NMT DOC. 900-4
Nordic Mobile Telephone group

Oktober 1992

Automatic Cellular Mobile Telephone System

NORDIC

NMT-900

Technical Specification for the Base Station Equipment

NMT DOC. 900-4
Nordic Mobile Telephone group

1992-10-01

Automatic Cellular Mobile Telephone System

NORDIC

TELEDANMARK MOBIL

Tele-mobil

NMT-900

Technical Specification for the Base Station Equipment

1. GENERAL

1.1 INTRODUCTION

1.2 ABBREVIATIONS

1.3 GENERAL SPECIFICATIONS

---

2. TEST CONDITIONS

2.1 POWER SOURCES AND AMBIENT TEMPERATURES

2.2 GENERAL CONDITIONS

---

9. SUPERVISORY UNIT (SU)

9.1 BASIC FUNCTIONS

9.1.1 Signal strength measurements and Ø-signal frequency detection

9.1.2 Fault alarm via SU

9.1.3 Data line loop

9.1.4 Data line test connector

9.1.5 RX used as SR

---

10. RF TEST LOOP

---

11. SUPERVISION OF FREE MARKED CC AND AC/TC (OPTION)

---

12. DIGITAL INTERFACE (OPTION)

---

13. REMOTE CONTROL (OPTION)

---

14. HANDOVER REQUEST CHANNEL (HC) (OPTION)

14.1 GENERAL

14.2 ADDRESSING UNITS AT BS VIA HC FROM SSE

14.3 SIGNALLING

14.3.1 Signalling procedures between BS and MTX
14.3.1.1 Handover request
14.3.2 Signalling procedures between BS and SSE
14.3.2.1 Start/Stop of a call
14.3.2.2 Traffic status report
14.3.2.3 Channel activation

14.4 O&M HANDLING OF THE HC

14.4.1 Initialization of HC

14.4.2 Fault handling

1. GENERAL

1.1 INTRODUCTION

This technical specification presented as NMT Doc. 900-4 refers to base station equipment for the Nordic Mobile Telephone network (NMT-900).

A general description of the NMT system is given in NMT Doc. 900-1.

The base stations will be connected to the mobile telephone exchange (MTX) through dedicated telephone lines. The base station has to meet all relevant functional requirements of the NMT system and shall fulfill the requirements in this specification.

1.2 ABBREVIATIONS

BS	Base station
CC	Calling channel
CU	Control unit
FFSK	Fast frequency shift keying
MS	Mobile station
MTX	Mobile telephone exchange
NMT	Nordic Mobile Telephone system
RF	Radio frequency
SR	Signal strength receiver
SU	Supervisory unit
TA	Traffic area
TC	Traffic channel
Ø-signal	Supervisory signal
DSS	Digital Supervisory Signal
SSE	Scanning Supervisory Equipment
HC	Handover request Channel
ASS	Analog Supervisory Signal
DC	Data Channel

1.3 GENERAL SPECIFICATIONS

1.3.1 Base station units

The base station may consist of the following functional units:

- Transmitter combiner figure 1.1
- Receiver multicoupler
- Transmitter
- Receiver
- Control unit (CU)
- Signal strength receiver (SR)
- Supervisory unit (SU)
- RF test-loop, figure 1.2

The physical realization of the equipment shall be optimized regarding reliability and maintenance.

The functional units may be built by separate modules or integrated (i.e. channel units).

The base station shall be controlled from the mobile telephone exchange through four-wire lines which carry speech and signalling.

1.3.1.1 Combining equipment

- The transmitter combiner shall give the possibility to combine several transmitters to a common antenna. It shall permit simultaneous connection of at least 8 and preferably 32 transmitters.
- The receiver multicoupler shall correspondingly permit connection of several receivers to a common reception antenna. Number of receiver outputs shall be 2 more than the number of channels.

1.3.1.2 Transmitter and Receiver units in the radio cabinet.

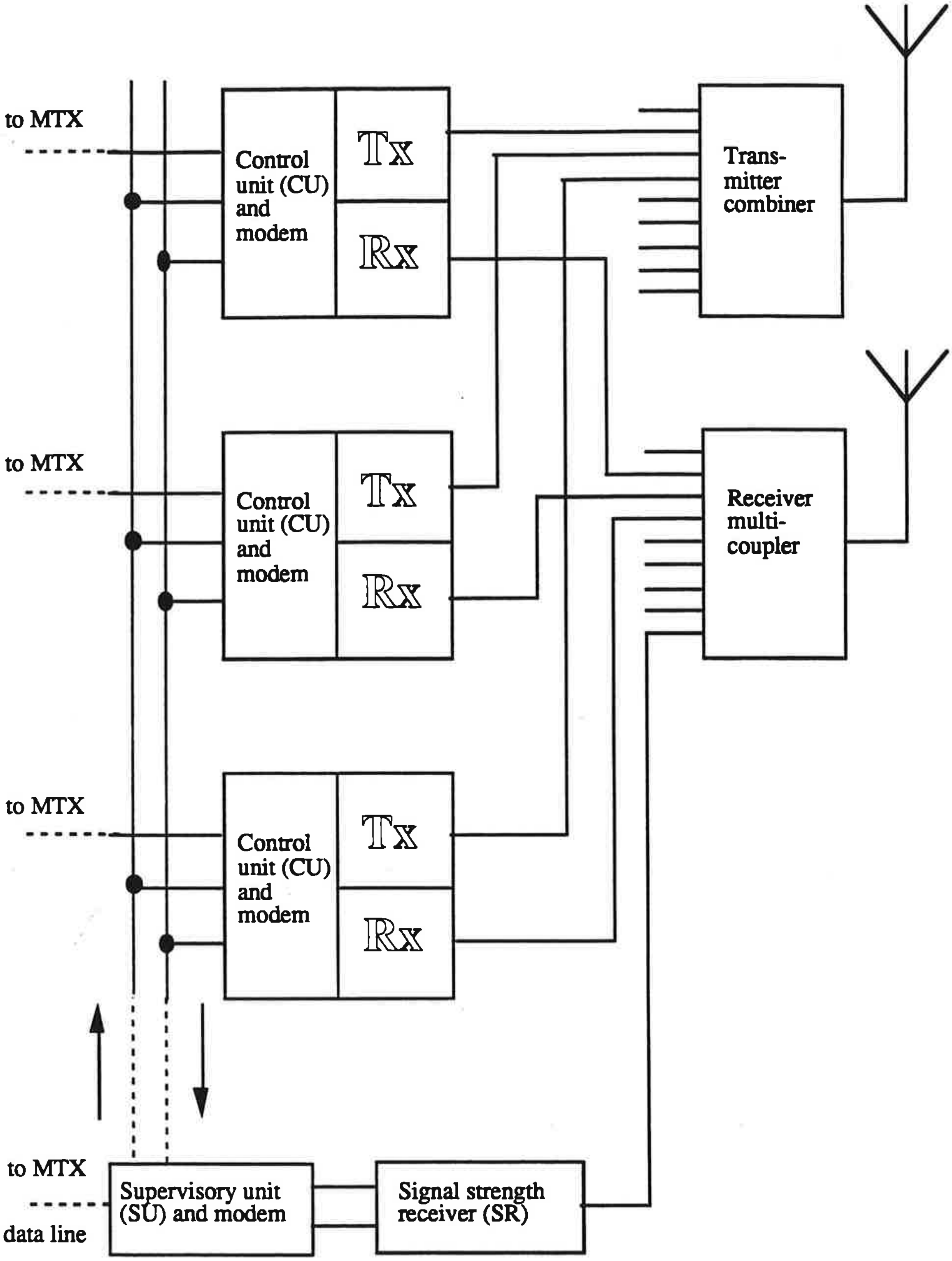
The transmitter and receiver shall provide signalling and voice transmission and reception.

1.3.1.3 Control unit (CU)

The control unit shall provide functions for each actual channel equipment and interface between MTX and the channel. It shall also be able to transfer data information between SU and MTX.

Primary functions:

- start and stop of transmitter remotely controlled from MTX;
- send channel status information back to MTX as acknowledgement for channel activation order;
- channel setting remote controlled from MTX;
- send fault alarm to MTX;
- loop connection of transmitter line input and receiver line output as ordered from MTX, or at fault in CU-modem;
- control the RF test loop for the actual channel;
- generate supervisory signal to the transmitter as ordered from MTX and detect the received supervisory signal looped in the mobile station and send the evaluated result to MTX;



Note 1. It shall be possible to connect at least 40 channels to one supervisory unit. The maximum distance between cabinets will be 100 m.

Fig. 1.1 Base station functional units

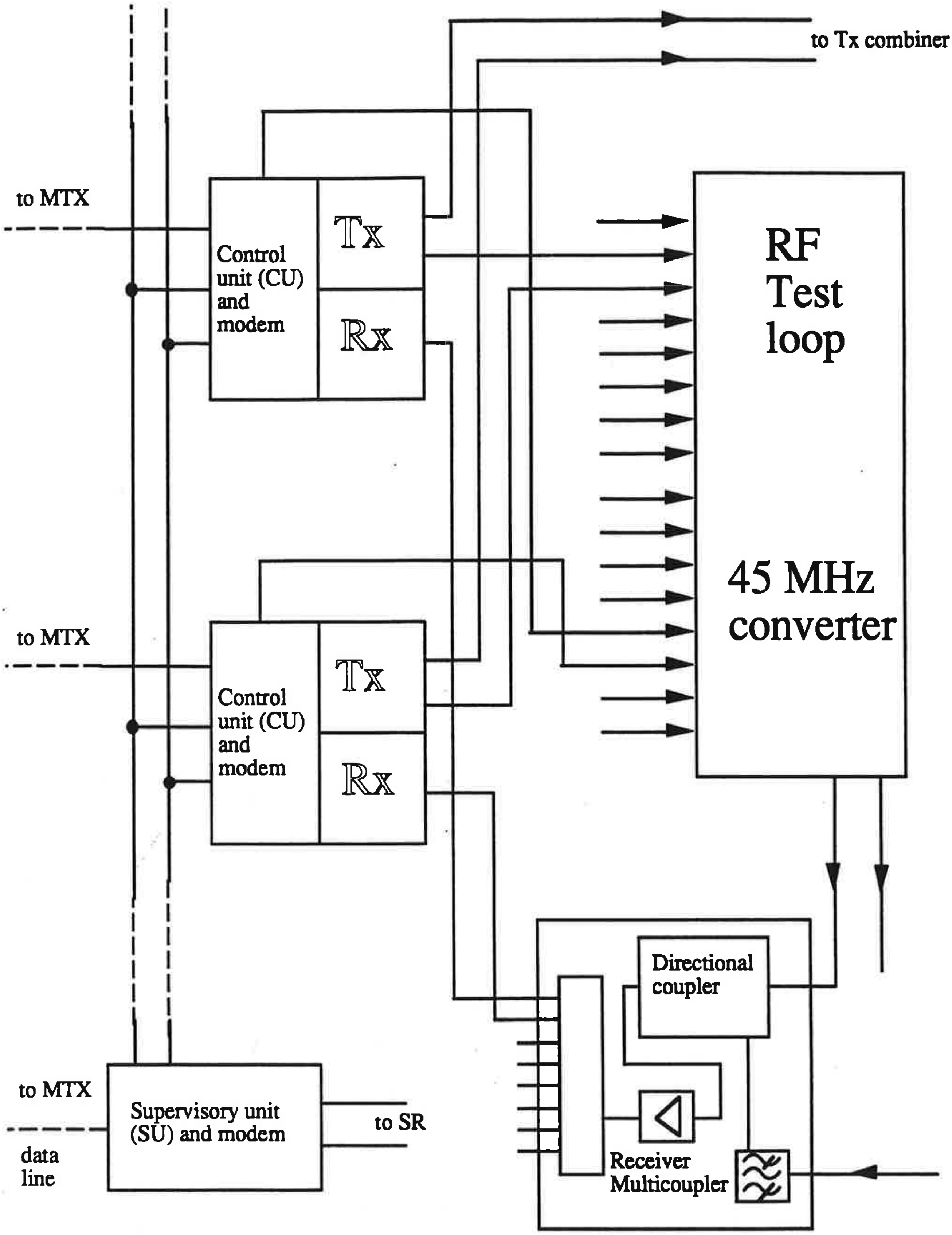


Fig. 1.2 RF test-loop

- perform a selftest initiated from MTX or activated locally at the base station.

- local control and service functions: start/stop of transmitter, channel setting, activation of squelch, RF test loop and supervisory signal, send block/deblocking signal to MTX, test measurements.

1.3.1.4 Signal strength receiver (SR)

The signal strength receiver shall provide measurement of radio frequency signal strength on channel ordered from the supervisory unit (SU). The signal strength information shall be sent to SU.

