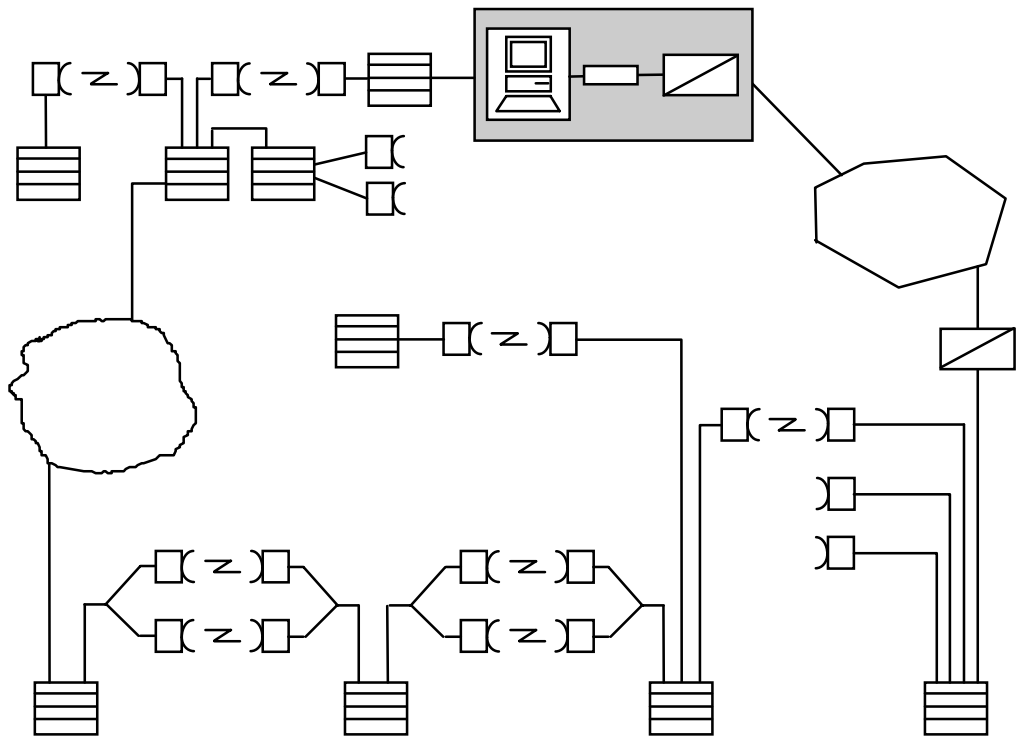


MINI-LINK E

Planning and Engineering Manual



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1 Introduction

1.1 General

This manual outlines how to realize a MINI-LINK microwave communication network, emphasizing the MINI-LINK E product range. The purpose is to support network planning and realization.

Detailed, technical information regarding equipment and tools is given in the MINI-LINK E Technical Description Manual. The entire MINI-LINK E programme is presented in the MINI-LINK E Product Catalogue. Please refer to the reference list in section 1.5.

1.2 Manual Structure

This manual is divided into chapters which correspond to the logical order of tasks to be carried out when planning a MINI-LINK microwave communication network.

The *Network Planning* chapter (2) describes the general background concerning network planning and also describes which measures to take before the configuration work can begin.

The *Configuration* chapter (3) describes how to configure a MINI-LINK E system regarding hardware units such as MMUs and SMUs.

The *O & M Network* chapter (4) describes how to supervise a MINI-LINK E network.

The *Traffic Routing* chapter (5) explains the possibilities with software controlled traffic routing and describes how to simulate the traffic routing setup by using the MINI-LINK Traffic Routing Guide.

The *Engineering* chapter (6) describes how to fill in the *Installation Data Forms* (7). When these forms are filled in they are used as input to the installation work.

1.3 Terminology

Access module	An indoor module housing units for one or several MINI-LINK E terminals. Up to four radio units may be served by one access module.
AM	Access Module
AMM	Access Module Magazine
BTS	Base Station Transceiver
EAC	External Alarm Channel - the alarm channel used within a site. See chapter 4 for further information.
Hop	A radio link connection with a pair of communicating terminals.
MIM	MINI-LINK Installation Manager - a PC based software package used for basic set-up and installation of MINI-LINK E equipment.
MINI-LINK Traffic Routing Guide	A software used for simulating the traffic routing setup of traffic signals between the terminals in one access module.
MMU	Modem Unit
MNM	MINI-LINK Network Manager - a PC based software package recommended for operation and maintenance centres, MNM includes centralized management plus all MSM functionality..
MOMS	Microwave Radio Operation and Maintenance System - a UNIX based software package for the same purposes as the MIM, MNM and MSM software packages.
MSC	Mobile Switching Centre
MSM	MINI-LINK Service Manager - a PC based software package used for installation and field service on MINI-LINK E, C and MkII equipment. This includes set-up, local and remote fault tracing and performance monitoring.
Network	All supervised terminals.
Node	Network branching point
O&M	Operation and Maintenance

PC	Personal Computer - IBM compatible.
RAU	Radio Unit.
SAU	Service Access Unit
SMU	Switch Multiplex Unit
Terminal	One side of a radio link connection.
TMOS	Telecommunication Management and Operation Support - a UNIX based system used to operate and maintain a telephony network.
Traffic Routing	Software controlled traffic routing in the back-plane of the AMM.
Unit	An exchangeable part of a system.

1.4 MINI-LINK Workflow

The following figure describes how the MINI-LINK E Engineering Manual can be used together with other MINI-LINK E documentation when planning, realizing and installing a MINI-LINK E microwave radio transport network.

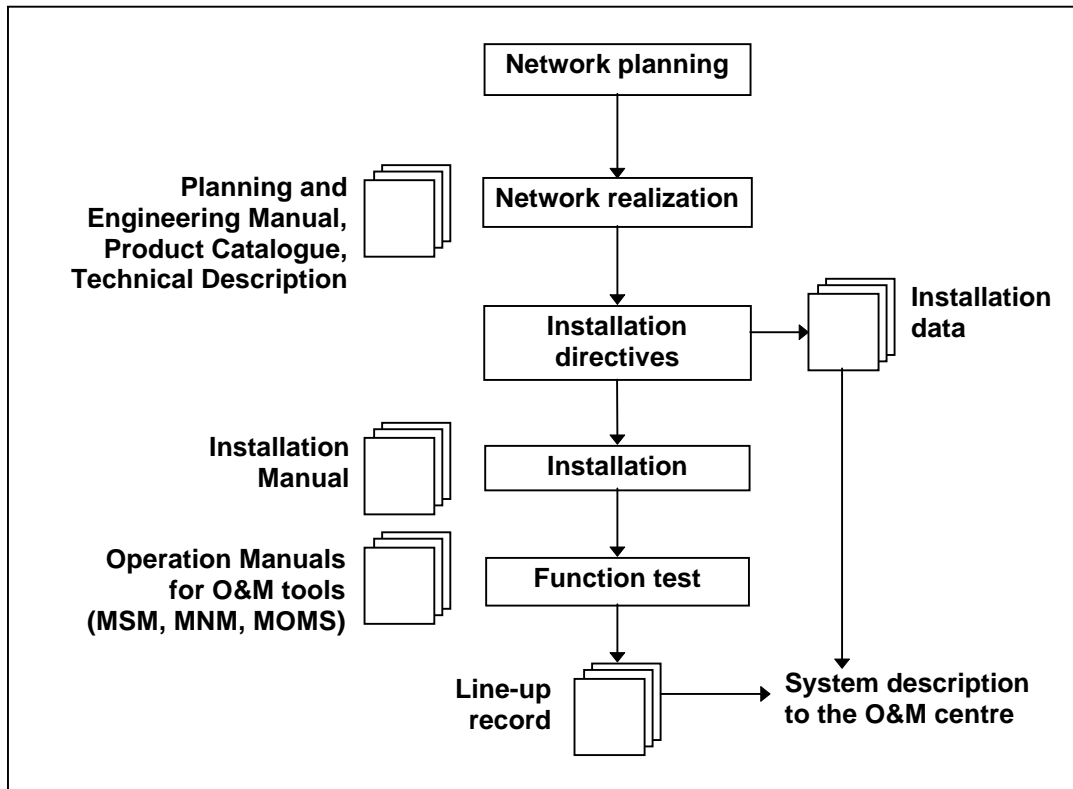


Figure 1-1 Workflow for the planning, realization and installation of a MINI-LINK E network

1.4.1 Network Planning

Network planning includes planning of the traffic capacity of the network, radio frequency allocation, communication quality and availability and the selection of suitable radio components.

The site locations and the paths must be selected considering distances, topography, climate and other aspects having an impact on the radio transmission.

You may use the Ericsson proprietary PC based software MINI-LINK Performance and Availability Prediction Programme for the calculation of path performance and availability.

Chapter 2 of this manual discusses the network planning in some depth. You may always contact your Ericsson representative for further help.

1.4.2 Network Realization

At this stage it is decided for instance how the network should be implemented and how the different equipment items (antenna, power supply, radio module, MMUs, SMUs, etc.) should be connected.

This manual (that is, mainly chapters 3-6) serves as the main documentation support in the realization process. The result of the network realization can be documented in the Installation Data form. The pages required for the Installation Data form (at the end of this manual) may be freely copied for this purpose. They are also available as a computer file for MS Word 6.0a for Windows.

1.4.3 Installation Directives

The information which is required for the installation of the MINI-LINK E network is compiled in the Installation Data form and handed over to the installation staff. Examples of input information are specifications of hardware, network maps from traffic and supervision network planning and the Installation Data from the realization stage.

1.4.4 Installation

When installing the MINI-LINK E network the staff uses the MINI-LINK E Installation Manual as support information. The Installation Manual contains instructions for installation, operation and maintenance. When using O&M tools, for instance MSM or MIM for the software setup, the user's manuals belonging to these tools are also required.

1.4.5 Function Test

The function tests are performed after installation. Support information is found in the MINI-LINK E Installation Manual.

The parameters given as a result of the installation are specified in a Test Record, a document which serves as an acknowledgment of the installation and function tests having been performed properly.

1.4.6 System Description

The Test Record and the Installation Data form a system description for the user's MINI-LINK E system. Other documents of relevance to the system, for instance accessories documents, should be added.

1.5 References

The MINI-LINK E system comprises the following manuals:

Document name	Document number
MINI-LINK E Product Catalogue	EN/LZT 110 2011
MINI-LINK E Technical Description	EN/LZT 110 2012
MINI-LINK E Installation Manual	EN/LZT 110 2014
MINI-LINK MIM, MSM and MNM Operational Manual	EN/LZT 110 2016

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2 Network Planning

2.1 Introduction

The purpose of this manual is to provide a brief description of network planning, that is, the general planning and engineering of microwave radio relay networks. This chapter deals with the configuration of a MINI-LINK network. It is not intended to be a complete guide on how to plan the communication path, but rather to be an introduction to the vast and complex task of this subject.

The description contains some actual calculable formulas which may be used for the planning. They are mainly supposed to facilitate the basic understanding of the task. Extensive networks may require aspects and considerations not mentioned in this chapter. We do strongly recommend that you contact your Ericsson representative for this task. Ericsson may undertake to perform all the required network planning for you.

This section, *2.1 Introduction*, provides a brief introduction to the main components of network planning.

Section *2.2 Radio Wave Propagation* provides a short and concise description of the propagation mechanisms which may be involved in high frequency network planning.

Section *2.3 MINI-LINK Path Planning* discusses the main components and objectives of the planning and engineering of a MINI-LINK communication path.

Generally, the subject of microwave radio transport networks involves a large amount of tasks and decisions which usually, but not always, are related to each other with a certain level of rigidity and complexity. The subject is not an academic one, but it may present different levels of complexity when it is applied in a real situation.

Network planning may generally be considered as a process comprising four main steps: planning, survey, engineering and test.

2.1.1 Planning

The general aspects of the planning stage cover channel capacity, radio frequency allocation, communication quality and availability and selection of suitable radio components. Preliminary site locations and paths may also be considered at this stage.

2.1.2 Survey

The survey stage is closely related to the initial planning stage. It comprises two activities: map and field survey. The purpose of the latter is to confirm the information collected in the former activity, and to add further information not obtainable by a map survey. Suitable site locations and path geometry and topography are preliminary established at this stage.

2.1.3 Engineering

The engineering step is very much concerned with the realization of the network, that is, all quality and availability requirements have to be fulfilled in accordance with the available equipment items.

In order to achieve the final results, propagation and interference calculations should be performed. These calculations are discussed to a certain extent in this chapter. The entire process is very much similar to general iterative calculations, where parameters are adjusted in order to accomplish the performance requirements.

This stage also comprises the final decisions and preparations for the installation of the hardware.

2.1.4 Test

The test is the final step. It is mainly concerned with and important to account for the occurrence of adverse network conditions occasionally experienced in transmission systems.

At this stage only minor modifications to improve the system performance are feasible.

2.1.5 Terminology

Administration	Any governmental department or service responsible for carrying out the obligations undertaken in the Convention of the International Telecommunication Union and the Regulation.
Allocation of a frequency band	An entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radio communication services, or the radio astronomy service under specified conditions. This term also applies to the frequency band concerned.
Assignment of a radio frequency or a radio frequency channel	An authorization given by an administration for a radio station to use a radio frequency or a radio frequency channel under specified conditions.

Decibel loss and gain

The decibel scale was originally used to compare the intensities of sound, but in modern usage the decibel scale is primarily used to compare power or voltage levels.

Decibel is defined as:

$$A[\text{dB}] = 10 \cdot \log\left(\frac{P_{in}}{P_{out}}\right) \text{ or } A[\text{dB}] = 20 \cdot \log\left(\frac{V_{in}}{V_{out}}\right)$$

where P_{in}/P_{out} or V_{in}/V_{out} is the input/output signal ratio.

When $P_{in} > P_{out}$ or $V_{in} > V_{out}$ there is a loss. When $P_{in} < P_{out}$ or $V_{in} < V_{out}$ there is a gain.

Table 2-2 provides a quick reference for power and voltage ratios versus dB.

Network

A microwave radio transport network system containing Terminals and Hops, each divided into groups and sub-groups.

Nomenclature of frequency bands

Radio waves are defined by the Radio Regulations of the International Telecommunication Union as electromagnetic waves of frequencies arbitrarily lower than 3,000GHz, propagated in space without an artificial guide. The frequency 3,000GHz corresponds to a wavelength of 0.1mm.

The radio spectrum is sub-divided into nine frequency bands, which are designated by progressive integers. Table 2-1 is adapted from the Radio Regulations of the International Telecommunication Union.

The frequency region comprising the UHF, SHF and EHF frequency bands is usually called the *microwave* region.

Band number	Symbol	Frequency range (lower limit excl., upper limit incl.)	Corresponding metric subdivision	Metric abbreviations for the bands
4	VLF	3 to 30 kHz	Myriametric waves	B.Mam
5	LF	30 to 300 kHz	Kilometric waves	B.km
6	MF	300 to 3,000 kHz	Hectometric waves	B.hm
7	HF	3 to 30 MHz	Decametric waves	B.dam
8	VHF	30 to 300 MHz	Metric waves	B.m
9	UHF	300 to 3,000 MHz	Decimetric waves	B.dm
10	SHF	3 to 30 GHz	Centimetric waves	B.cm
11	EHF	30 to 300 GHz	Millimetric waves	B.mm
12		300 to 3,000 GHz	Decimillimetric waves	

Table 2-1: Frequency bands according to the ITU Radio Regulations

Power level The definition of *Decibel loss and gain* illustrates the convenience of expressing the ratio between two signals with respect to power using dB. The same definition can, however, be used to express absolute power or voltage levels if a fixed reference level is used.

The power ratio can be written as:

$$A[\text{dB}] = 10 \cdot \log\left(\frac{P}{P_{\text{ref}}}\right)$$

If $P_{\text{ref}} = 1\text{W}$, then A will be given in dBW. If $P_{\text{ref}} = 1\text{mW}$, then A will be given in dBm.

Ratio	Power dB	Power dBW	Power dBm	Voltage dB
1 000 = 10³	30,00	30,00	60,00	60,00
100 = 10²	20,00	20,00	50,00	40,00
10 = 10¹	10,00	10,00	40,00	20,00
9	9,54	9,54	39,54	19,08
8	9,03	9,03	39,03	18,06
7	8,45	8,45	38,45	16,90
6	7,78	7,78	37,78	15,56
5	6,99	6,99	36,99	13,98
4	6,02	6,02	36,02	12,04
3	4,77	4,77	34,77	9,54
2	3,01	3,01	33,01	6,02
1 = 10⁰	0,00	0,00	30,00	0,00
0,5	-3,01	-3,01	26,99	-6,02
0,25	-6,02	-6,02	23,98	-12,04
0,125	-9,03	-9,03	20,97	-18,06
0,1 = 10⁻¹	-10,00	-10,00	20,00	-20,00
0,01 = 10⁻²	-20,00	-20,00	10,00	-40,00
0,001 = 10⁻³	-30,00	-30,00	0,00	-60,00

Table 2-2: Power and voltage ratios expressed in dB

Site The geographical location of a station.

Telecommunication Any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

2.2 Radio Wave Propagation

2.2.1 Relationship between Wavelength and Frequency

The wavelength and the frequency of electromagnetic waves are related according to the following formula:

$$\lambda = \frac{c}{f}$$

λ = Wavelength (in meters)
 f = Frequency, in Hz
 c = The propagation speed of electromagnetic waves in vacuum, $\cong 3 * 10^8$ m/s

If the frequency (f) is expressed in MHz, the wavelength will be expressed in meters according to the following formula:

$$\lambda = \frac{300}{f}$$

2.2.2 Propagation characteristics

2.2.2.1 Introduction

The propagation of radio waves is generally affected by several factors, irrespective of the radio communication service or the specified purpose of telecommunication. These factors are described below.

2.2.2.2 Frequency Effects

The relative importance of the factors influencing the propagation of radio waves mainly depends on the frequency band. In the LF and MF bands (see chapter 1 Introduction, section 1.5 Terminology, Table 2-1) the propagation is strongly influenced by the electrical characteristics of the ground and by the ionospheric conditions. In the VHF and UHF bands the effects from the ionospheric conditions decrease to such an extent that the terrain features and - to some degree - the meteorological characteristics of the troposphere (the lower parts of Earth's atmosphere) begin to dominate. At microwave frequencies the importance of the terrain features and the meteorological characteristics of the troposphere are still predominant. However, above about 6GHz the effects of gas absorption and precipitation must also be taken into account. At frequencies close to 10GHz the effects of precipitation begin to dominate. Gas absorption starts influencing at about 22GHz, where the water vapour shows a characteristic peak.

2.2.2.3 Terrain Effects

When radio waves propagate near the surface of the Earth, their characteristics are dominated by the electrical characteristics of the Earth and by the topography of the terrain, including the vegetation and man-made structures.

2.2.2.4 Tropospheric Effects

The gaseous constituents of the atmosphere influence the propagation of radio waves both by absorbing energy and by variations in the refractive index.

Variations in the refractive index of the atmosphere cause radio waves to reflect, to refract and to scatter. The magnitude of these effects depends, of course, on the frequency.

2.2.2.5 Multipath Effects

The term "multipath effects" applies to those cases in which the effective received signal is made up of several components arriving at the receiving antenna over different paths.

The components may have different phases and different amplitudes, and their mutual relationship may also vary continuously with time. Multipath effects result from reflections from buildings, from the surface of the Earth or from horizontal interfaces between different layers in the atmosphere. Multipath effects caused by reflections are responsible for the fast fading observed on microwave radio links. They can seriously degrade the quality of a service.

2.2.2.6 Summary

All four factors have an impact on the transmission. When combined, they ultimately decide whether the dimensioning of the MINI-LINK Hop is satisfactory or not.

2.2.3 Propagation Mechanisms

Depending on the topography and the meteorological conditions, radio waves can be propagated in different ways, normally, but not always, causing attenuation. One of the main tasks of radio engineering is to evaluate the attenuation of the radio signals transmitted between transmitters and receivers.

In order to evaluate the attenuation of the transmitted signals between transmitters and receivers, it is helpful to categorize the propagation mechanisms as follows:

- Free Space Propagation
- Refraction
- Diffraction
- Reflection and Scattering
- Absorption

The following sections will describe the propagation mechanisms in some detail. Calculation formulas will be presented to some degree in order to facilitate the basic understanding of the subject. The path planning will be discussed during training seminars presented by Ericsson staff.

2.2.4 Basic Free Space Transmission Loss

Free space propagation refers to the propagation of an electromagnetic wave in a homogenous, ideal dielectric medium which may be considered to be infinite in all directions.

Free space transmission loss is known as the least possible loss between a transmitter and a receiver. Radio engineers often separate out the free space transmission loss, concentrating more particularly on losses caused by other propagation mechanisms.

Basically, the calculation of the free space transmission loss refers to isotropic point sources at both ends. If these isotropic point sources are replaced by half-wave dipoles or other antennas having a certain gain, the calculations will have to be adjusted for the introduced gains.

Some terms used to designate the radiated power reflect this situation.

EIRP Effective Isotropic Radiated Power designates the power transmitted from an isotropic antenna in a specified direction.

ERP Effective Radiated Power designates the power transmitted from a half-wave antenna.

2.2.5 Refraction

Refraction through the atmosphere is possible because radio waves travel with different velocities in different parts of a medium with varying electrical characteristics. Radio waves travel slower in the atmosphere where the dielectric constant is greater than the dielectric constant of free space.

The dielectric constant depends on the pressure, the temperature and the water vapour content (humidity) of the atmosphere. Normally the values of these meteorological parameters decrease with the altitude. Since electromagnetic waves travel faster in a medium with a lower dielectric constant than in media with higher dielectric constants, the upper part of a wave front tends to travel faster than the lower part, thus causing a downwards deflection of the beam.

In a horizontally homogenous atmosphere the vertical change of the meteorological parameters (and thus the dielectric constant) is gradual. This causes a continuous deflection of the beam, and the beam is gradually deflected away from thinner to thicker air layers, following the curvature of the Earth. Consequently there is a relationship between the radius of the curvature of the radio beam and the true radius of the Earth. The radius of the radio beam curvature is usually called the *effective* or the *equivalent* Earth radius.

There is also a relationship between the effective Earth radius factor (k) and the refractive index of the atmosphere. This means that the factor k accounts for the departure from the straight line connecting two arbitrarily separated points in the atmosphere, with an arc between the points. If an atmosphere can be described by a value k , the radio beam between two arbitrary points can be represented by a straight line. This is illustrated in figure 2-1.

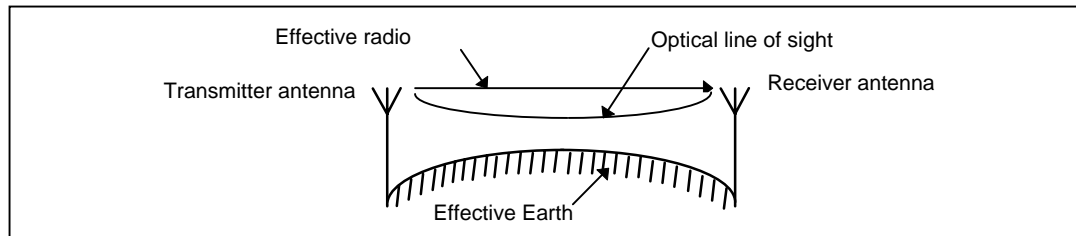


Figure 2-1: The Earth radius factor and the effective Earth radius

As previously mentioned, the deflection of a radio beam is related to the refractive index of the atmosphere or by its refractivity (N).

Refractivity depends on the pressure, the temperature and the water vapour content (humidity) of the atmosphere. Its variation with respect to the height (h) in the atmosphere is called the refractive gradient (dN/dh) and is related to the Earth radius.

In practice, the measured median of the mean gradient in the first kilometer above ground in most temperate regions is approximately $-40N$ units per kilometer. This gives an Earth radius factor of approximately $4/3 = 1.33$ and an effective Earth radius of approximately 8,500km. A negative refractivity gradient indicates decreasing refractivity (and refractive index) with the height in the atmosphere.

The combined effects of refraction and diffraction (see sections 2.2.5 and 2.2.6) will cause obstacle loss. This contribution appears in the link budget as A_o (see section 2.3.7).

2.2.6 Diffraction

Diffraction may occur and increase the transmission loss when the size of an obstacle between a transmitter and a receiver is large compared to the wavelength of the transmitted radio wave. The diffraction effects are faster and more accentuated with increased obstruction for frequencies above 1,000MHz. This can make a path unusable for normal radio communication purposes.

The transmission loss due to an obstruction depends on the diffraction properties of the obstacle and on the area of the obstructed beam as compared to the total area of the wave front. Thus, it is necessary to provide sufficient *path clearance* so that an appreciable transmission loss can be avoided.

If a wave front is partially obstructed by an obstacle, some energy will be diffracted into the shadow region of the obstacle. In real situations, however, the diffraction effects will be complicated by the shape of the obstacle and by the effects of the atmosphere, but in many cases a simplified model can produce useful approximations of the effect an obstacle may have on the radio path. The models are usually employed for propagation near the surface of the Earth which comprises the diffraction due to the bulge of the Earth and/or different obstacles on the surface of the Earth.

The transmission loss over irregular terrain is a complicated function of frequency, path geometry, vegetation density and other less significant variables. In spite of the complexity of this problem, some simplifications and assumptions have to be made in order to deal with it. The result is that some practical methods have to be devised for the estimation of obstruction losses. One well known method is the *knife edge* approximation for which a sharp ridge is considered to be a perfectly absorbing knife edge, extending infinitely downwards. This procedure is found to be reasonably accurate when there is a single well defined peak or a sharp ridge.

The following figure (figure 2-2) illustrates some examples (as rough estimates) of knife edge diffraction losses as compared to the penetration of the obstacle into the first *Fresnel* zone.

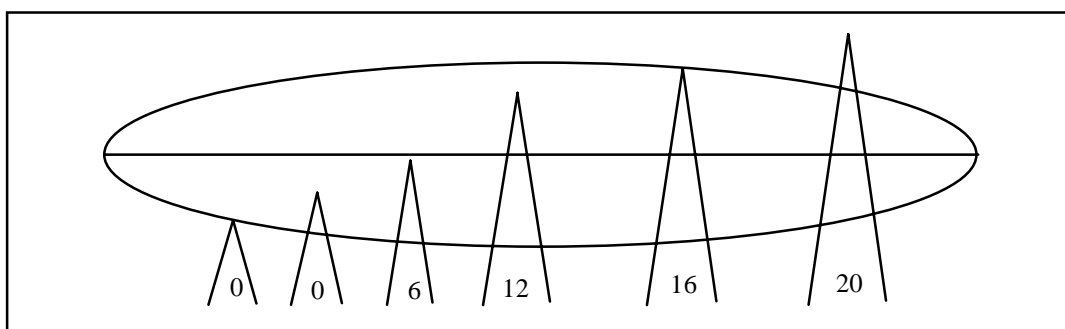


Figure 2-2: Rough estimates of knife edge diffraction losses in dB

So far we have considered diffraction due to knife edge obstacles close to the line-of-sight path. However, for paths in which there are no major diffraction edges, one may assume the loss to be those of diffraction over a smooth, spherical Earth. Since the Earth is spherical in shape, the distances from the transmitting and receiving points to the obstruction point (the horizon) are the line-of-sight distances.

Figure 2-3 illustrates some rough estimates of diffraction losses over a smooth spherical Earth as compared to the penetration of the bulge of Earth into the first *Fresnel* zone.

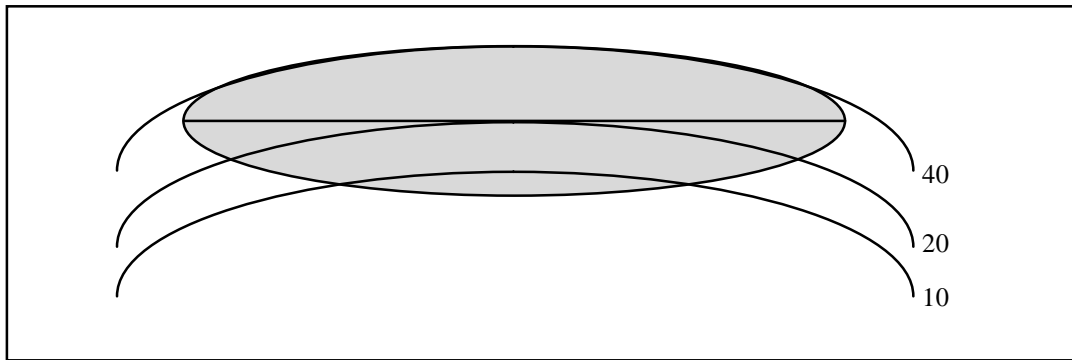


Figure 2-3: Rough estimates of diffraction losses in dB over a smooth, spherical Earth.

The contribution from the obstacle loss appears in the link budget as A_o (see section 2.3 Path Planning).

2.2.7 Reflection and Scattering

When electromagnetic waves incide on a surface they may be reflected. The reflected waves depend on the frequency, the angle of incidence and the electrical properties of the surface.

Under some assumptions energy is neither transmitted or absorbed by the surface, and the waves are simply reflected in a new direction. This is, of course, an ideal reflection called *specular reflection*, in accordance with the reflection of light waves as encountered in mirrors. Specular reflection is therefore an approximation which can be used in many applications related to radio communication.

Specular reflection is, as mentioned above, an ideal case encountered in some applications. In practice, however, surface reflection is somewhat more complicated.

The *Rayleigh criterion* is used for qualitative considerations of reflection on a surface. The main question in this case is: For what values of the wavelength, surface roughness and angle of incidence does specular reflection change to diffuse scattering? In other words: when does a smooth surface become rough?

According to the *Rayleigh criterion* a surface is considered to be smooth when

$$h < \frac{\lambda}{8 \cdot \sin \gamma}$$

h = The height of the irregularities on the surface
 λ = The wavelength
 γ = The grazing angle (= the complement of the angle of incidence)

The *Rayleigh criterion* is based on the assumption that the value of the phase difference between two parallel rays which incide on a surface is 90° .

Naturally, depending on the application, the adopted value for the phase difference may also be 45° , 22.5° and so on. Figure 2-4 presents a graphical illustration of the *Rayleigh criterion*.

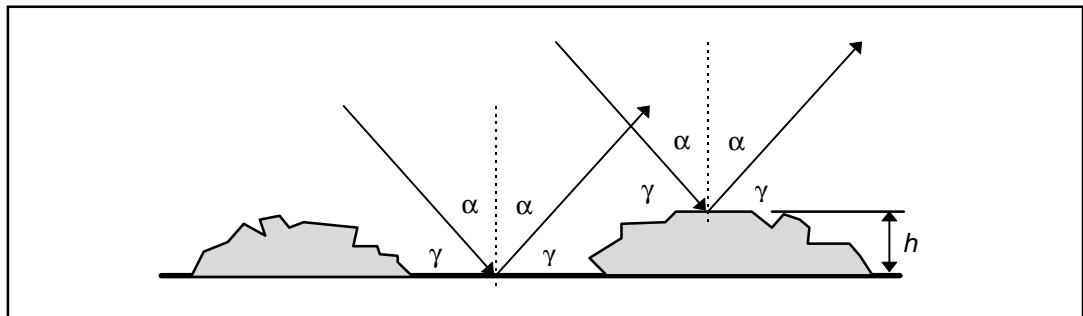


Figure 2-4: The Rayleigh criterion (α = the angle of incidence)

If the phase difference is small, the two rays will be almost in phase as in a perfectly smooth surface. If the phase difference increases the two rays will interfere until the difference is 180° . At this value the rays are in phase opposition and will cancel out. Having no energy flow in one specified direction, and because energy cannot disappear, one may conclude that the energy is redistributed in other directions, that is, scattered across the surface. Hence, when the phase difference equals 180° , the surface scatters energy and is considered to be rough. When the phase difference equals 0° , the surface reflects specularly and is considered to be smooth.

Generally speaking, reflection may be characterized by its *total reflection coefficient* ρ , which is defined by the quotient between the reflected and the incident field. The reflection coefficient quotient characterizes the capacity of the surface in question to reflect radio waves. When $|\rho| = 0$ nothing will be reflected. When $|\rho| = 1$ we have specular reflection.

The reflection coefficient depends on the polarization, the frequency, the electrical characteristics of the surface and on the grazing angle (see figure 2-4).

The resultant electromagnetic field at the receiver antenna is composed of two components: the direct field and the reflected field. Thus it depends on the cosine of the phase difference between the direct wave and the reflected wave. This means that the resultant signal at the receiver, for an arbitrary value of the reflection coefficient, will oscillate and pass through a maximum and a minimum value. The amplitude of the oscillations depends on the parameters determining the phase difference: the height of the antenna, the path length, the effective Earth radius factor, the frequency and the phase angle of the reflection coefficient.

When both components, that is the direct field and the reflected field, have the same direction, the angle between them is 0° and the signal passes through a maximum value. When the angle between the components is 180° they have opposite directions and the signal passes through a minimum value. These extreme values are illustrated in figure 2-5 as a function of the total reflection coefficient.

