WALKair™ 3000

Troubleshooting Guide

Version 5.0
March 2007
P/N 214420

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About this Guide

This guide summarizes the different scenarios that a field WALKair installer may encounter, and describes the corrective actions he/she may take in order to restore the WALKair system to its 'up and running' state.

This guide begins with systematic troubleshooting procedures and proceeds with network problems and analysis methods.

This guide includes the following chapters:

- **Chapter 1 - Air Link Setup Troubleshooting** – includes a listing of basic air link problems and a detailed description of how the air link is established using the relevant LCI message in each phase.
- **Chapter 2 – The WALKair E1 Alarm Mechanism** – since many service problems are the result of physical layer problems, this chapter describes the E1 alarm mechanism and how it is implemented in the WALKair as a point-to-multipoint system.
- **Chapter 3 - Possible Network Problems and Causes** – introduces possible problems that occur due to the network, and not necessarily due a specific link. These problems can be the result of installation, planning or commissioning issues.
- **Chapter 4 - Analysis Methods** –provides tools and methods for analyzing network radio problems. Some of the tools are included in the WALKair and WALKnet products, others however require the use of external measurement equipment
- **Appendix A** – Terminal Station Power Levels Calculation.
- **Appendix B** – System Performance Verification.

NOTE

This guide assumes that the reader is familiar with the WALKair 3000 system and the content of the WALKair 3000 System Manual and the release notes.

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Chapter 1 - Air link Setup Troubleshooting

In this Chapter:

Part 1: The Air Link is not established

Before performing a failure analysis at the Terminal Station side, make sure that the Base Station is operational. You can do this by either of the following methods:

- Ensuring that an operational Terminal Station is in the same sector as the Base Station, and that the Base Station Antenna is aligned correctly (the Terminal Station must be within the effective Base Station Antenna lobe). See also Chapter 3 - Possible Network Problems and Causes for further clarifications.
- If no other TS is installed:
  - Verify correct basic configuration according to Appendix B
  - Measure 48 V at the IF port at the BS-SA and measure the IF cable for no short or cutout.
  - If test equipment is available, measure the IF cable attenuation.
  - Measure the signal using a spectrum analyzer, by connecting the analyzer according to the RF survey instruction in the *User Manual*.

Once you have determined that the Base Station is operational, the problem is presumed to be at the Terminal Station site.

In this case, the next step is checking that the Terminal Station is effectively scanning frequencies.

Checking the Current Air Link Status

To check the Current Air Link Status:

1. Connect a monitor to the TS-BU LCI port, and log in as an Administrator (ADMIN) or as a Technician (TECH).
2. From the main menu, press **3→ 2→2→2**.

   The following messages appear in the TS test menu.

```
Fr:4186821
RXM:12 (080)- RX SYNC
RLC:8 (080,ON)- DATA SYNC
Channel BW:14MHz
EQU SNR [db]:+21.126968
TRUE SNR [db]:+21.981857
Init Gain:.515594
FER,Raw BER [ber]:7K57594034136700,< 0*E -2
RX curr. mod.:QAM16
RX Max. mod.:QAM16
Power [db]:-13.979980
RX gain [db]:-57.920181
Coarse AFC [khz]:-17.924808
Timing Error [deg]:+1.415434
Ph-Loop Freq [khz]:-3.467407
Ti-Loop Freq [KHz]:-2.387504
Ant RX pwr [dbm]:-32.213363
Ant TX pwr [dbm]:-1.320816
ALT. pos:21
MKR. pos:39
```

Air Link Status Symptoms and Corrective Actions

- There is no 'full' link if the **RLC** state is other than *DATA_SYNC.*
- If **RXM** is not *RX_SYNC*, there is currently no downlink.
- The number in the parentheses next to the RXM is the current frequency index that is being scanned.
- **RLC** state = *WAIT_FREQUENCY* indicates the modem is waiting for synthesizers to lock.
- **RLC** state = *SCAN* means 'seeking a carrier to establish downlink'.
- **RLC** state = *WAIT_SEARCH* means downlink exists, waiting for grant to establish up-link.
- **RLC** states = *SEARCH_HOLD, DISTANCE, TRAINING, SYNC* are preliminary phases in up-link / 'full' link establishment.

If the Terminal Station RXM is not = *RX_SYNC at all times (*no down-link):

- Make sure that all the radio configurations are correct (especially the RFU-Head-Type)
- Measure the IF cable for short/cut out
- If test equipment is available, measure the IF cable attenuation
- Measure 48 V at the TS-BU IF port
- Measure 48 V at the RFU IF cable (TS-RFU side), thus making sure that 48 V is supplied to the TS-RFU.
- Limit the TS start and stop frequency to those used by the BS.

If the Terminal RXM = *RX_SYNC and RLC is not = DATA sync at all times (*no up-link):

- Temporarily lower the RX operation point for this TS at the BS-SA (e.g. change to –80dBm)
- Temporarily change the cable gain to max values (TX=-20 dB RX=-12dB)

If all the measurements and configurations are OK:

- If there is another operational link in this sector:

  - Align Terminal Station antenna.
  - Confirm Base Station antenna alignment.
  - Replace TS-RFU.
  - Replace TS-BU.
- If there are no other operational links in this sector:
  - Confirm Base Station antenna alignment.
  - Confirm 48V at the IF cable (RFU-BS side).
  - Replace the BS-SA.
  - Replace IF-MUX if connected.
  - Replace BS-RFU.

Incorrect Configuration Problems

Three different symptoms indicate three different kinds of incorrect configuration, as described below:

Wrong Terminal Station Type

The Terminal Station is configured at the Base Station with the wrong Terminal Station type: this results in an 'Air Link status = Up' condition at the Terminal Station, but a Terminal Station mismatch at the Base Station.

```
MPU/L/U> Enter Option No:
TSC: Terminal Station configuration mismatch!!!
      BU slot      2
      TS           2
      Configured   TS3300 TYPE A
      Detected     TS3300 TYPE B
+====================================================+
```

Wrong estimated Distance

The Terminal Station is configured at the Base Station with a wrong Estimated distance, resulting in a more than 2.5Km difference from the actual distance. Since this condition can also cause problems to other links, verify using WALKnet → TS View → TS RFU& Antenna → that the actual distance is compliant to the estimated distance.

Terminal Station not defined or disabled at the Base Station

If the Terminal Station is not defined, or defined but with administrative status “disabled” at the Base Station, the following message is displayed:

```
Fr:7K57594029828375
RXM:12 - RX SYNC
RLC:3 - WAIT SEARCH
EQU SNR [db]:+21.359939
TRUE SNR [db]:+21.388687
Raw BER [ber]:1.784782*E -1
RX curr. mod.:QPSK
RX Max. mod.:QPSK
Power [db]:-13.870941
RX gain [db]:-45.730392
Coarse AFC [khz]:-0.034179
Timing Error [deg]:+1.625547
Ph-Loop Freq [khz]:+4.579468
Ti-Loop Freq [KHz]:-2.408695
Ant RX pwr [dbm]:-55.371322
Ant TX pwr [dbm]:-31.220596
ALT. pos:25
MKR. pos:39
```

Incorrect Configuration Resolution

To resolve an incorrect configuration:

- Make sure that the Terminal Station is registered at the BS-SA with the correct parameters: Customer ID, TS type and estimated distance (should be within ±2.5Km from actual distance).

Transmit/Receive Power Problems

Transmit/receive problems can result from either of the following:

- Weak signal received at the Terminal Station
- Weak signal received at the Base Station (as a result of a weak signal transmitted by the Terminal Station).

To correct transmit/receive problems:

1. Verify that the Terminal Station reaches the following condition:

RLC state *WAIT_SEARCH*

- ➢ If the Terminal Station does reach such a phase:
  - Verify configuration at the relevant BS-SA.
  - Replace the TS-BU.
- ➢ If the Terminal Station does not reach the phase mentioned for the operational frequencies proceed as follows:
  - Align the TS-RFU.
  - Replace TS-RFU.
  - Replace TS-BU.
  - Verify alignment of BS Antenna.

2. If RLC state is *WAIT_SEARCH* but not *DATA sync*, try to reduce the operation point for this TS at the BS-SA.

Part 2: The Air link is up, but not optimized

A WALKair link is deemed as operational (and optimized), if the following statements are true:

- The Link budget complies with the theoretical calculation given by radio planning (up to ±3 dB)
- The TS TX power is not more than 13dBm
- The Up/Down SNR figures are in compliance with the table below
- The link is stable (does not fail once every few minutes/hours)

Table 1-1: Rx Power versus Expected SNR Reading @26/28, 14MHz Channel

Rx Power [dBm]	SNR is between [dB]
-80	18-22
-76	22-26
-74	24-28
-72	26-32
-70	26-32
>-70	>30

Link Budget Compliance with Radio Planning

Ensure that the link budget complies with the theoretic value given by the radio planner (up to ±3 dB).