1.3.1.5 RF test-loop

The RF test-loop shall provide a 45 MHz frequency conversion of a small portion of the transmitter output power and loop this signal to the receiver for testing purposes performed in the MTX.

The RF test-loop may be common for several channels, and the selection of channel to be looped as ordered from the MTX via the actual channel line shall be controlled by the CU.

1.3.1.6 Supervisory unit (SU)

The supervisory unit is a functional unit which shall:

- order the SR to measure the signal strength on the channel as ordered from MTX. The result shall be evaluated and information sent to MTX;

- be able to send fault alarms to MTX;

- loop connection of data line input and output as ordered from MTX, or at fault in SU-modem.

1.3.2 <u>Radio frequency plan</u>

The radio frequency range allocated to the Nordic Mobile Telephone service is 890,000-915,000/935,000-960,000 MHz.

The channel spacing is 25 kHz at the same basestation and the frequency separation between the transmit and receive channels is 45 MHz. The equipment shall however be designed for use of interleaved channels i.e. channels with 12.5 kHz channel separation from the ordinary channels.

Channel No.	TX-frequency (MHz)	RX-frequency(MHz)
1	935,0125	890,0125
2	935,0375	890,0375
.		
.		
.		
.		
1000	959,9875	914,9875
1001-1024	no correspondance to any dedicated radio frequency (will be used for other purposes)	

Interleaved channels:

1025	935,0250	890,0250
1026	935,0500	890,0500
.		
.		
.		
2023	959,9750	914,9750

The NMT-900-system has 1000 ordinary channels plus 999 interleaved channels. The high frequency segment contains the base station transmit channels. The low frequency segment contains the base station receive channels.

1.3.3 Crosstalk

The purpose of this clause is to limit the crosstalk between the transmit and receive direction of one single channel and between arbitrary channels mounted in the same transmitter and receiver cabinet.

1.3.3.1 Crosstalk between a transmitter line input and any other line terminal

The measurements shall be made between two arbitrary channels in the cabinet. The transmitters of the two channels shall be in transmit condition and connected to artificial antennas.

An audio frequency test signal with nominal input level given in paragraph 4.18.3 shall be applied to the line input of the first transmitter to give normal test modulation defined in paragraph 2.2.4.1. The second transmitter shall be unmodulated.

Each of the two receiver inputs shall be supplied with an unmodulated test signal with a level of 30dB(1µV)EMF at a frequency equal to the nominal frequency of the receiver. The nominal audio frequency output level shall correspond to paragraph 5.10.3.

The four line terminals shall be terminated in 600 ohms resistive loads and the audio frequency levels shall be measured by a selective voltmeter connected to the line terminals.

The audio level measured at the second transmitter line input shall not exceed -60dB relative to the signal level at the first transmitter.

The levels measured at the receiver line outputs at both channels shall not exceed -60dB relative to the nominal audio output level.

The requirements shall be fulfilled for any combination of two channels contained in the same transmitter and receiver cabinet.

1.3.3.2 Crosstalk between a receiver line output and any other line terminal

The measurements shall be made between two arbitrary channels in the cabinet.

The transmitters of the two channels shall be in transmit condition and connected to artificial antennas. The transmitters shall be unmodulated.

The input of the first receiver shall be supplied with a test signal at a frequency equal to the nominal frequency of the receiver. The signal shall have normal test modulation as defined in paragraph 2.2.4.1 and shall have a level of 30dB(1µV)EMF The audio output level of the receiver shall be set to the nominal output level given in paragraph 5.10.3.

The second receiver input shall be supplied with an unmodulated test signal with a level of 30dB(1µV)EMF at a frequency equal to the nominal frequency of the receiver.

The four line terminals shall be terminated in 600 ohms resistive loads and the audio frequency levels shall be measured by a selective voltmeter connected to the line terminals.

The audio level measured at the second receiver line output shall not exceed -60dB relative to the signal level at the first receiver line output.

The audio level measured at the transmitter line inputs at both channels shall not exceed -60dB relative to the nominal input level given in paragraph 4.18.3.

The requirements shall be fulfilled for any combination of two channels contained in the same transmitter and receiver cabinet.

1.3.4 <u>Transmitter-cabinet intermodulation components</u>

The purpose of this clause is to limit the radio frequency intermodulation components generated by internal radiation between transmitters mounted in the same radio cabinet.

All transmitters in the cabinet shall be in transmit condition and unmodulated.
Each transmitter shall be connected to an artificial antenna.

Any intermodulation component measured at an arbitrary transmitter output therminal at the radio cabinet shall not exceed -70 dB relative to the corresponding transmitter carrier power. The odd order intermodulation components within the frequency range 890,000 to 915,000 MHz shall not exceed -95 dB relative to the corresponding transmitter carrier power.

In case the combiner is integrated in the radio cabinet the specification shall be exchanged with the specification given in paragraph 3.1.9.

1.3.5 Cabinet radiation

The radiated power in transmitter off condition from the equipment and cables conntected to it shall not exceed 2,0 nW in the frequency band 30-4000 MHz. In transmitter on condition the radiated power shall not exceed 2,0 nW in the receiver band 890,000-915,000 MHz. Elsewhere the requirements in paragraph 4.6 shall be fulfilled.

The measurement shall be performed in accordance with clause 4.6.3.

1.3.6 Ability to wihtstand electromagnetic fields

The equipment shall fulfil the specifications under the influence of an electromagnetic field of 3V/m in the frequency range 100 kHz to 1000 MHz except for the normal frequency of the actual receiver ± 20 kHz, the 1:st. IF and image frequency of the receiver.

1.3.7 Reliability

The equipment shall be designed for continuous operation (transmit and receive condition respectively). The mean time between failure (MTBF) for the base station equipment is specified for two groups.

Failure is in this context defined as a functional failure or a deviation from the requirements in the technical specification.

Group A:

Channel equipment consists of one transmitter, one receiver, one control unit.

The MTBF shall be at least 20000 hours for the total channel equipment.

Group B:

Common equipment which means equipment common for several radio channels. These equipments are transmitter combiner, receiver multicoupler, signal strength receiver, supervisory unit, RF testloop, common AC/DC converter and/or DC/DC converter.

For each of these individual equipments the MTBF shall be at least 50000 hours.

The confidence level for the evaluation is fixed to be 80%.
The MTBF-figures shall be valid for a period of 10 years starting at the end of the guarantee period.

The manufacturer shall state the predicted MTBF for each group and shall by calculations show how the MTBF values are obtained.

In case of using redundancy circuits a failure (of an active component) shall not be regarded as a failure of the equipment in the MTBF calculations if the equipment is still working without a significant degradation in performance. In this case the equipment shall be provided with means for indication of failure in the active component.

1.3.8 Statical charging

To prevent statical charging of the equipment from the antenna, with possible damage to the equipment, the RF output/input circuits shall have a galvanic connection to earth.

1.3.9 Safety requirements

The equipment shall fulfill the relevant requirements in IEC Publication 215 Third edition, 1987 "Safety requirements for radio transmitting equipment" and relevant requirements in IEC Publication 65 "Safety requirements for mains operated electronic and related apparatus for household ans similar general use".

Regarding IEC Publication 215, following items have to be fulfilled due to national regulation:

DANGEROUS MATERIALS, paragraph 23.

When dangerous materials, such as beryllium, are used in the manufacuring of components, full instruction for handling, storage and disposal of such components shall be given in the equipment handbook, together with a note explaining the hazards associated with the material contained in the component.

The manufacturer shall state that cadmium is not used in solder alloys, as coloring agents, as stabilizers or in surface treatment. Any other use of cadmium in any form in the equipment must be declared.

The use of polychlorobiphenyl in any form in the equipment is prohibited.

1.3.10 Power source

The equipment shall be capable of being supplied either directly from the mains or from an external battery with buffer. The cabinet shall be prepared in such away that a minimum of changes is necessary to change from 230 V power supply to 48 V power supply or vice versa.

- Nominal mains voltage is 230V, 50 Hz.
- Nominal voltage for the battery is 48 V, positive pole grounded.

The power supply unit shall be provided with a fuse (fuses) and a switch or corresponding which affects to the primary side (-48 V or 230 V).
Fuse(s) shall be located on the front panel.

It is of great interest that the power consumption will be minimized.

Maximum current drain at power start-up and the angle of phase difference for each input terminal shall be specified by the manufacturer.

The manufacturer shall state the total power consumption for a cabinet with 8 channels and for a full cabinet, if it consists of more than 8 channels.

1.3.11 Marking of the equipment

The function of all pilot lamps, terminals, and controls as well as the position of the controls, shall be clearly indicated on the equipment.

The equipment shall be clearly marked with the following:

- The name of the manufacturer
- The name of the unit
- The revision of the unit
- The serialnumber
- Space to mark status/modification
- The bar code.

The marking shall be placed on the equipment in such a manner that it is easy to see when the equipment is placed in its normal position.

The marking shall be mechanically solid and durable and may, for example, be made by means of engraving, embossing or application of a metal plate.
The bar code shall be of type 39 or possibly 49. The bar code information must include the following:

- The name of the Manufacturer
- The name of the Unit
- The Serialnumber

It is preferred that the bar code label is placed on the front of the unit.

The unique bar code shall also be placed on the package easily reached for personnel at stores.

1.3.12 Measuring points

For maintenance reasons the equipment (printed circuit boards) shall be provided with clearly marked measuring points, the typical measuring values of which shall be stated in the service manual.

1.3.13 Construction

- Cabinet and equipment

It is preferred that the base station equipment is built to fit into a cabinet wiht standard 490 mm (19") rack mounting. The maximum dimension of the cabinet shall be: 2200 mm (height), 600 mm (wide) and 600 mm (depth). Preferable height/depth of the cabinet is 2000 mm/300 mm respectively.

The cabinet shall be designed in such a way so that the floor space are minimized. It shall be possible to mount the cabinets back-to-back or against the wall, i.e. no access to the backside of the cabinet is required. Preferable weigth of the cabinet is 40 kg or less.

It shall be possible to install at least a complete 8-channel basestation with high power including transmitter combiner in one cabinet. Preferable is at least 16 channels.

No unit, except the cabinet, shall be heavier that one person can handle. Total floor load of cabinet including equipment shall be maximum 2000 kg/square meter.

The cabinet and equipment shall be designed in such a way so that the power consumption are minimized.

The maintainability of the complete basestationequipment shall be optimized.
Based on the manufactures philosophy regarding maintainability and reliability, other optimized solutions for floor space, weight, maintenance and power consumption may be proposed.

- Cabling in cabinet and equipment.

The cabling, used in the cabinet and equipment shall be of flame retardant halogen free cable. Requirements and tests for the cables, see clause 1.3.14.9.

1.3.14 Environmental requirements

1.3.14.1 Temperature range

The equipment shall fulfil the specified requirements within the temperature range -10 to +55°C. The test conditions are specified in clause 2.1.

1.3.14.2 Power source voltage

The equipment shall fulfil the specified requirements within following alternative power source voltage ranges:

- 230 V±10%, 50 Hz±2 Hz. The equipment shall not give any malfunctions within 230 V+15% and -20%.

- 43 to 63 V DC, positive pole grounded.

The test conditions are specified in clause 2.1.

1.3.14.3 Mains transients

The equipment shall be designed in such a way that mains transient with an amplitude of +30% from normal mains voltage 230 V with a duration of maximum 2 s or transients with an amplitude of 2 kV and with a duration of maximum 1 ms will not cause permanent defects in the equipment.

At tests a pulse generator will be used, giving 2 kV transients and having an impedance of appr. 40 ohms.

The transient has saw-tooth characteristics with a rise time 10 µs and a fall time down to 50% equal to 1ms. The transient shall be superposed to the mains.

1.3.14.4 Transients from DC-power source

The equipment shall be able to withstand transients from the DC power source according to Fig. 1.3 without permanent defects.