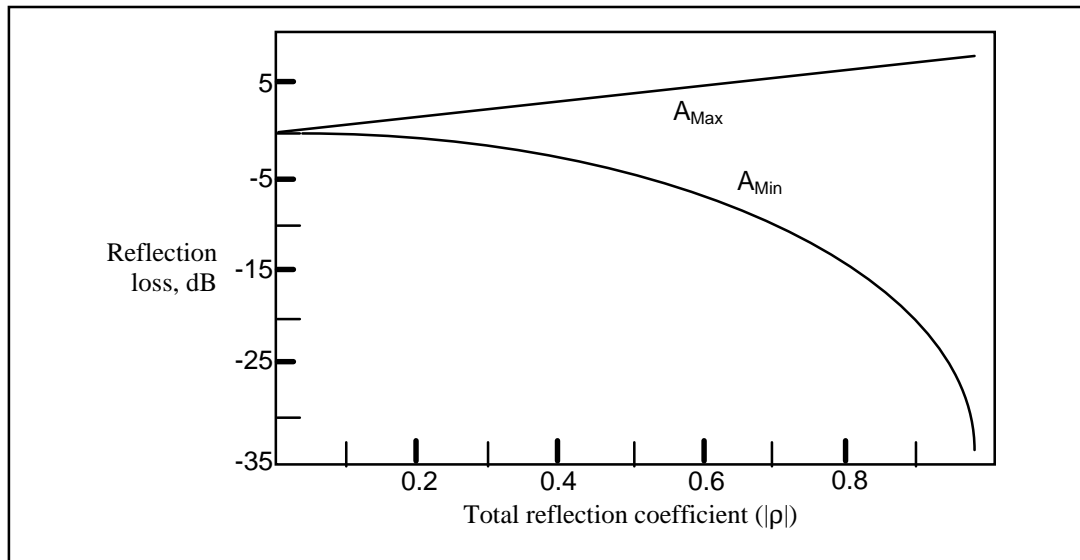


Figure 2-5: Maximum and minimum values of the reflection loss as a function of the total reflection coefficient

As illustrated in the figure, the range of the reflection loss is larger than 40dB for values of the reflection coefficient approaching 1.

The *total reflection coefficient* can be considered as the product of three factors:

- The *Fresnel* reflection coefficient, which is applicable for smooth surfaces only. The value of this coefficient depends on the frequency, the grazing angle, the polarization and on the electrical characteristics of the surface.
- The *divergence factor*, which allows for the curvature of both smooth and rough surfaces. The value of this factor depends on the antenna heights, the path length and on the Earth radius factor.
- The *roughness factor*, which accounts for the roughness of the surface. The value of this factor depends on the grade of roughness of the surface and on the frequency.

A rough estimation of possible values is illustrated in the following example.

Consider a radio path over the surface of a lake. The *Fresnel* reflection coefficient of the lake is very close to 1 for radio link applications (grazing angles between 1mrad and 10mrad), that is, approximately 0.90. For a radio path length of approximately 30km, the Earth radius factor is 1.33. With a height difference between the transmitter and receiver antennas of approximately 30m the *divergence factor* is considered to be approximately 0.90. For frequencies above 10GHz the *roughness factor* of the surface of a lake during relatively calm days is approximately 0.90.

When multiplied, these factors produce a total reflection coefficient of

$$0.90 * 0.90 * 0.90 \cong 0.70$$

Applying this result in the diagram of figure 2-5 yields a reflection loss of approximately 12dB.

The contribution from the reflection loss appears in the link budget as A_L (see section 2.3 Path Planning).

2.2.8 Absorption

At frequencies above 10GHz the propagation of radio waves through the atmosphere of the Earth is strongly affected by the resonant absorption of electromagnetic energy by molecular water vapour and oxygen. In radio engineering it is usual to classify the chemical composition of the atmosphere in two "gases": water vapour and dry air.

It is well known that nitrogen (N_2) and oxygen (O_2) account for approximately 99% of the volume of dry air (that is, atmosphere without water molecules), while the remaining 1% is shared by carbon dioxide (CO_2) and a number of rare elements. Fortunately, nitrogen molecules do not affect the radio spectrum and dry air can consequently be considered to be composed of oxygen only. Furthermore, the chemical composition of dry air does not show any significant variation through the atmosphere and can be considered to be constant from place to place. The absorption attenuation of oxygen shows a rather strong peak between 50GHz and 70GHz with a maximum at approximately 60GHz.

The amount of water vapour in the atmosphere, however, strongly varies from place to place according to the local meteorological conditions. Temperature and humidity is thus two important variables when determining the attenuation caused by water vapour. The absorption attenuation of water vapour shows a characteristic peak at about 23GHz. This peak value subsequently drops to a minimum (not zero) at approximately 29 - 31GHz and then rises again.

The contribution from gas attenuation appears in the link budget as A_G (see section 2.3 Path Planning).

2.2.9 Rain Attenuation

The following concept of scattering will be applied for diffuse scattering when radio waves interact with raindrops resulting in attenuation.

The effect of precipitation, and especially rain, on radio waves may be of considerable importance depending on the frequency band and on the intensity of the precipitation. Scattering and absorption of the radio wave by raindrops causes attenuation. Although all frequencies are subject to these effects, rain attenuation is of practical importance only for frequencies above 10GHz.

The specific attenuation can be obtained from special charts illustrating the interdependency of the specific attenuation in dB/km and the frequency in GHz. The effect of polarization will largely be ignored here. However, for high rain rates (30mm/h) and high frequencies (20GHz) horizontal polarization can give a specific attenuation as much as 0.5dB/km higher than for vertical polarization.

The rain dependent attenuation may be evaluated by introducing a reduction factor, which takes into consideration the extent of the rain clouds in the radio path, and then determining the *effective path length* by multiplying the actual path length by the reduction factor.

It should be pointed out that the rain rate is a parameter which is very dependent on the geographical location of the path. It must be obtained from cumulative distribution of long term measurements. Furthermore, it must be obtained for very short integration times, preferably nearly instantaneous. For the purpose of network planning the Earth is divided into 16 different rain zones for which instantaneous rain rate values can be obtained.

In spite of the random characteristics of the rain events, its attenuation is not included as a contribution in the link budget. However, its value is of crucial importance in the calculation of the rain fading.

2.2.10 Fading

Several influences may cause loss of the signal when the two terminals of a radio path are within line-of-sight. If the line-of-sight of the system is close to the ground with large size obstacles or hills obstacle losses may become important even though the line-of-sight is not obscured. If there are any changes in the Earth radius factor due to refraction, the path may be subject to diffraction/refraction fading.

Generally, radio waves traveling in the atmosphere undergo variations due to changes in meteorological and ground surface conditions. The received signal is normally not constant but "fades" around a nominal value, and the field strength with time is commonly called fading.

When the line-of-sight is well above the surface of the Earth, thus avoiding diffraction losses, fading may occur due to interference between the direct line-of-sight field component and the components reflected from the ground, from atmospheric layers and from buildings.

Multipath effects may give rise to short term fading. Furthermore, at frequencies above 10GHz the attenuation due to absorption by atmospheric gases and by rain may be even more important. Rain fading effects may give rise to longer term signal attenuation.

The relative importance of fading due to rain and that due to multipath effects depends on the frequency, the climate and on the path length. However, in general it can be said that multipath fading is the main influential factor causing attenuation below 10GHz, whereas heavy rain is the main influential factor above 10GHz.

Because multipath propagation in most climates normally occurs when there is no heavy rainfall, it is usually reasonable to add the time percentages for which the two causes produce fading of a certain level.

The path planning training seminar presented by Ericsson provides a deeper discussion of the probability calculations for the rain fading contribution.

2.3 Path Planning

2.3.1 Objective and Scope

Some actions must have been performed in order to supply input data to the path calculation software before a MINI-LINK network can be configured. These actions will be discussed briefly in this section. They are mostly built on factors such as the topography, the climate, the equipment data and the site configurations. Frequency planning is also an important factor to be dealt with when planning a microwave radio transport network.

This section will deal with a few of the requirements, provisions and dependencies to be considered when planning a microwave link Hop. Considerations covering the terrain profile, optical line of sight installations, input signal and its variations, diversity, quality and availability targets and frequency planning will be discussed.

The planning of a microwave radio Hop cannot be performed exclusively behind the office desk. The intended Hop paths and the suggested sites must be surveyed in situ. These aspects are also covered in this section.

2.3.2 Initial Planning

The planning of a microwave radio Hop always starts with a survey of the network in which the new Hop is supposed to be a part, and the function the network or the planned new Hop is supposed to provide. Based on these facts the planner has sufficient knowledge to decide which standard to apply during the dimensioning of the Hop in order to meet the requirements on the connection.

The network planning is generally based on the operational requirements of the network. These can be expressed in terms of:

- Traffic quality
- Traffic availability
- Traffic requirements and capacity

The influence of these requirements during the dimensioning of an individual microwave radio link Hop depends on the configuration and the dimensioning of the surrounding network and, if applicable, even other corresponding networks. Each and every Hop in the network must have sufficient availability and quality to keep the entire connection from one subscriber to another within the limits of the selected overall dimensioning standard.

The International Telecommunication Union (ITU) issues recommendations guiding the dimensioning of parts of or entire networks for international traffic. Examples of such networks in practical life are transmission to and from radio base stations in a mobile telephone network or company networks with connections to the public network.

2.3.3 Geometrical Line of Sight

In the frequency band in which the MINI-LINK terminals operate (7 - 38GHz) a free line of sight between the antennas is required. Obstacles protruding into and above the line of sight will cause considerable attenuation and may make the Hop unusable. These obstacles may be topographical (hilltops etc.), vegetational (forest trees etc), buildings, chimneys and other man made structures.

When using a topographical map to survey free line of sight conditions, one must be particularly observant considering obstacles close to the intended sites (within a few hundred meters) which might possibly not be included due to the scale dependent inherent inaccuracy of the maps. The map may also be inadequate when determining the actual height of buildings and other man made structures. An in situ determination of the line of sight conditions is therefore mandatory before finally deciding on site locations.

2.3.4 Radio Optical Sight

The Earth atmosphere influences the propagation of radio waves in different ways. The radio waves travel with different velocities in different parts of the atmosphere, due to the variations in the electrical characteristics which cause refraction.

Due to the atmospheric refraction the radio waves are usually bent slightly downwards, which allows a somewhat longer path length than the straight line. With the bending effect in mind it is customary to speak about a radio optical line of sight, rather than a geometrical line of sight. Under normal condition the radio optical line of sight reaches further than the geometrical line of sight.

The distance difference between the radio horizon and the geometrical horizon can be calculated for different k values using the sight formula:

$$d_{\text{eff}} \approx d\sqrt{k}$$

d_{eff} = the distance to the radio horizon (km)
 d = the distance to the geometrical horizon (km)
 k = The effective Earth radius factor

Assuming $k = 4/3$ yields $d_{\text{eff}} \cong 1.15 * d$

This shows that the radio horizon normally is approximately 15% farther distant than the geometrical horizon.

The standard atmosphere and other atmospheric conditions affecting the refraction factor and which occurs at a given site is described by the Earth radius factor k . The k value depending on the climatic conditions is $4/3$ when applied to a standard atmosphere.

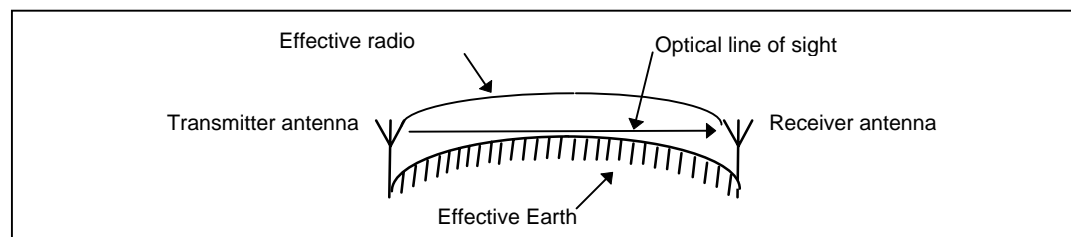


Figure 2-6: Radio optical sight

The radio optical Earth radius can be described using the effective Earth radius factor according to section 2.5 Refraction.

$$R_e = k * R$$

R_e = The radio optical Earth radius
 R = The true Earth radius (6,370km)
 k = The effective Earth radius factor

For true Earth radius $k = 1$.

2.3.5 Clearance

Even if free line of sight is available on the entire path, close-by obstacles may have an attenuating effect if they are located close enough to the path. It is customary to define a *Fresnel zone* around the centre line of the path. The first *Fresnel zone* is defined as a zone shaped as an ellipsoidal shell with its focal points at the antennas on both ends of the path. In the first *Fresnel zone* the phase difference between a beam taking the direct path and a beam reflected from an obstacle is a half wave length. The *Fresnel zone* decreases with increasing frequency.

Provided that there is no obstacle within the first *Fresnel zone* the obstacle attenuation can be ignored, and the clearance requirement is satisfied.

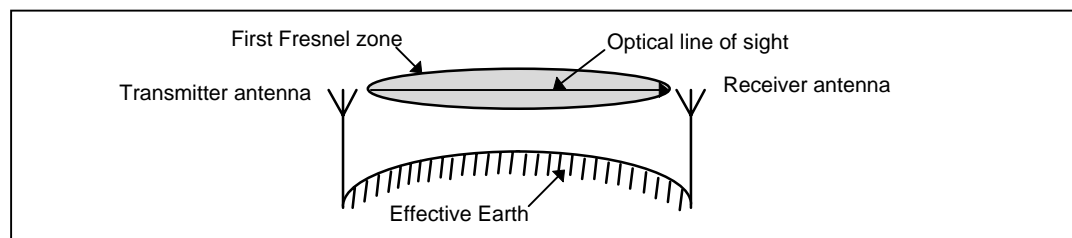


Figure 2-7: The First Fresnel zone

Calculating the Fresnel radii requires some knowledge of the geometry of an ellipsoid.

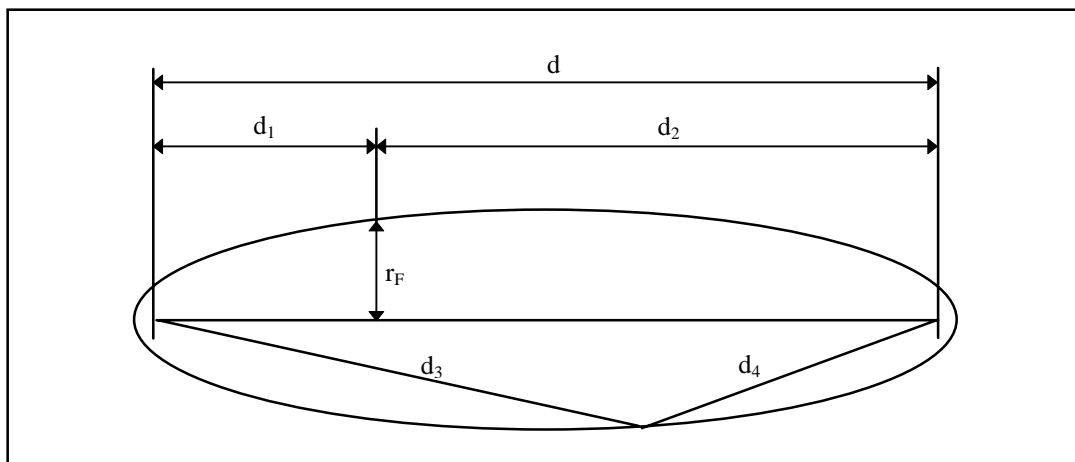


Figure 2-8: Calculation of the First Fresnel Radii

Using the units in figure 8, the following relationship exists:

$$d_3 + d_4 - d = \lambda/2$$

The figure also gives us the equation for the first *Fresnel* zone radii (r_F):

$$r_F = 17.3 \sqrt{\frac{d_1 \cdot d_2}{f \cdot d}}$$

- r_F = The first *Fresnel* radius at a given point (m)
- d_1 = The distance from the first focal point (antenna) to the point of interest (km)
- d_2 = The distance from the point of interest to the second focal point (antenna) (km)
- d = The total distance between the focal points (antennas) (km)
- f = The transmission frequency (GHz). The mid-band frequency of the band in question should be used for general calculations.

Table 2-3 shows some examples of the *Fresnel* zone radii as related to Hop length and MINI-LINK frequency bands. The table gives the centre radii, which serves as an indication of the required clearances.

Path distance (km)	MINI-LINK frequency (GHz)				
	7	15	23	26	38
5	7.1	5.0	4.0	3.8	3.1
15	12.3	8.7	7.0	6.6	5.4

Table 2-3: Radii (m) of the first Fresnel zone (midpath) for different MINI-LINK frequencies

2.3.6 Path Profiles

The purpose of the path profile is to provide information concerning free line of sight between the selected station sites, and to decide whether there is sufficient clearance to avoid obstacle attenuation. The path profile will also be used when determining the fading of the received signal.

The path profile is essentially a plot of the elevation of the Earth as a function of the distance along the path between the transmitting and receiving sites. The data is derived by locating the two terminals on an elevation contour map, drawing a straight line between the two points, and reading the elevation contours at suitable distance intervals.

The topographical information used to design a path profile can also be derived from topographical map databases, which include an altitude database and a land use database.

The path profile is plotted on a path profile chart. Also, the Earth bulge Δh must be calculated according to the following formula:

$$\Delta h = \frac{d_1 \cdot d_2}{2 \cdot k \cdot R}$$

Δh = The Earth bulge at a certain point along the path (m)

d_1 = The distance from one site to the calculated point (km)

d_2 = The distance from the opposite site to the calculated point (km)

k = The Earth radius factor

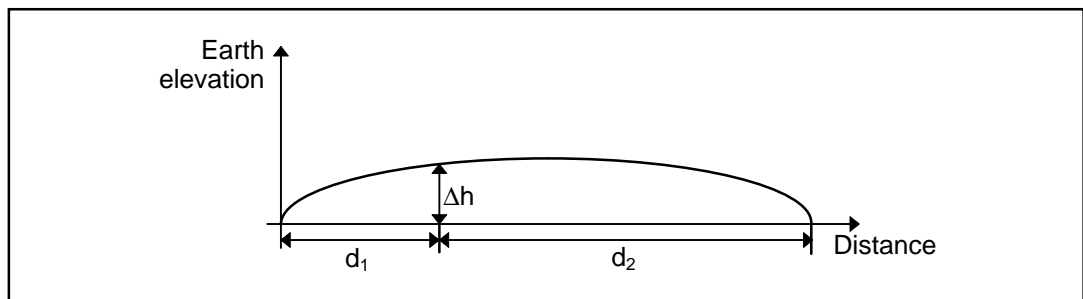


Figure 2-9: The Earth bulge

In a path profile chart designed with an Earth radius factor corresponding to the standard atmosphere (depending on the climate) at the geographical places in which the sites are located, the radio beam may be drawn as a straight line.

A factor for the calculation of the k value (ΔN) for different parts of the world can be found in ITU-R Rep. 563-4 (CCIR) "Radiometeorological Data" in volume V 1990, "Propagation In Non-Ionized Media". The charts shows ΔN from ground level up to an elevation of 1km. Section 2.2.5 describes how ΔN is converted to the k factor.

The elevation and distance scales of the path profile chart must be adjusted to fit the actual conditions. The elevation scale will normally cover a few hundred meters, and the distance scale will normally cover a number of kilometers.

Now the path profile can be entered in the form. The antenna elevations can be entered, and the line of free sight can be drawn. If the first *Fresnel* zone is also entered, the path planner can now determine whether there is sufficient clearance and a free line of sight on the projected path. The path profile must also contain information about forests, buildings and other man made structures along the path.

2.3.7 Link Budget

A link budget must be prepared in order to calculate the received signal level during non-fading time. The link budget sums all attenuations and amplifications of the signal between the transmitter output and the receiver input terminals. This can be illustrated according to figure 2-10.

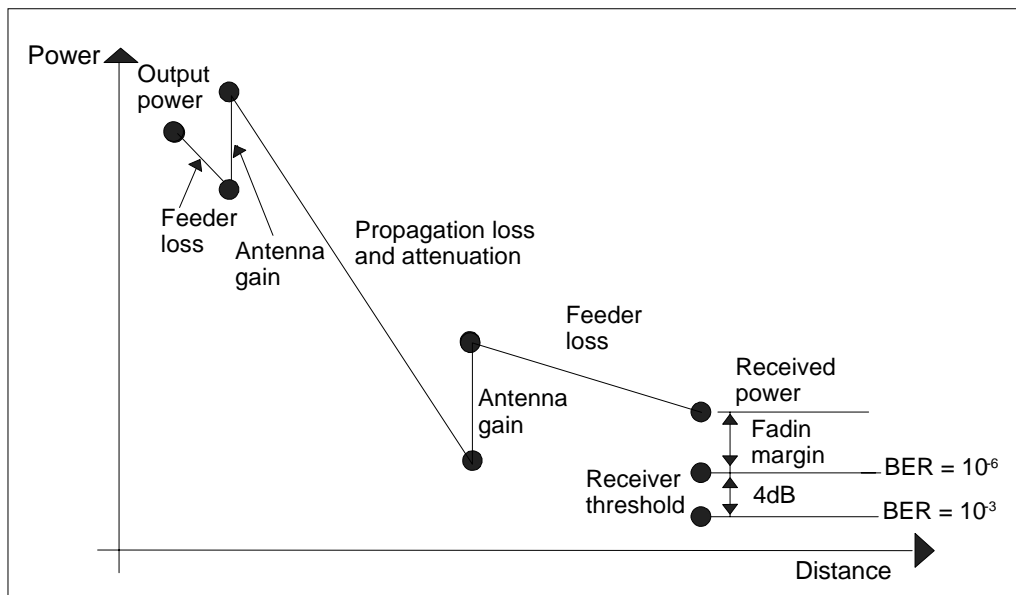


Figure 2-10: Transmitted and receiver power

As illustrated in the diagram of figure 2-10 the received power in the radio link terminal can be calculated according to the following formula.

$$P_{in} = P_{out} - \Sigma A_F + \Sigma G - A_{BF} - A_o - A_G - A_L$$

where

P_{in}	=	Received power (dBm)
P_{out}	=	Transmitted power (dBm)
A_F	=	Antenna feeder loss (dB)
G	=	Antenna gain (dBi)
A_{BF}	=	Free space loss (dB) (between isotropic antennas)
A_o	=	Obstacle loss (dB)
A_G	=	Gas attenuation (dB)
A_L	=	Additional loss (dB)

2.3.8 Fading

The receiver input signal varies with time due to fading. The input signal calculated with the link budget is valid for non-fading time only. The Hop must be dimensioned to provide a sufficient margin to the receiver threshold, the fading margin. The fading margin must be sufficiently large to allow the non-exceeding probability to be sufficiently small to meet the operational requirements for the connection. The fading margin requirement is indirectly decided by the adopted dimensioning standard. Usually the fading margin needs to be up to 40dB. The climate, the topographical situation and the Hop length are decisive factors for the fading sensitivity of a given microwave radio path.

The fading types normally taken into consideration are caused by precipitation (mainly rain), multipath propagation and refraction.

The rain intensity must be described in order to enable calculation of the rain induced fading. The calculating algorithm requires a value for the rain intensity which is exceeded during more than 0.01% of the time (annual mean value). Actual values for the 0.01% value of the rain intensity can be found in ITU-R Rep. 563-4 (CCIR) "Radiometeorological Data) in volume V, 1990, "Propagation In Non-Ionized Media". The fading itself, its causes and calculation is described in section 2.2.10.

The calculated probability for the occurrence of the various fading types on a given microwave radio Hop path must subsequently be translated into the quality and unavailability factors defined in the dimensioning standard. The factors usually adopted are standardized by ITU.

2.3.9 Diversity

Diversity can be used if a projected path is severely influenced by fading due to multipath propagation. The diversity setup reduces the effects of the fading, but it also increases the amount of required hardware. The difficult propagation conditions one tries to counteract may be caused by long Hops, by severe atmospheric conditions or by reflections of the radio beam from large, plane surfaces. This is often the case for paths crossing water areas depending on an unstable atmosphere over the water table and by reflections from the water surface, thus calling for a diversity arrangement.

Diversity means that the radio wave may reach the receiver via two or more paths. The input signal from the different paths are supposed to fade independently of and uncorrelated to each other. On the receiver terminal the signal with the largest energy is selected (in MINI-LINK the alarms control the switching). In some cases the received signals may be combined. The most frequently used diversities are space and frequency diversity.

Space diversity employs one transmitter antenna and two receiver antennas. The two receiver antennas enable reception of signals via different propagation paths. This requires double antennas on each side of the Hop, a unit for the selection of the best signal and partly or fully duplicated receivers.

In frequency diversity the same signal is transmitted simultaneously on two different frequencies. The different frequencies cause the two signals to fade with little correlation to each other. Only one antenna is required on either side of the Hop, but a unit selecting the best signal and duplicate transmitters and receivers are required. The inferior frequency economy of this solution often suggests the use of space diversity instead of frequency diversity.

In extremely difficult cases a combination of diversity schemes may have to be employed.

The computing algorithms normally used for multipath propagation will often give a too optimistic result for paths which largely pass over water tables. The climatic part of the algorithm should be compensated to produce a better result in these cases.

The improvement which may be obtained by employing diversity is expressed by a factor, the improvement factor, which influences the calculated probability for multipath propagation. The improvement is different for different fading depths. It largest for a deep fading, in which case a hundredfold improvement may be obtained.

The improvement factor is calculated with different algorithms depending on which diversity method is being employed. The largest part of the improvement stems from the antenna separation in space diversity and from the frequency difference in frequency diversity.

2.3.10 Availability and Quality Targets

The basis for the dimensioning of the connections in a network often stems from an operational user requirement which describes the required availability of a connection and the quality required during the available time. A dimensioning standard developed by ITU is often used in order to obtain an internationally accepted availability and quality for parts of or the entire network to be planned. Radio wave propagation, hardware failures, resetting times after repairs and frequency dependent interference problems are among the factors to be considered when dimensioning a network which is supposed to meet the standard requirements recommended by ITU.

The ITU target standards are based on two recommendations:

- ITU-T Recommendation G.821, used for digital connections with a bit rate of 64kBit/s.
- ITU-T Recommendation G.826, used for digital connections with bit rates of or higher than 2,048kBit/s (European standard) or 1,544kBit/s (USA Standard).

The recommendations define the measurement terms for availability and quality and a target standard for the dimensioning of connections according to these dimensions. The dimensioning standard sets forward demands on the availability and quality of the connection from one subscriber to another, that is an end to end demand. It is also subdivided into the international, national and local parts of a network.

The ITU-T Recommendation G.821 defines the following availability terms:

- **AT**, Available Time, which starts with the first second in a period of ten consecutive seconds in which each second has a Bit Error Rate (BER) better than $1 \cdot 10^{-3}$.
- **UAT**, UnAvailable Time, which starts when the Bit Error Rate (BER) in each second is worse than $1 \cdot 10^{-3}$ during ten consecutive seconds. These seconds are considered as unavailable time.
- Available Time + UnAvailable Time = Total Time (**TT**) studied.

The ITU-T Recommendation G.821 defines the following quality terms:

- **ES**, Errored Second, which is defined as a second containing one or more bit errors.
- **SES**, Severely Errored Second, which is defined as a one second period during which the Bit Error Rate is worse than $1 \cdot 10^{-3}$. Consequently an SES is also an ES.
- **DM**, Degraded Minute, which is defined by subtracting SES from AT and then grouping the remaining seconds in groups of 60 (one minute intervals). Each group containing a Bit Error Rate worse than $1 \cdot 10^{-6}$ is considered to be a Degraded Minute.
- ES, SES and DM are only calculated during AT.

The ITU-T Recommendation G.826 defines the following availability terms:

- **AT**, Available Time, which starts with the commencement of ten consecutive seconds with non SES events. These ten seconds are considered as available time.
- **UAT**, Available Time, which starts with the commencement of ten consecutive seconds with SES events. These ten seconds are considered as unavailable time.
- Available Time + UnAvailable Time = Total Time (**TT**) studied.

The ITU-T Recommendation G.826 defines the following quality terms:

- **EB**, Errored Block, which is defined as a block in which one or more bits are incorrect.
- **ES**, Errored Second, which is defined as a one second period during which one or more blocks are distorted.
- **SES**, Severely Errored Second, which is defined as a one second period during which 30% or more of the transmitted blocks are distorted.
- A block is defined as a group of consecutive bits in a digital connection where each bit only belongs to a single block. Table B.2/G826 recommends that, for example, the bit rate 2,048kBit/s should contain 2,048 bits per block.
- EB, ES, and SES are only calculated during AT.

The ITU-R recommendations specify the time scope of these availability and quality dimensions as applied to parts of or the entire microwave radio transport network.

ITU-R has applied the radio perceptible to the ITU-T Recommendation G.821, and has subdivided the international part (High Grade), the national part (Medium Grade) and the local part (Local Grade) into smaller parts suitable for the dimensioning of microwave radio transport network Hops.

The dimensioning standards for these network parts can be found in the following recommendations:

- **High Grade:** ITU-R Recommendations 556, 557, 594, 634 and 695, which are based on Rep. 445 and 930.
- **Medium Grade:** ITU-R Recommendation 696, which is based on Rep. 1052.
- **Local Grade:** ITU-R Recommendation 697, which is based on Rep. 1053.

Examples of the target standard for Medium Grade sections can be found in table 2-4. The SES, ES and DM values represent percentages of available time. The sections are sub-divided into four different classes, 1 - 4, which reflect the function of the section in the network. A section is the smallest network part defined by ITU-R. It encompasses only a part of the network which does not contain any multiplexing equipment or a PABX switchboard.

Quality Parameter	Percentage of Available Time (%)			
	Class 1 280km	Class 2 280km	Class 3 50km	Class 4 50km
SES	0.006	0.0075	0.002	0.005
DM	0.045	0.2	0.2	0.5
ES	0.036	0.16	0.16	0.4

Table 2-4: *Quality targets for Medium Grade sections*

The UAT assignment for class 1 - 4 sections in a Medium Grade network is as follows:

- **Class 1:** 0.033%
- **Class 2:** 0.05%
- **Class 3:** 0.05%
- **Class 4:** 0.1%

The percentages assigned to UAT consider parts of the total time. You should note that UAT also encompasses disrupted service due to severe radio wave propagation conditions and MTTR, that is resetting times following hardware failures.

2.3.11 Fading Margin versus Error Performance and Availability

During the dimensioning of a microwave radio link Hop the fading margin must be sufficiently high to allow for the meeting of the set availability and quality targets. This means that the time allotments for SES, ES, DM and UAT must not be exceeded.

When transforming the fading and the time aspects of the fading to availability and quality terms the designer must treat slow fading, which may have a time scope of minutes or even hours, and rapid fading, which has a time scope of seconds or parts of seconds, separately.

The slow fading covers fading due to rain and refraction, where the rain is the dimensioning factor for MINI-LINK applications. Hardware failures and the resetting times required following repairs, are also considered as a slow fading. Hardware failures are generally not considered as fading, although they influence the availability of the individual Hop.

Multipath propagation problems are accounted for when dealing with the rapid fading.

The fading mechanisms and the hardware failures versus the quality and unavailability terms can be grouped as follows:

- **UAT** Rain, refraction and hardware failures.
- **DM** Rain, refraction and multipath propagation.
- **ES** Rain, refraction and multipath propagation.
- **SES** Multipath propagation.

2.3.12 Reflection

Reflections of the radio beam from large, plane surfaces, for example lakes, may cause a degradation of the availability and quality of the connection. The reflected wave does not follow the same path as the direct wave which, in conjunction with a phase change at the point of reflection, may cause the received waves to have different phase angles at the receiver input. Should the phase difference be as much as 180° the result will be an attenuation and possibly even a cancellation of the resulting signal. The seriousness of the reflection effect is also determined by the electrical properties of the ground, the incidence angle of the radio wave and the small scale variations in the reflecting surface.

A microwave radio link Hop over areas where a reflection may be expected should be configured with space diversity. The distance between the antennas should be adjusted to the path geometry in order to ensure that at least one of the receivers will always have a good quality input signal.

In order to calculate the optimum height difference between the diversity antennas in the respective mast one must first calculate the elevation difference between two signal strength minimums (or maximums) caused by the reflection along the site A and site B masts according to the following formulas:

$$\delta h'_A = \frac{0.3 \cdot d}{2 \cdot f} \left[\frac{1}{h'_B - \frac{(d_B)^2}{12.74 \cdot k}} \right] \cdot 10^3$$

$$\delta h'_B = \frac{0.3 \cdot d}{2 \cdot f} \left[\frac{1}{h'_A - \frac{(d_A)^2}{12.74 \cdot k}} \right] \cdot 10^3$$

$\delta h'_A$ = The elevation distance between two maximums / minimums at station A (m)

$\delta h'_B$ = The elevation distance between two maximums / minimums at station B (m)

h'_A = The antenna elevation over the reflection point at station A (m)

h'_B = The antenna elevation over the reflection point at station B (m)

d_A = The distance between station A and the reflection point (km)

d_B = The distance between station B and the reflection point (km)

d = The distance between station A and station B (km)

f = The applied frequency (GHz)

k = The equivalent Earth radius factor

When these calculations have been performed the required elevation distance between the diversity antennas can be calculated:

$$\delta h_A = \frac{\delta h'_A}{2}$$

δh_A = The elevation distance between the antennas at station A (m)

$$\delta h_B = \frac{\delta h'_B}{2}$$

δh_B = The elevation distance between the antennas at station B (m)

If it is possible, the reflection Hop should be planned concerning the path itself and the antenna heights so that the reflected wave is attenuated by obstacles. The attenuation will reduce or eliminate the interference risk.