The theoretical calculation of fade margin is the expected attenuation between the Base Station and Terminal Station Antenna. By knowing in advance the fade margin, you can predict the power received/transmitted at the Terminal Station.

The compliance between the expected power and the power reported by the system may vary by ±3 dB.

If the Link Budget calculation does not comply with the power reported by the system:

1. Make sure that the RFU-Head-Type is configured correctly.
2. Follow the next steps according to the incompliance found.

Deviations between expected and reported power at the Terminal Station

Deviations between the expected and reported power at the Terminal Station may appear as one of the following three types (**A**, **B** and **C**):

Type A Deviation

Transmit power reported is higher than expected and Received power is reported lower than expected.

To resolve Type A deviation at the Terminal Station Site:

1. Make sure that IF-Cable Gain is configured properly.
2. Align the Terminal RFU Antenna.
3. Make sure that no objects, such a metal bar or buildings, block the front of the TS-RFU toward the Base Station.

To resolve Type A deviation at the Base Station Site:

1. Make sure that there are no objects in front of the Base Station antenna.

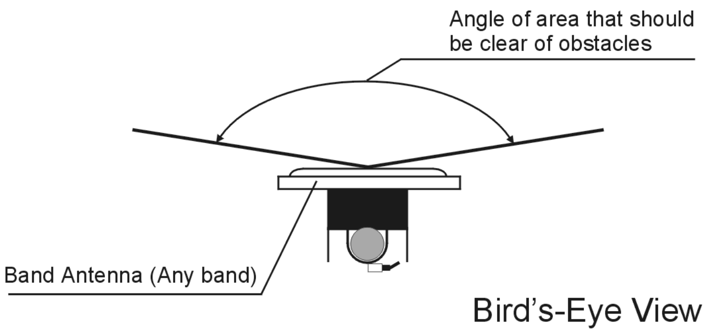

Figure 1-1: Bird's Eye Antenna View

2. Make sure that the Terminal Station is within the Base Station antenna effective lobe. If not, align the Base Station antenna, vertically and horizontally.

Type B Deviation

Type B deviation appears as one of the following:

- Transmit power reported is higher than expected, and Received power reported is as expected.
- Transmit power reported is as expected, and Received power reported is higher than expected.

To resolve Type B deviation:

- Check that the Cable Gain at the Terminal Station is not higher than the real (actual) value.

Type C Deviation

Type C deviation appears as one of the following:

- Transmit power reported is as expected, and Received power reported is lower than expected.
- Transmit power reported is lower than expected, and Received power reported is as expected.

To resolve Type C deviation:

1. Check that the cable gain at the Terminal Station is not lower than the real (actual) value.
2. If the previous step does not solve the problem:
   - At the Terminal Station site:
     - Replace TS-RFU.
     - Replace TS-BU.
   - At the Base Station (only if the current BS-SA is not connected to an operational Terminal Station):
     - If the sector configuration uses an IF MUX 4, connect the BS-SA to another port of the IF MUX 4
     - If the sector configuration uses a single BS-SA with IF-MUX, temporarily connect the BS-SA directly to the RFU
     - Replace the BS-SA.

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Chapter 2 - The WALKair E1 Alarm Mechanism

About this Chapter

The purpose of this chapter is to describe signaling over E1 and fractional E1 services in general, and in the WALKair system in special.

The WALKair system complies with the G703 standard. However, the signaling issue in Point to Multi Point fractional E1 service remains confusing. The main aspects of the signaling discussed are framing, alarming and CRC (on channel 0). Examples are provided following the explanations.

E1 Alarm Mechanism in WALKair

E1 Interface Modes

Unframed

In the unframed mode, there is no differentiation between time slot 0 and other time slots. The traffic is comprised of a 2Mbit/stream.

In unframed mode, the Fractional E1 (FE1) service is not relevant.

Transparent – Framed no Signaling

The E1 framer is set to work in framed mode. Hence, in addition to reconstructing the 2Mbit/Sec stream, the framer also constructs a 125µsec frame based on time slot 0.

The BS-SA and TS-BU refer to time slot 16 as a regular traffic time slot.

Framing Format

The framing structure is defined by the contents of time-slot 0.

Double Frame Format

Table 2-1: Double Frame Format

	1	2	3	4	5	6	7	8
Frame Containing the Frame Alignment Signal (FAS)	Si	0	0	1	1	0	1	1
Frame not Containing the Frame Alignment Signal (NFAS)	Si	1	A	Sa4	Sa5	Sa6	Sa7	Sa8

NOTE

- Si bits: reserved for international use. If not used, these bits should be fixed to ‘1’.
- Fixed to ‘1’: Used for synchronization. ‘0011011’ flag indication.
- Remote alarm indication: In undisturbed operation ‘0’; in alarm condition ‘1’.
- Sa bits: Reserved for national use. If not used, they should be fixed to ‘1’.

CRC4 Multi-Frame Format

Table 2-2: Basic Parameters

Sub-Multi-frame	Frame Num	1	2	3	4	5	6	7	8
1	0	C1	0	0	1	1	0	1	1
	1	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	2	C2	0	0	1	1	0	1	1
	3	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	4	C3	0	0	1	1	0	1	1
	5	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	6	C4	0	0	1	1	0	1	1
	7	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
2	0	C1	0	0	1	1	0	1	1
	1	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	2	C2	0	0	1	1	0	1	1
	3	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	4	C3	0	0	1	1	0	1	1
	5	E*	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	6	C4	0	0	1	1	0	1	1
	7	E*	1	A	Sa4	Sa5	Sa6	Sa7	Sa8

NOTE

- E: Spare bits for international use.
- Sa: Spare bits for national use.
- C1 …C4: Cyclic redundancy check bits.
- A: Remote alarm indication.
- Even frame number is always FAS. Odd frame number is always NFAS

Fractional E1 Alarms

AIS

In general, an Alarm Indication Signal will be transmitted whenever an RAI is received by an E1 interface.

An AIS is different in point-to-multi point fractional E1 service and in full E1 frame point-to-point service. AIS in point-to-point systems is known as transmission of “All Ones” in all time slots except time slot 0, whereas in fractional E1 service all ones will appear only on the time slots that have a service is assigned to them.

RAI

Remote Alarm Indication will be transmitted if the incoming E1 interface loses synchronization with the incoming data. The threshold is FAS error ratio greater than 10e-3. RAI will set bit A of the NFAS to “1”.

Time Slot 0 and Fractional E1 Service

In case of framed E1, WALKair does not transfer time slot 0 from the receive direction of the E1 frame (to the BU TS/BS) towards the air. In the transmit direction (the outgoing E1 frame from the BU interface), time slot 0 is re-created. The time slot 0 information is created as follows:

- CRC is calculated according to the time slots assigned to the port. Therefore, the CRC code for the BS-SA port and the TS-BU port containing fractional E1 service is NOT the same. RAI is Dependent on the receive direction of the interface.
- AIS – is dependent on the AIS alarm coming from the corresponding E1 interface on the other side of the air. The alarms are forwarded from BS to TS-BU and vice versa over the EOC channels.
- Alarm forwarding scenarios

The following are examples of signaling scenarios in a WALKair system, where the ‘**X’** symbol represents the point of failure. In all of the examples, the E1 service is applied at the physical layer. The second layer may be a Leased Line / V5.X / Frame Relay service.

TS-BU Rx Direction is Disconnected

In this case, the incoming E1 frame to the TS-BU telecom interface is disconnected.

The TS-BU (ID 20 in Figure 2-1) will transmit RAI to the corresponding telecom equipment. TS-BU ID 20 is faulty and TS-BU ID 10 is working normally.

The BS-SA will transmit AIS, 'all ones', only on the time slots that are assigned to TS-BU ID 20. The time slots are associated with a service. Time slots assigned to TS ID 10 will continue to transfer data/voice. This is known as fractional E1 AIS.

Note that if the equipment on the BS-SA side is disconnected in the same way, all the TS-BU's transmit AIS.