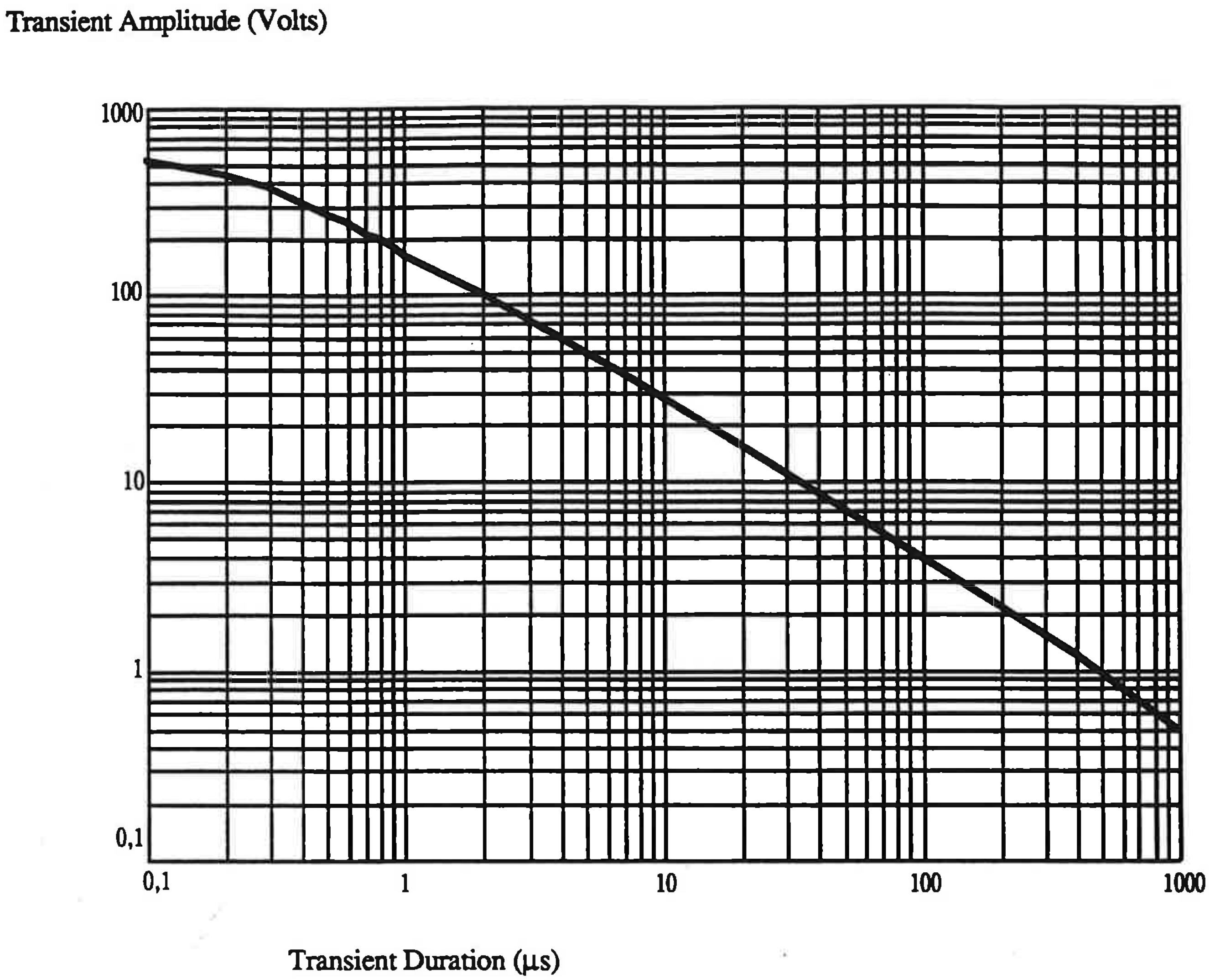


Figure 1.3

Permitted transient voltage amplitude and durations from DC-power source with battery back-up.

1.3.14.5 Noise from DC-power source

The equipment shall fulfil all specifications with noise up to 0,3 V rms within the frequency range 10 Hz to 30 MHz from the DC power source.

1.3.14.6 Over-voltage at line input/output

Necessary protection against damages caused by overvoltage at line input/output circuits shall be made as to withstand:

a) Impulsive voltage

Amplitude: 1500V
Risetime: 10 µs (1/2 amplitude)
Falltime: 700 µs (1/2 amplitude).

The voltage shall be applied between the two wires which constitute the transmitter line input or the receiver line output as well as between one of the wires and earth.

b) Mains voltage, 50 Hz

Amplitude: 1000 V_{eff} Duration: 500 ms

The voltage shall be induced between one of the wires and earth.

c) Mains voltage, 50 Hz

Amplitude: 350 V_{eff} Duration: 500 ms

The voltage shall be induced between the two wires which constitute the transmitter line input or the receiver line output. Generator impedance shall for case a) be appr. 40 ohms and for case b) and c) 125 ohms.

1.3.14.7 Malfunctions

The base station equipment shall not malfunction at mains interruption, power start-up, mains transients, mains frequency offset ± 5 Hz or DC-power source transients.

1.3.14.8 Bump test, non operating

The test shall be carried out in accordance with the recommendations of IEC publ. 68-2-29 (1968) Test Eb, Bump. The pulse shall be halfsine of 6 ms duration and 245 m/s^2 peak acceleration. The equipment shall be tested in three mutually perpendicular directions of the six possible attitudes,
making a total of 1000 bumps in each direction.

The equipment shall be tested as discrete units. During the test the equipment shall be nonoperative. Applicable checks shall be made immediately after completing the test.

1.3.14.9 Flame retardant halogen free cable

The tests shall be carried out and fulfill following requirements:

FLAME RETARDANCY

The test shall be carried out according to the IEC 332 Publication, Tests On Cables Under Fire Conditions.

Part 1 in this publication specifies a test for the flame propagation characteristics of a single vertical insultaed wire or cable and part 3 a test on bunched wires and cables.

LOW SMOKE PRODUCTION

The test shall be carried out according to the new IEC Publication which will be issued. The test is a measurement of smoke density of electric cables burning under defined conditions.

The specification (draft IEC 178) is worked out by Working Group 12 (WG 12) in the Technical Committee (TC 20).

CORROSIVENESS OF COMBUSTION GASES

The test shall be carried out according to following publications:

- IEC Publication 754-1 for determination of amount of halogen acid gas evolved during the combustion of polymeric materials taken from cables.
- German standard VDE 0472 Part 813 for determination of not only halogens, but oxides for phosphorus, sulphur, nitrogen as well as strong organic acids.

1.3.15.a <u>Power supply radiation</u>

Interference voltage shall fulfil the requirements according to IEC recommendation no. 521.

1.3.15.b <u>Acoustic noise</u>

Acoustic noise shall be measured according to ISO 6081 (which includes ISO 3743). The emitted sound power shall not exceed 60 dB (A) relative to 1 pW.

If the noise is of impulse type or contains audible tones, the radiated sound power Lw from the equipment shall not exceed 50 dB(A) relative to 1 pW.

1.3.16 <u>Noice from dc-power supply against dc-power with battery back-up</u>

The maximum allowed noise voltage from each equipment unit except the rectifier is given in Fig.4. The limits are r.m.s. values measured with a spectrum analyzer on the DC supply terminals of the unit.

In the frequency range of 100-5000Hz Fig.1.4 represents the limit of the maximum voltage of the largest noise component. The total noise contribution from the equipment unit shall not exceed 0,1mV measured with a psophometer on the DC supply terminals of the unit.

The measuring instruments are specified in Table 1.

The measuring arrangement is shown in Fig.1.5. The battery conductions (DC bus bars) are equivalated by a series connection of a resistor of 0,1ohm and an inductor of 0,1mH. The battery shall have a capacity of typically 150Ah/10h. In place of an accumulator battery a voltage source with high internal resistance in parallel with a capacitor of 10 000 µF may be used.

Measuring instrument	Specification	
Psophometer	Input impedance: Weight curve:	10 kohms CCITT Rec.P.53A(Vol V)
Spectrum	Input impedance:	100 kohms
	Selective bandwidth: 10 Hz (0 - 1 kHz) 30 Hz (1 - 50 kHz) 3 kHz (over 50 kHz) Reading: r.m.s voltage	

Table 1. Specification of measuring instruments

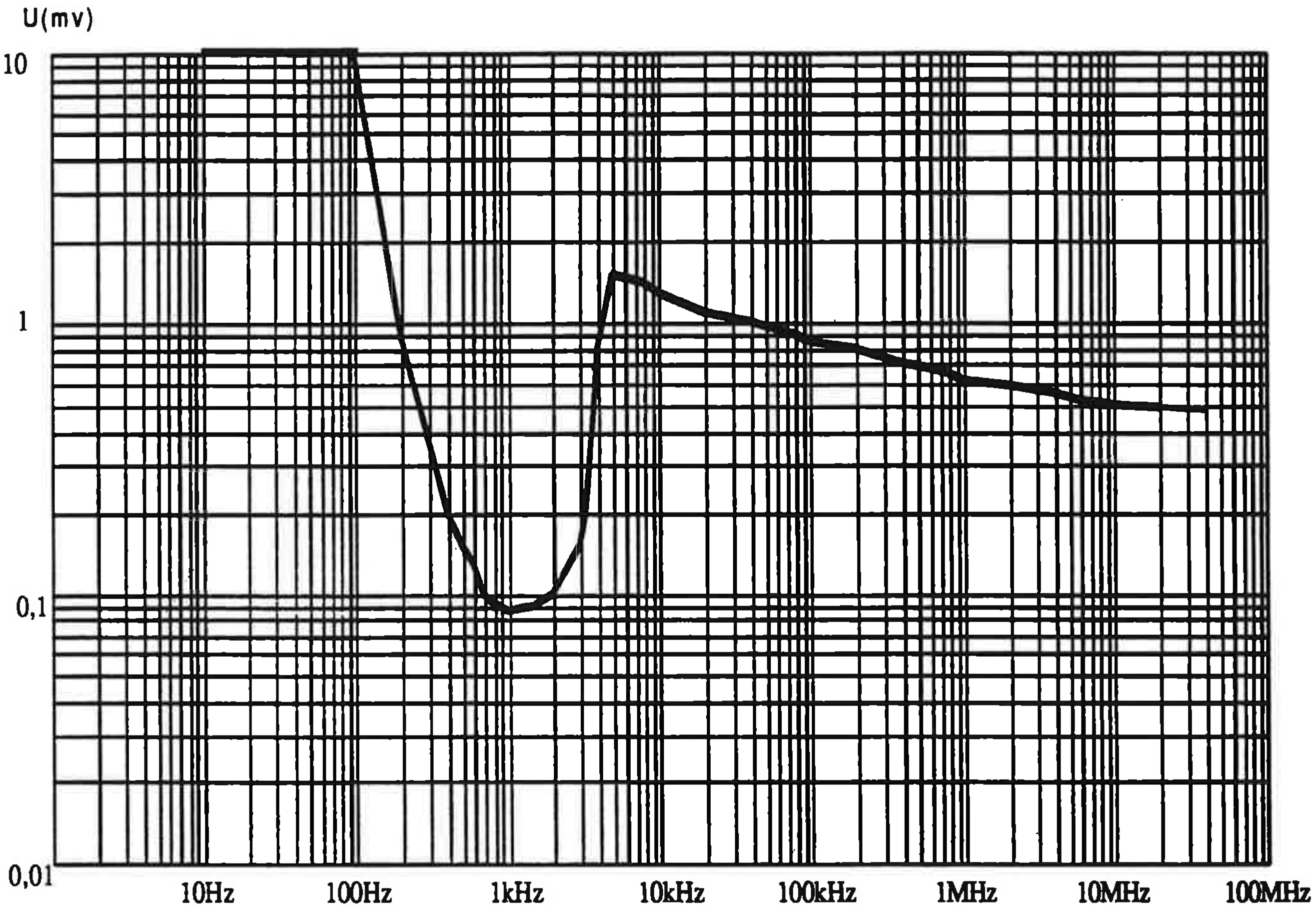


Fig. 1.4 Spectral distribution of the maximum allowed noise from individual equipment units except the rectifier on the battery supply terminals of the unit.

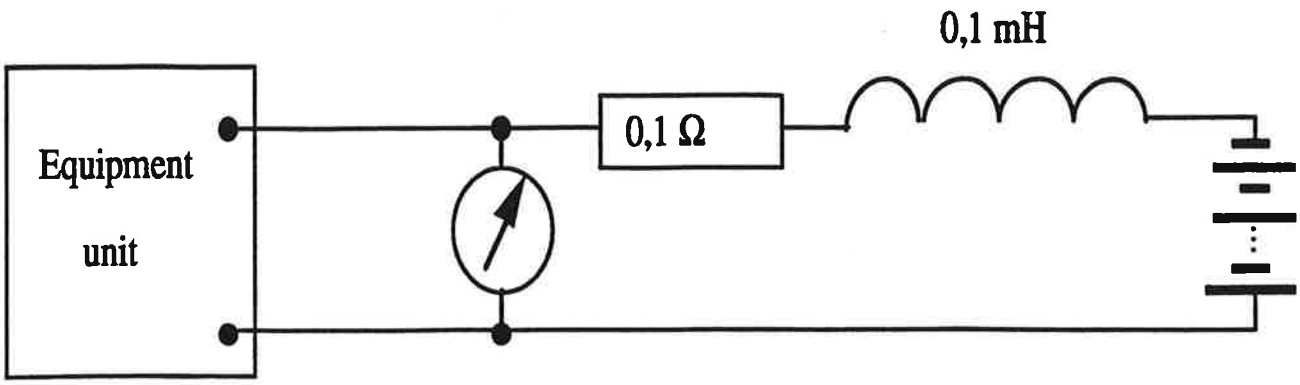


Fig. 1.5 Measuring arrangement for the measurement of noise from individual equipment units except the rectifier.

