	BTS Tx Antenna Gain (dB)		16	3	Head Loss (dB)		-3
4	Path Loss (dB) @ 960 Mhz for distance (Kmtrs) =	10	-112	4	Path Loss (dB) @ 915 Mhz for distance (mtrs) =	10	-52
5	Repeater Donor Antenna Gain (dBi)		10	5	Repeater Coverage Antenna Gain (dBi)		2
6	Cable Loss (dB)		-3	6	Distribution & Cable Loss (dB)		-19
7	Input to Repeater from BTS (dBm)		-49	7	Input to Repeater Power Per Carrier (PPC) from MS (dBm)		-48
					No. of Carriers = 4		
8	Repeater D/L Maximum Gain (dB)		72	8	Repeater U / L Maximum Gain (dB)		80
				9	Attenuation Inserted in U/L path		31
9	Repeater Used Gain in D/L path (dB)		62	10	Repeater Used Gain in U/L path (dB)		49
10	**Repeater O/P Power per carrier (PPC) (dBm)**		**13**	11	Repeater U / L Output Power to BTS (dBm)		1
	No. of Carriers =	**4**					
11	Distribution & Cable Losses (dB)		-19	12	Cable Loss (dB)		-3
12	Repeater Coverage Antenna Gain (dB)		2	13	Repeater Donor Antenna Gain (dB)		10
13	EIRP of Repeater		-4	14	EIRP of Repeater		8
14	Path Loss (dB) for 5 mtr @ 960 Mhz only		-52	15	Path Loss (dB) for 10 K.M. @ 960 Mhz only		-112
15	Head Loss (dB)		-3	16	BTS Rx Antenna Gain (dB)		16
16	Interference Degradation Margin (dB)		-3	17	BTS RX Antenna Diversity Gain (dB)		3
				18	BTS Cable & Duplexer Loss (dB)		-3
17	Input to MS (dBm)		-61.6	17	Input to RX of BTS (dBm)		-88

TYPICAL UP LINK Signal Flow Diagram



TYPICAL Down LINK Signal Flow Diagram



Typical Indoor Coverage Enhancement