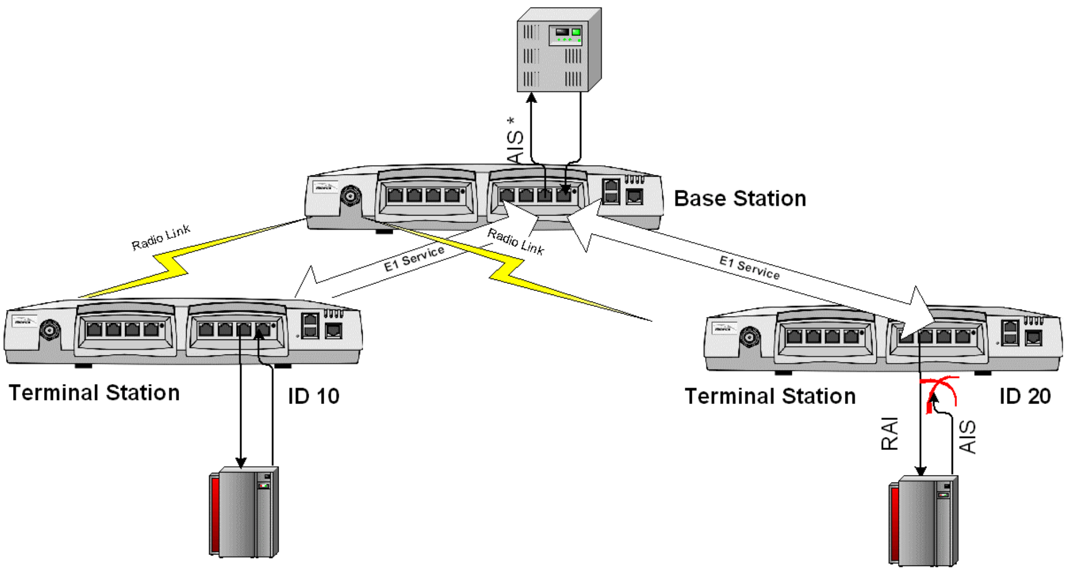

Figure 2-1: TS-BU RX Direction Disconnected

TS-BU Tx Direction is Disconnected

The transmitted E1 frame from the TS-BU is disconnected, and the information does not reach the telecom equipment on the CPE side.

The telecom equipment towards the TS-BU will generate RAI and the TS-BU will transmit AIS alarm on all time slots in response.

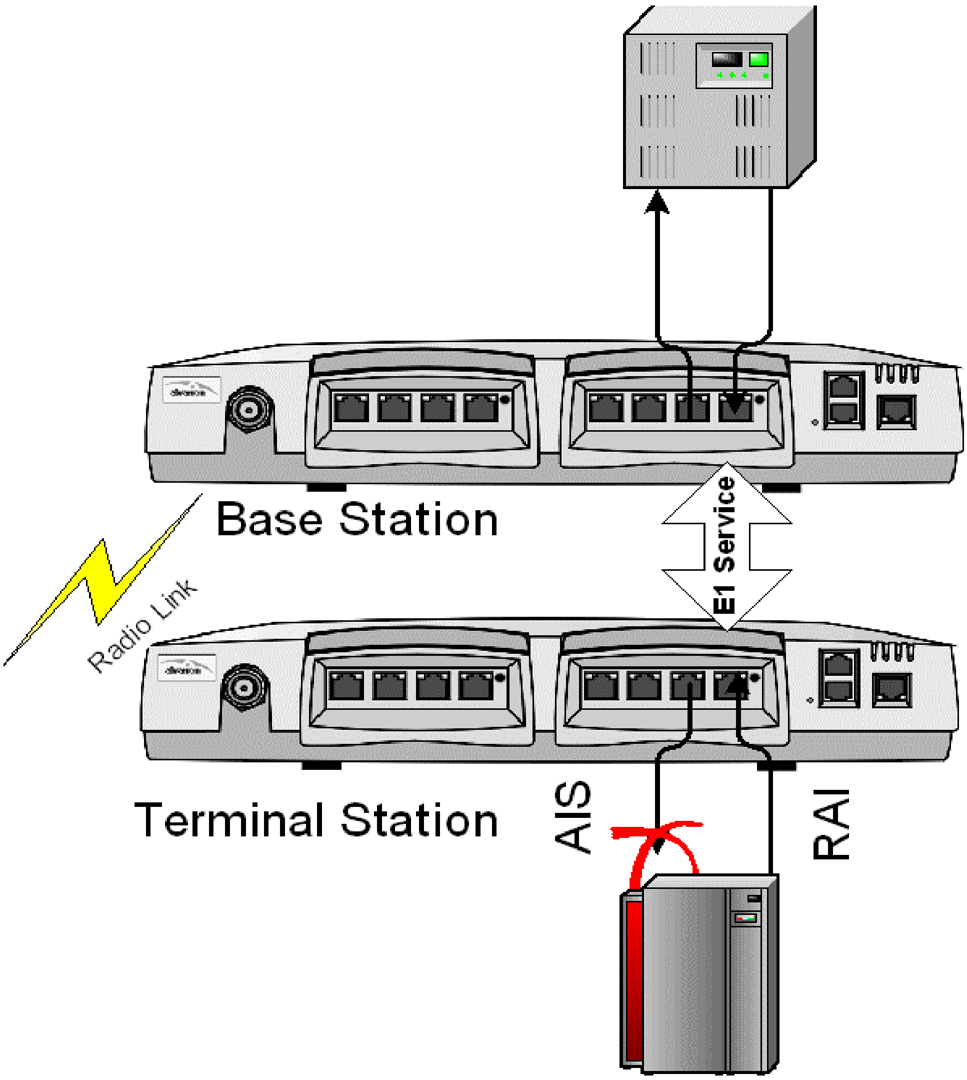

Figure 2-2: TS-BU TX Direction Disconnected

Radio Link Loss

In a Radio Loss scenario, AIS will be transmitted on all 32-time slots of the E1 towards the telecom equipment on both BS-SA and TS-BU sides. Even if the telecom equipment in the TS-BU side is disconnected, AIS is still transmitted.

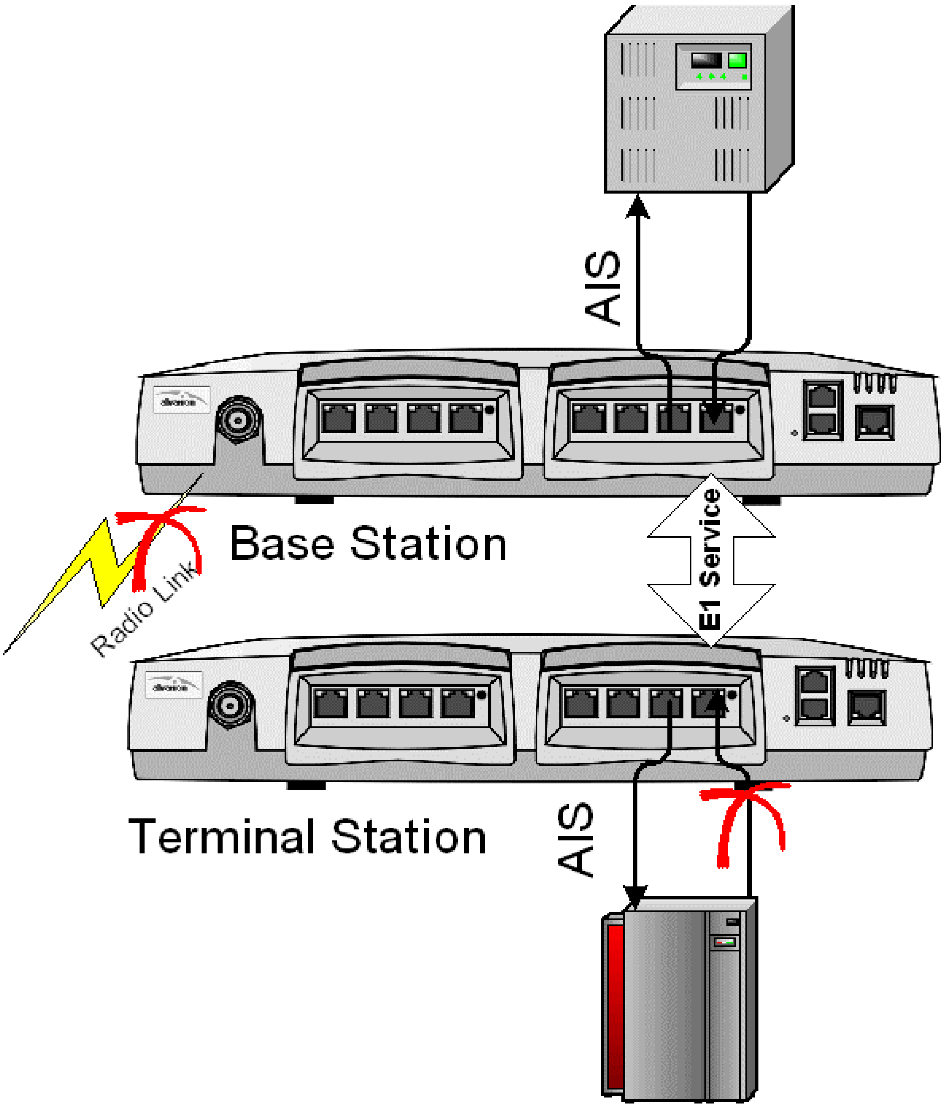

Figure 2-3: Radio Link Loss

E1 software loopback options

Local (L) loopback

Local loopback disconnects the Rx lines from the receiver, the data provided by the system interface is routed through the analog receiver back to the system interface. This test is used to check the E1 interface, including the Air interface.