1.3.17 Hysteresious function of dc-power supply

To protect against undesired functions at battery discharging the power supply shall have the hysteresious stated below:

41 V ± 2 V for switch off and

46 V ± 1 V for switch on.

2 TEST CONDITIONS

2.1 POWER SOURCES AND AMBIENT TEMPERATURES

2.1.1 Application of test conditions

The test conditions and procedures shall be as specified in 2.1.2 to 2.1.5.

2.1.2 Test power source

During the tests the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in 2.1.3.2 and 2.1.4.2.

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment. During the tests, the power source voltage shall be maintained within a tolerance of ±3% relative to the voltage at the beginning of each test.

2.1.3 Normal test conditions

2.1.3.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

Temperature +15 °C to +35° C

Relative humidity 20% to 75%

2.1.3.2 Normal test power source

2.1.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be 230 V, 50 Hz ± 1 Hz.

2.1.3.2.2 Battery power source with buffer

The normal test voltage for equipment to be supplied from a DC power source shall be 53 V, positive pole grounded.

2.1.4 Extreme test conditions

2.1.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in Clause 2.1.5 at the temperatures of -10°C and +55° C.

2.1.4.2 Extreme test voltage

2.1.4.2.1 Mains voltage

The extreme test voltage for equipment to be connected to the AC mains source shall be the upper and lower limits of 230 V ± 10%.

2.1.4.2.2 Battery power source with buffer

The extreme test voltage for equipment to be connected to a DC power source shall be 63 V and 43 V, positive pole grounded.

2.1.5 Procedure for tests at extreme temperatures

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be in continuous operation (transmit and receive condition).

If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or such period as may be decided by the testing authority, shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

2.2 GENERAL CONDITIONS

2.2.1 Continuous operation

The base station equipment shall be designed for continuous operation (transmit or receive condition, respectively). In connection with acceptance test and before measurements are made, a continuous operation test of 200 hours at normal test condition is foreseen.

2.2.2 Artificial antenna

Tests on the transmitter and transmitter combiner shall be carried out with a non-reactive non-radiating load of 50 ohms connected to the antenna terminals.

2.2.3 Arrangements for test signals at the line input of the transmitter

The transmitter audio-frequency modulation signal shall be supplied by a generator connected to the line input. The nominal impedance of the line input circuit shall be 600 ohms resistive.

2.2.4 Modulation

2.2.4.1 Normal test modulation

For normal test modulation, the modulation frequency shall be 1,0 kHz and the resulting peak to peak frequency deviation shall be ± 3,0 kHz.
The test signal shall be substantially free from amplitude modulation.

2.2.4.2 Normal data test modulation

Normal data test modulation is defined as the carrier frequency modulated with idle frames (6 or 15), see NMT Doc.900-1 to give a mean peak to peak frequency deviation of ± 3,5 kHz. This corresponds to actual measured peak deviation (1800 Hz tone) of 4,2 kHz.

The audio level for the datasignal at the line input/output terminal is thus -4,4 dB below the audio level for the 1000 Hz tone corresponding to normal test modulation of ± 3,0 kHz when the compandor is activated.
See paragraph 4.18 and 5.10.

2.2.5 Arrangements for test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the impedance presented to the receiver input is 50 ohms.

This requirement shall be met irrespective of whether one or more signals are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the EMF at the receiver input terminals.

The effects of any intermodulation products and noise produced in the signal generators should be negligible.

2.2.6 Psophometric filter

The psophometric filter, which is used in some of the test measurements, shall fulfil the requirements specified in CCITT Recommendation P.53A (Psophometer for Commercial Telephone Circuits).

2.2.7 Receiver squelch circuit

The receiver squelch circuit shall be made inoperative for the duration of the tests (with exception for the tests concerning the squelch circuit itself).

2.2.8 Test site and general arrangements for measurements involving the use of radiated fields

2.2.8.1 Test site

The test site shall be on a reasonably level surface or ground.

At one point on the site, a ground plane of at least 5 metres diameter shall be provided.
In the middle of this ground plane, a non-conducting support, capable of rotation through 360° in the horizontal plane, shall be used to support the test sample at 1,5 metres above the ground plane. The test site shall be large enough to allow the erection of a measuring or transmitting antenna at a distance of $\lambda/2$ or 3 metres whichever is the greater. The distance actually used shall be recorded with the results of the test carried out on the site.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site and ground reflections do not degrade the measurement results.

2.2.8.2 Test antenna

The test antenna is used to detect the radiation from both the test sample and the substitution antenna, when the site is used for radiation measurements; where necessary, it is used as a transmitting antenna, when the site is used for the measurement of receiver characteristics.
This antenna is mounted on a support such as to allow the antenna to be used in either horizontal or vertical polarization and for the height of its centre above ground to be varied over the range 1-4 metres.
Preferably test antenna with pronounced directivity should be used.
The size of the test antenna along the measurement axis shall not exceed 20% of the measuring distance.

For radiation measurements, the test antenna is connected to a test receiver, capable of being tuned to any frequency under investigation and of measuring accurately the relative levels of signals at its input.
When necessary (for receiver measurements) the test receiver is replaced by a signal source.

2.2.8.3 Substitution antenna

The substitution antenna shall be a λ/2 dipole, resonant at the frequency under consideration, or a shortened dipole, calibrated to the λ/2 dipole.

The centre of this antenna shall coincide with the reference point of the test sample it has replaced. This reference point shall be the volume centre of the sample when its antenna is mounted inside the cabinet, or the point where an external antenna is connected to the cabinet.

The distance between the lower extremity of the dipole and the ground shall be at least 30 cm.

The substitution antenna shall be connected to a calibrated signal generator when the site is used for radiation measurements and to a calibrated measuring receiver characteristics. The signal generator and the receiver shall be operating at the frequencies under investigation and shall be connected to the antenna through suitable matching and balancing networks.

2.2.8.4 Alternative indoor site

When the frequency of the signals being measured is greater than 80 MHz, use may be made of an indoor site. If this alternative site is used, this shall be recorded in the test report.

The measurement site may be a laboratory room with a minimum area of 6 metres by 7 metres and at least 2,7 metres in height.

Apart from the measuring apparatus and the operator, the room shall be as free as possible from reflecting objects other than the walls, floor and ceiling.

The site arrangement is in principle shown in Fig. 2.1

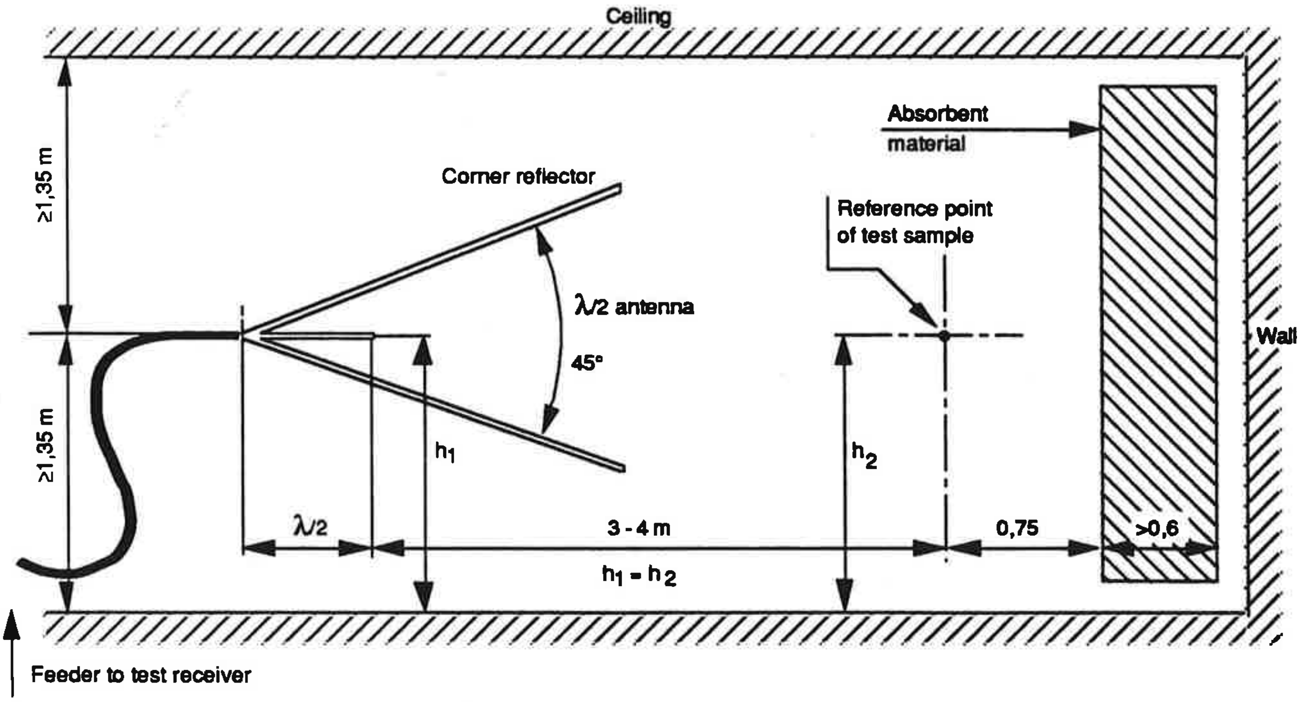


FIGURE 2.1 Indoor site arrangement (shown for horizontal polarization)

The potential reflections from the wall behind the equipment under test are reduced by placing a barrier of absorbent material in front of it. The corner reflector around the test antenna is used to reduce the effect of reflections from the opposite wall and from the floor and ceiling in the case of horizontally polarized measurements.

Similarly, the corner reflector reduces the effects of reflections from the side walls for vertically polarized measurements.
For the lower part of the frequency range (below appr. 175 MHz) no corner reflector or absorbent barrier is needed.

For practical reasons, the $\lambda/2$ antenna in Fig. 2.1 may be replaced by an antenna of constant length, allowing it to be used at frequencies corresponding to a length between $\lambda/2$ and λ, as long as the sensitivity is sufficient. In the same way the distance of $\lambda/2$ to the apex may be varied.

The test antenna, test receiver, substitution antenna and calibrated signal generator are used in a way similar to that of the general method.

To ensure that errors are not caused by the propagation path approaching the point at which phase cancellation between direct and the remaining reflected signals occurs, the substitution antenna shall be moved through a distance of $\pm$ 10cm in the direction of the test antenna as well as in the two directions perpendicular to this first direction. If these changes of distance cause a signal change of greater than 2 dB, the test sample should be resited until a change of less than 2 dB is obtained.

2.3 ACCURACY AT MEASUREMENTS

2.3.1	D.C. voltage	± 1%
2.3.2	A.C. mains voltage	± 3%
2.3.3	A.C. mains frequency	± 0,5%
2.3.4	Audio-frequency voltage, power, etc.	± 0,5%
2.3.5	Audio-frequency	± 0,1%
2.3.6	Distortion and noise, etc. of audio frequency generators	± 0,5%
2.3.7	Radio frequency	± 20Hz
2.3.8	Radio-frequency voltage	± 2dB
2.3.9	Radio-frequency field strength	± 3dB
2.3.10	Radio-frequency carrier power	± 5%
2.3.11	Impedance of artificial loads, combining units, cable, plugs, attenuators, etc.	± 5%
2.3.12	Source impedance of generators and input impedance of measuring receivers	± 10%
2.3.13	Attenuation by attenuators	± 0,5dB
2.3.14	Temperature	± 1° C
2.3.15	Humidity	± 5%

3 COMBINING EQUIPMENT

A calculation of some critical parameters in the combining equipment in relation to the transmitter/receiver-requirements in clause 4 and 5 is given in Annex 1.

3.1 TRANSMITTER COMBINER

This clause states the minimum performance requirements for a transmitter combining equipment, the purpose of which is to connect a number of radio transmitters to a common antenna.

3.1.1 Number of transmitters

The equipment shall permit the simultaneous connection of up to at least 8 transmitters, and preferably 32. The requirements of this clause shall be fulfilled for any number, from 1 to at least 8(32), of transmitters being connected to the transmitter combiner and being in operation or not.