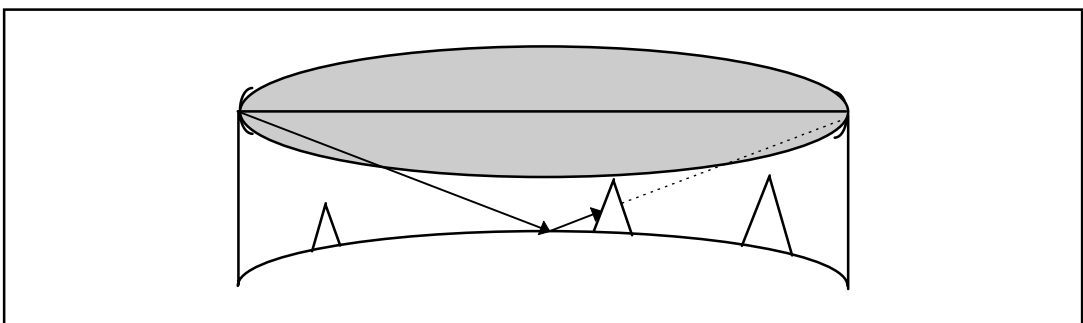


Figure 2-11: A reflected wave attenuated by an obstacle

Reflection prone paths often pass over water, where there is often a great risk for the occurrence of severe atmospheric conditions. This strongly suggests that this Hop type should always be designed with space diversity, regardless of whether the reflection has been planned to be attenuated by an obstacle or not.

2.3.13 Path and Site Survey

During the planning of microwave radio link paths it is often necessary to closely survey the intended Hop on the location in order to evaluate the obstacles by sight. Also the intended site and antenna carrier should be checked concerning space, power availability and strength. The following checklist covers the important items to be investigated.

Find / verify:

- The geographical position of the intended site.
- The antenna carrier height above ground level.
- The antenna carrier type, strength and torsion strength.
- The site level above mean sea level.
- The possibility to mount antennas at the required height.
- All obstacles in the path directions, including their heights and widths.
- Potential reflecting surfaces.
- The radio environment, other radio installations or interfering signals.
- The distance between the indoor and the outdoor equipment.
- The floor and/or wall space available for installation of indoor equipment.
- The mains power availability.
- The battery backup possibilities.
- The possibility to install antenna feeders or multiconductor cables between the indoor and outdoor equipment as regards available space, wall entrance, bending radii etc.
- For new sites also the access to roads and to power transformer stations.

2.3.14 Frequency Planning

The objective of frequency planning is to assign as few frequencies to a network in such a way as to obtain an interference level sufficiently low not to affect the availability of the microwave radio link Hops. Frequency planning for an entirely interference free network is rarely economically viable. In many cases the frequency planning calculates with an interference level giving a maximum radio link receiver threshold deterioration of 3dB. This causes the fading margin to be 3dB higher than the demands caused by wave propagation and hardware if the dimensioning targets are to be met.

The interference level acceptable to the radio link equipment without exceeding the 3dB threshold degradation can be obtained from the MINI-LINK manual C/I matrix. This matrix illustrates the level of the interference signal, I, as related to the carrier signal, C, for a given frequency interval.

The frequency planning must consider near and far interference.

Far interference are unwanted disturbances between transmitters and receivers which are not located on the same site. The distance between the interfering transmitter and the interfered receiver may be from a few hundred meters or a few kilometers up to tens of kilometers. The interfering transmitter will in this case cause the most severe interference if it transmits on the same frequency as the desired signal in the receiver. This is called common channel interference. A normal C/I-requirement for the common channel case is -20dB. In some cases a serious interference may also occur if the interfering signal frequency is different from the frequency of the desired signal. This is called neighboring channel interference. A normal C/I-requirement is -15dB for the neighboring channel. These requirements are equipment dependent and will for the neighboring channel case vary with the frequency separation between the interfering transmitter and the interfered receiver. The requirements on the C/I-relation also depends on the bandwidth of the interfering transmitter in relation to the bandwidth of the bandwidth of the interfered receiver.

Planning an "interference free" network as regards the far interference, requires a good knowledge of the geographical situation of the network sites, the configuration and the dimensioning of the individual Hops, equipment data, existing network frequency selections and a wave propagation model between interfering transmitters and interfered receivers. The far interference is often the limiting factor when deciding how many Hops one can combine in a star network. Good antennas, which often equals large antennas, will facilitate a good planning.

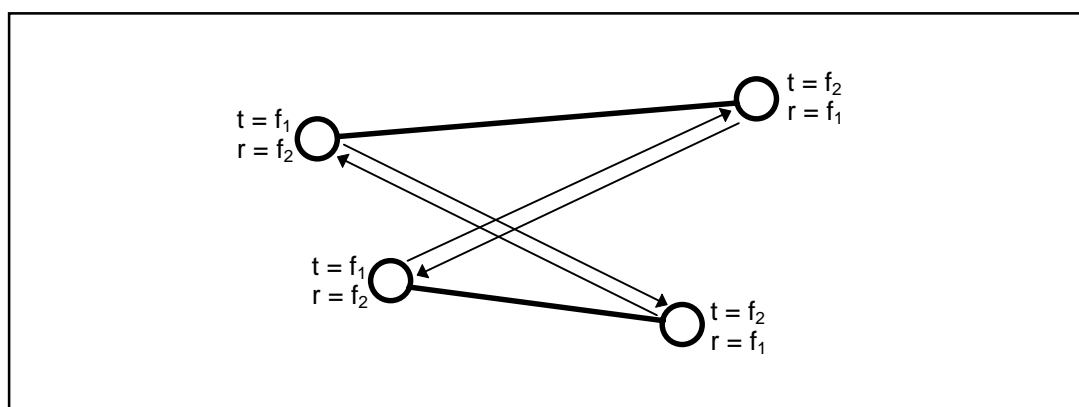


Figure 2-12: Far interference

Near interference refers to interference generated by transmitters which interfere with the reception in transmitters located on the same site. The cause of the interference signal may be proprietary or non-proprietary equipment, separately or in combination. The interference may occur as a mixture of multiple transmitter frequencies, where the products of the mixture are on or near the receiver frequencies (intermodulation). It may also be transmitter frequencies which are too close to the receiver frequencies, thus directly interfering with the receiver or generating field strengths sufficiently high to block the receiver completely and consequently considerably deteriorating the reception performance.

The MINI-LINK frequency band intermodulation interference is usually neglectable.

Selection of the correct duplex halves for transmitters and receivers is of prime importance to obtain control over the interference risks caused by small transmitter / receiver frequency gaps. The best frequency economy is obtained by locating all transmitter frequencies on one site in one duplex half and all receiver frequencies on the same site in the other half. Generally this also covers the requirement of minimum frequency interval between transmitters and receivers.

The frequency planning will be facilitated by using one of the standardised ITU frequency matrixes. These are mostly internationally accepted by the various frequency allocation administrations.

A few general points should be considered during the frequency planning:

- Re-use frequencies, that is, repeat the frequencies as often as possible.
- Use good antennas, that is antennas with a good front-to-back ratio and great side lobe suppression. This usually ensures both good frequency economy and a good bottom line total network economy. High performance antennas may be a worthwhile option.
- Do not use higher microwave radio link transmitter output power than necessary.
- If you have to choose between a high transmitter power output and a larger antenna, the larger antenna should be preferred if possible. The overall radiated power increases and is concentrated in the desired direction, that is towards the receiver.

2.4 References

ITU-R Rep. 563-4 (CCIR) "Radiometeorological Data", vol. V 1990
"Propagation in Non-Ionized Media".

ITU-T Recommendation G.821.

ITU-T Recommendation G.826.

ITU-R Recommendation 556.

ITU-R Recommendation 557.

ITU-R Recommendation 594.

ITU-R Recommendation 634

ITU-R Recommendation 695.

ITU-R Recommendation 696.

ITU-R Recommendation 697.

2.5 Performance Prediction

Based on the ITU-R recommendations (see section 2.4) Ericsson has developed the proprietary PC based MLPERF calculation software for MINI-LINK path performance and availability calculations. The software runs under the MS-Window environment (3.0 or higher), and may optionally be run directly from the diskette or from the computer hard disk.

The operator may perform the calculations for MINI-LINK hops. All technical data for the MINI-LINK equipment is stored in data files on the diskette.

When all data has been entered (by mouse clicking and keyboard entry, depending on the type of data), the program may be requested to calculate the Hop performance data and the link budget. The calculated Hop performance may be printed out.

The program is delivered on a single 3.5" 1.44Mb diskette. A short but fully sufficient Operator's Manual is also included.

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3 Configuration

3.1 Introduction

This chapter describes how to configure sites with the main MINI-LINK E equipment, that is, the radio units, the antenna module and the indoor units. An array of comprehensive example configurations on each level is also presented.

3.2 The Structure of a Network

A MINI-LINK network can consist of MINI-LINK equipment located at several sites and connected via microwave links or other fixed lines.

A MINI-LINK E network is illustrated in figure 3-1.

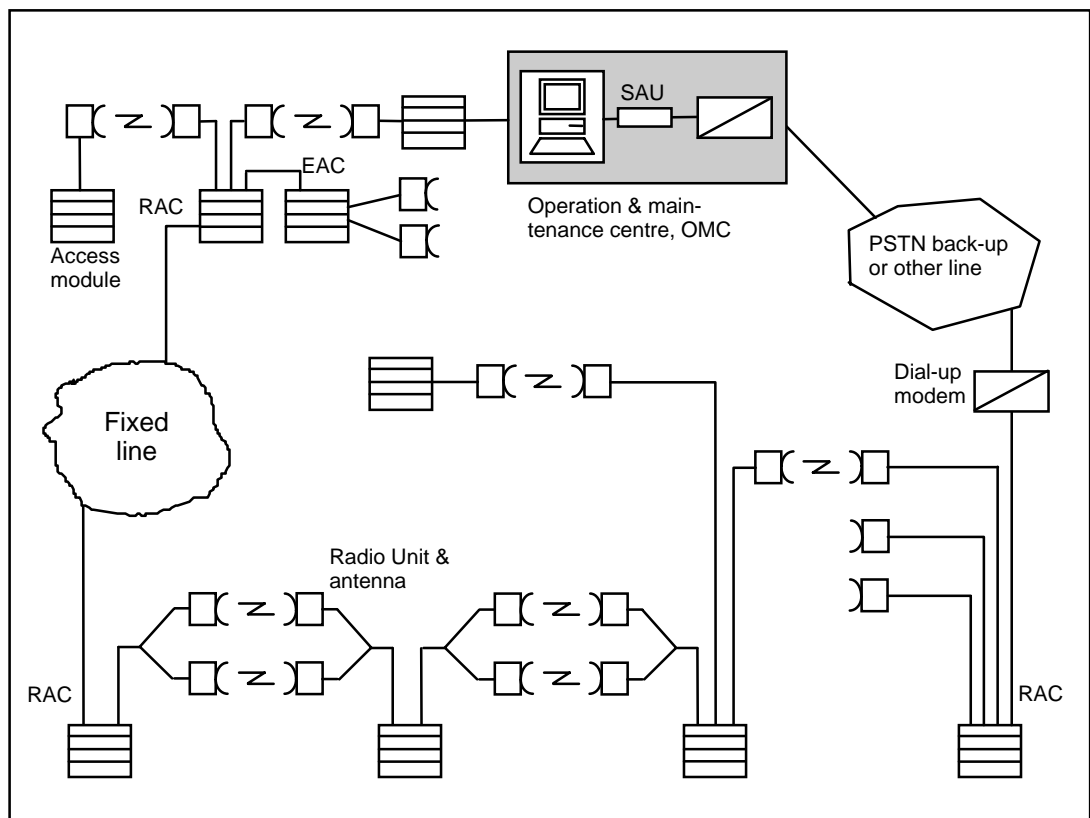


Figure 3-1: A Network Example

3.2.1 Terminal

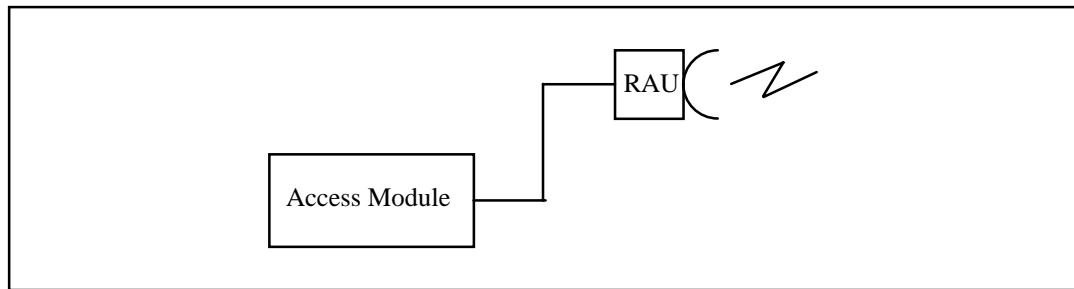


Figure 3-2 A Terminal

A terminal is one side of a microwave radio link hop, between two geographical locations. The MINI-LINK E terminal can be configured as: Unprotected 1+0, Protected 1+1 or Unprotected 2+0.

3.2.1.1 Unprotected 1+0 Terminal

Each side of the unprotected hop uses one radio and one antenna.

3.2.1.2 Protected 1+1 Terminal

The 1+1 terminal may be operated with two radio units and two antennas. It may also be operated with a power splitter and one antenna.

The 1+1 configuration should be considered for important and/or heavy traffic requiring high availability, but also if there are severe reflections and/or hard atmospheric conditions.

The protected terminal may be designed with frequency diversity or with space diversity.

3.2.1.3 Unprotected 2+0 Terminal

A 2+0 terminal is two independent, unprotected terminals (2(1+0)) which use one antenna with a power splitter or one double polarized antenna.

3.2.2 Access Module

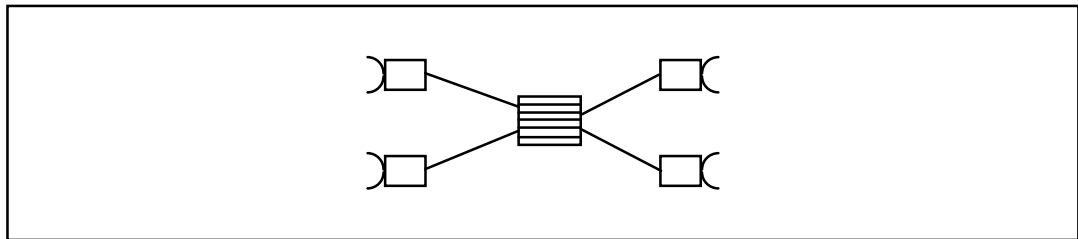


Figure 3-3 Access Module with four Terminals

The Access Module is the indoor part of the MINI-LINK E terminal. A maximum of four terminals may share one access module. Traffic signals may be routed between the terminals in the access module via the back-plane without any additional cabling.

An Access Module Magazine contains the indoor units for one or more terminals, which may share other resources, such as local power supplies or power feeders, alarm channels, remote controls etc. as provided by a common Service Access Unit (SAU).

3.2.3 Site

A site is a geographical location for one or more MINI-LINK terminals. The sites share some resources such as the housing, the mains power supply, the climatic control (air conditioner etc.) etc.

The access modules may, but need not, be interconnected to build an O&M network. See chapter 4 for further information.

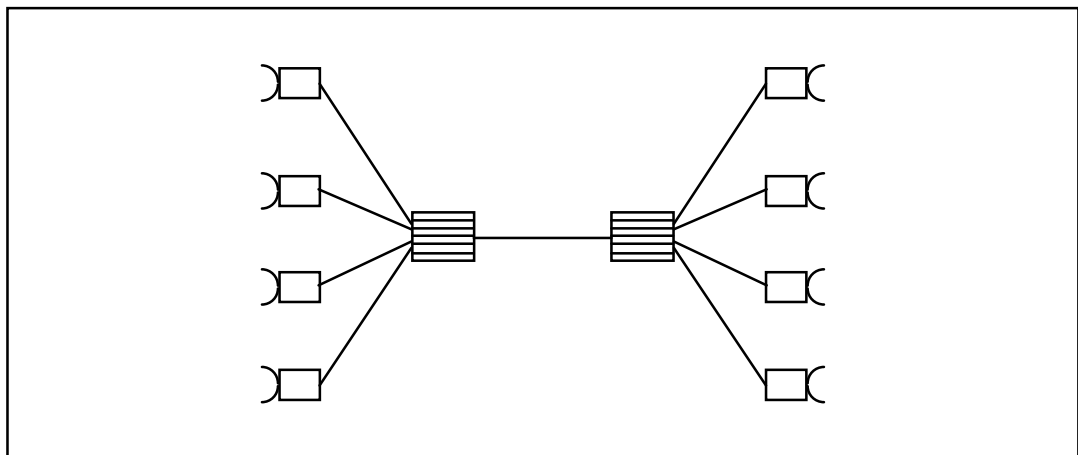


Figure 3-4 A MINI-LINK E site with two interconnected Access Modules

3.3 Outdoor Equipment

3.3.1 Radio Units

The operating frequency of MINI-LINK E is determined by the radio unit only. All traffic capacities and configurations may be selected for any frequency band. The MINI-LINK E programme presently contains six different radio units:

MINI-LINK radio	Frequency band, GHZ	Sub-band coverage, MHz
7-E	7.1 - 7.7	50
15-E	14.4 - 15.35	100
18-E	17.7-19.7	300/100
23-E	21.6 - 23.6	550
26-E	25.0 - 26.5	500
38-E	37.0 - 39.4	280

Table 3-1 MINI-LINK E frequency bands and sub-band coverage

The frequency band covered by a specific radio type is divided into sub-bands of varying coverage and duplex distances (the difference between the receiver and transmitter frequencies). The frequency steps within the sub-bands are uniform (0.25MHz). The MINI-LINK E Product Catalogue, document no. EN/LZT 110 2011, contains tables which list this. The operating transmitter (and consequently also the receiver) frequency is set in field.

Select one radio unit for a 1+0 configuration and two radio units with the same sub-band type for the 1+1 configuration.

3.3.2 Antenna Modules

The MINI-LINK E compact standard antennas with diameters 0.3m and 0.6m can be mounted integrated with the radio unit, or separately. A number of other antennas for separate installation can also be used, both from Ericsson and other manufacturers. The antenna should have a standard IEC 154 waveguide interface.

The antenna is selected during the network planning process.

3.3.3 Power Splitter

The power splitter is used when two radio units are connected to one antenna module. The power splitter comes in two versions, symmetrical one and asymmetrical. The asymmetrical version is used mainly for 1+1 systems, whereas the symmetrical version is used mainly in 2+0 systems.

The symmetrical splitter has equal attenuation in both channels. The asymmetrical splitter provides one main channel and one standby channel.

The power splitter is fitted directly on 0.3m and 0.6m antennas and installed separately when other antennas are used.

3.4 Indoor Equipment

This chapter describes the different indoor units. Section 3.5 describes the configuration of the indoor equipment.

3.4.1 Introduction

The indoor part is the Access Module, which contains a number of different units:

- one or more Modem Units (MMUs),
- one or two Switch/MUX Units (SMUs) and/or
- a Service Access Unit (SAU).

The composition of the Access Module controls:

- the traffic capacity (from 2x2Mbps to 17x2Mbps or 34Mbps),
- the number of terminals,
- the terminal configuration (1+0 or 1+1),
- and the availability of service channels and supervision (SAU).

3.4.2 Access Module Magazine

The Access Module comes in three different sizes: 1U for 1 unit, 2U for four units and 4U for seven units.

- AMM1U-0 can house a single Modem Unit (MMU).
- AMM2U can house up to one Service Access Unit (SAU), two MMUs and one Switch/Multiplex Unit (SMU).
- AMM4U-1 can house up to one SAU, two SMUs and four MMUs.

There are two old versions of AMM2U which both can house three units; AMM2U-1 and AMM2U-2. These are not described in this manual. For more information, see EN/LZT 110 2013 R2.

- AMM2U-1 can house up to one Service Access Unit (SAU) and two MMUs.
- AMM2U-2 can house up to one SMU and two MMUs.

3.4.2.1 AMM1U-0

The AMM1U-0 is intended for a site with only one unprotected (1+0) terminal. The AMM1U-0 can contain one MMU of any version.

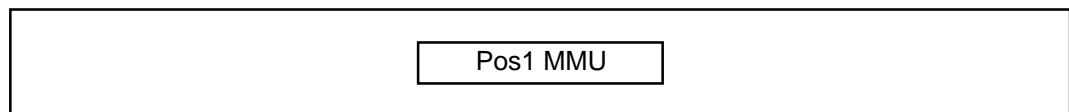


Figure 3-5 AMM1U-0

3.4.2.2 AMM2U

The AMM2U is intended for nodes containing one or two 1+0 terminals or one 1+1 terminal.

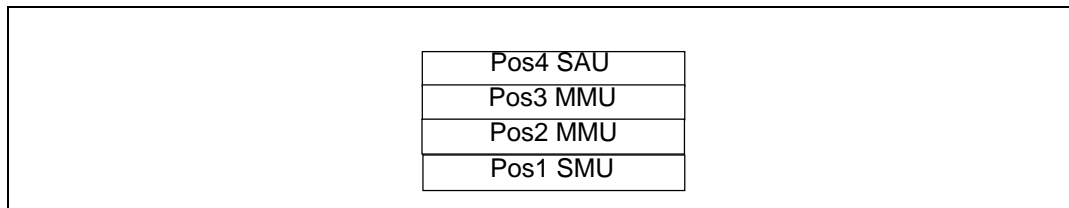


Figure 3-6 AMM2U

Terminal type	Number of terminals
1+0	1 or 2
1+1	1

Table 3-2 AMM2U capacities

3.4.2.3 AMM4U-1

The AMM4U-1 is intended for sites with up to four 1+0 terminals, two 1+1 terminal or one 1+1 and one or two 1+0 terminals. The AMM4U-1 can contain up to four MMUs, two SMUs and an optional SAU.

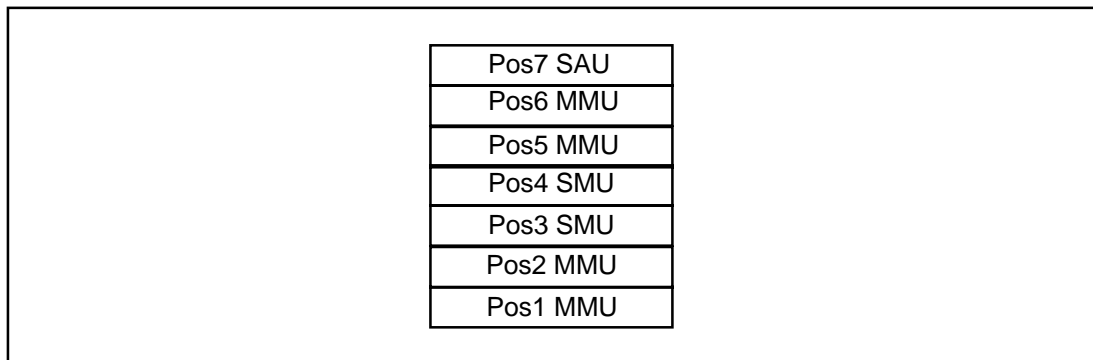


Figure 3-7 AMM4U-1

Terminal type	Number of terminals
1+0 or	1 - 4
1+1 or	2
1+1 and 1+0	1 + 1 or 2

Table 3-3 AMM4U-1 capacities

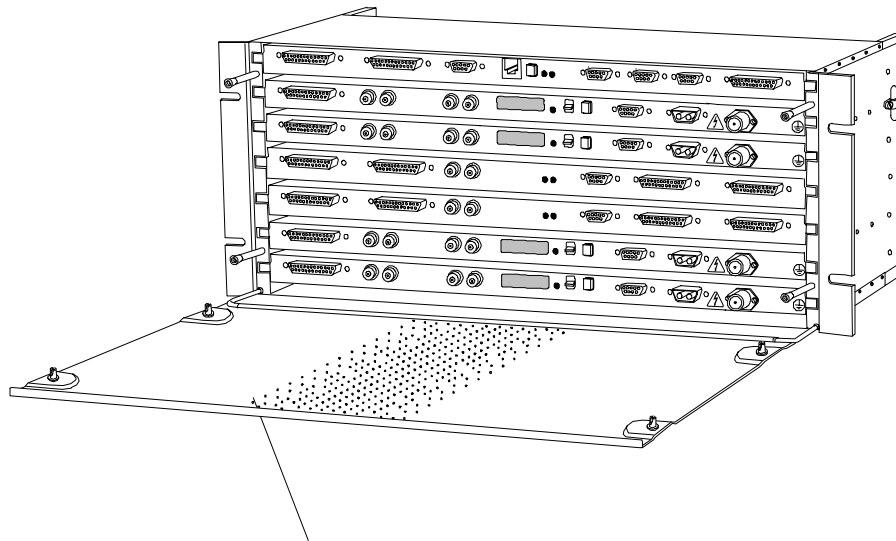


Figure 3-8 A fully equipped AMM4U-1

3.4.3 Modem Units (MMUs)

The MMU is the indoor interface to the radio unit (RAU). One MMU is required per RAU. The MMU comes in four different traffic versions:

1. **MMU 2 x 2** for 2x2Mbps;
2. **MMU 4 x 2/8** including a 2/8Mbps MUX for 4x2Mbps or 8Mbps;
3. **MMU 2 x 8** for 2x8Mbps without SMU or 8x2Mbps with SMU; and
4. **MMU 34 + 2** for 34Mbps and 2Mbps without SMU or 17x2Mbps with SMU.

The traffic signals can be connected to/from:

- the MMU front panel (from external equipment);
- an SMU providing multiplexing/demultiplexing of the traffic; or
- another MMU in the same access module (traffic routing).

3.4.3.1 MMU 2x2

The MMU 2x2 contains a modulator/demodulator for two 2Mbps traffic signals.

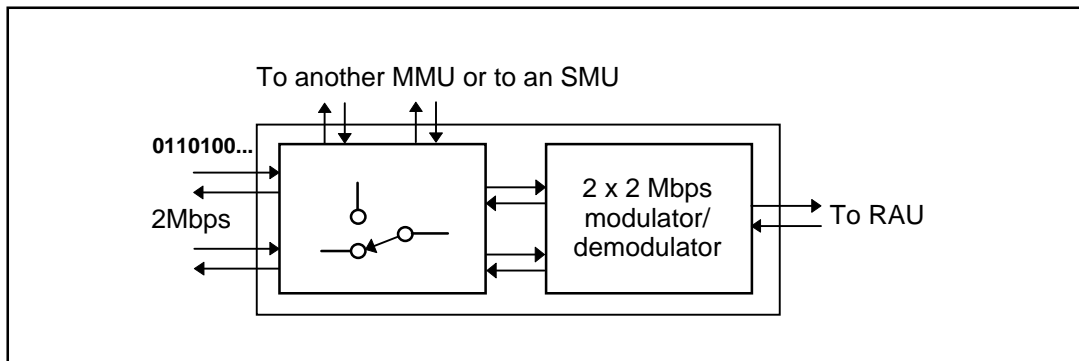


Figure 3-9 The MMU 2x2

3.4.3.2 MMU 4x2/8

The MMU 4x2/8 contains a modulator/demodulator for one 8Mbps signal and a 2/8 multiplexor/demultiplexor which converts four 2Mbps signals to a single 8Mbps and vice versa. This MMU can transmit/receive four 2Mbps traffic signals or one 8Mbps traffic signal.

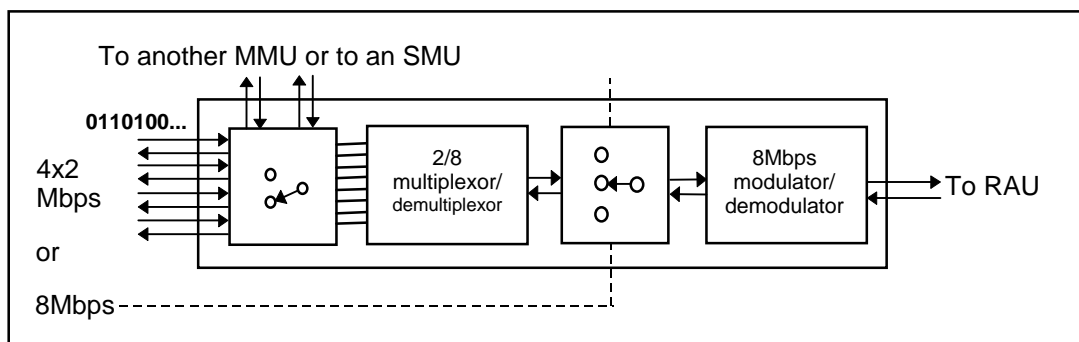


Figure 3-10 The MMU 4x2/8

3.4.3.3 MMU 2x8

The MMU 2x8 contains a modulator/demodulator for two 8Mbps traffic signals.

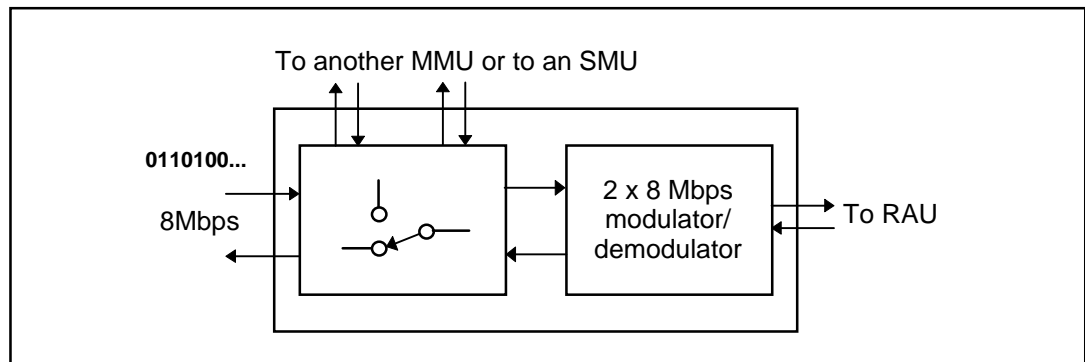


Figure 3-11 The MMU 2x8

3.4.3.4 MMU 34+2

The MMU 34+2 modulates and demodulates a 34Mbps signal plus an additional 2Mbps signal.

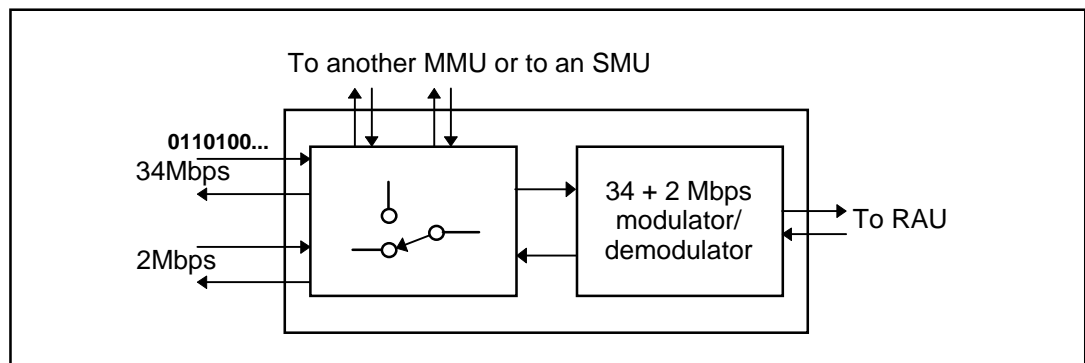


Figure 3-12 The MMU 34+2

3.4.4 Switch Multiplex Units

The SMU provides:

Protection switching for 1+1 hop configurations, and
Multiplexing / demultiplexing of 2Mbps traffic signals.

It comes in three different versions:

SMU Switch, containing no MUXes;

SMU 8 x 2, containing two 2/8 MUXes; and

SMU 16 x 2, containing four 2/8 and one 8/34 MUXes.

Each SMU also contains a 1+1 switch which is used to switch between two different MMUs in a protected configuration. The switch can switch one or two traffic channels.

3.4.4.1 SMU Switch

The SMU Switch contains the 1+1 MMU selection switch. It can terminate four 2Mbps, one 8Mbps or one 34Mbps and one 2Mbps traffic channel.

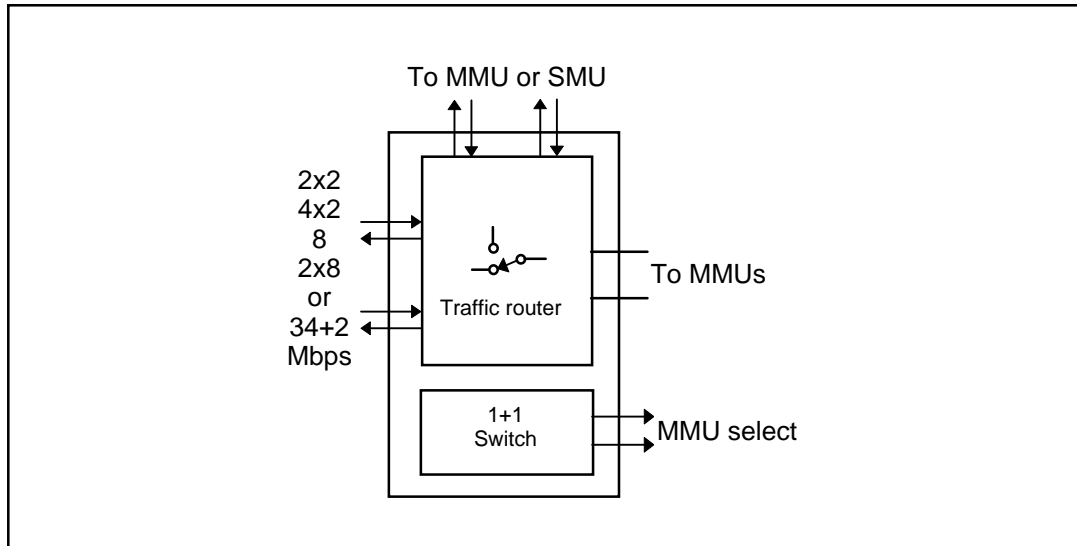


Figure 3-13 The SMU Switch

3.4.4.2 SMU 8x2

The SMU 8x2 contains two independent 2/8Mbps multiplexors/demultiplexors and the 1+1 MMU selection switch. It can terminate up to eight 2Mbps traffic signals.