When configuring E1 local loopback at the TS, the Test equipment should be connected to the BS. When configuring E1 local loopback at the BS, the test equipment should be connected to the TS (a compatible service should be defined).

Remote (R) loopback

In remote loopback testing, the clock and data recovered from the line inputs are routed back to the line outputs via the analog or digital transmitter. This loopback is used for remote self-testing.

Payload (P) loopback

Payload loopback loops the data stream from the receiver path back to the transmitter section. The looped data passes the complete Telecom port receiver including the wander and jitter compensation. Similar to the Remote loopback testing, it includes an additional component in the E1 interface.

The following diagram illustrates loopback testing:

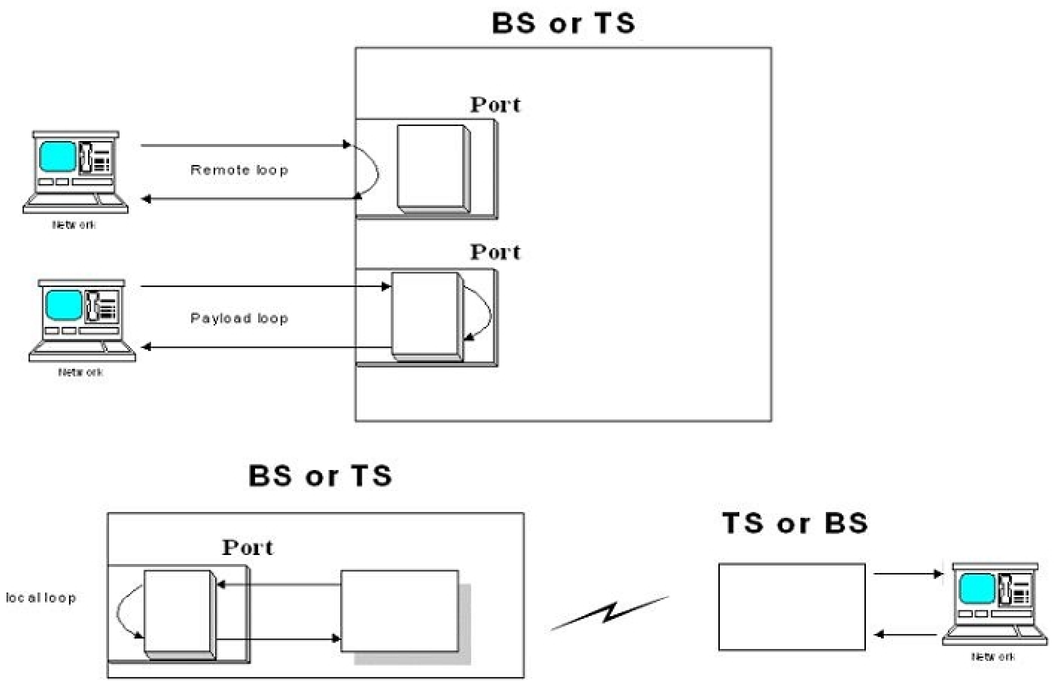

Figure 2-4: Loopback Testing

3

Chapter 3 - Possible Network Problems and Their Causes

About this Chapter

Some link problems are not concerned with a specific air link. Since the air is shared with other links and possibly other systems, problems can be common to more than one link. This Chapter includes examples of cases with problems common to several Terminal Stations.

Base Station Antenna Coverage

The effective Base Station antenna lobe is defined as the field in which the antenna gain is not less than 3 dB from its maximum gain.

The effective lobe is a function of the antenna opening angles (azimuth and elevation). These angles are dependent on the type of antenna chosen for a specific radio planning. An installation error occurs if the sector antenna is not pointed in the pre-planned heading direction. As a result, the Terminal Stations with poor coverage will exhibit degraded performance, lower received power and higher transmit power than expected (measured value compared to calculated value by radio planning or free space). This situation is illustrated by Figure 3-1 below:

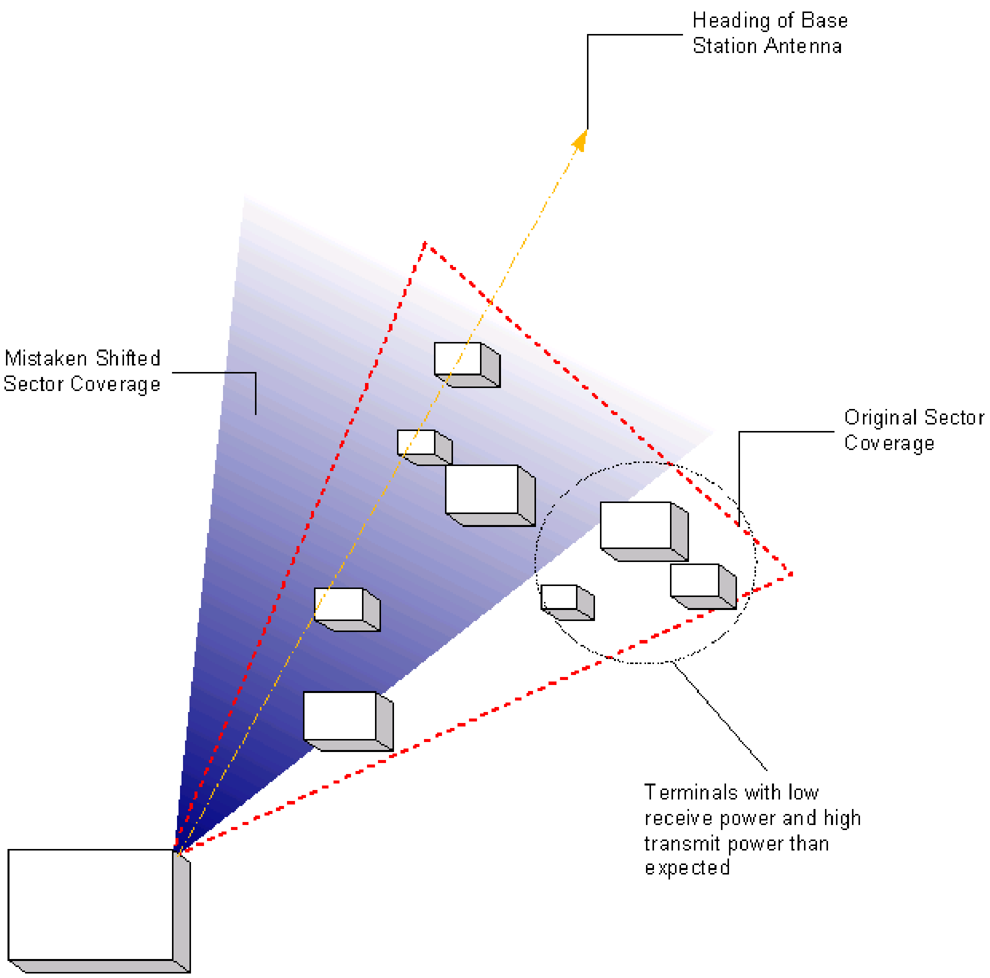

Figure 3-1: Sector Antenna Positioned in Wrong Direction

Furthermore, the effect of interfering signals on the uplink performance will be greater, as well as downlink interference with other sector links. For example, this occurs when the same frequency is applied to this sector and the opposite (180°-shifted) sector.

Frequency Reuse in the same Base Station

In the following scenario, an attempt is made to reuse the same frequency for two opposing sectors for the same Base Station. If the two sectors do not transmit with the same power (set deliberately or following a user error), inter-sector interference results.

The sector on the left side of Figure 3-2 below transmits at a greater power than the sector on the right side. The result is a lower C/I ratio to the Terminal Stations associated with the right sector, leading to low SNR, bit errors, while the left sector's performance is not degraded.

Frequency reuse will degrade the uplink and downlink SNR, however, the degradation should be symmetrical to both sectors.