3.1.2 Frequency range

The frequency range shall be at least 935,000-960,000 MHz.

3.1.3 Frequency separation

The combiner shall be able to combine transmitters with a frequency separation down to 475 kHz. It is however desired that the combiner is designed in such a way that no restrictions are made on the transmitter frequency separation.

3.1.4 Input and output impedances

The nominal input and output impedances shall be 50 ohms non-symmetric.

3.1.5 Voltage standing wave ratio (VSWR)

The voltage standing wave ratio (VSWR) at the output terminal (antennaterminal) shall not exceed 1,8 and at all input terminals not exceed 1,3. At extreme test conditions the VSWR shall not exceed 2,0 at the output terminal and 1,5 at the input terminals.

3.1.6 Connectors

The connectors at the inputs are prefered to be of type N (female).

The output connector shall be of type 7/16 (female).

3.1.7 Carrier power

The maximum carrier power available from each transmitter to be connected to the combiner inputs is 25 W + 1 dB.

- If the combiner is designed as a passive network the power loss from any one of the input terminals to the output terminal shall not exceed 4,0 dB at normal test conditions and 5,0 dB at extreme test conditions.

In the case of an integrated combiner this paragraph shall be exchanged with the specification according to paragraph 4.4.3 Carrier power.

3.1.8 Load test

Transmitters shall be simultaneously applied at all the input terminals of the combiner, each transmitter having an output corresponding to the specified carrier power at the output terminal of the combiner according to clause 3.1.7.

- The transmitter combiner shall then be submitted to a load test with continuous transmission for a period of 2 hours. The change in the carrier power at the output terminal shall not exceed 2dB during the load test when the output terminal is loaded with a resistive impedance giving a VSWR of 2. The test shall be carried out at normal test conditions.

- Furthermore the equipment shall be capable of withstanding, without being damaged, a load test when the output terminal of the combiner is loaded with an arbitrary load, including short circuit or open circuit at the output terminal for a period of 30 minutes.

3.1.9 Intermodulation attenuation

The power of any intermodulation product generated by the simultaneously applied transmitters connected to the input terminals of the equipment shall be attenuated at least 55 dB+A_T below each transmitter carrier power as measured at the input terminal of the combiner.

The 3.th. order intermodulation components within the receiver frequency band 890,000-915,000 MHz shall be attenuated at least 80 dB + A_T .
A_T is the intermodulation attenuation for the transmitters connected to the combiner inputs. (See clause 4.7).

An additional filter (see clause 3.1.12) shall be mounted at the extreme output of the combiner and speciall precautions shall be taken to prevent generation of intermodulation products in connector, dummyloads etc.

With all transmitters in operation the intermodulation products shall not exceed -36 dBm, at the output to the antenna, except for intermodulation products within the frequency band 890,0-915,0 MHz which shall not exceed -101 dBm.

In case of an integrated transmitter combiner in the radio cabinet this specification shall be exchanged with the following requirement:

With two or more transmitters in operation the intermodulation products shall not exceed - 36 dBm at the output to the antenna, except for intermodulation products within the frequency band 890,000 - 915,000 MHz which shall not exceed - 101 dBm.

3.1.10 Spurious emissions

In case of active components in the combiner the power of any spurious emissions, except for intermodulation products as specified in paragraph 3.1.9, generated in the transmitter combiner shall not exceed 0,25 µW at normal test conditions and 1,0 µW at extreme conditions. The definition and method of measurements are in accordance with clause 4.6.

3.1.11 Noise power within receiver channel

In case of avtive components in the combiner the noise power within the receiver band measured at the output to the antenna shall not exceed -112 dBm.

The definition and method of measurements are in accordance with clause 4.12.

3.1.12 Attenuation within the receiver frequency band

The combiner shall provide an attenuation not less than 55 dB within the frequency band 890,000-915,000 MHz, measured between any combiner input terminal and the combiner output terminal.

3.1.13 Test features

The transmitter combiner shall be provided with instruments for reading carrier power at the output terminal, and reflected power from the antenna.

Furthermore a fault alarm (two levels) shall be given to the control unit at unallowable low reflection attenuation at the TX-antenna terminal of the radio cabinet (antenna fault). The settings for antenna fault alarms shall be adjustable between reflection attenuation 21,0 dB (VSWR 1,2) and 2,0 dB (VSWR 9,0).

It shall be possible to supress the fault level 1 and level 2 alarms independently. The reflection attenuation alarm level shall not vary more that ± 1,0 dB from the setting level within the transmitter frequency band. The measuring accuracy shall be within the limits defined in the figure below with antenna output power 0,3 W or higher.

The TX-antenna supervising equipment shall not malfunction with any capable output power levels.

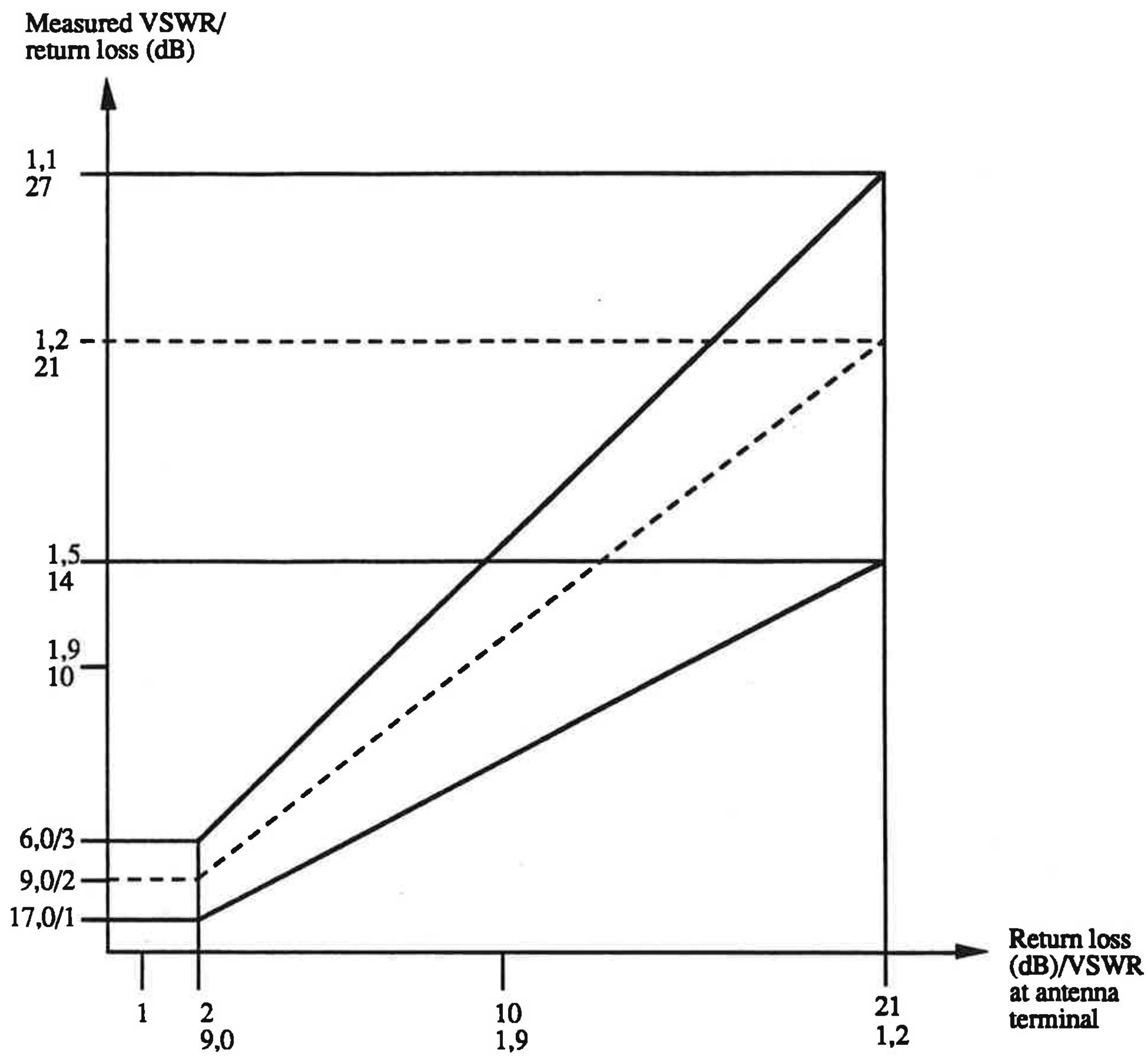


Fig. 3.1

3.1.14 Interface between transmitter combiner and control unit

The alarm output from transmitter combiner shall be connected to the control units (CU) by three wires. One of the wires shall be a common return wire and it may be connected to ground in the radio equipment cabinet. The alarms shall be given by closing relay circuits. In the table of signals below closed circuit in transmitter combiner is indicated by one (1) and an open circuit by zero (0).

Transmitter combiner alarm	code
no alarm	00
level 1	01
level 2	11

It shall be possible to connect up to 16 control units to a transmitter combiner alarm circuit.

In case of an integrated transmitter combiner it is not necessary to fullfil paragraph 3.1.14.

3.1.15 Power supply to alarm circuits in transmitter combiner

The power supply voltage to the combiner shall be supplied from the radio equipment cabinet.

3.2 RECEIVER MULTICOUPLER

3.2.1 Number of receivers

The equipment shall permit connection of two more "receivers" than the number of channels in the radio cabinet i.e. at least 10 and preferably 34 receivers. The requirements of this specification shall be fulfilled for any number, from 1 to at least 10(34) receivers connected.

3.2.2 Frequency range.

The frequency range shall be at least 890,000-915,000 MHz.

3.2.3 Input and output impedances

The nominal input and output impedances shall be 50 ohms non-symmetric.

3.2.4 Voltage standing wave ratio (VSWR)

The VSWR shall not exceed 1,5 at all terminals at normal test conditions and 1,8 at extreme test conditions.

3.2.5 Connectors

Antenna input terminal(s) of the radio cabinet shall be of type N (female).

The connectors at all other terminals shall be of type N (female) or type TNC (female).

3.2.6 Input filter

The receiver multicoupler shall be provided at the input with a filter which has an attenuation characteristics as shown below.

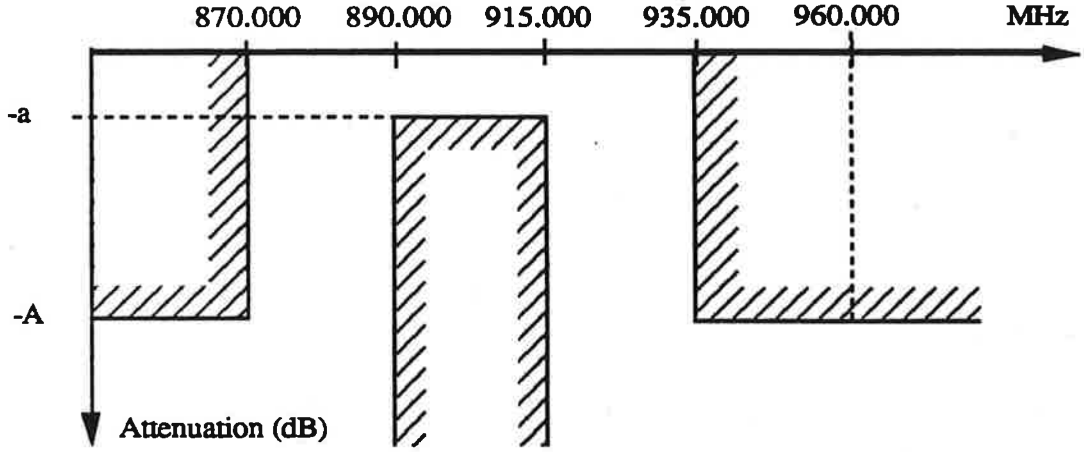


Fig. 3.2

A is equal to -60 dB at normal test conditions and -55 dB at extreme test conditions.

The passband ripple "a" shall together with the signal amplifier of the multicoupler give a total ripple of maximum 2 dB.

3.2.7 Redundance in multicoupler

The receiver multicoupler is recomended to be built up with amplifiers in parallel so that fault in one amplifier causes maximum 7 dB attenuation from input terminal to any one of the output terminals.

3.2.8 Isolation between multicoupler outputs

The isolation between arbitrary multicoupler outputs shall not be less than 30 dB.

3.2.9 Noise factor

See clause 5.3

3.2.10 Intermodulation

See clause 5.7

3.2.11 Blocking

See clause 5.8

3.2.12 Ability to withstand over voltage

The receiver multicoupler shall withstand without being damaged a continuous input voltage of 2 V EMF within the frequency range specified in paragraph 3.2.2.