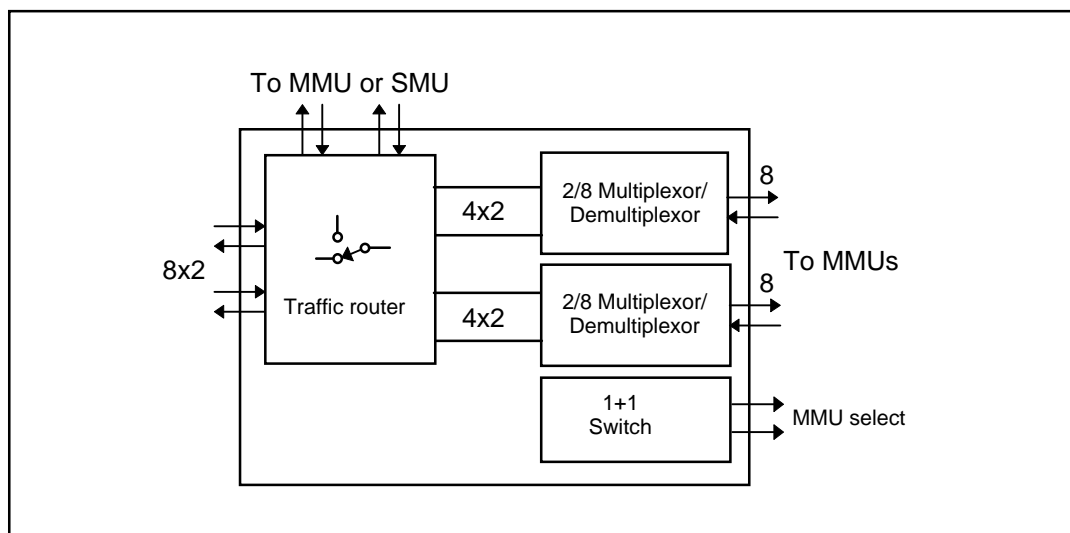


Figure 3-14 The SMU 8x2

The 2Mbps traffic signals can be connected to/from the SMU front panel to/from another SMU or MMU in the same access module. The 8Mbps traffic signals can be connected to one or two MMUs.

3.4.4.3 SMU 16x2

The SMU 16x2 can handle up to sixteen 2Mbps traffic signals. The unit contains four independent 2/8Mbps multiplexors/demultiplexors, one 8/34Mbps multiplexor/demultiplexor and the 1+1 MMU selection switch. It can terminate sixteen 2Mbps traffic signals.

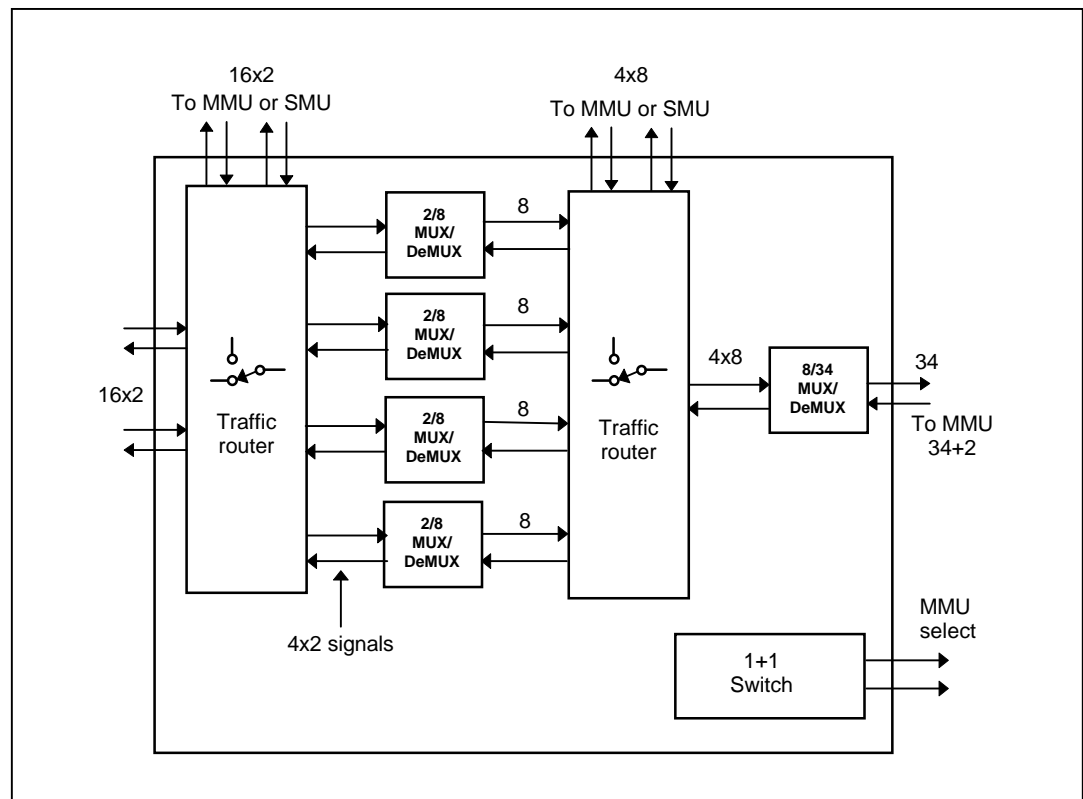


Figure 3-15 The SMU 16x2

The 2Mbps traffic signals can be connected to/from the SMU front panel or to/from another terminals in the same access module. An SMU 16x2 combined with an MMU 34+2 can terminate 17x2Mbps for one 1+0 or 1+1 terminal. An SMU 16x2 combined with two MMUs 8x2 can terminate 8x2Mbps for two 1+0 terminals.

3.4.5 Service Access Units

The Service Access Unit, SAU, provides service channels, parallel inputs and outputs and access to the External Alarm Channel (EAC). It is required to enable O&M communication between the MINI-LINK E and the MINI-LINK C or the MINI-LINK Mk II equipment on the site. It may also be required to provide O&M communication between different AMMs within the site, although in the future this will be provided directly between MMUs. A SAU will also be required if a Service Telephone must be connected.

The SAU comes in three different versions:

- Basic, which provides:
 - 2 External Alarm Channel (EAC) ports;
 - 8 user input interfaces;
 - 4 individually selectable user input/output interfaces.
- Exp1, which provides:
 - all items provided by Basic;
 - 2 Digital Service Channels (DSC);
 - 2 Remote Alarm Channels (RAC).
- Exp2, which provides:
 - all items provided by Basic;
 - 1 Analogue Service Channel (ASC) with a built-in line interface;
 - 1 Digital Service Channel (DSC);
 - 2 Remote Alarm Channels (RAC);

3.4.5.1 EAC Port

The EAC ports are used to connect the alarm and control information between the access module and MINI-LINK E, C or MkII equipment. The EAC is used in MINI-LINK E O&M networks.

See chapter 4 for further information.

3.4.5.2 User I/O

The user I/O ports connect the user's alarms to the MINI-LINK O&M network and control user functions. The user out ports can also be set to connect summary alarms from the access module to a separate supervisory system.

3.4.5.3 Digital Service Channels

The digital service channel(s) are used to distribute external ITU-T G.703 64kbps channels over the hop.

3.4.5.4 RAC

The RAC provides O&M connection between MINI-LINK E clusters at different sites via other fixed lines. Two interfaces are available: RS232 for analogue lines via modem or ITU-T G.703 64 kbps for digital lines.

3.5 Indoor Configuration

One access terminal may be set aside per terminal. Mostly, however, it will be advantageous to use one access module to serve multiple terminals (up to four). This concept will present the following benefits:

- Less indoor space will be required.
- Less cabling will be required (the traffic can be routed between the terminals without a single piece of cabling).
- The overall cost will be reduced.

It is recommended that the following procedure is followed in order to find the set of indoor units which can deal with a particular traffic situation.

1. Select MMUs for the radio units: one for each 1+0 configuration and two for each 1+1 configuration and establish the need for SMU(s).
2. Establish whether an SAU will be required or not. Please refer to section 3.4.5.
3. Sum up the required numbers of MMUs, SMUs and SAUs and decide which types of AMMs to use.

3.5.1 Configuring One 1+0 Terminal

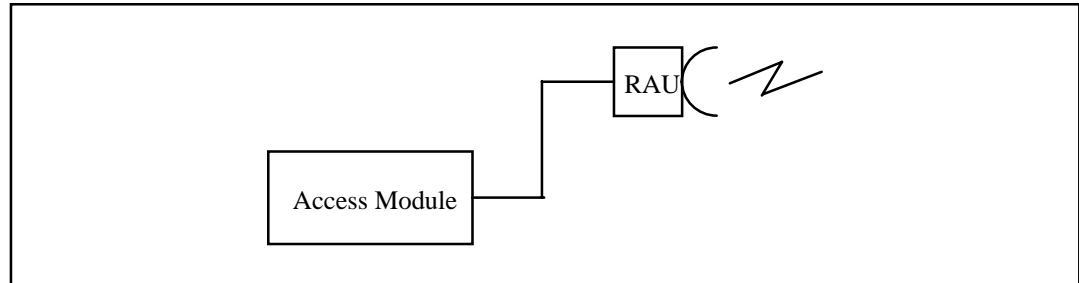


Figure 3-16 One 1+0 Terminal

3.5.1.1 Step 1: MMU and SMU Selection

The table below indicates which MMUs and SMU to use to obtain a required traffic capacity. For example, a required traffic capacity of 17x2Mbps requires an SMU 16x2 and an MMU 34+2.

Terminal 1 Mbps	Pos3 MMU * Type	Pos2 MMU Type	Pos1 SMU Type
2x2	2x2	-	-
4x2	4x2/8	-	-
8x2	2x8	-	8x2
17x2	34+2	-	16x2
8	4x2/8	-	-
2x8	2x8	-	-
34+2	34+2	-	-

* The MMU type refers to an AMM2U. For AMM1U-0: Pos1 MMU.

Table 3-4 MMU and SMU selection for one 1+0 terminal

3.5.1.2 Step 2: SAU Selection

Decide whether an SAU is required or not according to the criteria described in section 3.4.5.

3.5.1.3 Step 3: AMM Selection

Now decide which AMM type to use according to the following table.

MMU	SMU	SAU	AMM Type
1	0	0	AMM1U-0
1	0	1	AMM2U
1	1	0	AMM2U
1	1	1	AMM2U

Table 3-5 AMM selection for one 1+0 terminal

3.5.2 Configuring Two 1+0 Terminals

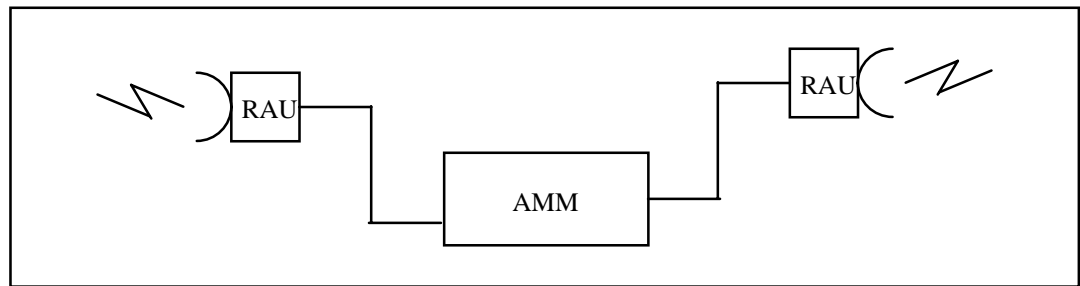


Figure 3-17: Two 1+0 Terminals

3.5.2.1 Step 1: MMU and SMU Selection

The tables below indicate which MMUs and SMUs to use to obtain a required traffic capacity. For example, a required traffic capacity of 4x2Mbps for terminal 1 and 17x2Mbps for terminal 2 requires an MMU 4x2/8 as Pos3 MMU, an MMU 34+2 in as Pos2 MMU and an SMU 16x2 as Pos1 SMU.

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
2x2	2x2	2x2	2x2	-
2x2	4x2	2x2	4x2/8	-
2x2	8x2	2x2	2x8	8x2
2x2	17x2	2x2	34+2	16x2
2x2	8	2x2	4x2/8	-
2x2	2x8	2x2	2x8	-
2x2	34+2	2x2	34+2	-

Table 3-6a MMU and SMU selection for two 1+0 terminals, part 1

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
4x2	2x2	4x2/8	2x2	-
4x2	4x2	4x2/8	4x2/8	-
4x2	8x2	4x2/8	2x8	8x2
4x2	17x2	4x2/8	34+2	16x2
4x2	8	4x2/8	4x2/8	-
4x2	2x8	4x2/8	2x8	-
4x2	34+2	4x2/8	34+2	-

Table 3-6b MMU and SMU selection for two 1+0 terminals, part 2

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
8x2	2x2	2x8	2x2	8x2
8x2	4x2	2x8	4x2/8	8x2
8x2	8x2	2x8	2x8	16x2
8x2	17x2	Please refer to table 3-6h		
8x2	8	2x8	4x2/8	8x2
8x2	2x8	2x8	2x8	8x2
8x2	34+2	2x8	34+2	8x2

Table 3-6c MMU and SMU selection for two 1+0 terminals, part 3

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
17x2	2x2	34+2	2x2	16x2
17x2	4x2	34+2	4x2/8	16x2
17x2	8x2	Please refer to table 3-6h		
17x2	17x2	Please refer to table 3-6h		
17x2	8	34+2	4x2/8	16x2
17x2	2x8	34+2	2x8	16x2
17x2	34+2	34+2	34+2	16x2

Table 3-6d MMU and SMU selection for two 1+0 terminals, part 4

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
8	2x2	4x2/8	2x2	-
8	4x2	4x2/8	4x2/8	-
8	8x2	4x2/8	2x8	8x2
8	17x2	4x2/8	34+2	16x2
8	8	4x2/8	4x2/8	-
8	2x8	4x2/8	2x8	-
8	34+2	4x2/8	34+2	-

Table 3-6e MMU and SMU selection for two 1+0 terminals, part 6

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
2x8	2x2	2x8	2x2	-
2x8	4x2	2x8	4x2/8	-
2x8	8x2	2x8	2x8	8x2
2x8	17x2	2x8	34+2	16x2
2x8	8	2x8	4x2/8	-
2x8	2x8	2x8	2x8	-
2x8	34+2	2x8	34+2	-

Table 3-6f MMU and SMU selection for two 1+0 terminals, part 7

Terminal 1 Mbps	Terminal 2 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
34+2	2x2	34+2	2x2	-
34+2	4x2	34+2	4x2/8	-
34+2	8x2	34+2	2x8	8x2
34+2	17x2	34+2	34+2	16x2
34+2	8	34+2	4x2/8	-
34+2	2x8	34+2	2x8	-
34+2	34+2	34+2	34+2	-

Table 3-6g MMU and SMU selection for two 1+0 terminals, part 8

Terminal 1 Mbps	Terminal 2 Mbps	Pos6 MMU Type	Pos5 MMU Type	Pos4 SMU Type	Pos3 SMU Type	Pos2 MMU Type
8x2	17x2	2x8	-	8x2	16x2	34+2
17x2	8x2	34+2	-	16x2	8x2	2x8
17x2	17x2	34+2	-	16x2	16x2	34+2
4x2+8	17x2	2x8	-	8x2	16x2	34+2

Table 3-6h MMU and SMU selection for two 1+0 terminals, part 9

3.5.2.2 Step 2: SAU Selection

Decide whether an SAU is required or not according to the criteria described in section 3.4.5.

3.5.2.3 Step 3: AMM Selection

Now decide which AMM type to use according to the following table.

MMU	SMU	SAU	AMM Type
2	0	0	AMM2U
2	0	1	AMM2U
2	1	0	AMM2U
2	1	1	AMM2U
2	2	0	AMM4U-1
2	2	1	AMM4U-1

Table 3-7 AMM selection for two 1+0 terminals

3.5.3 Configuring Three or Four 1+0 Terminals

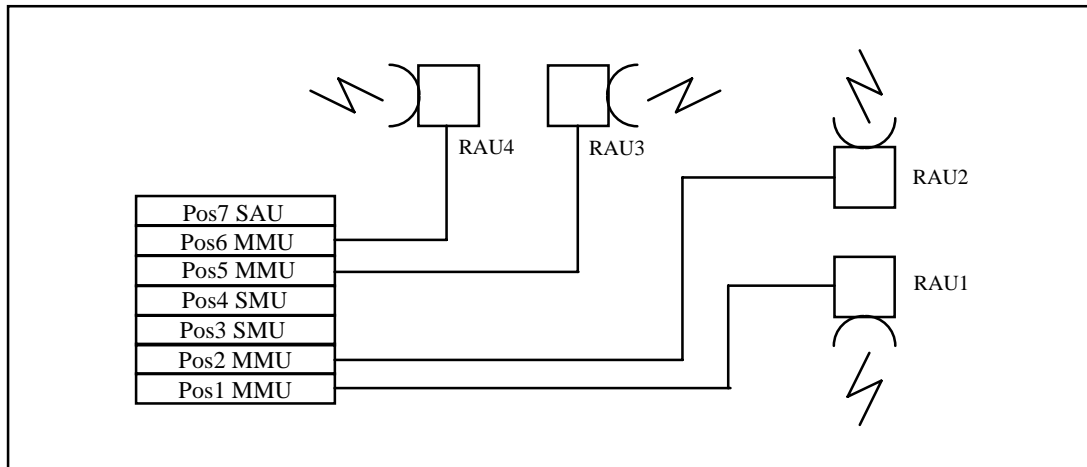


Figure 3-18: Four 1+0 Terminals

When deciding the required equipment for three or four 1+0 terminals it is essential that the equipment is configured according to figure 3-18.

3.5.3.1 Step 1: MMU and SMU Selection

First use table 3-6 in section 3.5.2.1 to select the Pos5 MMU, Pos6 MMU and Pos4 SMU required for two 1+0 terminals with the desired traffic capacities.

For three 1+0 terminals, then use table 3-4 in section 3.5.1.1 to select the Pos2 MMU and Pos3 SMU required for an additional 1+0 terminal.

For four 1+0 terminals, use table 3-6 in section 3.5.2.1 to select the Pos1 MMU, Pos2 MMU and Pos3 SMU required for the last two terminals.

We recommend you to install the terminal with the highest traffic capacity in the position with highest number (preparation for traffic routing).

3.5.3.2 Step 2: SAU Selection

Decide whether a SAU is required or not according to the criteria described in section 3.4.5.

3.5.3.3 Step 3: AMM Selection

Three or four 1+0 terminals will always require an AMM4U-1.

3.5.4 Configuring One 1+1 Terminal

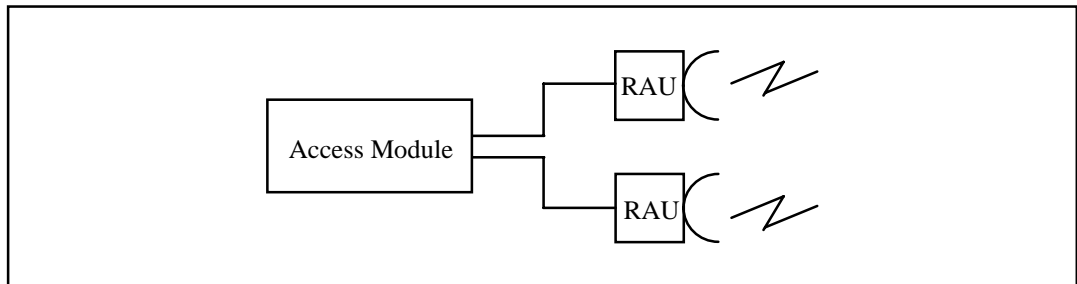


Figure 3-19: One 1+1 Terminal

3.5.4.1 Step 1: MMU and SMU Selection

Table 3-8 below indicates the MMUs and SMU required for one 1+0 terminal.

Terminal 1 Mbps	Pos3 MMU Type	Pos2 MMU Type	Pos1 SMU Type
2x2	2x2	2x2	Sw
4x2	4x2/8	4x2/8	Sw
8x2	2x8	2x8	8x2
17x2	34+2	34+2	16x2
8	4x2/8	4x2/8	Sw
2x8	2x8	2x8	Sw
34+2	34+2	34+2	Sw

Table 3-8 MMU and SMU selection for one 1+1 terminal

3.5.4.2 Step 2: SAU Selection

Decide whether an SAU is required or not according to the criteria described in section 3.4.5.

3.5.4.3 Step 3: AMM Selection

Now decide which AMM type to use according to the following table.

MMU	SMU	SAU	AMM Type
2	1	0	AMM2U
2	1	1	AMM2U

Table 3-9 AMM selection for one 1+1 terminal

3.5.5 Configuring Two 1+1 Terminals or One 1+1 Terminal and One or Two 1+0 Terminals

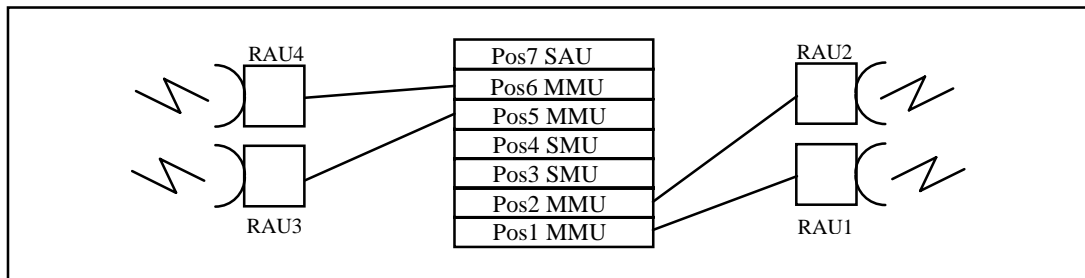


Figure 3-20: Two 1+1 Terminals

3.5.5.1 Step 1: MMU and SMU Selection

Two 1+1 terminals

Use table 3-8 in section 3.5.4.1 twice to select the MMU 1 - 4 required for two 1+1 terminals.

One 1+1 terminal and one or two 1+0 terminals

Use table 3-8 in section 3.5.4.1 to select the Pos5 MMU, Pos6 MMU and Pos4 SMU required for one 1+1 terminal. Then use table 3-4 in section 3.5.1.1 or table 3-6 in section 3.5.2.1 to select the Pos1 MMU, Pos2 MMU and Pos3 SMU required for one or two 1+0 terminals.

We recommend you to install the terminal with the highest traffic capacity in the position with highest number (preparation for traffic routing).

3.5.5.2 Step 2: SAU Selection

Decide whether a SAU is required or not according to the criteria described in section 3.4.5.

3.5.5.3 Step 3: AMM Selection

These configurations will always require AMM4U-1.

3.6 Indoor Configuration Examples

This section of the manual presents some indoor configuration examples in complexity order. However, due to the very large number of possibilities this will be a few typical cases only. It should in no way be construed as a full listing of all possible MINI-LINK E combinations.

3.6.1 Example 1: 1+0 Repeater Hop

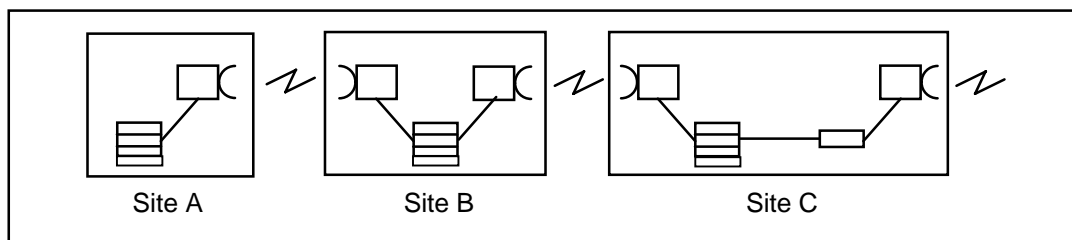


Figure 3-21 A simple 1+0 repeater hop configuration for 4x2Mbps traffic

Site B is configured as a simple 1+0 repeater, relaying the traffic from Site A to Site C. Neither service channel nor user I/O is asked for. At site C the repeater hop is to be connected to an existing MINI-LINK network via MINI-LINK C equipment.

3.6.1.1 Site A Configuration

1. Use table 3-4 in section 3.5.1.1 to establish the MMU type required. The table also indicates that no SMU is required.
2. No SAU is required.
3. The required equipment can be installed in an AMM1U-0.

3.6.1.2 Site B Configuration

1. Use table 3-6 in section 3.5.2.1 to establish the MMU types required. Both types will be MMU 4x2/8. The table also indicates that no SMU is required.
2. No SAU is required.
3. The required equipment can be installed in an AMM2U.

3.6.1.3 Site C Configuration

1. Use table 3-4 in section 3.5.1.1 to establish the MMU type required: MMU 4x2/8. The table also indicates that no SMU is required.
2. An SAU is required to provide connectivity to the MINI-LINK C equipment. An SAU Basic will do nicely.
3. All indoor equipment can be housed in an AMM2U.

3.6.1.4 Configuration Summary

The required indoor equipment is illustrated in figure 3-22.

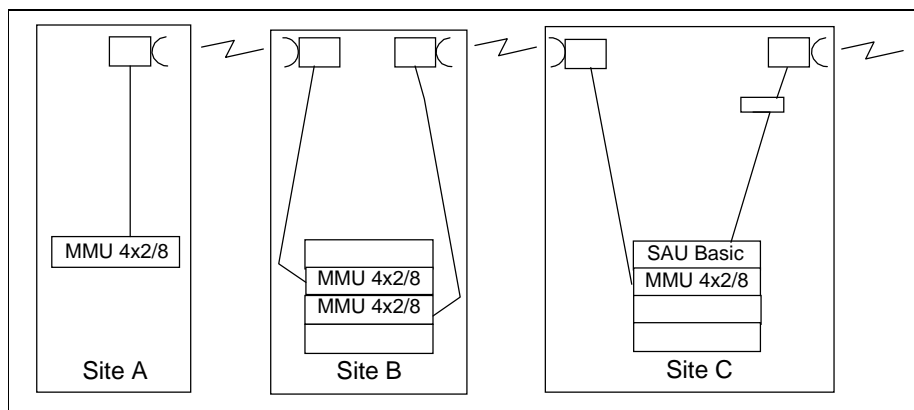


Figure 3-22 1+0 repeater hop summary

Before placing the final order you should consider the need for possible future extensions of the traffic capacity or addition of terminals. Other topics of interest in this context is the possible future need for service channel(s), alarm connections etc.

3.6.2 Example 2: A Tree Topology Network

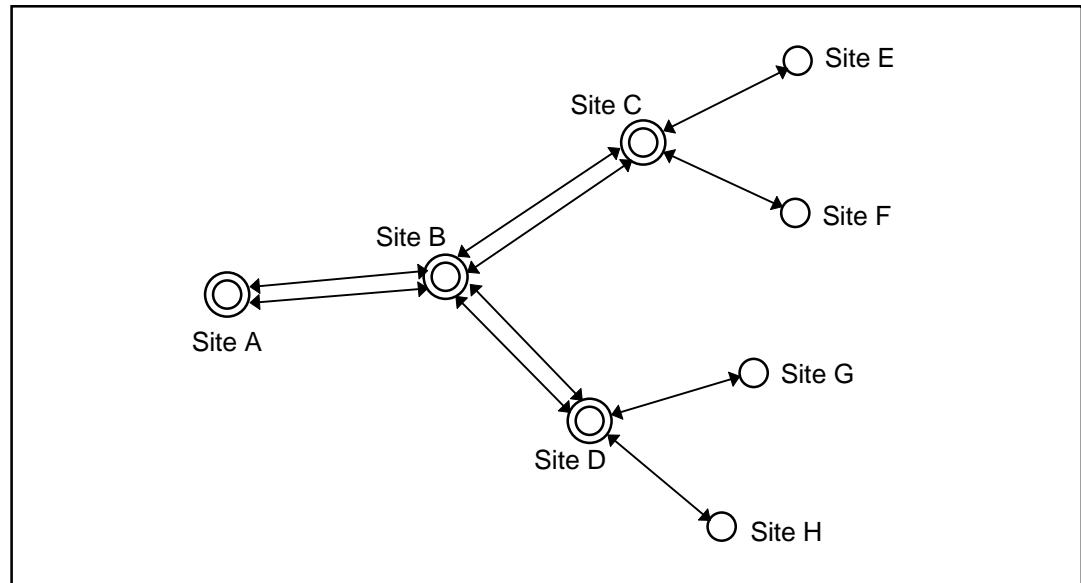


Figure 3-23 A tree topology network

Hop	Capacity, Mbps	Configuration
A - B	17 x 2	1+1
B - C, B - D	8 x 2	1+1
C - E, C - F, D - G, D - H	4 x 2	1+0

Table 3-10 Required capacities and hop configurations

Alarm connections to an external supervisory system is required.

3.6.2.1 Site A Configuration

- Use table 3-8 in section 3.5.4.1 to establish the required MMUs and SMU:
 - MMU 34+2
 - MMU 34+2
 - SMU 16x2
- Due to the requirement for alarm connections, an SAU Basic is required.
- The equipment can be installed in an AMM2U.

The units' positions in the AMM are illustrated in figure 3-24, section 3.6.2.5.

3.6.2.2 Site B Configuration

1. Use table 3-8 in section 3.5.4.1 to establish the MMU and SMU types required for hop B-A: MMU 34+2
MMU 34+2
SMU 16x2
2. Use table 3-8 to establish the MMU and SMU types required for hop B-C:
MMU 2x8
MMU 2x8
SMU 8x2
3. Use table 3-8 to establish the MMU and SMU types required for hop B-D:
MMU 2x8
MMU 2x8
SMU 8x2
4. Due to the requirement for alarm connections, one SAU Basic is required per AMM.
5. One AMM4U-1 and one AMM2U are required for the indoor components.

The units' positions in the AMMs are illustrated in figure 3-24, section 3.6.2.5.

3.6.2.3 Site C and D Configuration

1. Use table 3-8 in section 3.5.4.1 to establish the MMU and SMU types for hops C-B and D-B respectively: MMU 2x8
MMU 2x8
SMU 8x2
2. Use table 3-6 in section 3.5.2.1 to establish the MMU and SMU types for hops C-E, C-F, D-G and D-H respectively: MMU 4x2/8
MMU 4x2/8
SMU not required
3. Due to the requirement for alarm connections, one SAU Basic is required per hop.
4. An AMM4U-1 is required for the indoor equipment.

The units' positions in the AMM are illustrated in figure 3-24, section 3.6.2.5.

3.6.2.4 Site E, F, G and H Configuration

1. Use table 3-4 in section 3.5.1.1 to establish the MMU type required: MMU 4x2/8
2. No SMU is required on either site.
3. Due to the requirement for alarm connections, one SAU Basic is required per site.
4. AMM2U is required for the indoor equipment on all sites.

The units' positions in the AMM are illustrated in figure 3-24, section 3.6.2.5.

3.6.2.5 Configuration Summary

The required indoor equipment is illustrated in figure 3-24 below.

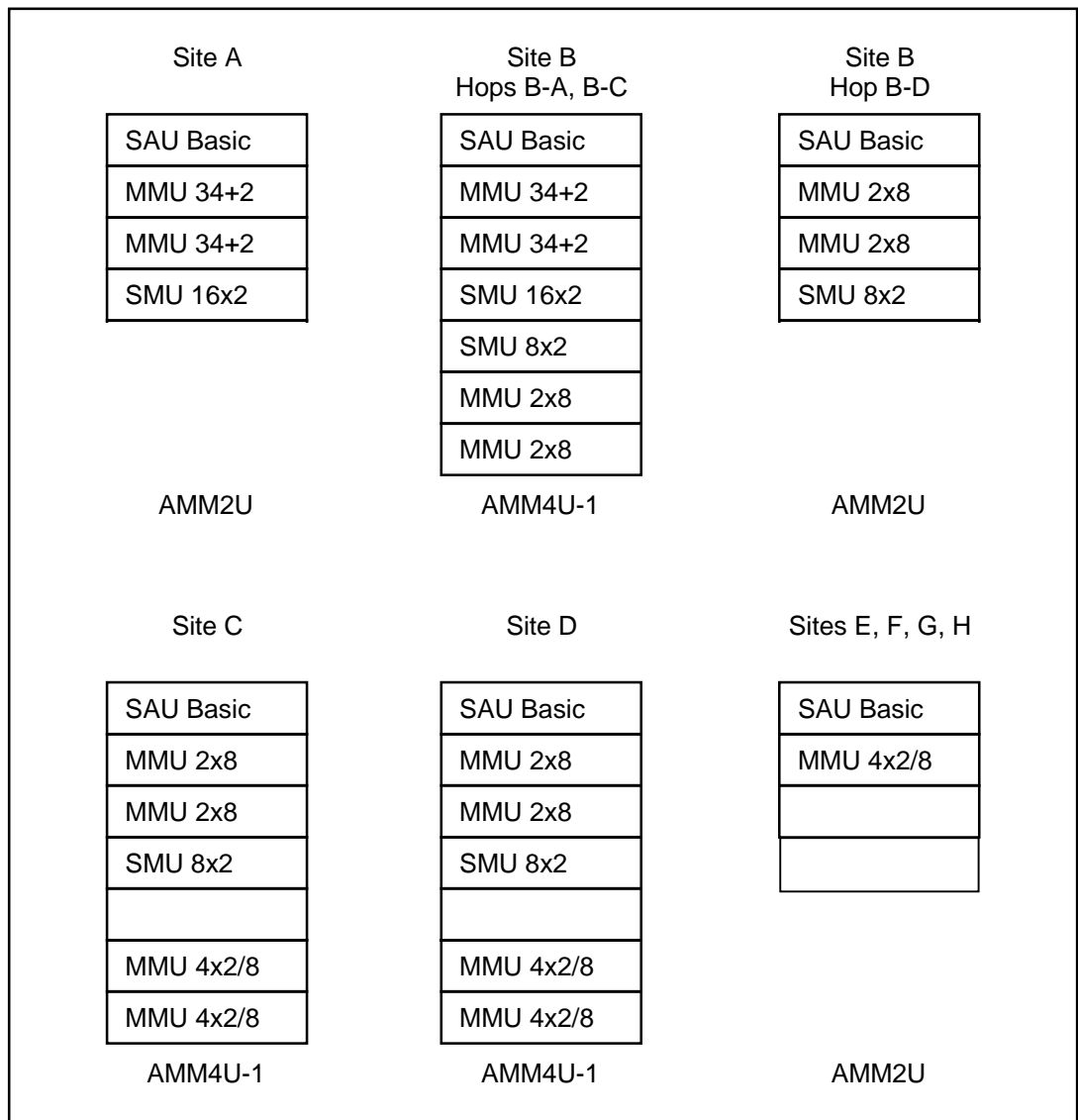


Figure 3-24 Indoor equipment summary

3.7 Summary

The purpose of this chapter is to show that good knowledge, a systematic approach and some common sense will bring you a good way to being able to configure a MINI-LINK E network. However, the systems engineers of your Ericsson representative will be most glad to assist you in this endeavor.