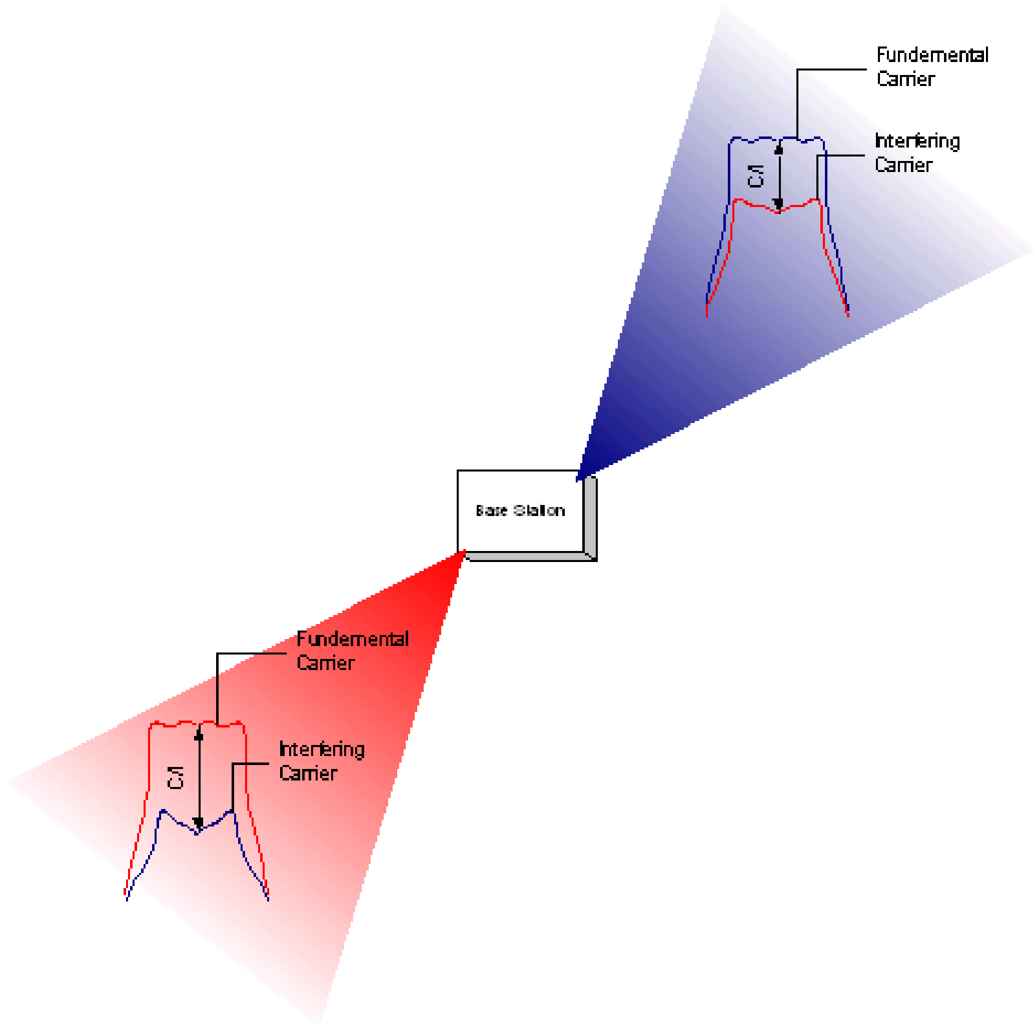

Figure 3-2: Frequency Reuse

See Chapter 4 - Analysis Methods for details on how to measure the C/I value.

Random Interference

The WALKair system operates in the regulated frequency bands. Leasing radio spectrum should assure freedom from external interference spectrum. A deployed network normally exhibits interference (deterministic and due to frequency reuse). External interference, not caused by the WALKair system, can result as a consequence of the activity of other operators, radar or other types of radio transmission. In some cases, the required spectrum (or part of it) may be influenced by interference, resulting in errors. Interference can manifest itself in a variety of ways: short bursts, over wide bands of spectrum, constant interference.

The symptoms of these kinds of interference can appear either as bit errors, or can cause air link loss for a period of time. Interference can easily be detected prior to the deployment of the system by performing a radio survey, as recommended in the WALKair 3000 System manual. As the spectrum is occupied by the signals of the WALKair system, it becomes very difficult to detect interference, because this requires disabling the links/carriers that are suspected of suffering from interference. See Chapter 4 - Analysis Methods for a method of interference evaluation based on measurements presented by WALKnet Performance Monitoring.

4

Chapter 4 - Analysis Methods

In this Chapter

This Chapter includes:

Diagnosis of an Interference Problem

When the symptoms of a problem are detected, it is possible to observe the WALKair system's air performance behavior (using the WALKnet application) and determine in most cases if the cause is radio interference or something else.

To diagnose an interference problem:

1. In the WALKnet application activate the air performance monitoring for the required terminal, display the last 24 hours in 15 minutes intervals and follow the instructions below.
2. Proceed by differentiating the performance of the uplink channel from the downlink channel. In this way the analysis is more focused. A link subject to interference is characterized by one or more of the following symptoms:
   - Bad FER (Frame Error Rate), less than 10e-6
   - Minimum SNR lower than 22dB in one or more intervals of 15 minutes
   - More than 1% of Error Seconds
   - Appearance of unavailable seconds

The above symptoms are not conclusive that interference is present. The same symptoms can appear if the Received signal of a Terminal Station or a Base Station is varied over a large power range and drops to lower than expected values. In the case of low received power, the SNR is degraded naturally to the lower signal.

In the case of random interference, low SNR along with bit errors will appear when the received power remains constant, in other words, if the signal level is constant and the interference level is increasing.

Constant interference is harder to analyze, especially in deployed networks, because there is no time reference for periods of time when the link had good performance relative to periods of time when random interference appears. However, certain power levels should match certain SNR values. Therefore, if the SNR value is constantly low, but the Received power is fine, this might be an indication of interference.

During the radio-planning phase, network deployment takes into account the predicted level of interference (caused due to frequency reuse) for every customer. It is important to know these values and compare them with the system performance.

After it is determined that the errors are caused either by a stronger level of interference than predicted in radio planning, or by random interference, it is necessary to verify this condition by measurement. In order to measure interference, you can disable the transmission of the carrier subject to interference, and use a spectrum analyzer as described in the next section.

Measuring Interference

In order to rule out an interference problem, you can measure the interference in the WALKair IF.

Measuring Uplink

An Uplink IF measurement is conducted by connecting the Spectrum Analyzer to the Rx port on the IF-MUX II.

Measuring a WALKair Signal

The following table summarizes the WALKair signal characteristics versus the setting of a spectrum analyzer that is used to measure it.

Table 4-1: WALKair Signal Characteristics vs. Spectrum Analyzer Settings

WALKair Signal Characteristics	Spectrum Analyzer Settings for Proper Power Measurement
3.5/7/14 MHz wide 16QAM modulated signal.	RBW: Optimal is 1.75 MHz, a setting of 1 MHz will yield however close results.
Pseudo Random Signal.	Detection type: normal. Storage type: Average (more than 100 counts).
TDMA transmission: Downlink is a constant transmission of the BS, consequently the signal is constantly operative. Uplink is operative only when bandwidth is allocated for the TS transmitting.	In case of Downlink, the measurement is exact. In case of the Uplink measurement, the power measured is a function of how many timeslots are allocated for the transmitting TS.

NOTE

Using a calibrated spectrum analyzer with the above settings will result in a measurement error of up to ±2 dB.

Detecting Cable Gain Configuration Problems

The WALKair Cable Gain setting, which is done by the person commissioning the WALKair device, informs the system of the IF cable attenuation (connecting the indoor unit (BU) with the outdoor unit (RFU)).

The system uses the configured value in its calculation of the overall gain for the system.

NOTE

The Cable Gain is always set to a negative value.

Incorrect Cable Gain configuration may result in a number of different scenarios, as described below:

Base Station Cable Gain Configuration

At the Base Station, a variation of the configured values from the real (actual) Cable Gain will directly affect the power transmitted by the Base Station and the power transmitted by the Terminal Station.

Base Station Transmit Cable Gain

In the TX path (see Figure 4-3), a higher configured cable gain (absolute value) than the real cable attenuation (absolute value) results in higher transmitted power. A lower configured cable gain (absolute value) than the real cable attenuation (absolute value) results in a lower transmitted power.

Example:

- If the real cable attenuation is 15 dB, and the cable gain is configured at 10 dB (+10 dB in absolute value), (variation of 5 dB lower), then the transmitted power is 5 dB lower. Thus the transmitted power is:

  Expected transmitted power - deviation = Real transmitted power.