3.2.13 Susceptibility to the output terminals not in use

The requirements of clause 3.2 shall be fulfilled irrespective of whether output terminals not in use are terminated with a load or not.

3.2.14 Test features

The receiver multicoupler shall give fault alarm to the control unit (CU) in case of power failure or amplifier failure.

3.2.15 RF test loop input

The receiver multicoupler shall be provided with an input terminal for connection to RF test loop. See also chapter 10.

3.2.16 RX-antenna supervision

The base station shall be provided with instruments for supervision of RX-antenna reflection attenuation.

Furthermore fault alarm (two levels) shall be given to the control unit at unallowable low reflection attenuation at the RX-antenna.

It shall be possible to suppress the fault level 1 and level 2 alarms independently. The settings for antenna fault alarms shall be adjustable between reflection attenuation 21,0 dB (VSWR 1,2) and 2,0 dB (VSWR 9,0). The measuring accuaracy shall be within the limits defined in the figure below. The level shall not vary more than ± 1,0 dB from setting level within the receiver frequency band.

The RX-antenna supervising function shall be done automatically at least once every hour. This test shall not interfere the normal operation of BS. In every case RX-antenna fault shall be indicated by RX-antenna alarm.

In case of diversity both RX-antennas shall be supervised.

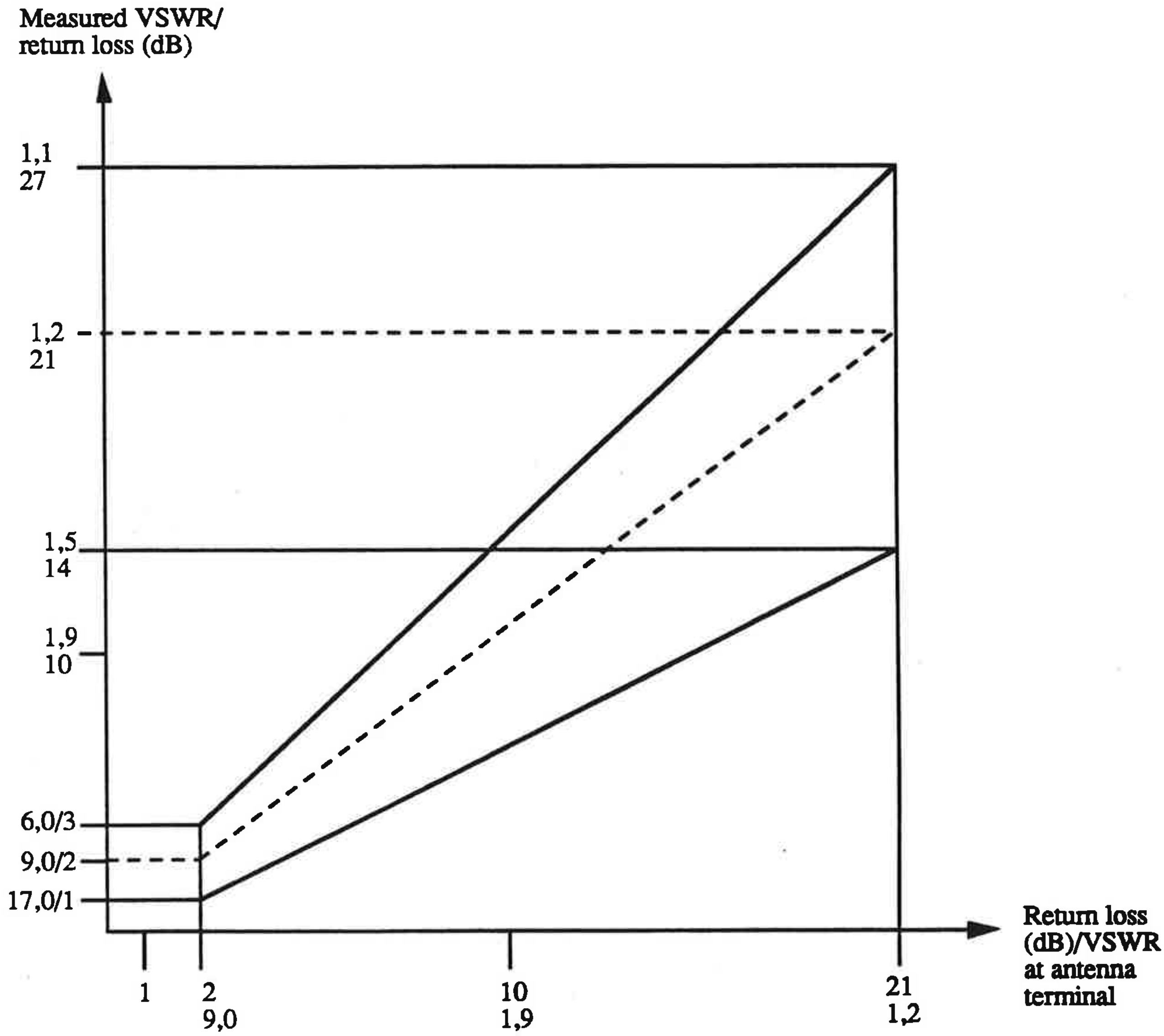


Fig 3.3

4 TRANSMITTER

Unless otherwise specified all measurements in chapter 4 shall be carried out excluding the syllabic compressor (see paragraph 4.25).

4.1 FREQUENCY RANGE

Transmitter frequency range shall be 935,000-960,000 MHz. Channel separation shall be 25 kHz, with the possibility to use interleaved channels separated 12,5 kHz from the ordinary channels.

4.2 NUMBER OF RF CHANNELS

The transmitter shall be capable of being set to any one of the 1999 channels (including 999 interleaved channels) in the frequency range specified in clause 4.1.

The channel setting shall be possible in two different ways:

- locally by means of channel selector on the control unit (CU);
- remotely from the MTX via the control unit (CU).

The channel setting order from MTX shall override the local channel setting.

4.3 FREQUENCY ERROR

4.3.1 Definition

The frequency error of the transmitter is the difference between the measured carrier frequency and its nominal value.

4.3.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation with the transmitter connected to an artificial antenna.
The measurements shall be repeated with modulation specified in clause 4.11.

4.3.3 Requirements

The frequency error of the transmitter shall not exceed ± 250 Hz.
This requirement includes the effect of aging for a period of one year.

The amount of annual aging shall be stated by the manufacturer.

In case of using "OCXO" the following will apply:

a) At mains interruption of more than 2 minutes the following warming up periods are allowed:

   Measured from power start up the frequency error shall be
   - equal or less than ± 2,5 kHz within 4 minutes
   - equal or less than ± 250 Hz within 5 minutes.

b) At short mains interruption equal or less than 2 minutes the following warming up periods are allowed:

- equal or less than ± 2,5 kHz within 40 sec.
- equal or less than ± 250 Hz within 5 minutes.

In case a and b the mains return alarm shall be delayed according paragraph 8.1.3.3.

During the carrier rise time and decay time specified in clause 4.5 the following requirement applies.

During the carrier rise time the frequency error shall be less than ± 2,5 kHz. One frame-length (138 ms) after the end of frame 20 A(14 or 15) the error shall be less than ± 250 Hz.

During the carrier decay time the frequency error shall be less than 250 Hz.

4.3.4 Connection of external reference frequency source (OPTION)

The master oscillator of the basestation shall be equipped with an input terminal to which an external reference clock can be connected. It shall be possible to choose either the internal or the external source.

The clock rate of the possible external source are:

Frequency	Accuracy
2048 kHz	$\pm 1*10^{-11}$

The level of the input signal fulfills the CCITT rec. G703 para 10.2 (blue book), jitter and wander fulfills CCITT rec. G823 and long time stability fulfills CCITT rec. G811.

The input terminal shall comply to CCITT rec. G703 para 10.3 (blue book) and the input impedance shall be (75 ohms) resistive.

The frequency error of the transmitter shall not exceed ± 50 Hz with external reference clock. If the reference clock level does not fulfill the CCITT rec. G703 para 10.2 (blue book), the equipment shall contain a memory which stores the last frequency correction and a continuous degradation to a frequency accuracy of ± 250 Hz is accepted.The transition time shall not be less than 2 minutes. If the reference clock jitter and wander does not fulfill the CCITT rec. G823 or the long time stability does not fulfill CCITT rec G811, a continuous degradation of the frequency error of the transmitter to ± 2.5 kHz for up to 40 sec is accepted. Thereafter the error shall be decreased to within ± 250 Hz with a monotonic slope of less than 200 Hz/s.
As soon as the input signal fulfills the requirements specified above the error of the transmitter shall be continously decreased to within ±50 Hz if the external reference clock is in use.

If the basestation is equipped with a digital connection it shall be possible to use this as the reference source (see para 12).

During the carrier rise time and decay time specified in clause 4.5 the following requirement applies.

During the carrier rise time the frequency error shall be less than ± 2,5 kHz. One frame-length (138 ms) after the end of frame 20 A(14 or 15) the error shall be less than ± 50 Hz.

During the carrier decay time the frequency error shall be less than 50 Hz.

4.4 RF-CARRIER POWER

4.4.1 Definition

The transmitter carrier power is the mean power delivered to the artificial antenna measured at the output terminal of the radio cabinet during a radio frequency cycle, without modulation. Thus including cables in the radio cabinet.

In case of an integrated transmitter combiner the transmitter carrier power shall be measured at the antenna output terminal of the radio cabinet.

4.4.2 Method of measurement

The transmitter output terminal shall be connected to an artificial antenna and the power delivered to this artificial antenna shall be measured.

With an integrated transmitter combiner the transmitter carrier power shall be measured at the antenna output terminal of the radio cabinet.

4.4.3 Requirements

The nominal output power into 50 ohms unbalanced shall be selectable manually as follows:

25 W, 6 W, 1,5 W

The manufacturer shall state the corresponding power at the output connector of the transmitter unit.

In case of an integrated transmitter combiner the nominal output power at the antenna output terminal of the radio cabinet shall be selectable as follows:

8 W, 2 W, 0,5 W

Concerning a small cell base station it is possible to delete the highest power level, i.e. 25W in the ordinary base station and 8W in the integrated solution.

When using an integrated transmitter combiner the power consumption to the eight channel radio cabinet with all the transmitters activated shall be below 1100 W for the highets power level.

The manufacturer shall state the corresponding power at the output connector of the transmitter unit.

For the purpose of optimizing the system balance it shall be possible to manually reduce the output power from the levels given above to at least 3 dB below these levels. In case the reduction is made stepwise the steps shall not be greater than 1 dB.

Under normal test conditions and independent of selected channel the carrier output power shall be within ±1 dB, and in case of an integrated combiner within +1 dB and -2 dB of the nominal output power.

Under extreme test conditions the carrier output power shall be within +1 dB and -2 dB and in case of an integrated combiner within +1 dB and -3 dB of the nominal output power.

4.4.4 Load test

The transmitter shall be submitted to load tests, continuous transmission, for a period of 2 hours.

- The change in the transmitter output power shall not exceed 2dB during a load test when the transmitter is loaded with resistive impedance at the output terminal giving a voltage standing wave ratio (VSWR) of 2. The test shall be carried out at normal test conditions.

- Without being damaged, the equipment shall be able to withstand a load test when the transmitter is loaded with a resistive impedance giving a voltage standing wave ratio of 2. The test shall be carried out at extreme test conditions.

Furthermore the equipment shall be capable of withstanding, without being damaged, a load test when the transmitter is loaded with an arbitrary load, including short circuit or open circuit at the output terminal for at least one minute.

4.5 CARRIER ON/OFF CONDITION AND CARRIER RISE/DECAY TIME

4.5.1 Definition

Carrier off conditions:	Transmitter output power below 0.25 μW.
Carrier on conditions:	Transmitter output power within 2 dB relative to the steady-state output power value.
Carrier rise time:	Elapsed time between the end of the control signal start transmitter from the MTX and the moment the carrier on condition is obtained.
Carrier decay time:	Elapsed time between the end of the control signal stop transmitter from the MTX and the moment carrier off condition is obtained.

4.5.2 Method of measurement

The carrier rise time and the carrier decay time.

The transmitter shall be connected to an artificial antenna. The time elapsed from the end of received frame 20A(15) to the moment the transmitter has reached the carrier on condition is measured.

The time elapsed from the end of received frame 20A(0) to the moment the transmitter has reached the carrier off conditions is measured.

4.5.3 Requirements

In the carrier off condition, the carrier output power shall not exceed 0,25 µW.

The carrier rise time shall not exceed 138 ms measured from the end of the order frame.

The carrier decay time shall not exceed 50 ms.