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4 O & M Network

4.1 Introduction

The basic concepts of Operation and Maintenance (O&M) are described in the MINI-LINK E Technical Description Manual, EN/LZT 110 2012, chapter 6.

The O&M functionality for alarm and control handling is incorporated in each radio unit, thus eliminating the need for extra equipment for the O&M functions.

The O&M network requires four basic steps to be completed:

- Cabling Section 4.2
- User Inputs and Outputs Section 4.3
- Identities Section 4.4
- Tools Section 4.5

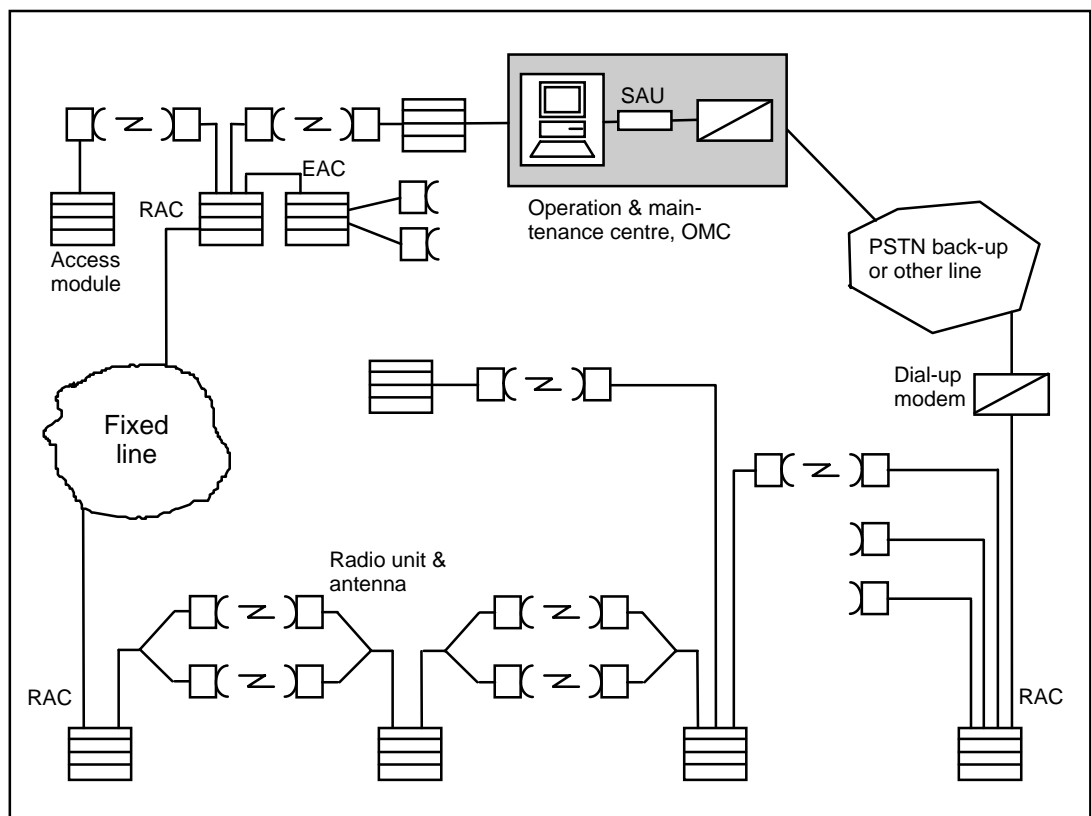


Figure 4-1: A Network Example

4.2 Cabling

4.2.1 AMM Interconnections

The AMMs within a site must be interconnected.

An SAU with EAC is required for interconnection. However, in the future it will be possible to interconnect MMUs directly.

4.2.2 EAC Cabling

The EAC cabling is used to connect MINI-LINK C and/or Mk II equipment to MINI-LINK E equipment or to interconnect MINI-LINK E equipment.

The EAC cable is connected from the EAC1 connector on one SAU to the EAC2 connector on the next SAU, and from the EAC1 connector on the last SAU to the corresponding connector on the MINI-LINK C or Mk II equipment, as illustrated in figure 4-2.

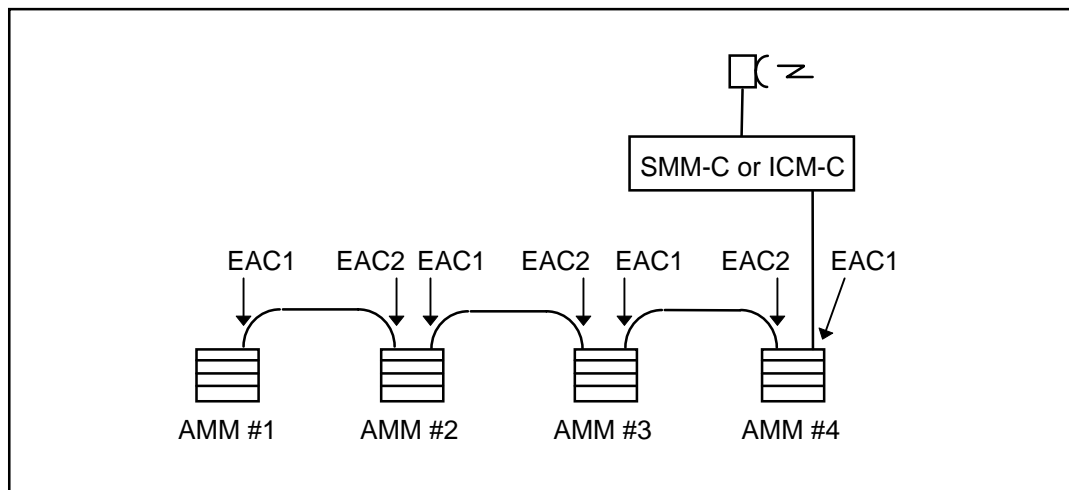


Fig. 4-2 SAU - EAC Cabling

There are a few limitations concerning the use of EAC cabling.

A maximum of 32 MINI-LINK E terminals per site can be interconnected using EAC cabling. For MINI-LINK C terminals the number is even smaller. Please refer to the applicable MINI-LINK C User's Manuals for further information.

The maximum EAC cable length is 1,200m total.

If these limitations prohibits the implementation of the full site as required, RAC cabling may be used as described in figure 4-4.

4.2.3 RAC Cabling

The RAC port is used when isolated sites are to be connected via another traffic medium. This traffic medium can be a fixed line connected to a modem at each end using the RS232 interface, or it may be an ITU-T G.703 64kbit/s interface. The RAC connection requires two SAUs, one at each end of the fixed line.

The MINI-LINK network can consist of MINI-LINK C and MkII equipment, but the RAC connection must be made to SAUs on both sides. A stand-alone SAU is available for this purpose.

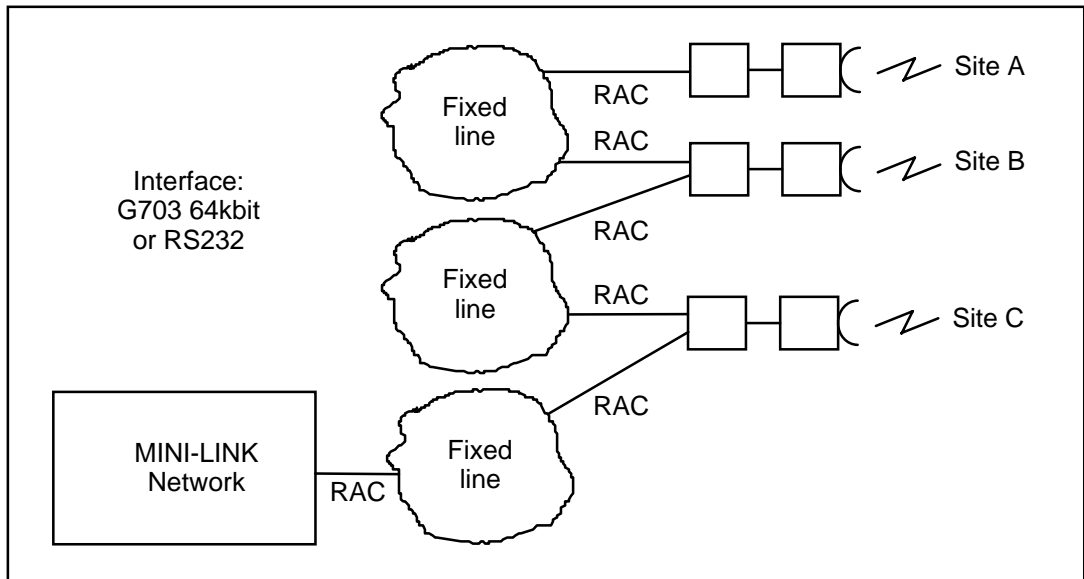


Figure 4-3 Connection of Isolated Sites

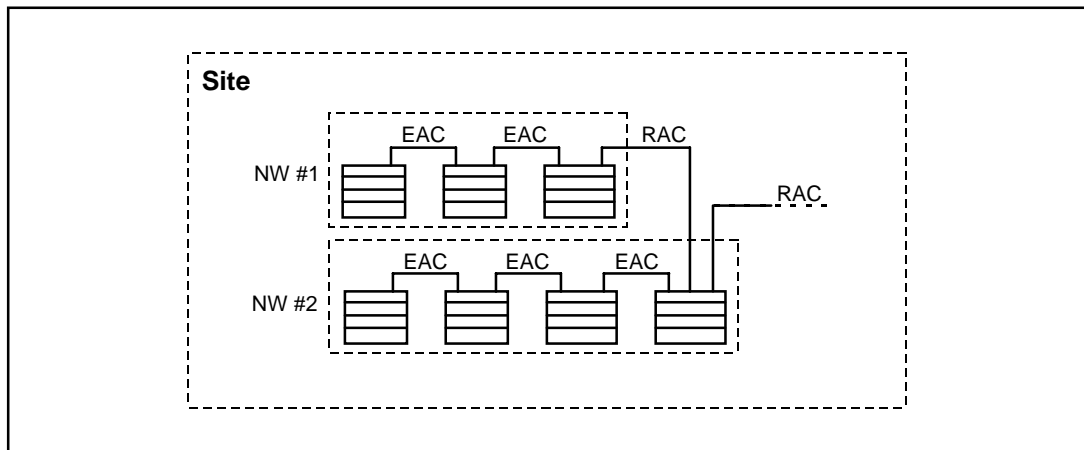


Figure 4-4: RAC Cabling for a Multi-Network Site

Each network in figure 4-4 must meet the limitation requirements for EAC cabling as discussed in section 4.2.2.

4.3 SAU Exp2 Omnibus

The Omnibus feature is used to interconnect the Service Channels in the AMM in which the SAU Exp2 is installed.

4.3.1 Service Channel Interconnections

The service channel is connected from the service telephone to the terminals in the AMM. This connection is controlled via MNM, MSM, MIM or MOMS.

The service channels are distributed to the remote Site via the MMUs and RAUs.

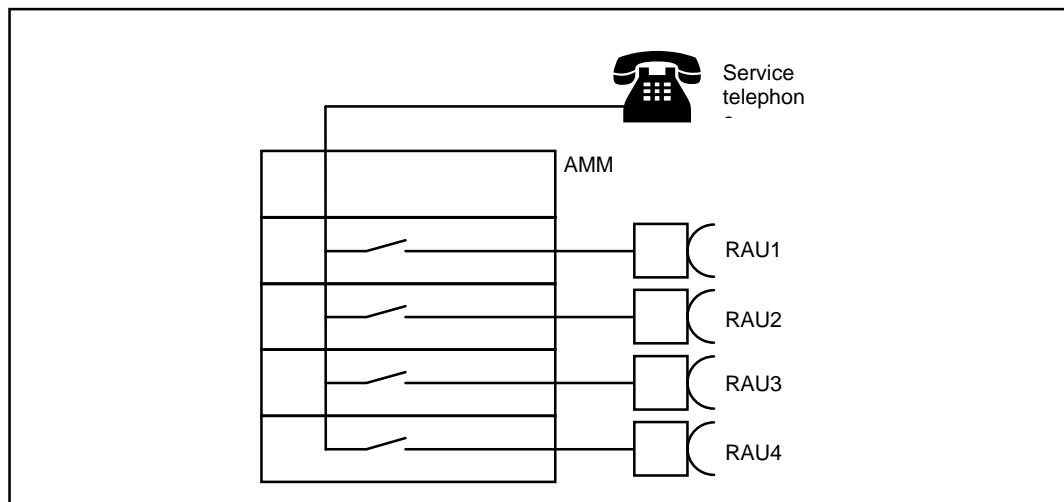


Figure 4-5: Service Channel Interconnections

4.3.2 Branching

The output level of the branching ports may be set in steps of 1dB using the control software.

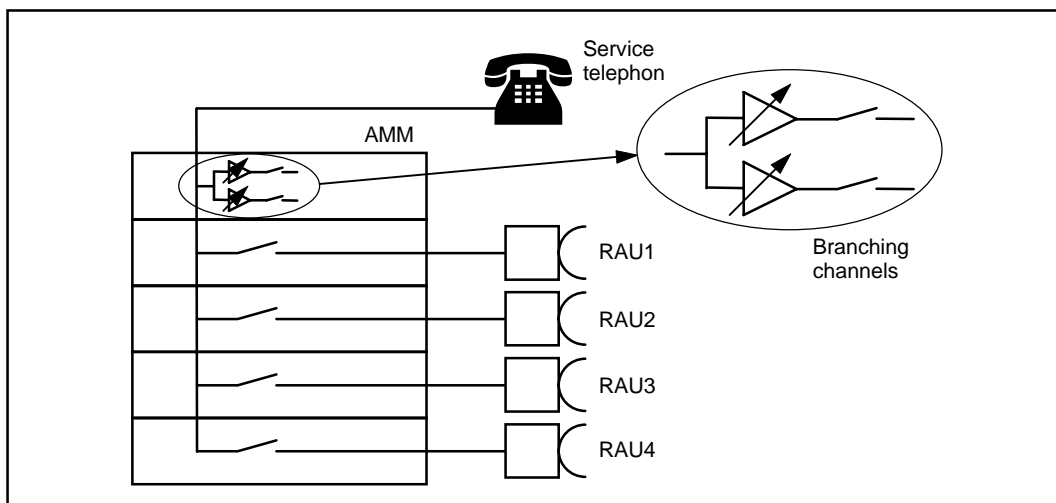


Figure 4-6: Service Channel Branching Ports

Two branching ports may be selected for connection to other AMMs on the Site. These ports are interconnected using the BR/EAC connector.

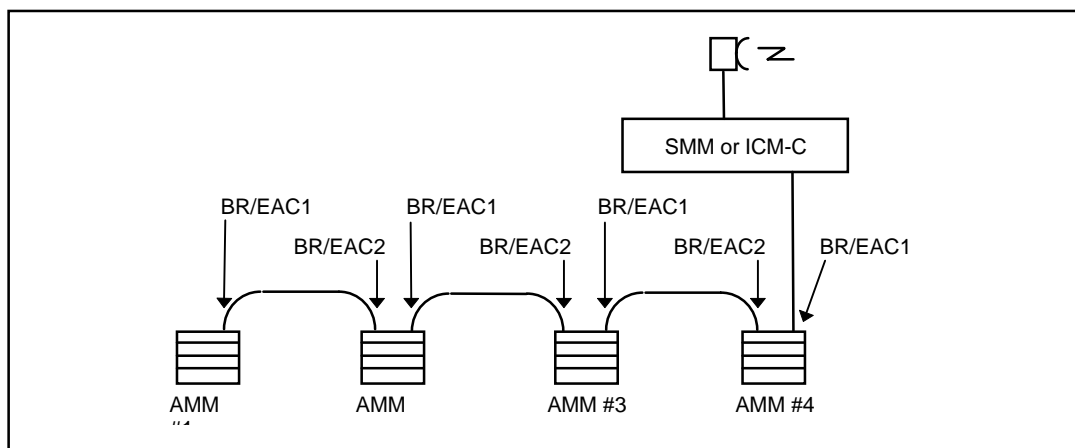


Figure 4-7: Service Channel Interconnections on a Site

4.3.3 Limitations

- An SAU Exp2 is required in all AMMs in the network.
- A point-to-point service telephone link is possible if the AMMs contains one terminal only or if the service channel connections to all other terminals are shut off.
- Service telephones connected to MINI-LINK E networks are assigned two-digit call numbers in MNM. Dialling "23" routes the *ring signal* to telephone no. 23 only.
- Service telephones connected to MINI-LINK C networks are assigned single-digit call numbers in MNM. Dialling "23" routes the *ring signal* to telephones no. 2 **and** 3 simultaneously.
- There is **absolutely no call privacy** or **secrecy** on the service telephone network. Ongoing conversations can be listened in to and participated in simply by lifting the receiver.
- No more than five service telephones should be in use simultaneously. The static and echo effects increase with the number of telephones in simultaneous use, and beyond five telephones the levels rapidly become intolerable in terms of an intelligible conversation.
- There should be no more than ten Hops between any two service telephones. This is also a conversation quality limitation.
- Ring nets are **not** allowed.

4.3.4 Useful Hints

- The "hash" (#) button on the telephone may be used to make all telephones ring simultaneously (general call, group conversation).
- Limited group calls can be made if the same subscriber number is assigned to two or more telephones.

4.4 User Inputs and Outputs

The User Input ports can be used to connect the user's alarms to the MINI-LINK O&M network. The user's alarms may for example be a fire alarm or a power supply alarm. A severity is assigned to each individual alarm.

The User Output ports can be used to control the user's functions via the O&M network. The User Output ports can also be used to connect summary alarms from the Access Module to the user's supervisory control system.

The SAU is required for the user input and output function. Eight user input ports and four selectable input or output ports are available

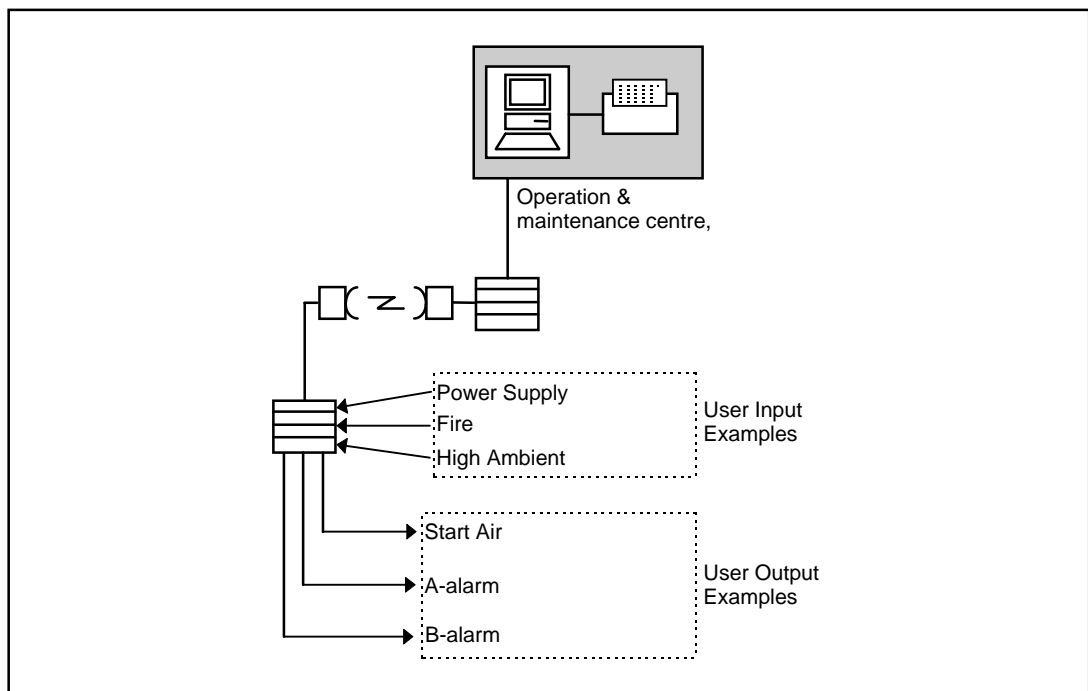


Figure 4-8: Examples of User Inputs and Outputs

The alarms are forwarded to the O&M centre, which handles them and acknowledges them.

4.5 Identities

MINI-LINK E equipment uses two different identities in the O&M networks: terminal identities and SAU identities. All identities within a supervised network must be fully unambiguous.

The requirement for unambiguity calls for a centralized planning of all identities in order to prevent confusion within a network. The identities may be reused one or several times, but **NEVER** in networks supervised by the same computer or in networks which might in the foreseeable future be supervised by the same computer.

An identity is a four character string, for example composed of two letters and two digits. An identity might for example be GOE1. In this case, the two first characters could identify the site (GO = Gothenburg), the third character could identify the type of the equipment (E = MINI-LINK E), and the fourth character could identify the number in a series of equipment (1 = equipment #1). In practise, the identity can be any combination of characters from the range A - Z, a - z and 0 - 9, except for some restricted identities as given in section 4.4.1.

The actual setting of the identities is performed in the AM Setup function of the MIM (MINI-LINK Installation Manager), the MSM (MINI-LINK Service Manager) or the MNM (MINI-LINK Network Manager) software. This procedure is also discussed in detail in the appropriate Operation Manual, where several examples are also given.

When MINI-LINK E equipment is installed on a site which is already containing MINI-LINK C or MkII equipment, only the SAU identity is added to the EAC list of the existing equipment.

4.5.1 Restricted Identities

The identities cannot be set fully arbitrarily. Some letter combinations are not allowed. They are:

AAAA BBBB SMMA SMMB TRMA TRMB

The identity BBBB is used for non-existing equipment.

4.6 Tools

The following tools are available for an O&M Network.

- MIM MINI-LINK Installation Manager
- MSM MINI-LINK Service Manager
- MNM MINI-LINK Network Manager
- MOMS Microwave radio Operation and Maintenance System

4.6.1 MIM

MIM is a PC based software used for basic setup and installation of MINI-LINK E equipment. The applicable procedures are discussed in detail in the MINI-LINK MNM, MSM, MIM Operation Manual.

4.6.2 MSM

MSM is a PC based software tool used for installation and field service on MINI-LINK E, C and MkII equipment. This includes setup, local and remote fault tracing and performance monitoring. The applicable procedures are discussed in detail in the MINI-LINK MNM, MSM, MIM Operation Manual.

4.6.3 MNM

MNM is a PC based software recommended for operations and maintenance centres (OMCs). It includes centralized management plus all MSM functionality. The applicable procedures are discussed in detail in the MNM User's Manual, and in the MINI-LINK MNM, MSM, MIM Operation Manual.

4.6.4 MOMS

MOMS is a workstation based TMOS (UNIX) version of MNM. It is used when relatively large networks are to be supervised. The MOMS User's Manual is customized to suit the individual network.

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5 Traffic Routing

5.1 Introduction

This chapter explains the possibilities with software controlled traffic routing and describes how to simulate the traffic routing setup by using the MINI-LINK Traffic Routing Guide. Software controlled traffic routing in the back-plane of the AMM enables routing of the traffic within a magazine, minimizing the need for external cabling between the units.

The actual interconnection is controlled from a PC with the MINI-LINK Installation Manager (MIM), MINI-LINK Service Manager (MSM) or MINI-LINK Network Manager (MNM).

Note that although many realistic routing requirements can be solved with the back-plane routing, it is not possible to solve *all* traffic routing cases in the back-plane (see next section).

5.2 Configurations and Traffic Selection

5.2.1 Positioning in the AMM

The principle of how the units are fitted in the Access Module Magazine (AMM)

Terminal are placed A, B, C, D (from the position with highest pos number in the AMM), unless the SMU requirements forces a different positioning.

- A = Feeder
- B = Sub-link 1
- C = Sub-link 2
- D = Sub-link 3

The feeder has the highest traffic rate, sub-link 1 the second highest and sub-link 3 the lowest according to the formula:

Feeder \geq Sub-link 1 \geq Sub-link 2 \geq Sub-link 3

The network group tree used in the MINI-LINK Traffic Routing Guide is built up after this principle.

5.2.2 Traffic selection

Define the number of 2 Mbps needed and select "Traffic" configuration in the table below. The tables shows feeder and sub-link recommendations in order to minimize the costs.

Recommendations for all configuration used

No of 2Mbps	Traffic	Comment
1 - 2	2x2	Routed as 2Mbps
1 - 3	4x2	Routed as 2Mbps
4	8	Routed as 8Mbps
5 - 7	8x2	Routed as 2Mbps and/or 8Mbps
8	2x8	Routed as 8Mbps
9 - 15	16x2+2	Routed as 2Mbps and/or 8Mbps
16 - 17	34+2	Routed as 34Mbps and 2Mbps

Recommendations for feeder selection

Traffic	Comment
2x2	One or two sub-links with a total of max 2x2Mbps used traffic
4x2	One to three sub-links with a total of max 4x2Mbps used traffic
8	One sub-link with 8Mbps used traffic
8x2	One to three sub-links with a total of max 8x2Mbps used traffic using 2Mbps or a combination of 2 and 8Mbps
2x8	One or two sub-links with a total of max 2x8 Mbps used traffic using 8Mbps interface
16x2+2	One to three sub-links with a total of max 17x2Mbps used traffic using 2Mbps or a combination of 2 and 8Mbps
34+2	One or two sub-links with a total of max 17x2Mbps used traffic using 34Mbps or a combination of 34 and (1x)2Mbps

Fig 5-1. Recommendations for traffic selection.

5.2.3 Traffic Configurations

Six types of traffic routing cases can be distinguished, as illustrated in the figures below. The number of different configurations are limited by the number of terminals possible to house in one AMM.

5.2.3.1 One Feeder (1+0) and one Sub-link (1+0)

Traffic Configuration 1+0 to 1x(1+0).

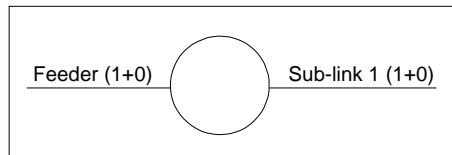


Fig 5-2. An AMM with an unprotected feeder link and one unprotected sub-link.

5.2.3.2 One Feeder (1+1) and one Sub-link (1+0)

Traffic Configuration 1+1 to 1x(1+0)

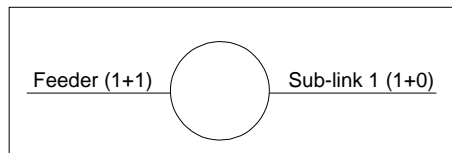


Fig 5-3. An AMM with a protected feeder link and one unprotected sub-link.

5.2.3.3 One Feeder (1+1) and one Sub-link (1+1)

Traffic Configuration 1+1 to 1x(1+1)

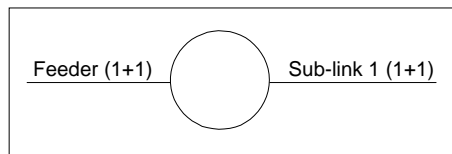


Fig 5-4. An AMM with a protected feeder link and one protected sub-link.

5.2.3.4 One Feeder (1+0) and two Sub-links (1+0)

Traffic Configuration 1+0 to 2x(1+0)

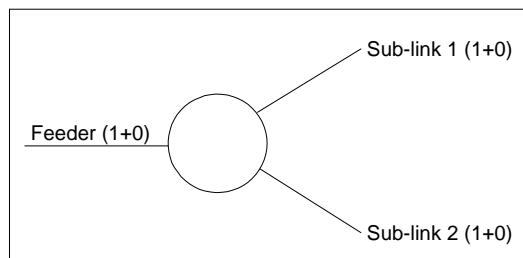


Fig 5-5. An AMM with an unprotected feeder link and two unprotected sub-links.

5.2.3.5 One Feeder (1+1) and two Sub-links (1+0)

Traffic Configuration 1+1 to 2x(1+0)

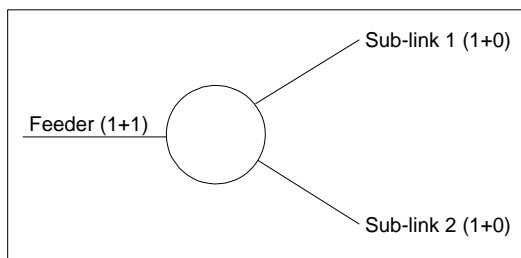


Fig 5-6. An AMM with a protected feeder link and two unprotected sub-links.

5.2.3.6 One Feeder (1+0) and three Sub-links (1+0)

Traffic Configuration 1+0 to 3x(1+0)

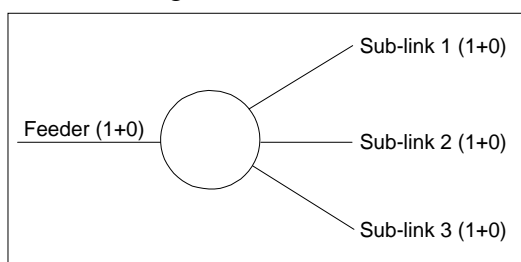


Fig 5-7. An AMM with an unprotected feeder link and three unprotected sub-links.

5.2.4 Prerequisites for Traffic Routing

The following prerequisites apply to traffic routing:

- The MMUs and SMUs must have software version \geq R4.
- The back-plane in the AMM is optimized for a net with tree structure. To fully use an AMM, the feeder should be placed in the position with highest pos number in the AMM.
- The traffic can be routed between the terminals on a 2, 8 and 34 Mbps level.
- Always route on the highest possible traffic rate level (on 8 Mbps level instead of 2 Mbps level, for example).
- The MUXes are defined in the AM setup. In the traffic setup it is possible to connect or disconnect the MUXes - this can only be done for SMU MUXes.
- 8 Mbps can be connected to the 2 Mbps connector on the front.

5.3 MINI-LINK Traffic Routing Guide

5.3.1 Introduction

The purpose with the MINI-LINK Traffic Routing Guide is to help the network planner to find the right equipment configuration for his traffic case and to let him verify if the traffic signals can be connected (routed) via the access module back-plane.

The MINI-LINK Traffic Routing Guide is a software intended for and can be used for simulating the traffic routing setup of traffic signals between the terminals in one access module. The functions for AM setup and traffic setup are similar to the handling in the MINI-LINK Network Manager (MNM).

The terminal configuration is based on the alternatives provided in the AM Setup. In the MINI-LINK Traffic Routing Guide all AM setups are defined - only the ID and (for 1+1) protection mode can be changed.

The traffic setup made in MINI-LINK Traffic Routing Guide can be saved and printed as a text file, consisting of the access module and the traffic routing, as well as your site information. This Routing Setup form should be used to instruct the installation personnel.

5.4 Installation of MINI-LINK Traffic Routing Guide

5.4.1 Package Contents

The MINI-LINK Traffic Routing Guide program package LZY 202 526/1 includes:

- Two program diskettes, 3.5" 1.44 Mbyte (1/LZY 202 526/1)
- Planning and Engineering Manual (LZT 110 2013)

5.4.2 System Requirements

MINI-LINK Traffic Routing Guide requires at minimum:

- an IBM personal computer or any other compatible PC (minimum processor requirement 386)
- Microsoft Windows 3.1 or later version
- a VGA display
- 4 Mbytes of RAM
- a hard disk with 10 Mb available
- a disk drive for 1.44 Mb 3.5" diskettes
- a mouse

5.4.3 Installation Procedure

To install MINI-LINK Traffic Routing Guide, follow this procedure:

1. Start Microsoft Windows.
2. Insert diskette 1 in the disk drive (a:).
3. From the Program Manager, select **Run** from the **File**-menu.
4. Type **a:\setup** in the dialogue box, and click **OK**.
5. Follow the instructions given during installation;
 - Fill in name, company and serial number (printed on the diskette).
 - Ignore password.
6. After installation, read the README.TXT file, for the latest news.

5.5 Getting Started

5.5.1 General Action Procedures

Throughout the chapter, text preceded by a dot (•) is a job action of some kind.

In instructions which are sequences of actions, the actions are numbered.

Instructions in *italic* are used to indicate a traffic case example used to illustrate the job action in the program window figures.

5.5.2 Selecting Menu Items

It is recommended to run MINI-LINK Traffic Routing Guide with a mouse, although all functions can be reached with the keyboard. In the procedures described in this manual, the use of a mouse is assumed.