  +15 dBm (expected by the system) - 5 dB (deviation) = 10 dBm

- If the real cable attenuation is 15 dB, and the cable gain is configured at -20 dB (+20 dB absolute value), (variation of 5 dB higher), then the power transmitted is 5 dB lower. Thus the power transmitted is:

Expected transmitted power + deviation = Real transmitted power.

15 dBm (expected by the system + 5 dB (deviation) = 20 dBm.

NOTE

Take into account the 1dB compression point when transmitting higher than optimal transmitted power.

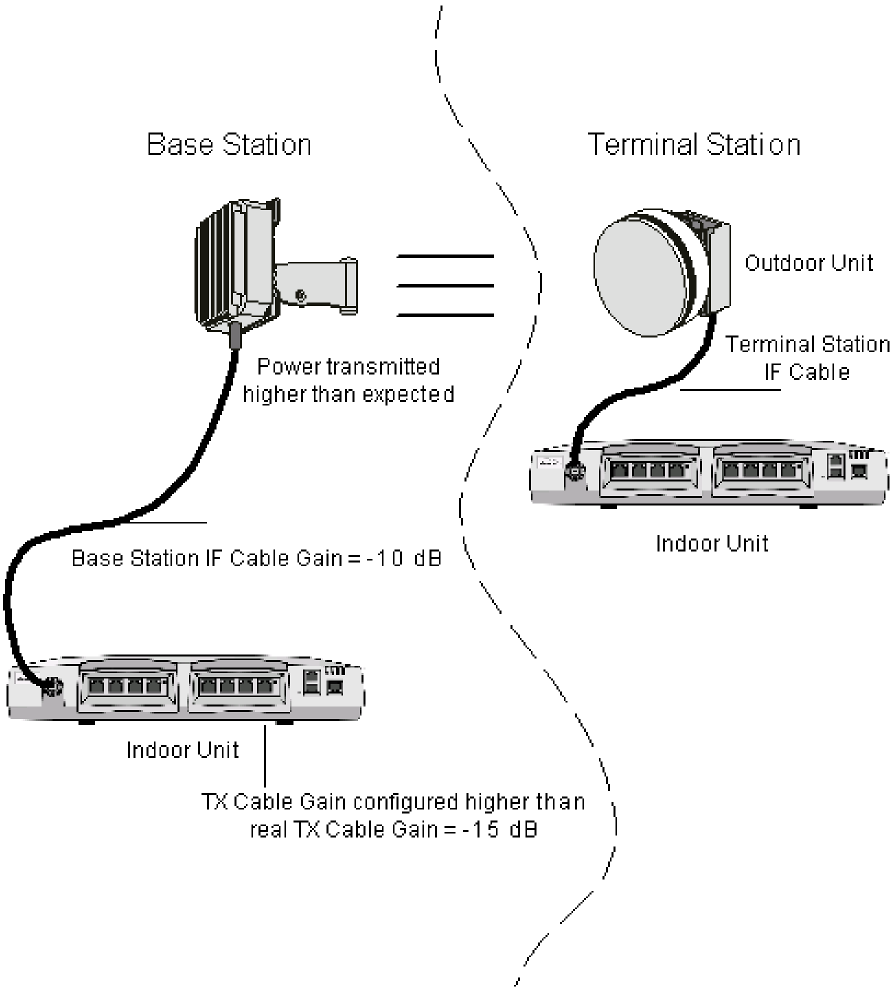

Figure 4-3: Base Station Transmit Cable Gain

Base Station Receive Cable Gain

In the RX path the Base Station regulates the Terminal Stations' Transmit power (using the RTPC mechanism). The Terminal Stations' power is set to a point where the Receive power at the Base Station is the MODEM working point (default = -70 dBm).

As the gain of each unit in the system is known (RFU, IF-MUX, cable gain), a power of -70 dBm is estimated by the system. The system measures the power received by the BS-SA and then subtracts the known overall gain of the system.

Thus, an incorrectly configured cable gain will cause a wrong estimation of the power received by the Base Station.

In the RX path (see Figure 4-4), a higher configured (larger absolute) cable gain than the real cable attenuation results in lower Terminal Station Transmit power and thus lower "real" received Base Station power (poorer SNR). A lower configured (smaller absolute) cable gain than the real cable attenuation results in higher transmitted Terminal Station power and thus higher "real" received Base Station power (better SNR).

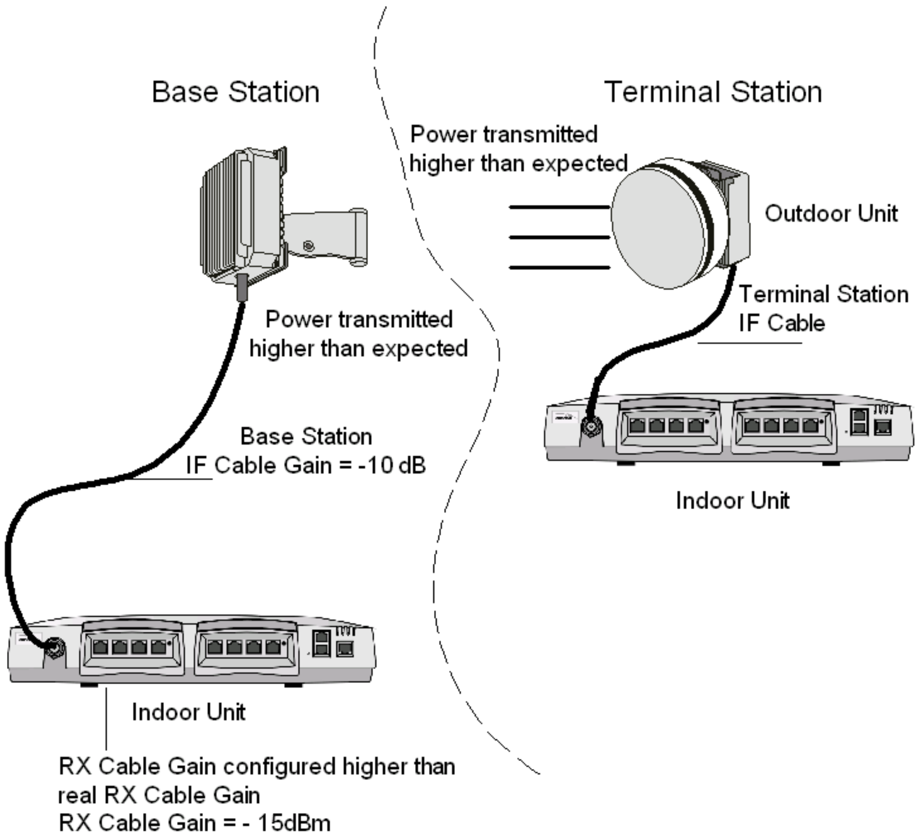

Figure 4-4: Base Station Receive Cable Gain

Example:

- If the real cable attenuation is 15 dB, and the attenuation is configured at 10 dB, (variation of 5 dB, lower), then the power transmitted by the Terminal Station is 5 dB higher, and the actual received power level at the Base Station antenna is 5 dB higher. Thus the power received is:

  Power received expected + deviation = power received

  -70 dBm + 5 dB = -65 dBm

- If the real cable attenuation is 15 dB, and the attenuation is configured at 20 dB, (variation of 5 dB, higher), then the power transmitted by the Terminal Station is 5 dB lower, and the actual received power level at the Base Station antenna is 5 dB lower. Thus the power received is:

  Power receive expected - deviation = power received

  -70 dBm - 5 dB = -75 dBm

NOTE

The real power received by the Base Station may be evaluated by the receive SNR. When an SNR of 20 dB is obtained, the real power received at the Base Station antenna is -80 dBm. Refer to Table 1-1Receive power versus SNR for information.

Terminal Station Cable Gain Configuration

At the Terminal Station, the configured cable gain does not directly affect the power transmitted by the Terminal Station, but only limits it in extreme cases.

Terminal Station Transmit Cable Gain

In the TX path (see Figure 4-5), a higher configured Cable Gain (absolute value) than the real cable attenuation (absolute value) results in higher reported Transmit power, and does not affect the power transmitted (set by Base Station). A lower configured Cable Gain (absolute value) than the real cable attenuation (absolute value) results in lower reported Transmit power, although the real Transmit power does not change.