4.6 SPURIOUS EMISSIONS

4.6.1 Definition

Spurious emissions are emissions at frequencies other than those of the carrier and sidebands associated with normal modulation.

The level of spurious emissions shall be measured as:

- their conducted power in an artificial antenna and
- their effective radiated power when radiated by the cabinet and structure of the equipment (also called "cabinet radiation").

4.6.2 Method of measuring conducted power level

Conducted spurious emissions shall be measured as the power of a discrete signal delivered into a 50 ohms load. This may be done by connecting the transmitter output through an attenuator to a spectrum analyser or selective voltmeter, or by monitoring the relative levels of the spurious signals delivered to an artificial antenna. When the transmitter combiner is integrated in the radio cabinet the measurement shall be done at the antenna output terminal of the radio cabinet.

a) The transmitter shall be unmodulated and the measurements made over at least the frequency range 100 kHz to 4000 MHz except for the channel on which the transmitter is intended to operate and its adjacent channels.

b) The measurements shall be repeated with the transmitter modulated with normal test modulation and the transmitter connected to a load with VSWR=2.

The phase angle of the load impedance shall be varied in the range 0° - 360° at the carrier frequency.

c) The measurements in case a) shall be repeated in the carrier off condition.

4.6.3 Method of measuring the effective radiated power

a) On a test site, fulfilling the requirements of paragraph 2.2.8, the sample shall be placed at the specified height on a nonconducting support. The transmitter shall be operated without modulation at the carrier power levels specified in paragraph 4.4.3, delivered to an artificial antenna.

Radiation of any spurious components shall be detected by the test antenna and receiver, over at least the frequency range 30-4000 MHz, except for the channel on which the transmitter is intended to operate and its adjacent channels. At each frequency at which a component is detected, the transmitter shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement.

The measurements shall be repeated with the test antenna in the orthogonal polarisation plane.

b) The measurements shall be repeated with the transmitter modulated by normal test modulation.

c) The measurements in case a) shall be repeated in the carrier off condition.

4.6.4 Requirements

For cases a) and b) the power of any spurious emission in the specified range of frequencies shall not exceed 0,25 µW, except on the second adjacent channel (± 50kHz) where the spurious emission shall not exceed 1,0 µW.
At extreme test conditions the spurious emission shall not exceed 1,0 µW including second adjacent channel.

For case c) the spurious emission shall not exceed 2,0 nW.

Regarding spurious emission within receiver band see clause 4.13.

4.7 INTERMODULATION ATTENUATION

4.7.1 Definition

For the purpose of this specification the intermodulation attenuation is a measure of the capacity of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal reaching the transmitter via its antenna.

In case of an integrated transmitter combiner paragraph 4.7 shall be replaced by paragraph 3.1.9.

4.7.2 Method of measurement

The output of the transmitter under test shall be connected to a signal source via a coupling device, presenting to the transmitter a load with an impedance of 50 ohms.

The coupling device can consist of a circulator, one port of which is to be connected by a coaxial cable to the output terminal of the transmitter, the second port is to be correctly terminated (nominal value 50 ohms).
This termination is to be provided with means for connection to a selective measuring device (e.g. a spectrum analyser). The third port of the circulator is to be connected to the test signal source by means of an isolator.

Alternatively, the coupling device may consist of a resistive attenuator, which may be combined with an isolator, one end to be connected to the output terminal of the transmitter by coaxial cable and the other end to be connected to the test signal source. A selective measuring device is to be connected to the transmitter end of the attenuator by means of a sampling probe, giving the required attenuation.

The transmitter under test and the test signal source shall be physically separated in such a way that the measurement is not influenced by direct radiation. The test signal shall be unmodulated and the frequency shall be within 1-7 neighbouring channels above the frequency of the transmitter under test. The frequency shall be chosen in such a way that the intermodulation components to be measured do not coincide with other spurious emissions. The test signal power level shall be adjusted to -30dB relative to the carrier power level of the transmitter, both levels being measured at the output of the transmitter. The power level of the test signal shall be measured at the transmitter end of the coaxial cable, when disconnected from the transmitter and then correctly matched (nominal value 50 ohms).

The output power of the transmitter shall be measured directly at the output terminal connected to an artificial antenna.
With the transmitter switched on in an unmodulated condition, the levels of the transmitter carrier and the intermodulation components are compared by means of the selective measuring device.

The length of the coaxial cable between the transmitter output and the coupling device shall be varied until the maximum level of the intermodulation component considered is obtained.

This measurement shall be repeated with the test signal at a frequency within 1-7 neighbouring channels below the transmitter frequency.

The measurement shall be repeated with the transmitter frequency and the test signal frequency selected in such a way that 3rd, 5th, 7th... order components will be within the receiver frequency band (890,000-915,000 MHz).

When the above measurements are performed, precautions must be taken so that non-linearities in the selective measuring device do not influence the results appreciably. Furthermore it should be ensured that intermodulation components, which may be generated in the test signal source, are sufficiently reduced, e.g. by means of circulator.

The intermodulation attenuation is expressed as the ratio in dB of the test signal power level to the power level of an intermodulation component.

4.7.3 Requirements

The intermodulation attenuation shall be at least 15 dB for any intermodulation component except for odd order intermodulation components of 5.th order or higher within the frequency range 890,000 to 915,000 MHz which shall be attenuated by at least 40 dB.

4.8 FREQUENCY DEVIATION

The frequency deviation is the maximum difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency alone.

4.8.1 Maximum permissible frequency deviation

4.8.1.1 Definition

The maximum permissible frequency deviation is the maximum value of frequency deviation stipulated in these specifications.

4.8.1.2 Method of measurement

The frequency deviation shall be measured at the output of the transmitter connected to an artificial antenna, by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency shall be varied. The level of the test signal at the line input shall be 20 dB above the level giving normal test modulation.

4.8.1.3 Requirements

The maximum permissible frequency deviation shall be ± 4,7 kHz.

4.9 SUPERVISORY SIGNAL INPUT CIRCUIT

A separate supervisory signal (ø-signal) input shall be provided. The supervisory signal shall not pass through the limiter.

The supervisory signal stated in paragraph 8.1.5 (about 4000 Hz) shall give a frequency deviation of ± (0,3 ± 0,03) kHz.

4.10 LIMITING CHARACTERISTIC OF THE MODULATOR (INCLUDING LINE INPUT CIRCUIT)

4.10.1 Definition

The limiting characteristic of the modulator expresses the transmitter's capability of being modulated to a frequency deviation close to the maximum permissible frequency deviation as defined in paragraph 4.8.1.

4.10.2 Method of measurement

A test signal with a frequency of 1000 Hz shall be applied to the transmitter line input terminal.

a) The level shall be adjusted so that the frequency deviation is ± 3,0 kHz. The level is then increased by 6dB and the frequency deviation is again measured.

b) The level shall be adjusted so that the frequency deviation is ± 1,0kHz. The level is then increased by 20 dB and the frequency deviation is again measured.

c) The level shall be adjusted so that the frequency deviation is ± 3,0kHz. The level is then increased by 20 dB and the compandor shall be activated. The frequency deviation is again measured.

The measurements shall be carried out under normal test conditions and extreme test conditions.

4.10.3 Requirements

a) The frequency deviation shall be at least ± 4,0 kHz.

b) The frequency deviation shall be between ± 4,3 kHz and ± 4,7 kHz.

c) The frequency deviation shall be between ± 4,0 kHz and ± 4,7 kHz.

4.11 CARRIER SHIFT DUE TO MODULATION

4.11.1 Definition

Carrier shift due to modulation expresses symmetry of the limiter and modulator of the transmitter.

4.11.2 Method of measurements

The carrier frequency of the transmitter without modulation shall be measured. Then a signal with a frequency of 1000 Hz shall be applied to the line input terminal. The level shall be adjusted so that the frequency deviation is ± 4,0 kHz.

The average radio frequency shall be measured again.

4.11.3 Requirements

The average value of the radio frequency shall not shift more than ± 100 Hz from its unmodulated value. However, the average value shall be within ±250 Hz from the nominal carrier frequency.

4.12 ADJACENT CHANNEL POWER

4.12.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation, which falls within the bandwidth of a receiver of the type normally used in the system and operating in either of the adjacent channels. This power is the sum of the mean power produced by the modulation, hum and noise of the transmitter.

4.12.2 Method of measurement

The adjacent channel power shall be measured with a power measuring receiver which conforms to paragraph 4.12.4. The transmitter shall be operated at the carrier power levels determined in clause 4.4. The output of the transmitter shall be linked to the input of the receiver by a connecting device such that the impedance presented to the transmitter is 50 ohms and the level at the "receiver" input is appropriate.
When the transmitter combiner is integrated in the radio cabinet the measurement shall be done at the antenna output terminal of the radio cabinet.

The transmitter shall be simultaneously modulated with a signal of 1250 Hz and the supervisory signal (4000 Hz ± 0,3 kHz deviation).

The signal of 1250 Hz shall be adjusted to a level 20 dB higher than that required to produce ± 3,0 kHz deviation (without supervisory signal).
The "receiver" shall be tuned to the nominal frequency of the transmitter and the variable attenuator in the "receiver" shall be adjusted to a value p dB such that a meter reading of the order of 5 dB above the "receiver" noise level is obtained.

The "receiver" shall then be tuned to the nominal frequency of one of the adjacent channels and the variable attenuator shall be adjusted to a value
q dB such that the same meter reading is obtained.
The measurement shall be repeated with normal data test modulation (paragraph 2.2.4.2).

The ratio of adjacent channel power to carrier power is the difference between the attenuator settings p and q. The adjacent channel power is determined by applying this ratio to the carrier power.

The measurement shall be repeated for the other adjacent channel.

4.12.3 Requirements

The adjacent channel power shall not exceed a value of -70 dB relative to the carrier power of the transmitter.

4.12.4 Specifications for the power measuring receiver

The power measurement receiver shall fulfil the requirements given in the latest CEPT recommendation T/R24-1.

4.13 NOISE POWER WITHIN RECEIVER CHANNEL

4.13.1 Definition

The noise power within receiver channel is that part of the total power output of a transmitter, which falls within the bandwidth of a receiver of the type normally used in the system and operating within the frequency range of the receiver.

4.13.2 Methods of measurement

The receiver channel noise power shall be measured with a power measuring receiver which corresponds to paragraph 4.12.4.

The transmitter shall be operated at the carrier power determined in clause 4.4.

The output of the transmitter shall be linked to the input of the receiver in such a way that the impedance presented to the transmitter is 50 ohms and the level of the transmitter carrier, attenuated at least 55 dB by a "stop filter", is appropriate at the receiver input.

When the transmitter combiner is integrated in the radio cabinet "the output of the transmitter" shall be replaced by "the antenna output terminal of the radio cabinet".

The transmitter shall be set to channel 1 (935,0125 MHz) and shall be unmodulated. The "receiver" shall be tuned over the frequency range
890,000 MHz to 915,000 MHz and the noise power of the transmitter shall be measured.

The measurements shall be repeated with the transmitter set to channel 250, 500, 750 and 1000.

4.13.3 Requirement

The noise power within any receiver channel shall not exceed 2,0 nW (-57 dBm).

In case of an integrated transmitter combiner the noise power within any receiver channel shall not exceed -112 dBm.

4.14 AUDIO FREQUENCY RESPONSE OF THE TRANSMITTER (INCLUDING LINE INPUT CIRCUIT)

4.14.1 Definition

The audio frequency response is the frequency deviation of the transmitter carrier as a function of modulation frequency at a constant level of the modulation signal.

4.14.2 Method of measurement

A modulation signal at a frequency of 1000 Hz and adjusted to such level that a frequency deviation of ± 1,0 kHz is obtained, is applied to the transmitter line input terminal. The frequency of the modulation signal is then varied between 20 Hz and 25 kHz, its level being kept constant. The connection values of frequency deviation and modulation frequency shall be determined. The measurement shall be made without the supervisory signal.

4.14.3 Requirement

The audio frequency response shall be within the limits shown in the figure below.