In all click instructions with the mouse, use the **left-hand** mouse button unless otherwise stated.

To select a menu item,

- use the mouse to move the pointer to the item wanted and click on the item.

5.5.3 Enter the MINI-LINK Traffic Routing Guide

- Start Windows.



Fig 5-8. The MINI-LINK Traffic Routing Guide icon.

- Double-click on the MINI-LINK Traffic Routing Guide icon in the MINI-LINK Managers program group.

The Network window opens.

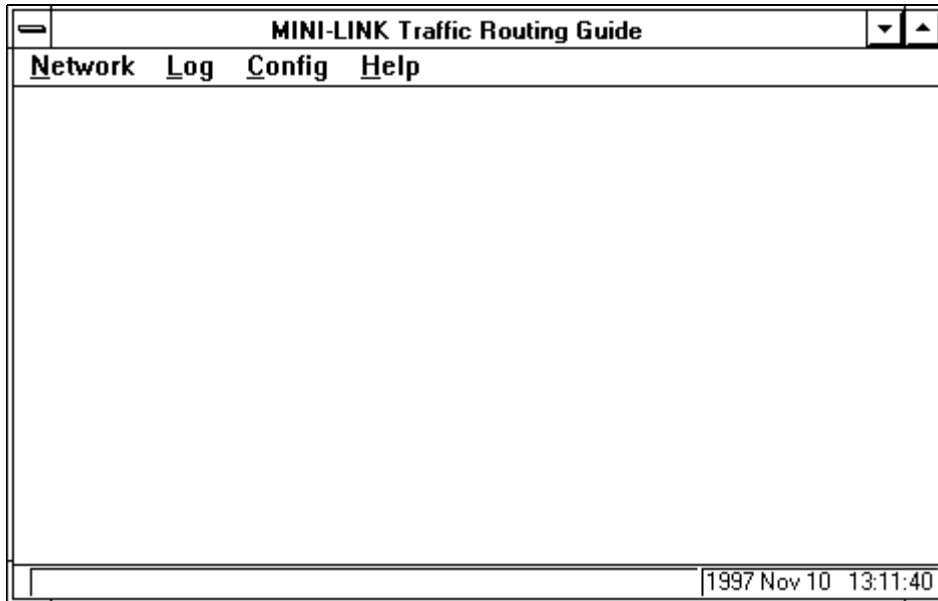


Fig 5-9. The empty Network window.

When you enter MINI-LINK Traffic Routing Guide, you enter an empty Network window.

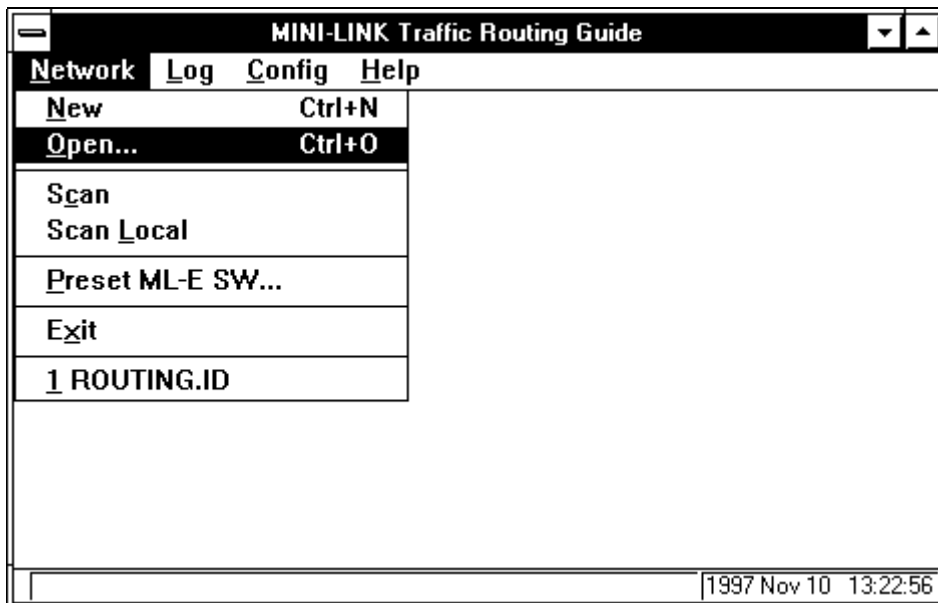


Fig 5-10. The Network menu in the Network window.

- To open the network file for the first time, select **Open** from the Network menu.

The File Open window opens.

The next time you want to open the network file, you can select the network file name (ROUTING.ID) from the bottom of the Network menu. (This is a faster way to open the network file.)

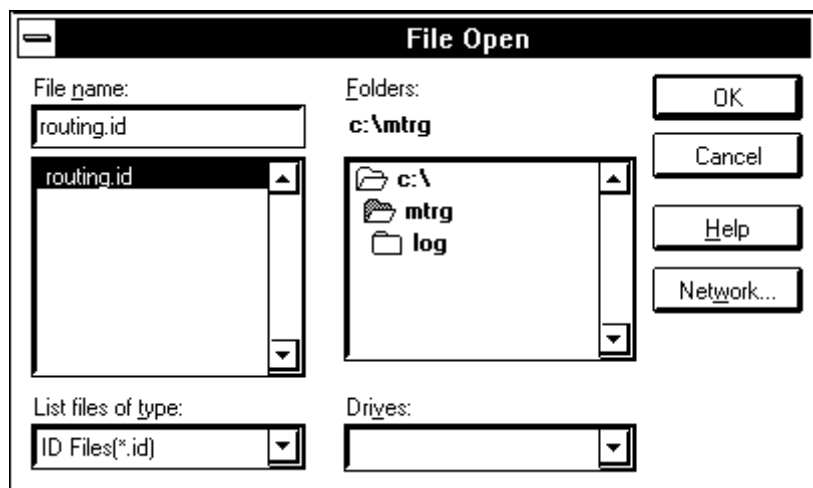


Fig 5-11 The ROUTING.ID file in the File Open window.

- Select the ROUTING.ID file in the MTRG rout directory.
- Click on the **OK** button.

The network file is now presented in the Network window.

5.5.4 The Network file Group tree

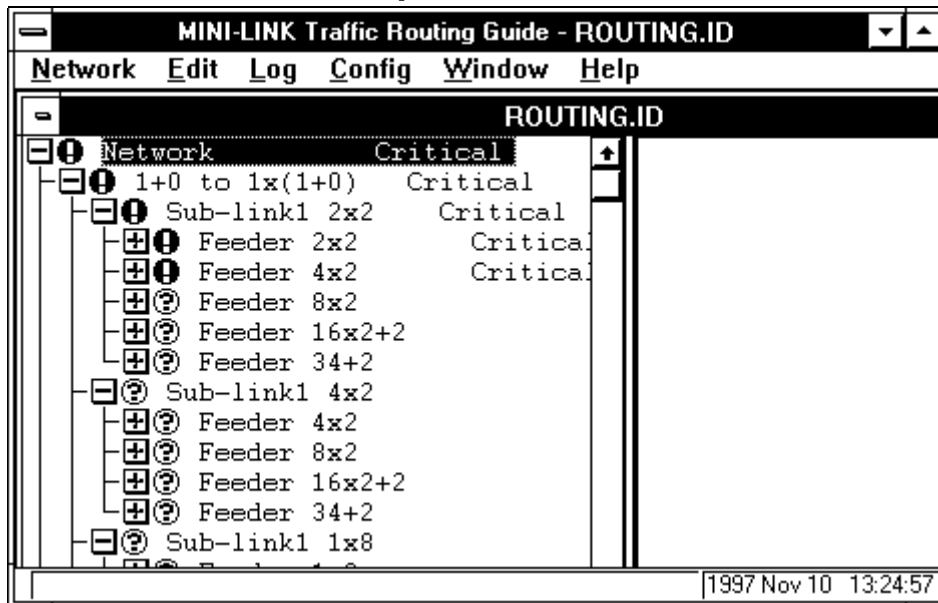









Fig 5-12. The Network window shows the network file group tree.

5.5.4.1 The Symbols used in the Group tree

-  Indicates a closed sub-group level.
-  Indicates an opened sub-group level.
-  Indicates an unchecked terminal. The symbol is visible for up to 10 minutes (depending on which level in the group tree) after the network file has been opened, before the program has verified the terminal. In an actual network it indicates alarm status for no connection.
-  Indicates a checked terminal. This symbol replaces the  symbol when the program has verified the terminal. In an actual network it indicates Critical alarm status for disturbed traffic.

To see a sub-group,
double-click on the group name or the symbol .

To hide a sub-group,
double-click on the group name or the symbol .

To see a list of terminals,
click on the last sub-group level (feeder or magazine).

The handling of groups and terminals largely corresponds with the File Manager of Microsoft Windows, where groups equal directories and terminals equal files.

5.5.4.2 The Sub-groups and Terminals

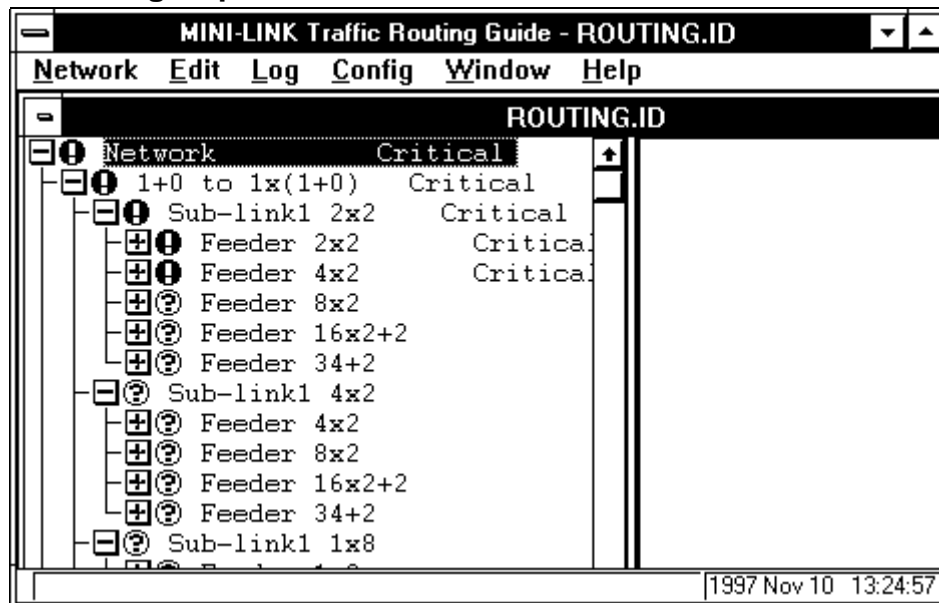


Fig 5-13. The group tree with three sub-group levels opened.

When the network file is first opened, the group tree is presented as a long list with three sub-group levels opened.

To find your traffic configuration, first close all sub-groups.

- double-click on the Network group at the top.

All the sub-group levels in the group tree closes.

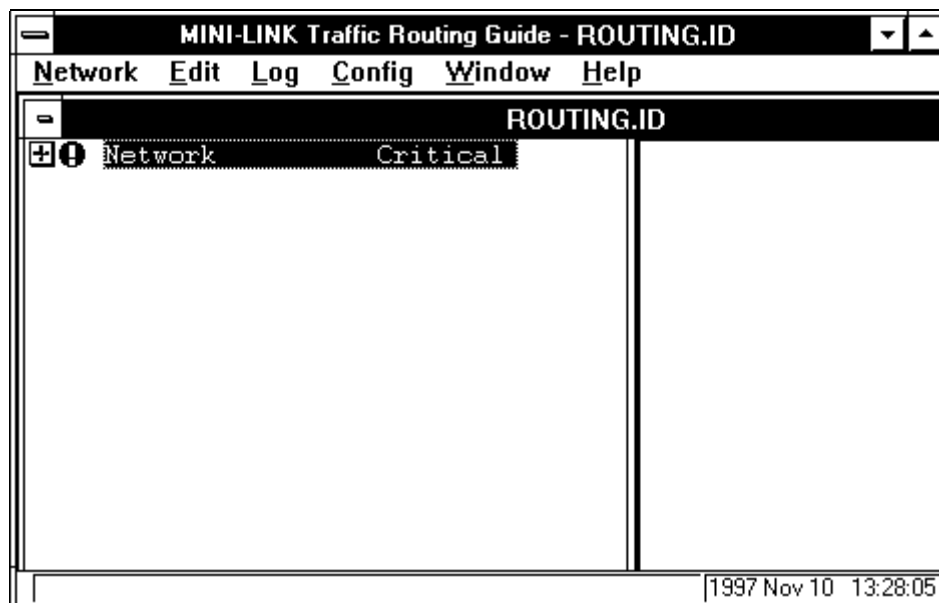


Fig 5-14. The group tree with all the sub-group levels closed.

To open the first level of sub-groups.

- double-click on the Network group at the top.

The traffic configuration sub-groups opens.

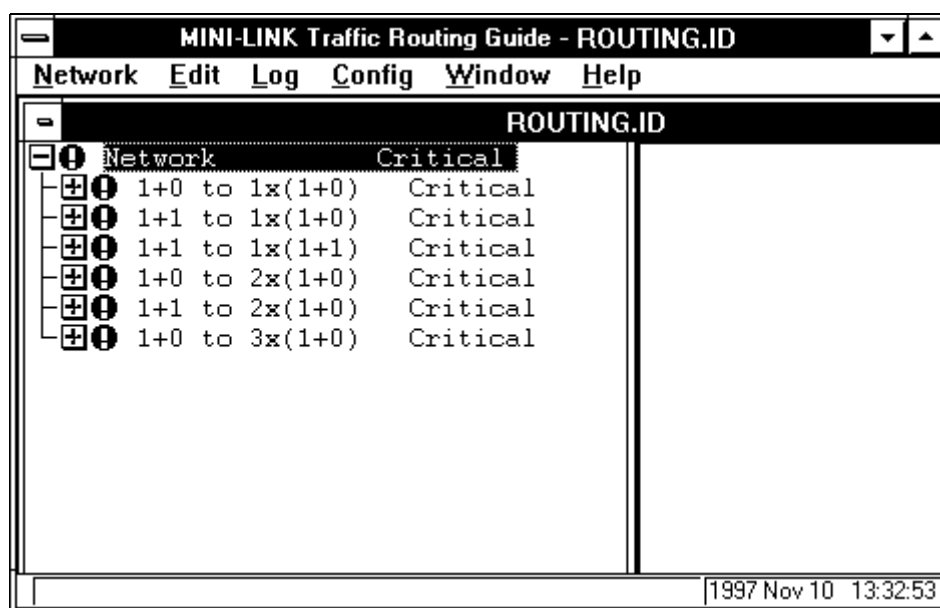


Fig 5-15. The group tree with the traffic configuration sub-groups opened.

The Network window now shows a group tree consisting of six different traffic configurations. The traffic configurations correspond to the six types described in section 5.2.3.

To select your sub-links for the traffic configuration from the group tree, open up the next sub-group level(s) by double-clicking on the traffic configuration and on the sub-link(s).

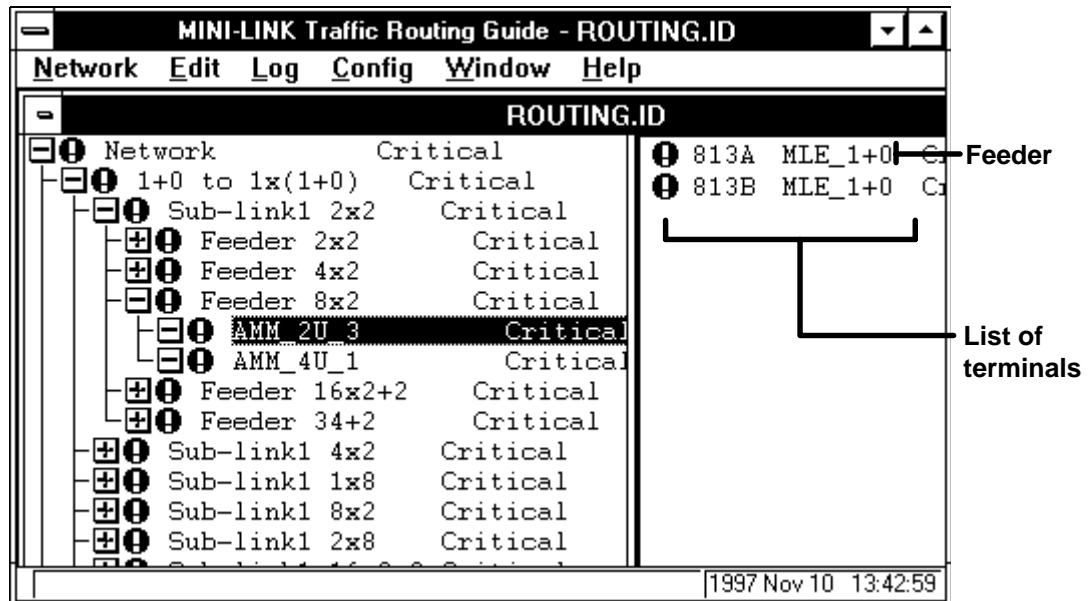


Fig 5-16. The group tree with sub-groups and a list of terminals.

The six different traffic configurations are structured in groups, with the group tree shown to the left. The group tree is built up by a root group with sub-groups in different levels.

The sub-groups are divided into one or more levels of sub-links (depending on the traffic configuration) and a feeder sub-group.

In the 1+0 to 1x(1+0) traffic configuration you are able to select between a 2U-3 and a 4U magazine. In all other traffic configurations a 4U magazine is required.

On the last sub-group level, a list of terminals are shown to the right (the contents of an AMM).

The terminal at the top of the list are used as a feeder. The feeder terminal has the letter "A" in the end of the ID.

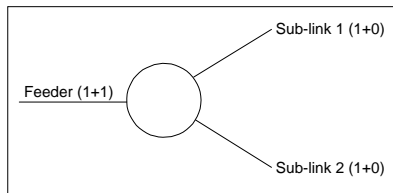
Note: I will take about 10 minutes for all the terminals to be checked. Please wait until your configuration is indicated with the **!** symbol, before you select a terminal and start the job action.

5.6 Working with MINI-LINK Traffic Routing Guide

5.6.1 Workflow (Overview)

Before you start working with the MINI-LINK Traffic Routing Guide

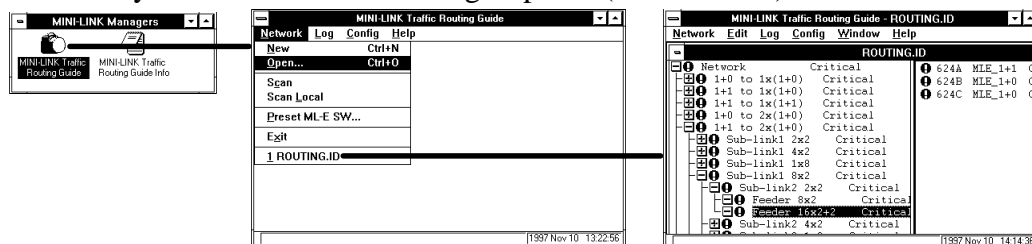
1. Consider the prerequisites for traffic routing (section 5.2)
2. Make a sketch of your planned traffic case with the desired traffic capacities.



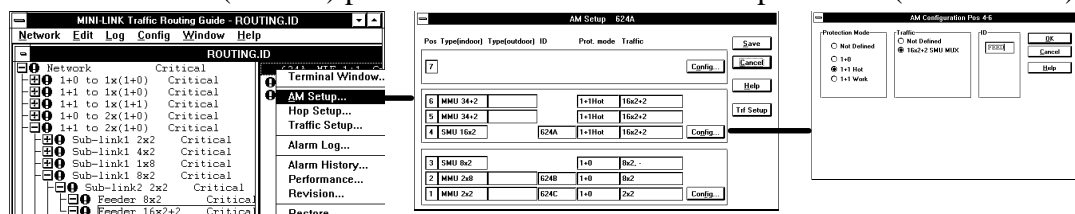
3. Select suitable traffic configuration for the feeder and the sub-links (section 5.2.2)

Working with the MINI-LINK Traffic Routing Guide

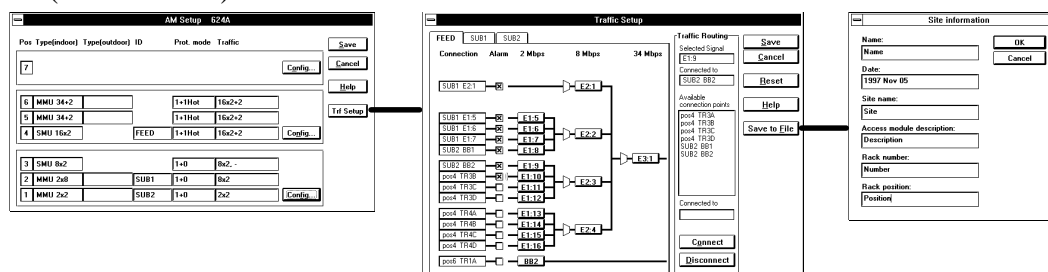
4. Select your traffic case from the group tree (section 5.5.4).



5. Enter ID and (for 1+1) protection mode in the AM Setup window (section 5.6.2).



6. Select connections and activate alarms in the Traffic setup window (section 5.6.3).



7. Save and print the routing setup as a text file (section 5.6.3.3).
8. Check the traffic routing setup (section 5.6.3.4).

5.6.2 AM Setup

How to open the Network window and to handle the structure of the group tree are described in section 5.5.3 and section 5.5.4 respectively.

Traffic case example:

To illustrate the job procedure in the different program windows a traffic case example is used. In this case we want to use a site with a protected (1+1) feeder link and two unprotected (1+0) sub-links.

Sub-link 1 traffic capacity 7x2 Mbps (use 8x2 Mbps configuration)

Sub-link 2 traffic capacity 2x2 Mbps

Drop 1x2 Mbps

A total of 11x2 Mbps for the sub-links and drop requires a 16x2+2 feeder

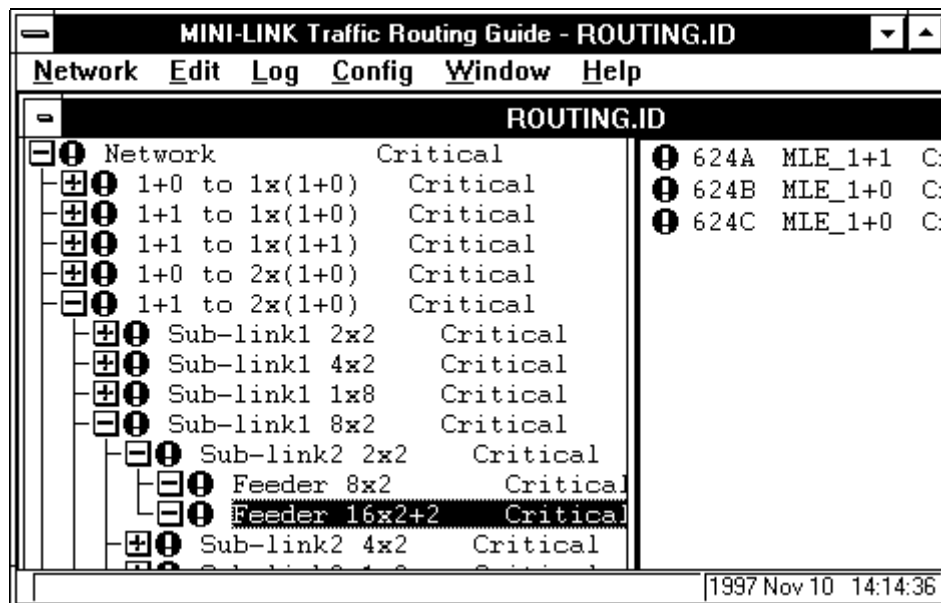


Fig 5-17. The group tree with sub-groups and a list of terminals.

- Select your traffic configuration from the opened ROUTING.ID group tree in the Network window.

Traffic case example: 1+1 to 2x(1+0)

- Select the sub-link(s).

Traffic case example: Sub-link1 8x2 and Sub-link2 2x2

- Select feeder.

Traffic case example: Feeder 16x2+2

- Select AMM - only available for applicable 1+0 to 1x(1+0).

Traffic case example: not applicable

A list of terminals are shown to the right.

The terminal at the top of the list are used as a feeder. The feeder terminal has the letter "A" in the end of the ID.

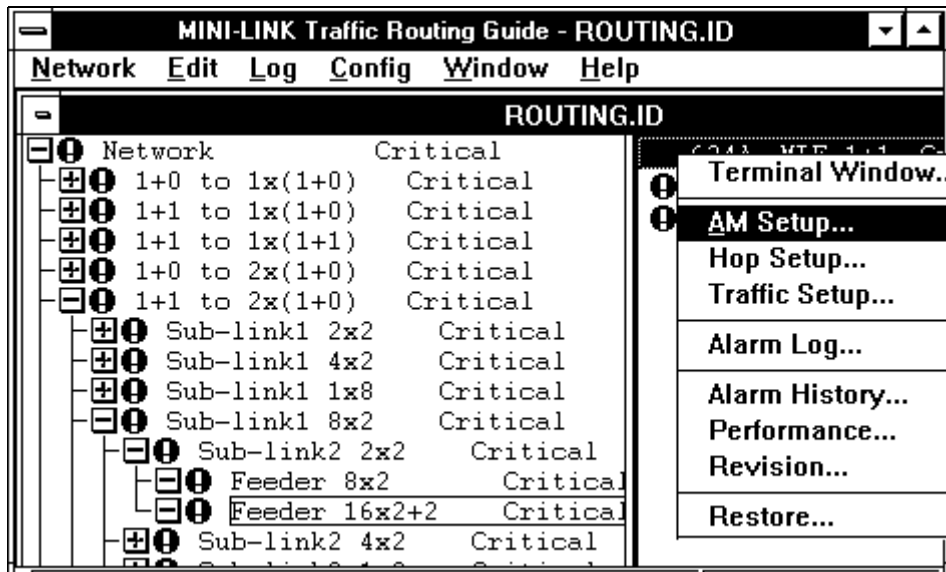


Fig 5-18. The pop-up menu for selection of AM Setup.

To open the AM Setup window.

- Use the **right-hand** mouse button to click on the feeder terminal at the top of the terminal list. (The feeder terminal has the letter "A" in the end of the ID.)
- Select **AM Setup** from the pop-up menu.

The AM Setup window opens.

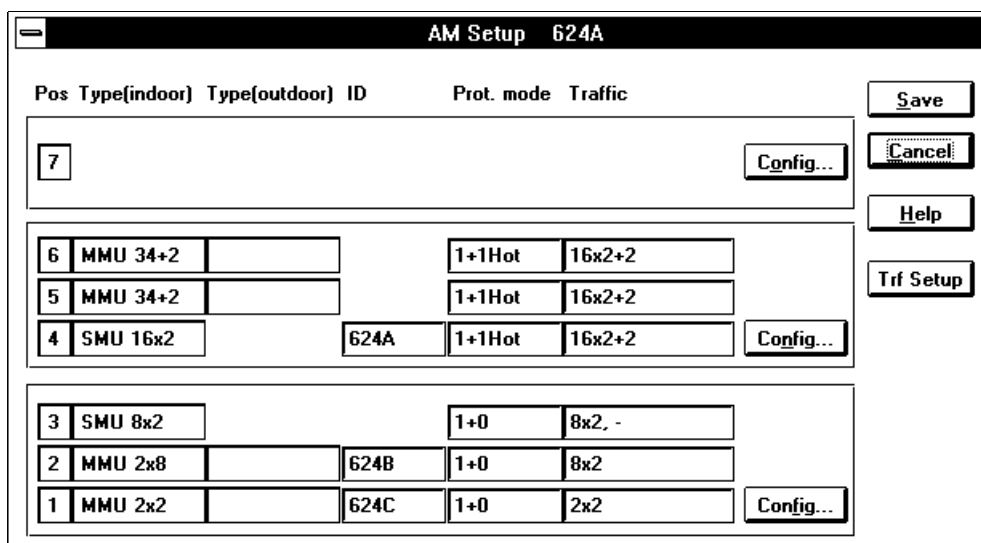


Fig 5-19. The AM Setup window.

If you want to leave the AM Setup window and return to the group tree, click on the **Cancel** button. All changes made in the AM Setup window will be erased.



Do not use the Save button, the save function is disabled.

Pos	Type(indoor)	Type(outdoor)	ID	Prot. mode	Traffic	
7						Config...
6	MMU 34+2			1+1Hot	16x2+2	
5	MMU 34+2			1+1Hot	16x2+2	
4	SMU 16x2		624A	1+1Hot	16x2+2	Config...
3	SMU 8x2			1+0	8x2, -	
2	MMU 2x8		624B	1+0	8x2	
1	MMU 2x2		624C	1+0	2x2	Config...

Buttons: Save, Cancel, Help, Trf Setup

Fig 5-20. The AM Setup window.

The AM Setup window shows the type of access module magazine (AMM) to be used and how the indoor units should be installed in the AMM.

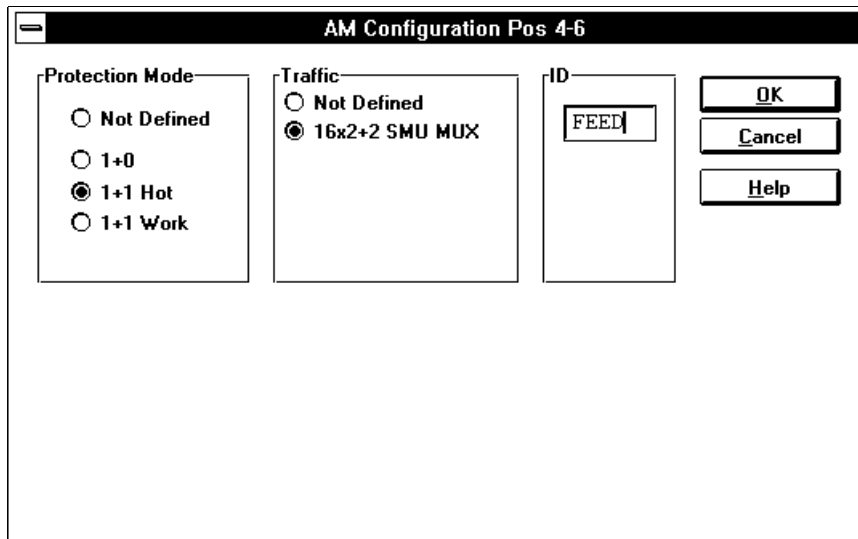
AMM	7
4U	6 MMU 34+2
	5 MMU 34+2
	4 SMU 16x2
	3 SMU 8x2
	2 MMU 2x8
	1 MMU 2x2

Fig 5-21. The indoor units position in the AMM used in the AM Setup window above.

Open the AM Configuration window to enter ID and (for protected terminal) to select protection mode.

- Click on the **Config** button to open the AM Configuration window.
Traffic case example: Click on the Config button for pos 4-6 to set feeder ID.

The AM Configuration window for pos 4-6 opens.

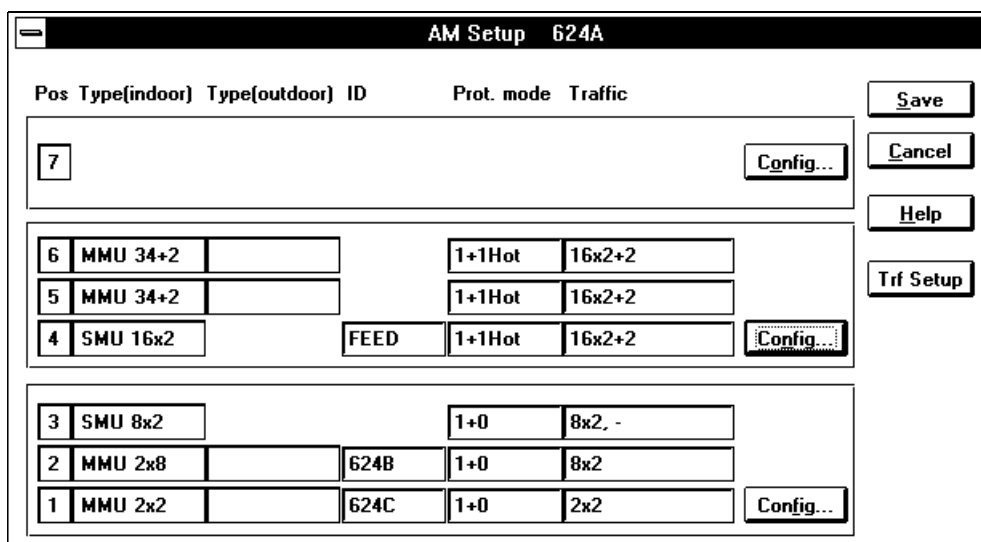


The screenshot shows the 'AM Configuration Pos 4-6' window. It has three main sections: 'Protection Mode', 'Traffic', and 'ID'. The 'Protection Mode' section has four radio buttons: 'Not Defined', '1+0', '1+1 Hot' (which is selected), and '1+1 Work'. The 'Traffic' section has two radio buttons: 'Not Defined' and '16x2+2 SMU MUX' (which is selected). The 'ID' section has a text input field containing the text 'FEED'. To the right of these sections are three buttons: 'OK', 'Cancel', and 'Help'.

Fig 5-22. The AM Configuration window for pos 4-6.

- Enter the ID for the terminal(s).
*Traffic case example: To illustrate our traffic case we have used "FEED" as ID.
 You should instead use a suitable individual ID.*
- Select protection mode for protected terminal, 1+1 Hot or 1+1 Working.
- Click on the **OK** button when the selected terminal(s) has the correct ID and protection mode.