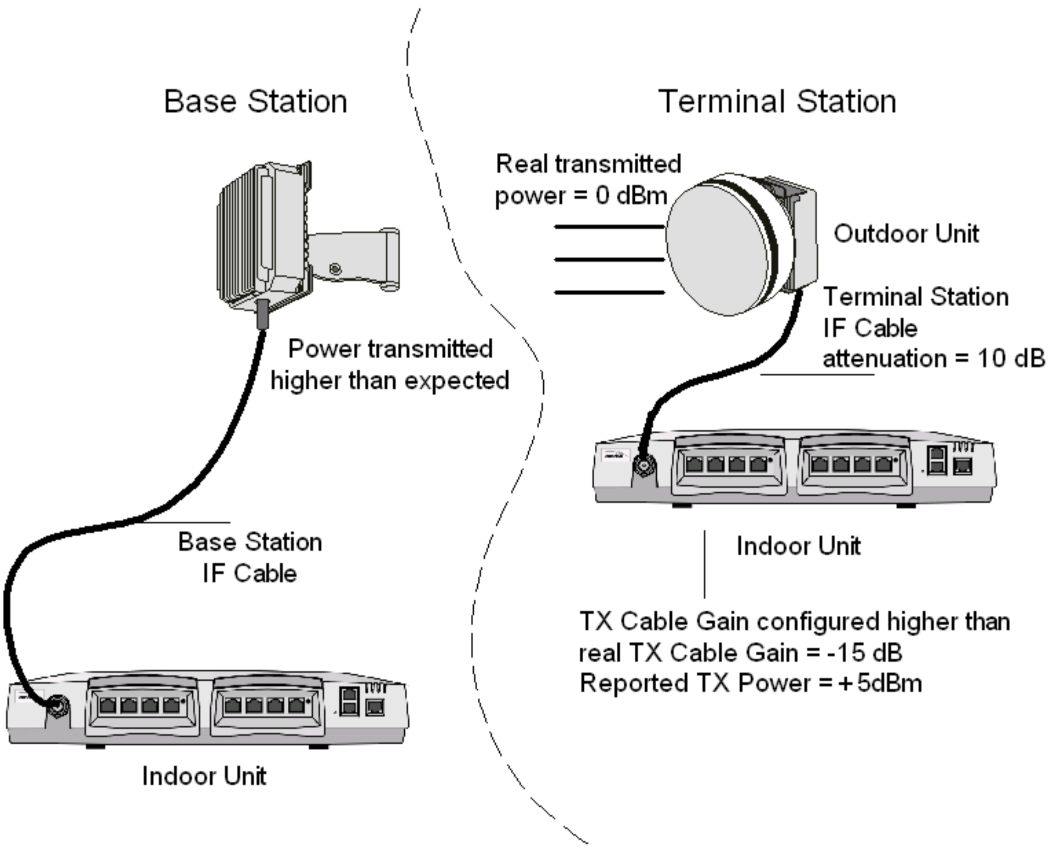

Figure 4-5: Terminal Station Transmit Cable Gain

Example:

- If the real cable attenuation is 10 dB, the power transmitted is 0 dBm (set by Base Station), and the cable gain is configured at -15 dB (+15 dB in absolute value, a variation of 5 dB higher), then the Transmit power reported by the TS-BU will be 5 dB higher. The real power transmitted is still 0 dBm. Thus the Transmit power reported is:

  Real power transmitted + deviation = reported power

  0 dBm + 5 dB = 5 dBm

- If the real cable attenuation is 10 dB, and the cable gain is configured at -5 dB (+5 dB in absolute value, variation of 5 dB lower), then the power reported by the TS-BU will be 5 dB lower. The real power transmitted is 0 dBm. Thus the transmit power reported is:

  Real power transmitted - deviation = reported power

  0 dBm - 5 dB = -5 dBm

NOTE

Although the Terminal Station Transmit power is automatically set by the Base Station using the RTPC process, there is a maximal Transmit power limitation in the Terminal Station Radio parameters menu - Modem working point option. This option will limit the Transmit power of the Terminal Station if the power reported by the TS-BU exceeds the limitation.

If an incorrect cable gain is configured (at the TX path), a link may not be established because of insufficient transmitted power. Alternatively, a Terminal Station may transmit using a higher power than allowed.

Terminal Station Receive Cable Gain

In the Rx path (see Figure 4-6), a higher configured Cable Gain (absolute value) than the real cable attenuation (absolute value) results in higher reported Receive power, and does not affect the power transmitted (as set by Base Station). A lower configured cable gain (absolute value) than the real cable attenuation (absolute value) results in lower reported received power, although the real received power does not change.

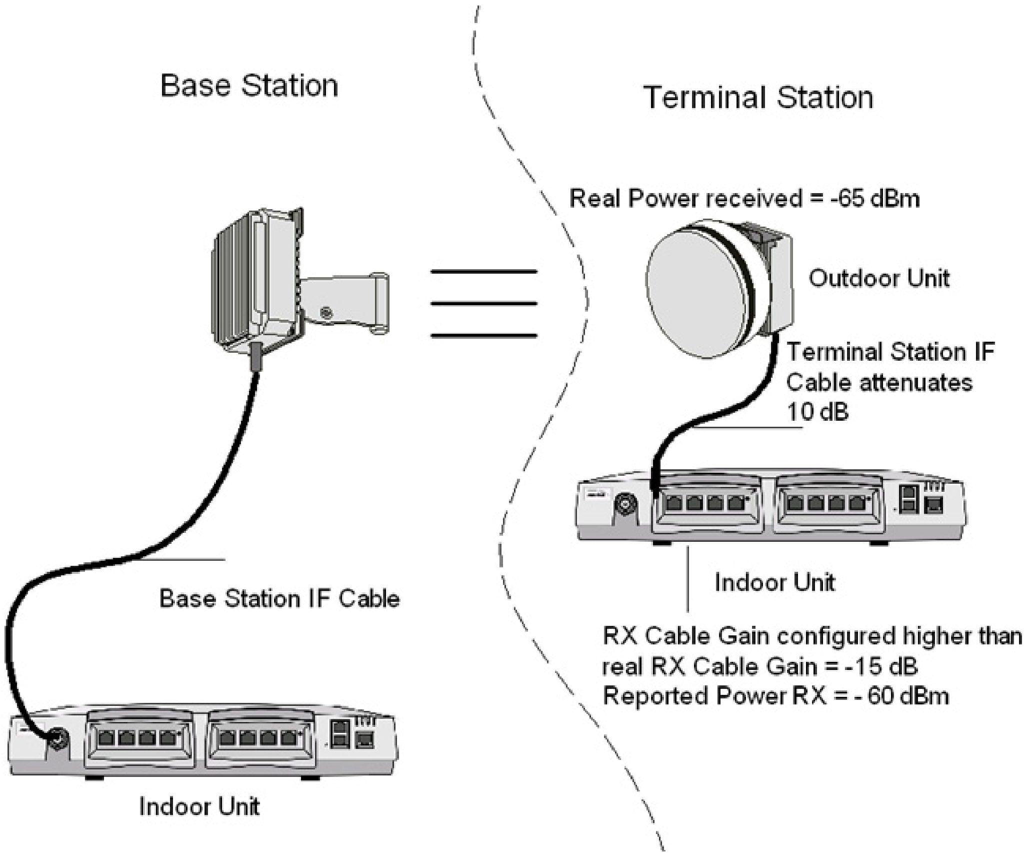

Figure 4-6: Terminal Station Receive Cable Gain

Example:

- If the real cable attenuation is 10 dB, the power received is 0 dBm (received from Base), and the cable gain is configured at -15 dB (+15 dB absolute value, variation of 5 dB higher), then the Transmit power reported by the TS-BU is 5 dB higher. The real power transmitted is still 0 dBm. Thus the Transmit power reported :

  Real power received + deviation = reported power

  -65 dBm + 5dB = -60 dBm

- If the real cable attenuation is 10 dB, the power received is -65 dBm (received from Base Station) and the cable gain is configured at -5 dB (+5 dB absolute value, variation of 5 dB lower), then the power reported by the TS-BU is 5 dB lower. The real power transmitted is still -65 dBm, and the transmit power reported is:

  Real power transmitted - deviation = reported power

  -65 dBm - 5 dB = -70 dBm

NOTE

The real power received by the Base Station may be evaluated by the receive SNR. When an SNR of 20 dB is obtained, the real power received at the Base Station antenna is -80 dBm. Refer to Table 1-1 *Receive power versus SNR* table.

A

Appendix A - Terminal Station Power Levels Calculation

In this Appendix

- Calculation of received and transmit power levels of a Terminal Station based on a clear line of sight link and using the free space model.

Terminal Station Power Levels Calculation

NOTE

All calculations of the fade margin in this Appendix apply to good weather conditions (no rain, snow, fog, etc).