The AM Configuration window closes.



The screenshot shows the 'AM Setup 624A' window. It features a table with columns: Pos, Type(indoor), Type(outdoor), ID, Prot. mode, and Traffic. There are also buttons for 'Save', 'Cancel', 'Help', and 'Trf Setup'. A 'Config...' button is next to the 'FEED' ID in the table.

Pos	Type(indoor)	Type(outdoor)	ID	Prot. mode	Traffic
7					
6	MMU 34+2			1+1Hot	16x2+2
5	MMU 34+2			1+1Hot	16x2+2
4	SMU 16x2		FEED	1+1Hot	16x2+2
3	SMU 8x2			1+0	8x2, -
2	MMU 2x8		624B	1+0	8x2
1	MMU 2x2		624C	1+0	2x2

Fig 5-23. The AM Setup window after configuration of ID and protection mode.

The AM Setup window now shows the new ID for pos 4-6.

- Click on the **Config** button to open the AM Configuration window.
Traffic case example: Click on the Config button for pos 1-3 to set ID for Sub-link 1 and Sub-link 2.

The AM Configuration window for pos 1-3 opens.

The screenshot shows the 'AM Configuration Pos 1-3' window. It contains several sections:

- Protection Mode:** Radio buttons for 'Not Defined', '1+0' (selected), '1+1 Hot', and '1+1 Work'.
- Traffic Pos 2:** Radio buttons for 'Not Defined', '2x8', and '8x2 SMU MUX' (selected).
- ID Pos 2:** A text box containing 'SUB1'.
- Traffic Pos 1:** Radio buttons for 'Not Defined' and '2x2' (selected).
- ID Pos 1:** A text box containing 'SUB2'.
- Buttons:** 'OK', 'Cancel', and 'Help' buttons are located on the right side.

Fig 5-24. The AM Configuration window for pos 1-3.

- Enter the ID for the terminal(s).
Traffic case example: To illustrate our traffic case we have used "SUB1" and "SUB2" as ID. You should instead use a suitable individual ID.
- Select protection mode for protected terminal, 1+1 Hot or 1+1 Working.
Traffic case example: not applicable.
- Click on the **OK** button when the selected terminal(s) has the correct ID and protection mode.

The AM Configuration window closes.

The screenshot shows the 'AM Setup 624A' window. It features a table with the following columns: Pos, Type(indoor), Type(outdoor), ID, Prot. mode, and Traffic. The table contains the following data:

Pos	Type(indoor)	Type(outdoor)	ID	Prot. mode	Traffic
7					
6	MMU 34+2			1+1Hot	16x2+2
5	MMU 34+2			1+1Hot	16x2+2
4	SMU 16x2		FEED	1+1Hot	16x2+2
3	SMU 8x2			1+0	8x2, -
2	MMU 2x8		SUB1	1+0	8x2
1	MMU 2x2		SUB2	1+0	2x2

Buttons for 'Save', 'Cancel', 'Help', 'Trf Setup', and 'Config...' are visible on the right side of the window.

Fig 5-25. The AM Setup window after configuration of ID and protection mode for all terminals.

The AM Setup window now shows the new ID for pos 1-3 and pos 4-6.

- Click on the **Trf Setup** button when every terminal have correct ID and protection mode.

The Traffic Setup window opens.

5.6.3 Traffic Setup

How to open the Traffic Setup window are described in section 5.6.2.

Note: You must consider the prerequisites in section 5.2.4 regarding traffic routing, in order to select the best possible configuration.

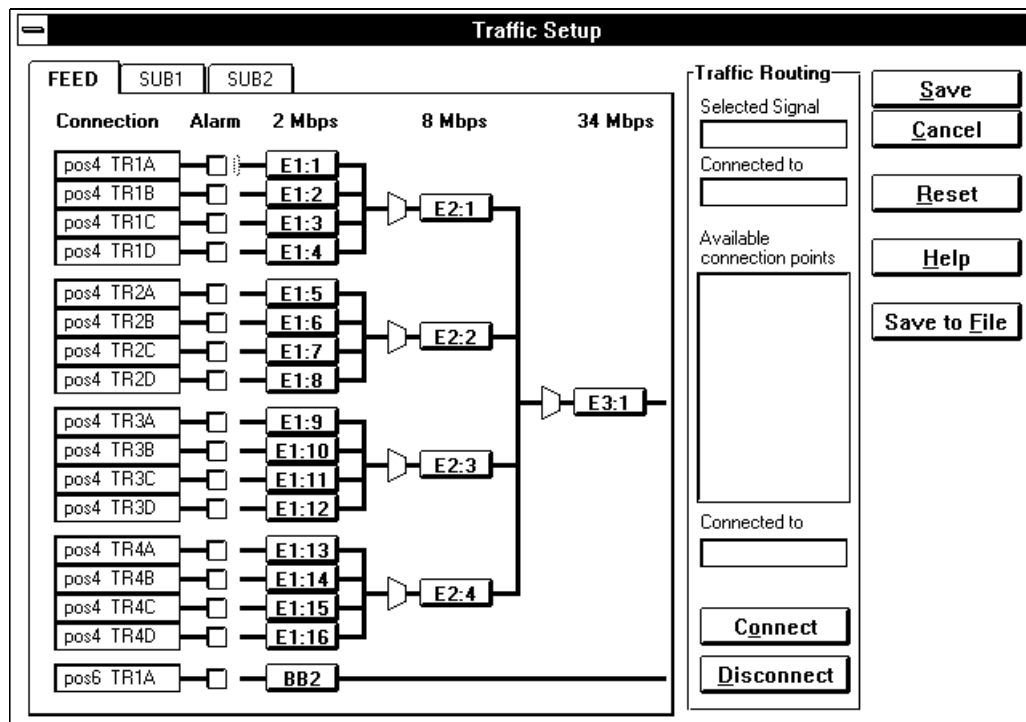


Fig 5-26. The Traffic Setup window.

In the Traffic setup window you are able to simulate the traffic routing of signals in the AMM back-plane.

By default all signals are connected to the front.

Note: Please make sure that the terminal for the feeder is selected. The ID for the feeder should be highlighted in the top left corner.

If not, click on the top left corner.

If you want to leave the Traffic Setup window and return to the AM Setup window, click on the **Cancel** button. All changes made in the Traffic Setup window will be erased.



Do not use the Save button or the Reset button, the functions are disabled.

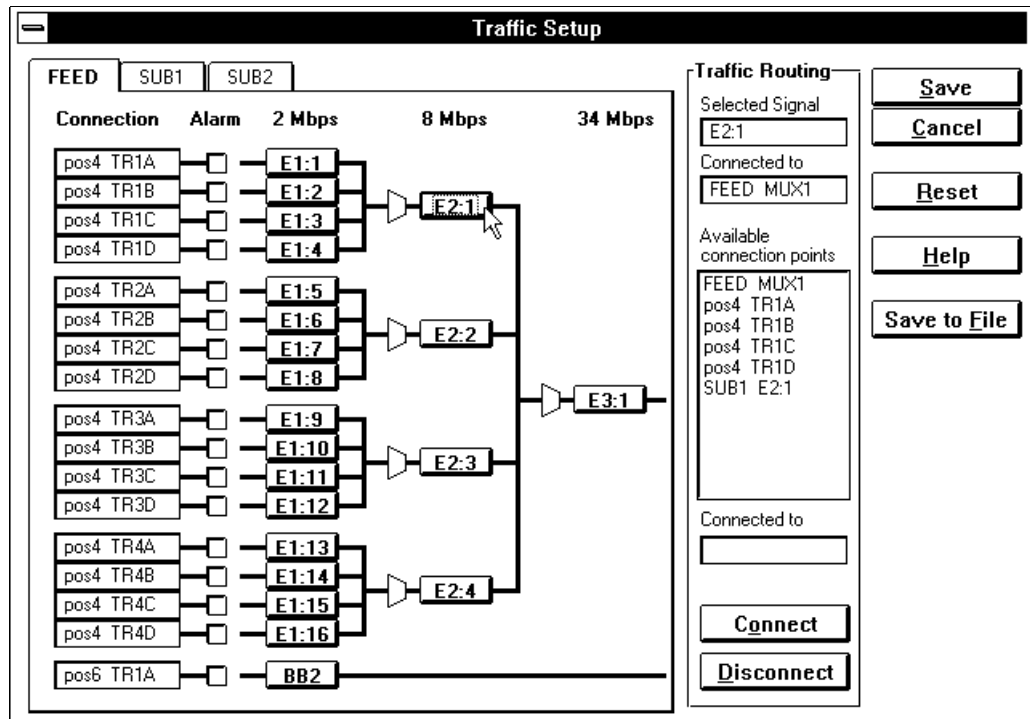


Fig 5-27 Available connection points for signal E2:1.

Note: Try to route on the highest possible traffic level (2, 8 or 34 Mbps) and always start with the signals from the top (E1:1, E2:1 or E3:1) and work your way down.

- Click on the button with the first signal.
In the Traffic routing field to the right, the selected signal is presented with:
 - Selected Signal (number).
 - Connected To (if already connected to a point).
 - Available connection points. The connection points with pos number are to the front and the connection points with your ID are for back-plane routing.

Traffic case example:

STEP1. For Sub-link 1 traffic capacity 7x2 Mbps we need to connect FEED E2:1 (8 Mbps) and E1:5, E1:6, E1:7 (2 Mbps) to SUB1.

STEP2. For Sub-link 2 traffic capacity 2x2 Mbps we need to connect FEED E1:8 and E1:9 (2 Mbps) to SUB2.

STEP3. For Drop we use FEED E1:10 (2 Mbps) for front connection.

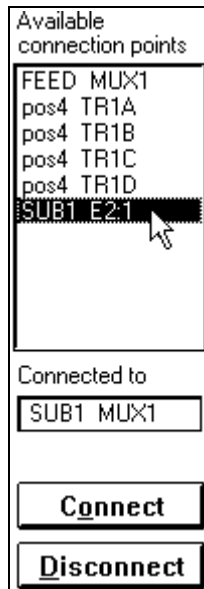


Fig 5-28. Connection points for signal FEED E2:1 to SUB1 E2:1.

- Select an available connection point from the list. If the connection point is already connected to another point, this is presented in the bottom of the Connected to field.
- Click on the **Disconnect** button to disconnect the former connection.
- Click on the **Connect** button to make the new connection.

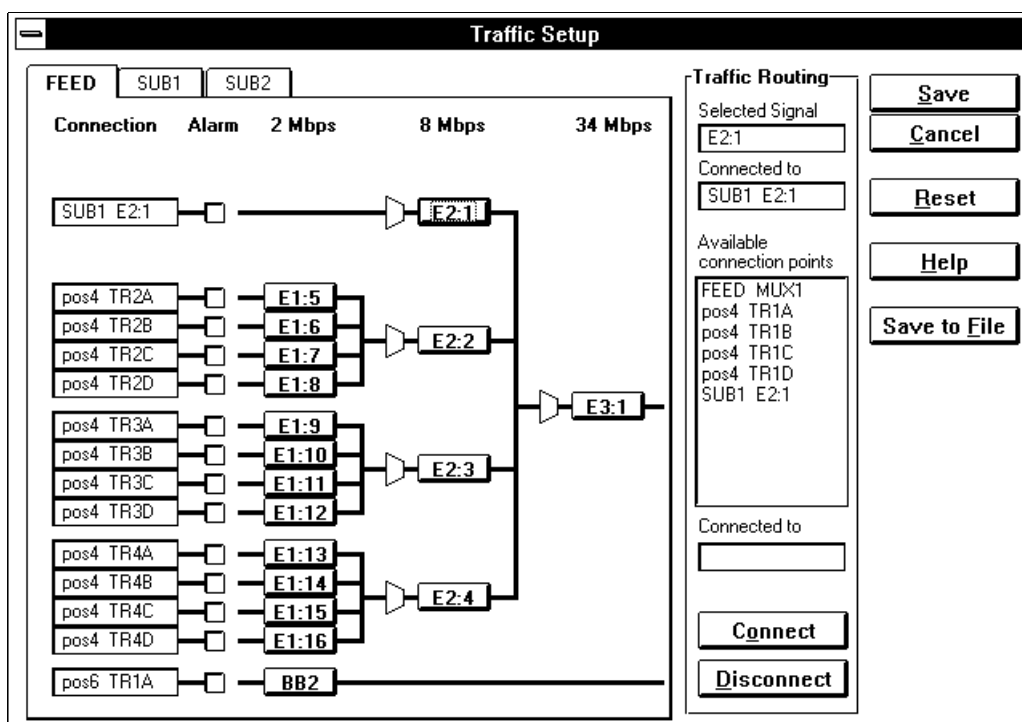


Fig 5-29. The Traffic Setup window after connection of signal E2:1.

The Traffic Setup window shows the routed signal FEED E2:1 (8 Mbps) to SUB1 E2:1.

- Repeat the steps above until all desired connections are done.

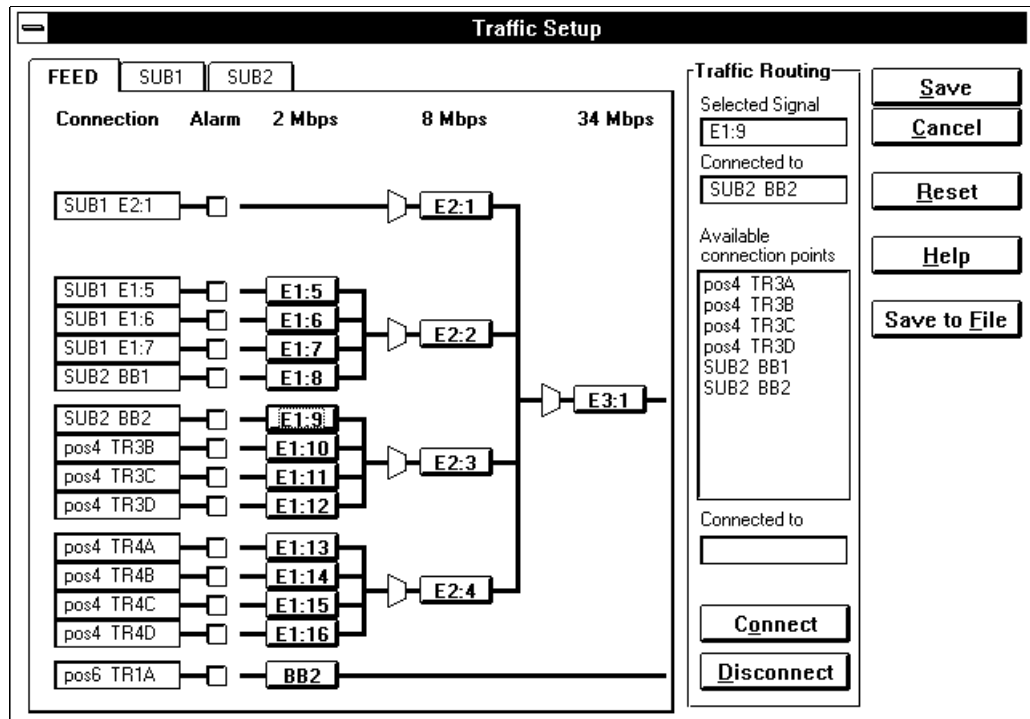


Fig 5-30. The Traffic Setup window after connection of all signals.

5.6.3.1 Routing Error message

Note: Many routing requirements can be solved with back-plane routing, but it is not possible to solve all traffic routing cases in the back-plane.

If it is not possible to make the connection to the desired point, you will be notified by a Routing Error message.



Fig 5-31. The Routing Error message window.

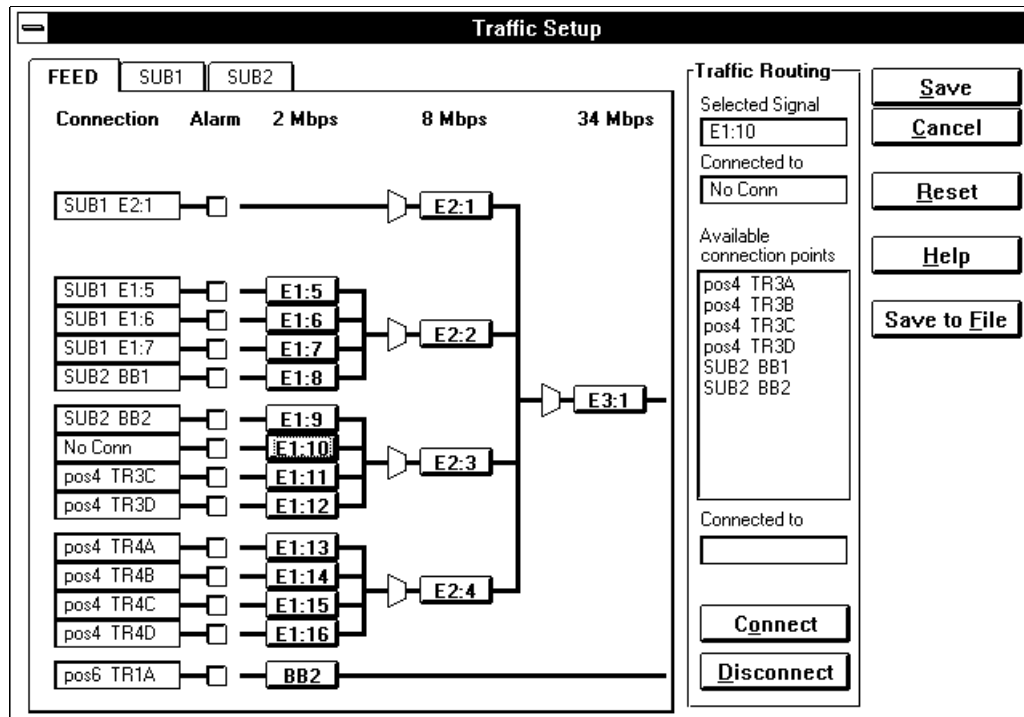


Fig 5-32. No connection of a signal (E1:10) in the fields "Connection" and "Connected To".

In the field "Connection" on the left side and in the field "Connected To" on the right side of the Traffic Setup window, the former connection will be changed to **No Conn**.

In this case, you should try to connect the signal to another available connection point. You can always connect to the former connection for the front.

Note: Every signal must have a connection point.

If you don't succeed to connect the signal the way you want, close the Traffic Setup window and re-open it in order to try to make the connections in another way. If you still not succeed, try another hardware alternative for your traffic case in the group tree.

5.6.3.2 Alarm activation

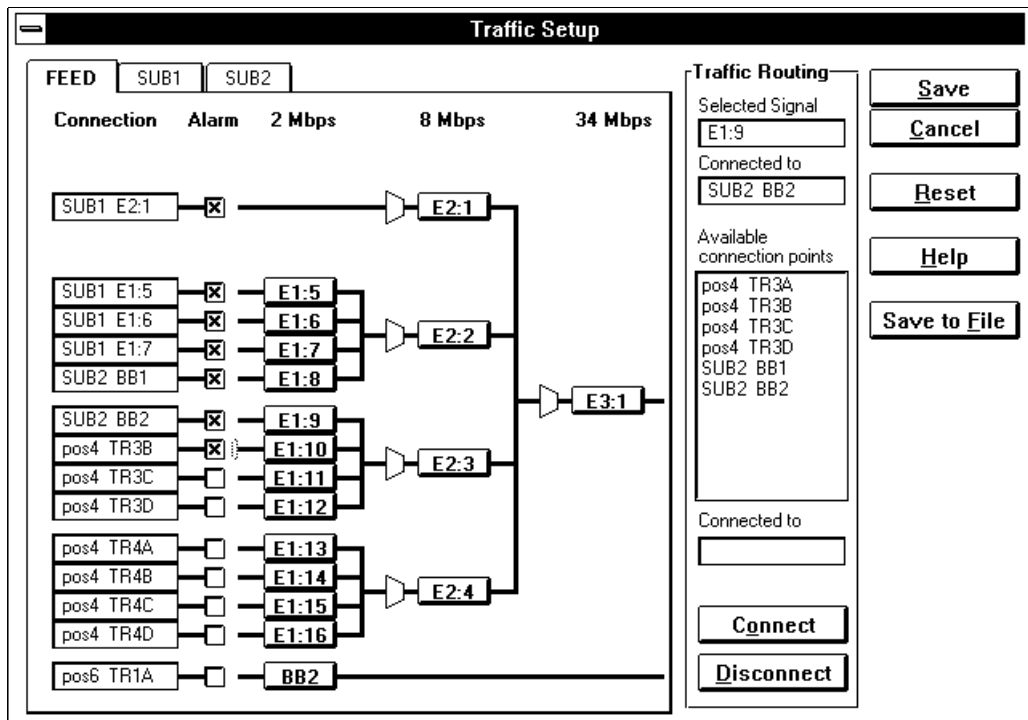


Fig 5-33. All alarms activated for the used signals on the feeder side.

Activate the feeder side input alarms for the signals which should be used and deactivate the ones that should not be used.

indicates an activated alarm.

indicates a deactivated alarm.

- Click on the Alarm check boxes respectively (to mark or remove the crosses).

Activate the sub-link side input alarms for the signals which should be used and deactivate the ones that should not be used.



- Click on the top corner for the sub-link(s) to activate respectively sub-link connection window.

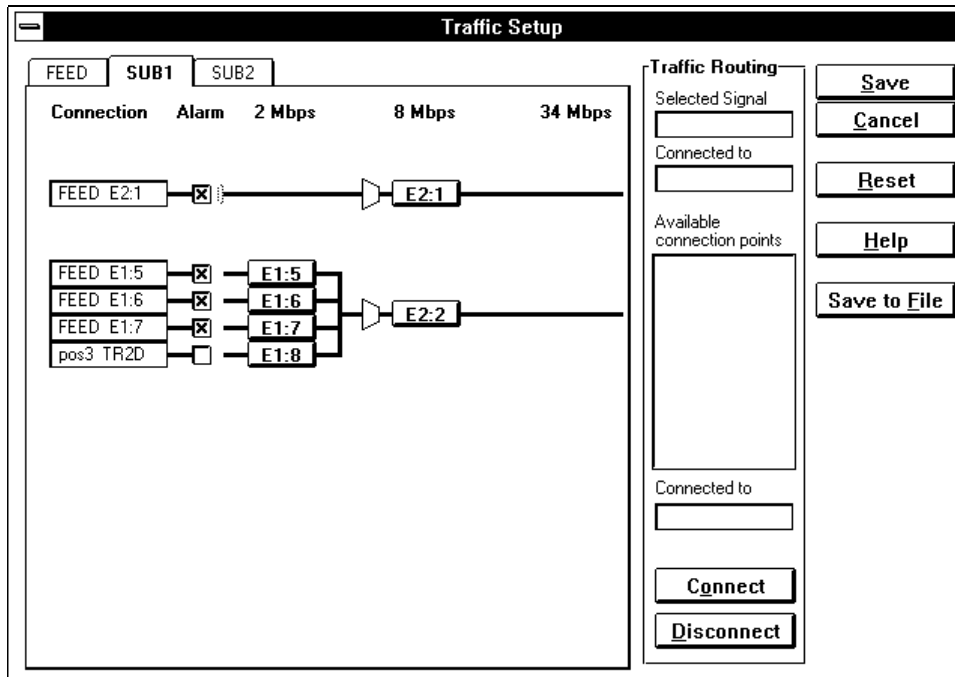


Fig 5-34. All alarms activated for the used signals on the sub-link1 side.

- Click on the Alarm check boxes respectively (to mark or remove the crosses).
- Repeat the steps above the other sub-link(s) until all desired alarms are activated.

Note: Take your time to make sure feeder and sub-link(s) have correct alarm and connections (check for any signals with no connection).

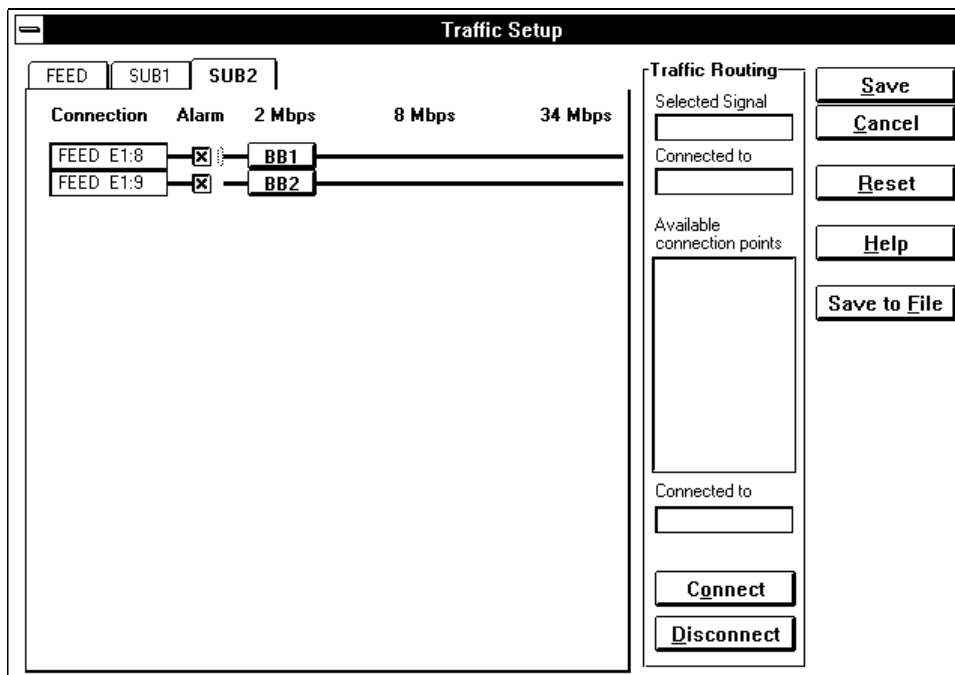


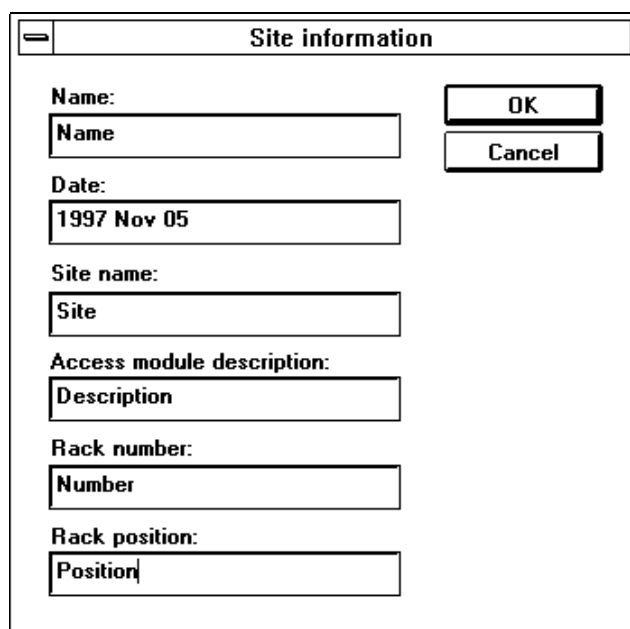
Fig 5-35. All alarms activated for the used signals on the sub-link2 side.

5.6.3.3 The Routing Setup text file

The completed routing setup can be saved as a text file.

- Click on the **Save to File** button.

The Site Information window opens.

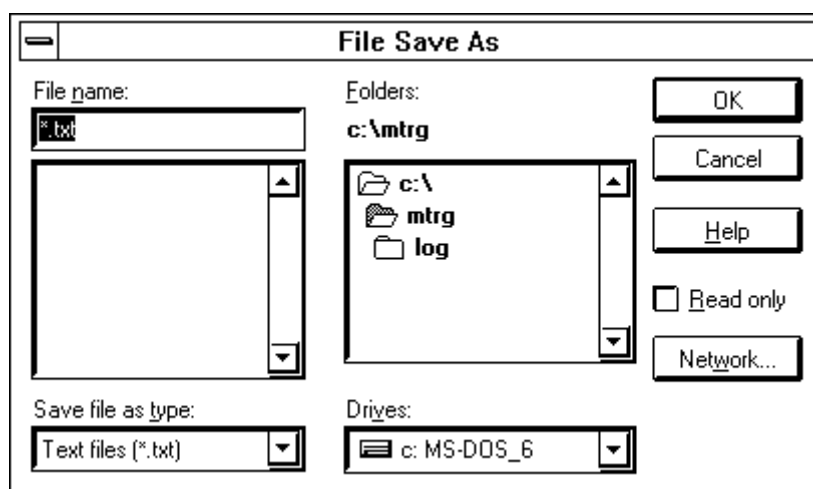


The screenshot shows a dialog box titled "Site information". It contains several input fields and two buttons. The fields are: "Name" (with "Name" entered), "Date" (with "1997 Nov 05" entered), "Site name" (with "Site" entered), "Access module description" (with "Description" entered), "Rack number" (with "Number" entered), and "Rack position" (with "Position" entered). The "OK" and "Cancel" buttons are located on the right side of the dialog.

Fig 5-36. The Site information window.

- Fill in your site information.
- Click on the **OK** button.

The File Save As window opens.



The screenshot shows a "File Save As" dialog box. It has a "File name:" field containing "*.txt". Below it is a large empty text area. To the right, the "Folders:" section shows "c:\mtrg" selected, with a list of subfolders: "c:\", "mtrg", and "log". Below the folders is a "Drives:" section with "c: MS-DOS_6" selected. At the bottom left, the "Save file as type:" dropdown is set to "Text files (*.txt)". On the right side, there are buttons for "OK", "Cancel", "Help", "Read only" (unchecked), and "Network...".

Fig 5-37. The File Save As window.

- Select a file name and directory.
- Click on the **OK** button to save the text file.

The text file can now be opened and printed out from a word processor (for instance Microsoft Windows Write, Notepad, Microsoft Word or compatible). ASCII text code is used for the text file contents. Use typeface Courier if available.

The illustration below shows the saved text file from the used *Traffic case example*.

```

Name:
Date:1997 Nov 10
Site name:
Access module description:
Rack number:
Rack position:

AM Setup
=====
AM type: 4U

Pos  Type(indoor)  Type(outdoor)  ID      Prot.mode  Traffic
-----
7
6    MMU 34+2                1+1Hot  16x2+2
5    MMU 34+2                1+1Hot  16x2+2
4    SMU 16x2                FEED   1+1Hot  16x2+2
3    SMU 8x2                  1+0    8x2
2    MMU 2x8                  SUB1   1+0    8x2
1    MMU 2x2                  SUB2   1+0    2x2

Traffic Setup
=====

Terminal ID FEED
Signal    Connected to    Alarm
-----
E2:1     SUB1  E2:1    x
E1:5     SUB1  E1:5    x
E1:6     SUB1  E1:6    x
E1:7     SUB1  E1:7    x
E1:8     SUB2  BB1     x
E1:9     SUB2  BB2     x
E1:10    pos4  TR3B    x
E1:11    pos4  TR3C
E1:12    pos4  TR3D
E1:13    pos4  TR4A
E1:14    pos4  TR4B
E1:15    pos4  TR4C
E1:16    pos4  TR4D
BB2      pos6  TR1A

Terminal ID SUB1
Signal    Connected to    Alarm
-----
E2:1     FEED  E2:1    x
E1:5     FEED  E1:5    x
E1:6     FEED  E1:6    x
E1:7     FEED  E1:7    x
E1:8     pos3  TR2D

Terminal ID SUB2
Signal    Connected to    Alarm
-----
BB1      FEED  E1:8    x
BB2      FEED  E1:9    x

```

Fig 5-38. The Routing Setup form.

5.6.3.4 Check the Traffic Routing Setup

It could be a good idea to make a final check if your traffic routing setup works the way it is supposed to.

- Open the saved routing setup text file in your word processor and print it out.
- Click on the **Cancel** button to close the Traffic Setup window.

All changes made in the Traffic Setup window will be erased.

- Click on the **Trf Setup** button in the AM Setup window to re-open the Traffic Setup window.

Imagine yourself in the role of the installation engineer and try to follow the information in the routing setup text file to make the same connections in the Traffic Setup window.

If any additional information are required, use your word processor to make notes in the routing setup text file, for example in the field "Type (outdoor)" (see figure 5-38).

- Repeat the steps in section 5.6.3. Make sure feeder and sub-link(s) have correct alarm and connections (check for any signals with no connection).

5.6.3.5 Routing Setup form

The routing setup text file can now be used to instruct the Installation engineer on how to install and setup the AMM.

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6 Engineering

6.1 Introduction

A number of calculations and decisions must be made before the MINI-LINK network can be ordered and installed. This chapter describes a work flow for this job.

Chapter 7 in this manual contains the forms aiding the planning, ordering and installation of the network and its components. When the forms have been filled in, they may be used both as ordering information and during the actual installation.

During the installation the installation staff adds more information in the forms, such as equipment serial numbers. When the installation is completed the forms contain all vital site information for future reference.