In order to calculate fade margins in the free space the following formula may be used:

$$L_{dB}\ 92.5 + 20\log(F_{GHz} \times D_{km})$$

where the parameters are as follows:

L - The Free Space loss [dB]

F - The frequency Band (10.5 GHz; 26 GHz; 28 GHz).

D - Distance from Base to Terminal [km]

In order to compute the loss between the two antennas (Terminal Station and Base Station), the Gain of each antenna needs to be subtracted from the Total Fade Margin Loss. All the antenna gains are listed in the following table:

Table A-1: Antenna Gains and Opening Angles

Band	Gain [dBi]	Elevation Opening Angle [deg]	Antenna Type and Azimuth Angle [deg]
10.5GHz	25	±8°	Terminal
10.5GHz	16	±7°	Base 60° Horizontal
10.5GHz	16	±7°	Base 60° Vertical
10.5GHz	16	±4.5°	Base 90° Vertical
10.5GHz	16	±4.5°	Base 90° Horizontal
26GHz	36	±2.6°	Terminal
26GHz	42	±1.3°	Terminal
26GHz	18	±9°	Base 45° Vertical

Table A-1: Antenna Gains and Opening Angles

Band	Gain [dBi]	Elevation Opening Angle [deg]	Antenna Type and Azimuth Angle [deg]
26GHz	18	±9°	Base 45° Horizontal
26GHz	15	±9°	Base 90° Vertical
26GHz	15	±9°	Base 90° Horizontal
28 GHz	24	±4°	Base 45° Vertical
28 GHz	24	±4°	Base 45° Horizontal
28 GHz	21	±4°	Base 90° Vertical
28 GHz	21	±4°	Base 90° Horizontal
28 GHz	19	±4°	Base 180° Vertical
28 GHz	19	±4°	Base 180° Horizontal
28 GHz	34	±2.6°	Terminal Vertical/Horizontal
28 GHz	37	±2°	Terminal Vertical/Horizontal
28 GHz	40	±1.3°	Terminal Vertical/Horizontal

Thus the loss between Terminal and Base will be:

$$L_{Total\,(dB)} = L_{Fade\,Margin\,(dB)} - G_{Base\,Antenna\,(dBi)} - G_{Terminal\,Antenna\,(dB)}$$

Now that the Total Loss is calculated, the power expected to be transmitted/received by the Terminal Station may be calculated as well:

$$P_{Rx(dBm)} = P_{BaseTx(dBm)} - L_{Total(dB)}$$

$$P_{Tx(dBm)} = P_{BaseRx(dBm)} - L_{Total(dB)}$$

Example:

In a WALKair 3000 26 GHz system, the base antenna lobe is 90° and the distance between Base Station and Terminal Station is 1 km. The Base Station is working in the default MODEM working point of –70dBm.

What is the expected Terminal Transmit/Receive power?

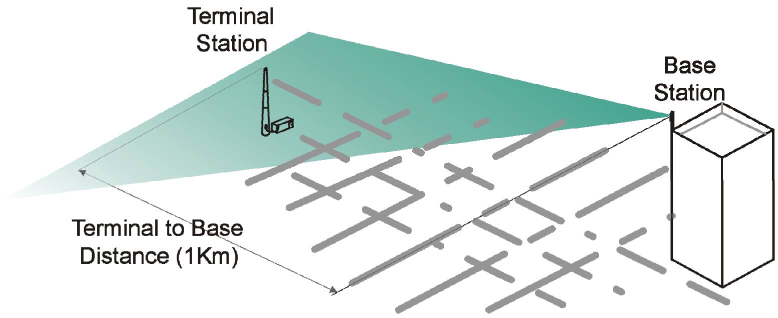

Figure A-1: Example Calculation of Expected Terminal TS/RX Power

Resolution:

First, let's calculate the Free Space fade margin:

$$L_{Fade\ Margin} = 92.5 + 20\log(26 \times 1) = 120.8_{dBm}$$

Now subtract the two antenna gains. At 26 GHz, the gain of a 90° is 15 dBi. The gain of Terminal Station antenna at 26 GHz is 35 dBi.

Thus the total loss is:

$$L_{Total} = 120.8_{dBi} - 35_{dB} - 15_{dB} = 70.8_{dBm}$$

The default Base Station MODEM working point values at 26 GHz are -70 dBm Receive power and +15 dBm Transmit power. Thus the power received and transmitted at the Terminal Station should be:

$$P_{Rx} = 15_{dBm} - 70.8_{dB} = -55.8_{dBm}$$

$$P_{Tx} = 70_{dBm} - 70.8_{dB} = -0.8_{dBm}$$

The expected SNR according to Table 1-1for both BS-SA and TS is >28dB.

NOTE

When reported by the system these values may vary by ±3 dB.

B

Appendix B - System Performance Verification

In this Appendix

- Parameters Checklist to verify that the system is configured and operating correctly.

Configuration Checklist

Note: the table below is used to verify correct configuration. In order to configure the system, refer to the *Commissioning* chapter of the *WALKair 3000 System Manual.*

Section	Parameter	Expected result	How to Verify
NMS	WALKnet Version	Updated and compliance to the WALKair 3000 firmware	WALKnet → Help→About
NMS	Management IP	Configured	BS-SA LCI → 1. Configuration Menu → 9. Management Menu → 1. Get out band IP address
NMS	Authorized Manager	Configured	WALKnet →BS-SA view →Authorized Managers
BS-SA RFU & Antenna	IF MUX type	Configured	WALKnet →BS-SA view → RFU and antenna
BS-SA RFU &Antenna	RFU type	Configured	WALKnet →BS-SA view → RFU and antenna
BS-SA RFU & Antenna	IF Cable gains of RFU A and RFU B (when using ODU redundancy)	Configured according to the cable attenuation	WALKnet →BS-SA view → RFU and antenna
BS-SA RFU & Antenna	ODU redundancy	Enabled and Communication is UP	WALKnet →BS-SA view → RFU and antenna
BS-SA parameters	Modulation Change	Enabled	WALKnet →BS-SA view → RFU and antenna
BS-SA parameters	TX value	Configured (default 15dBm for 26/28GHZ band)	WALKnet →BS-SA view → RFU and antenna

Section	Parameter	Expected result	How to Verify
BS-SA parameters	Frequency channel	Configured	WALKnet →BS-SA view
BS-SA parameters	BS-SA admin & operational status	Enable & UP	WALKnet →BS-SA view
BS-SA parameters	Channel BW	Configured	WALKnet →BS-SA view
BS-SA parameters	BS-SA Type	Detected correctly	WALKnet →BS-SA view
BS-SA parameters	Ethernet and E1 Ports Admin & operational status	All used ports are Enable & UP	WALKnet →BS-SA view
BS-SA parameters	Clock Configuration	Clock priority list is configured (in case of TDM services)	WALKnet →BS-SA view → BS-SA → Clock configuration
BS-SA parameters	BS-SA current & Backup Version	Updated Version, Status OK	WALKnet →BS-SA view → BS-SA → Versions
BS-SA parameters	IDU Redundancy	Configured status equal actual status, operational status is UP	WALKnet →BS-SA view
TS parameters	TS admin & operational status	All TS's are Enable & UP	WALKnet →BS-SA view → BS-SA → Registered terminals
TS parameters	Ethernet and E1 Ports Admin & operational status	All TS used ports are Enable & UP	WALKnet →TS-BU View (repeat for all TS's)
TS parameters	Actual UP & DOWN	QAM	WALKnet →TS-BU View (repeat for all

Section	Parameter	Expected result	How to Verify
	Modulation		TS's)
TS parameters	TS Type	Detected correctly	WALKnet →TS-BU View (repeat for all TS's)
TS RFU & Antenna	IF cable gain	Configured according to the actual cable attenuation	WALKnet →TS-BU View → RFU & Antenna (repeat for all TS's)
TS RFU & Antenna	Estimated distance	Not more than ±2.5 km deviation from actual BS to TS distance	WALKnet →TS-BU View → RFU & Antenna (repeat for all TS's)
Services	IP and E1 services Admin & operational status	All defined services are Enabled and Active	WALKnet →BS-SA view → Services → BS-SA Client list →Service (repeat for all Clients)
Air performance	TS RX & TX power	Compliant to Appendix A calculation	WALKnet →TS-BU View → Detailed Air Performance → selected 15 min (select all intervals) → mark DL SIG & UL SIG
Air performance	DL SNR & UL SNR	According to Table 1-1	WALKnet →TS-BU View → Detailed Air Performance → selected 15 min (select all intervals) → mark DL SNR& UL SNR
Air performance	FER	FER=0 for at least 24 hour	WALKnet →TS-BU View → Detailed Air Performance → selected 15 min (select all intervals) → mark DL FER, UL FER