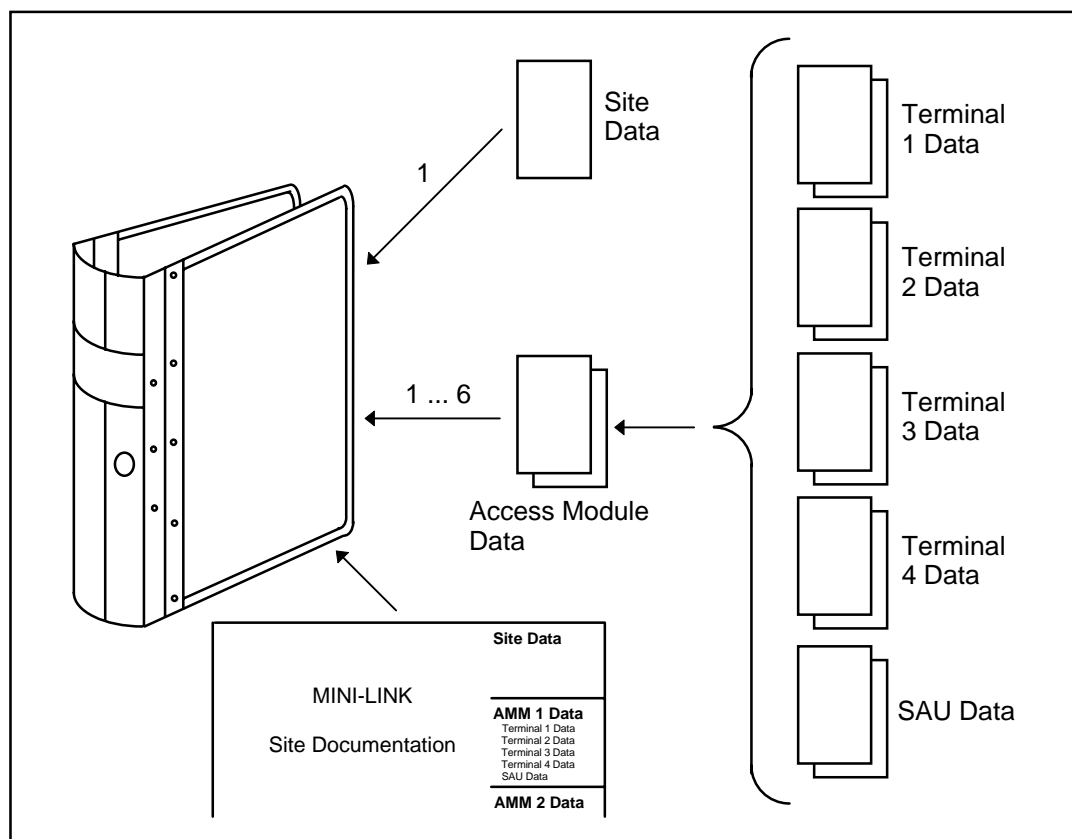


Figure 6-1: Installation Data structure

The following documents should be available when the form is filled in: MINI-LINK E Technical Description (EN/LZT 110 2012), the MINI-LINK E Installation Manual (EN/LZT 110 2014) and the MINI-LINK E Product Catalogue (EN/LZT 110 2011).

The forms are available as a computer file for MS Word 6.0a for Windows on a 3.5" 1.44Mb computer diskette. They may be freely copied, modified etc., to meet individual requirements. Please ask your Ericsson representative for a free copy.

The Installation Data Form can be divided into Site Data, Access Module Data, Hop Data and SAU Data. The page headers identify the type of data they are intended for and the name of the site.

The site name should tell the supervisor the whereabouts of the site. The site name must be totally unambiguous! Given the following example a suitable site name might be *Deep Lake* (provided that there are no other Deep Lakes within the network area).

Site Data (2 pages) contains general site information such as the geographical location of the site, the available installation structures and buildings as well as general site hardware.

Access Module Data (2 pages) contains detailed information concerning the indoor part, that is the indoor equipment required for the terminals.

Hop Data (4 pages) contains path data and all terminal data details.

SAU Data (3 pages) contains data concerning the Service Access Unit in the appropriate Access Module Magazine.

Supplementary Information (two pages included, copy as required) is intended for information not provided by the other sections but which nevertheless is considered important or worthwhile, or for personal notes during installation and maintenance.

6.1.1 Work Flow

The Installation Data Form as presented in chapter 7 of this manual is divided into logical parts suitable for the installation staff. This division, however, does not represent the most appropriate work flow when the data is being compiled.

We recommend that you use the following work flow during the planning phase.

Step	Section	Description	Page
1	6.2.1	Site Survey	8
2	6.4.1	General Terminal Data	15
3	6.4.2	Path Calculation Summary	16
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6.2 Site Data

6.2.1 Site Survey

The very basis for all site data is a thorough on-the-spot site survey, noting all information which is vital for the erection of the site itself and for the equipment installation. A "desktop" survey, irrespective of the quality of the maps used, cannot provide all the required information. However, it is a good preparation for the actual field job.

6.2.1.1 Site Street Address

Enter any other address information data if "street address" is not applicable. This will help maintenance or supervision staff to find the site.

Example: *25 Deep Lake Road.*

6.2.1.2 Site Address

Enter the name of the city, municipality, village or whatever localizes the site in a somewhat greater context than the street address.

Example: *Smallville, KY.*

6.2.1.3 Site Contact's Name

Enter the name of the site contact, that is the person who should normally be contacted if any problem arises concerning this particular site.

Example: *Mr John Doe Jr.*

6.2.1.4 Site Contact's Telephone Number

Enter the telephone number including the area code, if applicable, of the site contact.

Example: *(123) 456-7890*

6.2.1.5 Site Contact's Address

Enter the address of the site contact. Use the spare lines if required.

Example: *32 Great Junction Road, Smallville, KY 12345*

6.2.1.6 Site Latitude

Enter the value as exactly as possible.

Example: *38° 32' 15" N*

6.2.1.7 Site Longitude

Enter the value as exactly as possible.

Example: *83° 15' 45" W*

6.2.1.8 Site Height-Above-Sea Level

Enter the value in meters as exactly as possible.

The value will be used in conjunction with the antenna mounting height-above-ground level to determine the maximum possible effective antenna height-above-sea level. A good topographical map will give this information provided that the isometric level distance does not exceed 5 meters.

6.2.1.9 Site Antenna Carrier Type

Enter the type of equipment carrying the antenna(s), that is roof, wall, steel tube mast, lattice mast etc.

6.2.1.10 Site Antenna Carrier Maximum Height

Enter the height of the antenna carrier top above ground level in meters.

The value will be used in conjunction with the site height-above-sea level and the antenna mounting height-above-ground level to determine the maximum possible effective antenna height-above-sea level.

6.2.1.11 Available Indoor Location

Enter the indoor location where the hardware is installed. Given that a site may contain up to six AMMs, multiple positions may have to be entered.

Example: *AMM1: Rack no. A5, position 4*
 AMM2: Rack no. A5, position 3

6.2.1.12 Supplementary Information

Enter any information concerning the site which is considered to be important.

6.2.2 General Site Hardware

This section covers the equipment common to all Access Modules on a site.

6.2.2.1 Estimated Power Consumption

Enter the calculated sum of the power consumption (W) of the equipment to be served by the site power supply. Chapter 8 in the MINI-LINK E Installation Manual provides the data required for the consumption calculations.

6.2.2.2 Power Supply Type

Enter the power supply manufacturer and type selected considering the voltage specifications stated in the MINI-LINK E Installation Manual and the calculated power consumption. Always allow for some spare capacity.

6.2.2.3 Cooling Equipment

Enter the fan type and the location of the cooling equipment. The cooling equipment may also be an air conditioner if required.

The MINI-LINK E Installation Manual provides further information about this theme.

6.2.2.4 Steel Tube Diameter and Length

Enter the appropriate values ONLY if the antenna carrier is a steel tube.

Long steel tube masts may require guy wires to stabilize the antennas and to prevent them from swaying. The orientation of the guy wires, if used, must be carefully planned to avoid obstruction of the radio signal(s).

Example: $\varnothing 100\text{mm}$, 2.5m

6.2.2.5 Antenna Tripod

Enter a description of the tripod to be used. The MINI-LINK E Product Catalogue provides further information about the installation of tripods.

Example: 0.3/0.6m antenna tripod

6.2.2.6 Universal Installation Kit

The universal installation kit comes in two versions. They can be used if the radio and the antenna cannot be mounted directly on the carrier. Enter the appropriate ordering code if a kit is required.

6.2.2.7 Lattice Mast Height

Enter this value (in meters) ONLY if a lattice mast is used. Lattice masts will normally be used when multiple antennas should be installed (for example antennas for more than one hop).

The lattice mast may have a uniform cross-sectional area, or it may have a broadened base. In any case, suitable mounting pads must invariably be present, and guy wires have to be used for the uniform area type.

The lattice mast and the equipment installed on it is subjected to wind loads and torsion. Even ice loads may be present depending on the climatic conditions at the installation site.

6.2.2.8 Lightning Rod

A lightning rod, properly connected to a high quality earthing network prevents lightning strokes from damaging essential parts of or the site installation. Enter the ordering code if a lightning rod is required (which is normally the case in tube or mast installations).

6.2.3 Site Drawings

Attach all appropriate site drawings which are considered necessary to present the situation on the site. These drawings may for example be a general site layout drawing, antenna carrier and indoor layout drawings.

6.2.4 Installation Tools

The MINI-LINK E Installation Manual describes all tools required for a proper installation - even standard merchandise tools. The MINI-LINK E Product Catalogue describes all special purpose tools that may be obtained from Ericsson.

Enter the ordering codes and - if applicable - the quantities for all tools required.

6.2.5 PC Software Tools

The available PC software tools are described in chapter 4 of this manual.

Enter the ordering code for all desired tools.

6.3 Access Module Data

This section sums up the results of the terminal and SAU decisions based on the configuration according to chapter 3.

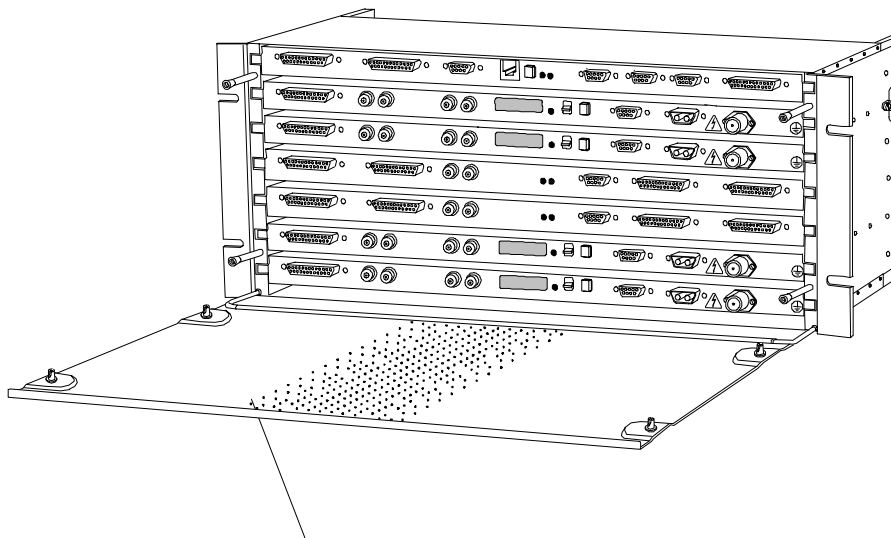


Figure 6-1: A fully equipped AMM4U-1

6.3.1 Access Module Hardware

6.3.1.1 Access Module Name

Enter the assigned name of the AMM, if any.

6.3.1.2 Access Module Code

Enter the assigned code of the AMM, if any.

6.3.1.3 Rack Number

Enter the identity of the rack in which the AMM is (to be) installed.

Also see section 6.2.1.11, Available Indoor Location.

6.3.1.4 Rack Position

Enter the AMM location in the rack.

Also see section 6.2.1.11, Available Indoor Location.

6.3.1.5 AMM Installation

Check the appropriate box indicating the installation of the AMM, or enter your own description if the boxes are inappropriate. The installation method will decide the installation accessories to be used.

6.3.1.6 AMM1U-0, AMM2U-1, AMM2U-2 and AMM4U-1

Chapter 3, sections 3.4 and 3.5, of this manual describes how to select the proper AMM size.

Enter the applicable MMU, SMU and SAU types, identities, ordering codes, hardware and software revision states.

Example:

Module	Type	Identity	Ordering code	Serial no.	Hardw. rev.	Softw. rev.
MMU	2x2	ABCD	MM0012201/00	12345	R2	R3

The identity is a code used by the network supervisory software, and it must be established during the network planning process. Please observe that identities are established for SAUs and terminals ONLY. The MMU identity therefore is identical to the terminal of which it is a part. Consequently, SMUs may serve two different identities.

The ordering code appears in the MINI-LINK E Product Catalogue. The serial number and the hardware and software revision states appear on the brand label of the individual equipment or can be obtained from MNM, MSM and MIM.

The network planning engineer enters the types, the identities and the ordering codes. The installation engineer enters the serial number and the hardware and software revision states.

AMM4U-1 / Module type		Identity
Pos7 SAU	SAU Basic	AB01
Pos6 MMU	MMU 34+2	AB02
Pos5 MMU	MMU 34+2	AB02
Pos4 SMU	SMU 16x2	AB02
Pos3 SMU	SMU 16x2	AB03, AB04
Pos2 MMU	MMU 2x8	AB03
Pos1 MMU	MMU 2x8	AB04

Table 1 Possible identities in an AMM4U-1

6.3.1.7 AMM Accessories

Enter the quantities and the ordering codes for all items required for the AMM installation.

The MINI-LINK E Product Catalogue provides further information concerning the accessories.

6.3.2 Access Module Software Setup

This is the very first step of the software setup. It is performed after all equipment has been installed and properly connected.

The setup procedures are described in the software users manual.

Also see section 6.3.1 and page 1 of the Access Module Data Form.

6.4 Terminal Data

One set of forms is required per terminal. The site name in the header refers to Site A name.

6.4.1 General Data

6.4.1.1 Site Name

Enter the Site A and Site B names. The Site A name is identical to the site name used in the header (Near End). The Site B name represents the communicating site (Far End).

6.4.1.2 Terminal Identity

Enter the terminal identity code established during the network planning process. Also see chapter 4 of this manual, sections 4.4 and 4.4.1.

6.4.1.3 Customer

Enter the name of the network operator.

6.4.1.4 Site Installation Responsible

Enter the company, team or person responsible for the site installation work.

6.4.1.5 Site Supervisor

Enter the team or person responsible for commissioning, setting up and testing the site installation.

6.4.1.6 Ready for Installation Date

Enter the date when all components must be available at the site for the start of the installation.

6.4.1.7 Commissioning Date

Enter the date when the installation must be completed and the equipment ready for commissioning.

6.4.1.8 Start-up Date

Enter the date when the equipment is supposed to be in full active service.

6.4.1.9 Frequency Band

Check the appropriate box.

6.4.1.10 System Configuration

Check the appropriate box.

6.4.1.11 Hop Type

Check the appropriate box.

6.4.1.12 Path Length

Enter the distance in kilometers between the communicating sites.

The distance may be calculated directly from the map or be measured using land survey instruments.

6.4.1.13 Traffic Capacity

Enter the desired traffic capacity in Mbps.

6.4.2 Path Calculation Summary

This information is used for the calculation of the performance and availability of the hop. The forms produced by the path calculation software, for example MLPERF, should be included.

6.4.2.1 Climate

Enter the precipitation intensity 0.01% of time expressed in millimeters (mm) of precipitation per hour (h).

This information is available from the ITU-R Rep. 563-4 (CCIR) "Radiometeorological Data", volume V, 1990, "Propagation in Non-Ionized Media".

6.4.2.2 Terrain

Enter *multipath* or *single path*, the inclination in *degrees*, the *refraction gradient* and other parameters influenced by the terrain.

6.4.2.3 Azimuth Location of the Communicating Site

This is the (360°) compass heading to the communicating site (Far End). The difference between the headings for Site A and Site B is exactly 180°.

6.4.2.4 Antenna Mounting Height-Above-Ground Level

Enter the distance in meters between the radio-optical centre of the antenna and the ground.

6.4.2.5 Effective Antenna Height-Above-Sea Level

Enter the sum of the site height above sea level and the antenna mounting height above ground level.

6.4.2.6 Antenna Size, Type and Gain

Enter the antenna dish diameter in meters and the type of the antenna (standard, standard with radome, high performance). If the antenna is not manufactured by Ericsson, the gain (in dBm) must be entered.

6.4.2.7 **Antenna Polarization**

Enter *vertical* or *horizontal* as appropriate.

The polarization has a certain impact on the attenuation in some cases, and may be used to enhance frequency reusability in other cases. Vertical polarization produces lower attenuation in some cases. Also see chapter 2 of this manual, section 2.2.9.

6.4.2.8 **Transmitter Power (dBm)**

Enter the appropriate value for the selected MINI-LINK E equipment.

6.4.2.9 **Transmitter Attenuation / Losses (dBm)**

Enter the appropriate value for the fixed or the variable attenuation and for losses in the waveguides, the power splitter, etc.

6.4.2.10 **Receiver Attenuation / Losses (dBm)**

Enter the appropriate value for known losses in the waveguides, the power splitter etc.

6.4.2.11 **Fade Margin**

Enter the value as calculated in the link budget. This information is listed for information only.

The fade margin constitutes a safety margin for the radio signal.

The fading is discussed in chapter 2, section 2.3.8, of this manual.

6.4.2.12 **Unfaded RF Input Level**

The unfaded RF input level is the result of the Link Budget as discussed in chapter 2, section 2.3.7, of this manual.

Enter the calculated figure (in dBm) along with the allowable tolerances.

6.4.2.13 **Other Aspects Concerning the Path Calculation**

Enter anything which might influence the path calculation - for example obstacles which might be expected to attenuate the signal. The information may be continued on the rear side of the page if required.

6.4.3 **Outdoor Hardware**

Use the configuration performed according to chapter 3 of this manual when you enter the following data. Some of the entries, such as for example serial numbers, are only available during the installation, however.

The information you enter in this section concerns Site A ONLY.

Radio Units

6.4.3.1 Frequency Band and Sub-Band

Enter the appropriate values.

6.4.3.2 Frequency (MHz)

Enter the appropriate value in MHz.

6.4.3.3 Output Power (dBm)

Enter the output power in dBm from the radio unit without regard to whether or not there is a fixed RF attenuator but including RF power adjustment.

6.4.3.4 Fixed Attenuator (dBm)

Enter the attenuation value in dB if a fixed RF attenuator is (to be) installed.

6.4.3.5 Ordering Code

Enter the radio unit ordering code appearing in the MINI-LINK E Product Catalogue.

6.4.3.6 Serial Number

This information is entered during the installation.

Enter the radio unit serial number as displayed on the radio unit brand label.

6.4.3.7 Hardware Revision State

This information is entered during the installation.

Enter the appropriate hardware revision state. This is available from MNM, MIM or MSM.

6.4.3.8 Software Revision State

This information is entered during the installation.

Enter the appropriate software revision state. This is available from MNM, MIM or MSM.

Antennas

6.4.3.9 Diameter and Type

Enter the antenna dish diameter in meters. If the antenna is not manufactured by Ericsson, also enter enough information to properly identify it.

6.4.3.10 Ordering Code

Enter the antenna ordering code appearing in the MINI-LINK E Product Catalogue.

6.4.3.11 Serial Number

This information is entered during the installation.

Enter the antenna serial number as displayed on the antenna unit brand label.

6.4.3.12 Polarization (H / V)

Enter *H* for Horizontal polarization or *V* for Vertical polarization.

6.4.3.13 Installation (Integrated / Separate)

Enter *Integrated* if the radio unit is to be installed directly on the antenna, or *Separate* if the radio unit is to be installed separated from the antenna.

Power Splitter and Waveguides**6.4.3.14 Symmetrical / asymmetrical**

Enter the appropriate type and ordering code of the power splitter.

6.4.3.15 Installation (Integrated / Separate)

Enter the appropriate installation of the power splitter. The ordering code was entered in the previous step.

6.4.3.16 Waveguides

Enter the length, type and ordering code for any required waveguide.

The MINI-LINK E Product Catalogue, provides further information.

6.4.3.17 Installing Hardware

Enter a type designation, a number, a length and an ordering code as appropriate for all required installation hardware.

6.4.4 Indoor Installation**6.4.4.1 Connect to**

Enter the opposite terminal for the connectors. Also see Traffic Software Setup and Hop Setup in the MNM, MSM, MIM Operation Manual, chapter 3.

6.4.4.2 Cable Type and Length

Use the cables specified in the MINI-LINK E Product Catalogue. Enter the appropriate cable type and the cable length in meters.

6.4.4.3 Power Supply Specification

Enter the manufacturer's type designation and the voltage according to the set specifications. Also enter the dimensioning power output requirement (W). This can be summed up using the configuration according to chapter 3 in this manual and chapter 8 of the MINI-LINK E Installation Manual.

6.4.4.4 Power Requirement

Enter the input power requirement of the power supply.

6.4.5 Hop Software Setup

The hop software setup is described in depth in the MNM, MSM, MIM Operation Manual.

The values, identities etc. to be entered are derived from the configuration as described in chapter 3 of this manual, from the path calculation process, and from the network planning process.

6.4.5.1 Tx Frequency (MHz)

Enter the desired Tx (transmitter) frequencies as determined during the planning process.

The Rx (receiver) frequency is automatically set in accordance with the Tx frequency.

The Radio 2 frequencies are set automatically in accordance with Radio 1.

6.4.5.2 Remote Controlled Output Power

Check this box if the output power is supposed to be set.

6.4.5.3 Output Power

Enter the output power as decided during the path calculation process if the Remote Controlled Output box has been checked.

6.4.5.4 AGC Alarm Threshold

Enter the value as determined during the path calculation process. This value is used for 1+1 switching.

6.4.5.5 Tx Attenuator

Enter the value of the fixed attenuator to be fitted if applicable.

6.4.5.6 Radio ID Check

Check this box if the Near End radio is supposed always to perform an identity check on the Far End radio before the data transmission starts.

6.4.5.7 Far End ID

Enter the identity of the Far End radio terminal in the hop.

6.4.5.8 BER Alarm

Enter the appropriate value as decided during the path calculation process.

6.4.5.9 Local Control Disabled

Check this box if the programming facilities of the MMU local supervision interface should be disabled.

6.4.6 Traffic Software Setup

The Traffic Setup is entered for the Near End terminal only. Some traffic signals are available in front panel connectors, and some signals are routed to other units via the back plane.

6.4.6.1 Signal

These are the individual traffic signals. The number of available signals depends on the type of MMU employed for the hop.

6.4.6.2 Comments

Some signals are differently named in some cases. This column provides the necessary information. No further entry is required.

6.4.6.3 Active Inputs

Check the ports which are used.

6.4.6.4 Connection Port

Enter the front panel connector from which the individual traffic port is available, for example *TRIA*. Also see the Indoor Installation section and the MNM, MSM, MIM Operation Manual, hop setup in chapter 3.

6.5 SAU Data

The SAU (Service Access Unit) "leads a life of its own", with an identity separated from the identity of the radio terminals it is serving. This is due to the fact that one SAU may serve up to four different radio terminals.

The configuration performed according to chapter 3 of this manual has determined whether or not an SAU is required and, if so, which type to use for the individual AMM.

6.5.1 SAU General Data

6.5.1.1 SAU Identity

Enter the identity code of the SAU. The identity constraints applied to the terminals also apply for the SAU.

6.5.2 SAU Hardware

6.5.2.1 SAU Type

Enter the appropriate SAU type.

6.5.2.2 Ordering Code

Enter the SAU ordering code appearing in the MINI-LINK E Product Catalogue.

6.5.2.3 Serial Number

This information is entered during the installation.

Enter the SAU serial number. This information is available on the brand label or from MNM, MIM or MSM.

6.5.2.4 Hardware Revision

This information is entered during the installation.

Enter the appropriate hardware revision state. The information is available from MNM, MIM or MSM.

6.5.2.5 Software Revision

This information is entered during the installation.

Enter the appropriate software revision state. The information is available from MNM, MIM and MSM.

6.5.3 SAU Connections

6.5.3.1 Connect to

Enter the equipment and the connector to which the individual port should be connected or from which it originates.

6.5.3.2 Cable Type and Length

Enter the cable type and length in meters used to connect the applicable signal.

6.5.4 SAU Software Setup - Communication

6.5.4.1 EAC

Enter the identity of all connected EACs.

6.5.4.2 RAC x

For each RAC (1 or 2), enter *Yes* or *No* indicating whether or not the individual RAC is active, the Remote IDs and the interface.

6.5.4.3 NCC

This information is automatically supplied by the software. It is displayed as information only.

6.5.5 SAU Software Setup - User I / O

This is a listing of the individual channels and their respective use.

6.5.5.1 Status NO / NC

Enter *NO* for a normally open and *NC* for a normally closed contact.

6.5.5.2 Severity (in)

Enter the severity denomination as applicable. See the MNM, MSM, MIM Operation Manual for further information.

6.5.5.3 Source (out)

Enter the type of the signal as applicable. See the MNM, MSM, MIM Operation Manual for further information.

6.5.5.4 Input / Output

Channels 9 - 12 are user selectable inputs or outputs, and consequently the individual setting (In / Out) must be indicated. Check the applicable box.

6.5.6 SAU Software Setup - Service Channel

6.5.6.1 DIG SC

The number of the Digital Service Channel.

6.5.6.2 Active Y / N

Enter *Yes* if the signal is active, *No* if it is not.

6.6 **Supplementary Information**

This page is intended for information not provided by the other sections but which nevertheless is considered important and/or worthwhile, or for personal notes during installation and maintenance. Add as many pages as is required.

MINI-LINK

Site documentation

Site name:

Preparation date:

1 Site Data

2 AMM 1 Data

- 2.1 Terminal 1 Data
- 2.2 Terminal 2 Data
- 2.3 Terminal 3 Data
- 2.4 Terminal 4 Data
- 2.5 SAU Data

3 AMM 2 Data

- 3.1 Terminal 1 Data
- 3.2 Terminal 2 Data
- 3.3 Terminal 3 Data
- 3.4 Terminal 4 Data
- 3.5 SAU Data

4 AMM 3 Data

- 4.1 Terminal 1 Data
- 4.2 Terminal 2 Data
- 4.3 Terminal 3 Data
- 4.4 Terminal 4 Data
- 4.5 SAU Data

5 AMM 4 Data

- 5.1 Terminal 1 Data
- 5.2 Terminal 2 Data
- 5.3 Terminal 3 Data
- 5.4 Terminal 4 Data
- 5.5 SAU Data

6 AMM 5 Data

- 6.1 Terminal 1 Data
- 6.2 Terminal 2 Data
- 6.3 Terminal 3 Data
- 6.4 Terminal 4 Data
- 6.5 SAU Data

7 AMM 6 Data

- 7.1 Terminal 1 Data
- 7.2 Terminal 2 Data
- 7.3 Terminal 3 Data
- 7.4 Terminal 4 Data
- 7.5 SAU Data

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Site Data		
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Site Survey

Site street address		Site contact' name
Site address (City, municipality, ...)		Site contact's telephone number
Site latitude	Site longitude	Site contact's address
Site height above sea level (m)	Site antenna carrier type	Site antenna carrier maximum height
Available indoor location		
Supplementary information		

General Site Hardware

Equipment	Number, type designation, value, etc.
Estimated power consumption (W)	
Power supply type	
Cooling equipment (fan type and location)	
Steel tube diameter (mm) and length (m)	
Antenna tripod	
Universal installation kit	
Lattice mast height (m)	
Lightning rod	

Site Drawings

Attach drawings as required.

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Site Data		
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Installation Tools

Qty	Ordering Code	Description
	LTT 237 13	Installation Tool Kit
	LTX 102 17	Cable cutter for radio cable jacket
	LSD 319 82	Crimping tool for radio cable and SMZ connectors
	LSD 349 20	Band tensioner for radio cable clamping
	LSB 903 36	Long Allen key
	LSD 319 80	Crimping tool for DC wires
	LSY 141 12	Pin extraction tool for DC wires
	LSD 319 83	Tool for IDC D-sub connectors
	LSD 319 84/1	Crimping tool for pair cable braid
	LSY 120 10/1	Pin extraction tool for IDS D-sub connectors

PC Software Tools

Qty	Ordering Code	Description
	LZY 202 341/1	MIM - MINI-LINK Installation Manager
	LZY 202 340/1	MSM - MINI-LINK Service Manager
	LZY 202 522/1	MNM - MINI-LINK Network Manager

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Access Module Data		
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AM Software Setup

Equipment	Protection mode	Traffic	Identity
Pos7 SAU			
Pos6 MMU			
Pos5 MMU			
Pos4 SMU			
Pos3 SMU			
Pos2 MMU			
Pos1 MMU			

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Terminal Data		
Site name:		Page 1 / 4

General Data

	Site A	Site B
Site name		
Terminal identity		

Customer	Site installation responsible	Site supervisor
Ready for installation date	Commissioning date	Start-up date

Frequency band (GHz)	7-E	15-E	18-E	23-E	26-E	38-E
System configuration	1+0	1+1	2+0			
Hop type	Direct	Repeater				
Path length (km)						
Traffic capacity (Mbps)						

Path Calculation Summary

Climate	
Terrain	

Parameter	Site A	Site B
Azimuth location of the communicating site		
Antenna mounting height above ground level (m)		
Effective antenna height above sea level (m)		
Antenna size, type and gain		
Antenna polarization		
Transmitter power (dBm)		
Transmitter attenuation / losses (dBm)		
Receiver attenuation / losses (dBm)		
Fade margin (dB)		
Unfaded RF input level (dBm)		
Other aspects concerning the path calculation		

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Terminal Data		
Site name:		Page 2 / 4

Outdoor Hardware

Radio Units

Parameter	Radio 1	Radio 2
Frequency band and sub-band		
Frequency (MHz)		
Output power (dBm)		
Fixed attenuator (dBm)		
Ordering code		
Serial number		
Hardware revision		
Software revision		

Antennas

Parameter	Antenna 1	Antenna 2
Diameter and type ¹⁾		
Ordering code		
Serial no.		
Polarization (H/V)		
Mounting (integrated/separate)		

¹⁾ S = Standard, SR = Standard with radome, HP = High performance

Power Splitter and Waveguides

Parameter	Type	Ordering code
Symmetrical / asymmetrical		
Mounting (integrated / separate)		
Waveguides		

Mounting Hardware

Hardware description	Information	Ordering code
Separate mounting kit		
Universal installation kit		
Power splitter mounting kit		
Flexible waveguide kit (length (m) / number)		
Radio 1 cable type / length (m)		
Radio 2 cable type / length (m)		
Maximum radio 1 / radio 2 cable clamp spacing (m)		
Radio cable earthing kits		
Radio cable earthing connection point		
Radio cable wall glands		
Additional outdoor installation data		

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Terminal Data			
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Indoor Installation

Port	Connect to (also see Traffic Software Setup)	Cable type and length (m)
TR1A		
TR1B		
TR1C		
TR1D		
TR2A		
TR2B		
TR2C		
TR2D		
TR3A		
TR3B		
TR3C		
TR3D		
TR4A		
TR4B		
TR4C		
TR4D		
DC cable		

Power Supply

Specification	
Power requirement	

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Terminal Data		
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Hop Software Setup

Parameter	Site A		Site B	
	Radio 1	Radio 2	Radio 1	Radio 2
RF Parameters:				
Tx Frequency (MHz)				
Remote controlled output power				
Output Power (dBm)				
AGC Alarm Threshold (dBm)				
Tx Attenuator (dBm)				
General Parameters:				
Radio ID Check				
Far End ID				
BER Alarm				
Local Control Disabled				

Traffic Software Setup

Signal	Comments	Active input	Connection port (Also see Indoor Installation)
E1:1	BB1 for MMU 2x2		
E1:2	BB2 for MMU 2x2		
E1:3			
E1:4			
E1:5			
E1:6			
E1:7			
E1:8			
E1:9			
E1:10			
E1:11			
E1:12			
E1:13			
E1:14			
E1:15			
E1:16			
E1:17	BB2 for MMU 34+2		
E2:1	BB1 for MMU 4x2/8 and MMU 2x8		
E2:2	BB2 for MMU 2x8		
E2:3			
E2:4			
E3:1	BB1 for MMU 34+2		

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SAU Data			
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SAU General Data

SAU identity	
---------------------	--

SAU Hardware

SAU Type (Basic / Exp 1 / Exp 2)	
Ordering code	
Serial no.	
Hardware revision	
Software revision	

SAU Connections

Signal	Connect to	Cable type and length (m)
DIG SC 1		
DIG SC 2		
DIG SC 3		
DIG SC 4		
DIG SC 5		
DIG SC 6		
DIG SC 7		
DIG SC 8		
PHONE		
RAC1		
RAC2		
O&M		
EAC		
BR/EAC1		
BR/EAC2		
USER I/O 1		
USER I/O 2		
USER I/O 3		
USER I/O 4		
USER I/O 5		
USER I/O 6		
USER I/O 7		
USER I/O 8		
USER I/O 9		
USER I/O 10		
USER I/O 11		
USER I/O 12		

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SAU Data		
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SAU Software Setup - Communication

EAC	Identity	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	Active	Remote ID	Interface
RAC1			
RAC2			

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SAU Data		
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SAU Software Setup - User I / O

User In/Out	Parameter	Value
User In 1	Status (NO / NC)	
	Severity	
User In 2	Status (NO / NC)	
	Severity	
User In 3	Status (NO / NC)	
	Severity	
User In 4	Status (NO / NC)	
	Severity	
User In 5	Status (NO / NC)	
	Severity	
User In 6	Status (NO / NC)	
	Severity	
User In 7	Status (NO / NC)	
	Severity	
User In 8	Status (NO / NC)	
	Severity	
User In/Out 9	Status (NO / NC)	
	Input Severity (in)	
	Output Source (out)	
User In/Out 10	Status (NO / NC)	
	Input Severity (in)	
	Output Source (out)	
User In/Out 11	Status (NO / NC)	
	Input Severity (in)	
	Output Source (out)	
User In/Out 12	Status (NO / NC)	
	Input Severity (in)	
	Output Source (out)	

SAU Software Setup - Service Channel

DIG SC	Active	Comments
1		
2		
3		
4		
5		
6		
7		
8		

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Supplementary Information			
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8 NOTES

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