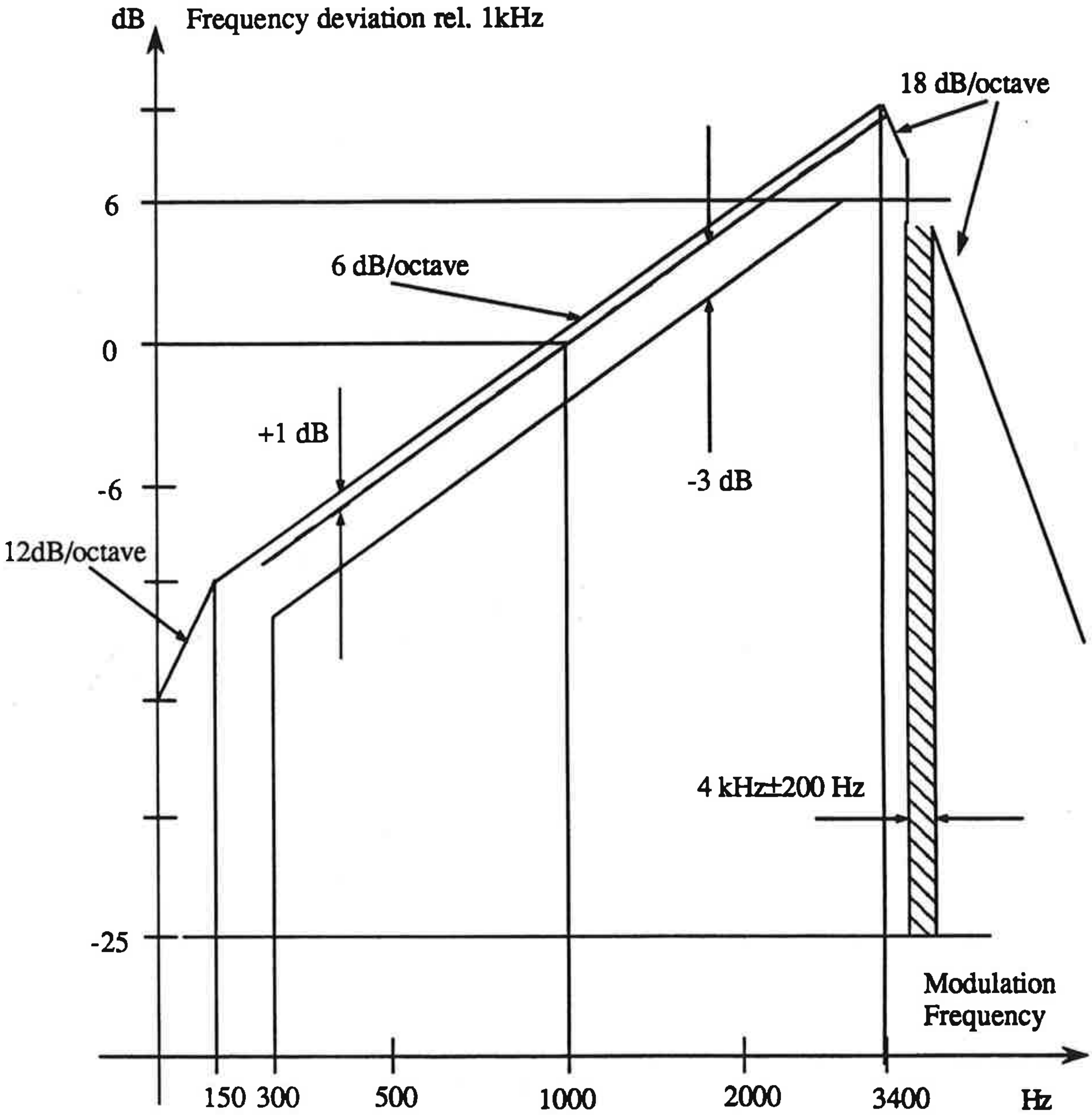


Fig. 4.1

4.15 HARMONIC DISTORTION FACTOR IN TRANSMISSION

4.15.1 Definition

The harmonic distortion factor of a transmitter modulated by an audio frequency signal is defined as the ratio, expressed as a percentage, of the r.m.s. voltage of all the harmonic components of the fundamental audio frequency to the total r.m.s. voltage of the signal after linear demodulation.

With the method described below, when a distortion meter is used, the hum and noise components are included in the distortion measurement.

4.15.2 Method of measurement

The radio frequency signal produced by the transmitter is applied, by means of a suitable coupler, to a linear demodulator equipped with a de-emphasis network of 6 dB per octave.

A modulation signal at a frequency of 1000 Hz shall be applied to the line input terminal. The level shall be adjusted to such a level that a frequency deviation of ± 3,5 kHz is obtained. The harmonic distortion factor of the audio frequency signal is measured.

The measurement shall be repeated for a modulation signal at a frequency of 300 Hz and 500 Hz with a frequency deviation of ± 3,0 kHz.

The audio input levels shall be within the corresponding range as given in paragraph 4.18.3.

4.15.3 Requirement

The harmonic distortion factor shall not exceed 5%.

4.16 RELATIVE AUDIO FREQUENCY INTERMODULATION PRODUCT LEVEL OF THE TRANSMITTER

4.16.1 Definition

The relative intermodulation product level is the ratio, expressed in decibels, of

- the level of an unwanted modulation component of the output signal caused by the presence of two modulating signals as a result of nonlinearity in the transmitter to

- the level of one of the wanted modulation signals measured at the output of the transmitter.

4.16.2 Method of measurement

a) Connect the equipment as shown in the following figure

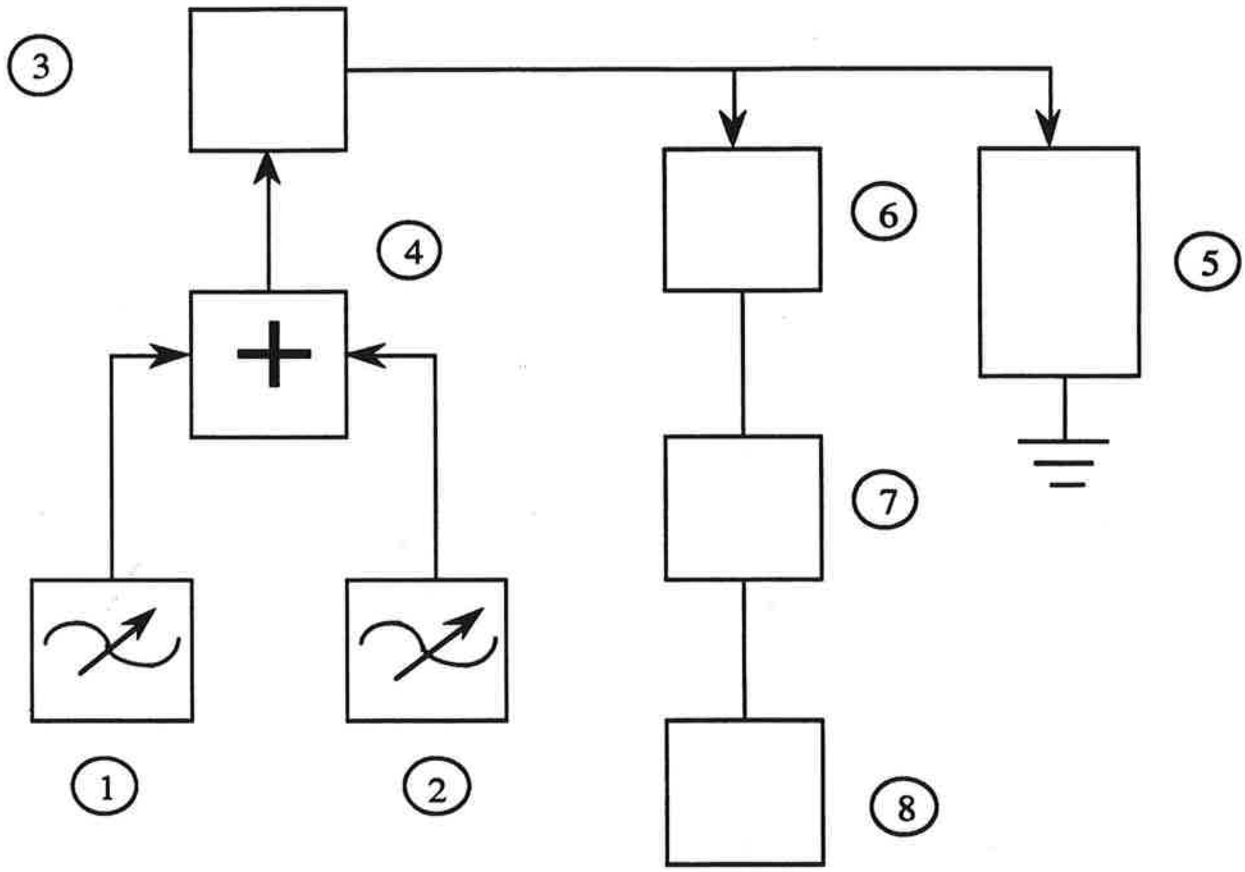


Fig. 4.2

1. Audio frequency generator A
2. Audio frequency generator B
3. Transmitter under test
4. Audio frequency combining unit
5. Test load
6. Coupler/attenuator
7. Deviation meter
8. Audio frequency selective voltmeter.

b) In the absence of an output from audio frequency generator B, adjust the audio frequency generator A to produce ± 2,3 kHz frequency deviation at a modulating frequency F1 of 1000 Hz.

Record the output level of the audio frequency signal generator.
The output level shall be within a range corresponding to the level range given in paragraph 4.18.3.

c) Reduce the output of generatorA to zero and adjust the output of generator B to produce ± 2,3 kHz frequency deviation at a modulating frequency F2 of 1500 Hz.

d) Restore the output of generator A to the level recorded according b) and measure the relevant intermodulation products with the selective voltmeter.

The deviation meter shall be provided with a de-emphasis network of 6 dB per octave.

4.16.3 Presentation of results

Calculate the ratio, in decibels, of the levels of the intermodulation products measured in step (d), to the level of the wanted signal at 1000 Hz.

4.16.4 Requirement

The relative intermodulation product level shall not exceed - 20 dB,except within the ø-signal frequency band (3800 Hz-4200 Hz) where the intermodulation product not shall exceed -40 dB.

4.17 RESIDUAL MODULATION

4.17.1 Definition

The residual modulation of the transmitter is the ratio, expressed in dB, of the audio frequency noise level produced after radio frequency signal demodulation in the absence of modulation by the wanted signal, by the spurious effects of the power supply system, by the modulator or by other causes, to the audio frequency level produced by normal test modulation applied to the transmitter.

4.17.2 Method of measurement

a) The normal test modulation, defined in paragraph 2.2.4, is applied to the transmitter line input terminal. The RF-signal produced by the transmitter is applied by means of a suitable coupler to a linear demodulator.

The demodulator is equipped with a de-emphasis network of 6 dB per octave.

All precautions shall be taken to prevent the measurement results from being affected by emphasis at the low audio frequencies of the internal linear demodulator noise.

Measurements shall be carried out on the demodulator output signal by means of an r.m.s. voltmeter equipped with psophometric filter network described in CCITT Recommendation P.53.A.

The modulation is then removed and the level of the residual audio frequency output signal is again measured.

b) The same method as a) above but without the psophometric filter at the output.

In this case the measurements are carried out by means of a peak-to-peak voltmeter.

4.17.3 Requirement

For case a) the residual modulation shall not exceed -50 dB.
For case b) the residual modulation shall not exceed -30 dB.

4.18 SENSITIVITY OF MODULATOR, INCLUDING CONTROL UNIT (CU) AND MODEM

The transmitter line input terminal at the control unit (CU) shall be provided with a six-way socket link and test connector with double U-link plug according to IEC publication 130-12 IEC SO4/P03 to make it possible to break the line for maintenance measurements.

4.18.1 Definition

This characteristic expresses the ability of the transmitter to be sufficiently modulated when an audio frequency signal corresponding to the mean normal speech level is applied at the line terminal of CU.

4.18.2 Method of measurement

An audio frequency test signal of 1000 Hz is applied at the transmitter line input terminal. The compandor shall be activated (see paragraph 4.25), however without starting the ø-signal. The level of the test signal is adjusted until ± 3,0 kHz deviation is obtained.

The audio frequency signal level under these conditions is the sensitivity of modulator.

4.18.3 Requirement

The sensitivity of modulator shall be settable in steps of 1 dB or less (or continously) between -23 dBm and -3 dBm.

The nominal input level is -10 dBm.

4.19 INPUT IMPEDANCE

Input impedance measured at line input terminal in the frequency range 300-3400 Hz shall not deviate from $600/\underline{0^\circ}$ ohm by more than what corresponds to a reflection attenuation of 15 dB.

$$\text{Reflection attenuation} = 20 \log \left| \frac{Z_1 + Z_2}{Z_1 - Z_2} \right| \text{ dB}$$

where Z_1 = line input impedance.
$Z_2 = 600/\underline{0^\circ}$ ohm

4.20 IMPEDANCE SYMMETRY

The impedance unbalance attenuation measured at line input terminal shall not be less than:

46 dB in the frequency range 300 - 600 Hz

50 dB in the frequency range 600 -3400 Hz.

The unbalance attenuation shall be measured as shown in the figure below.

The source impedance of the generator shall be 300 ohm.

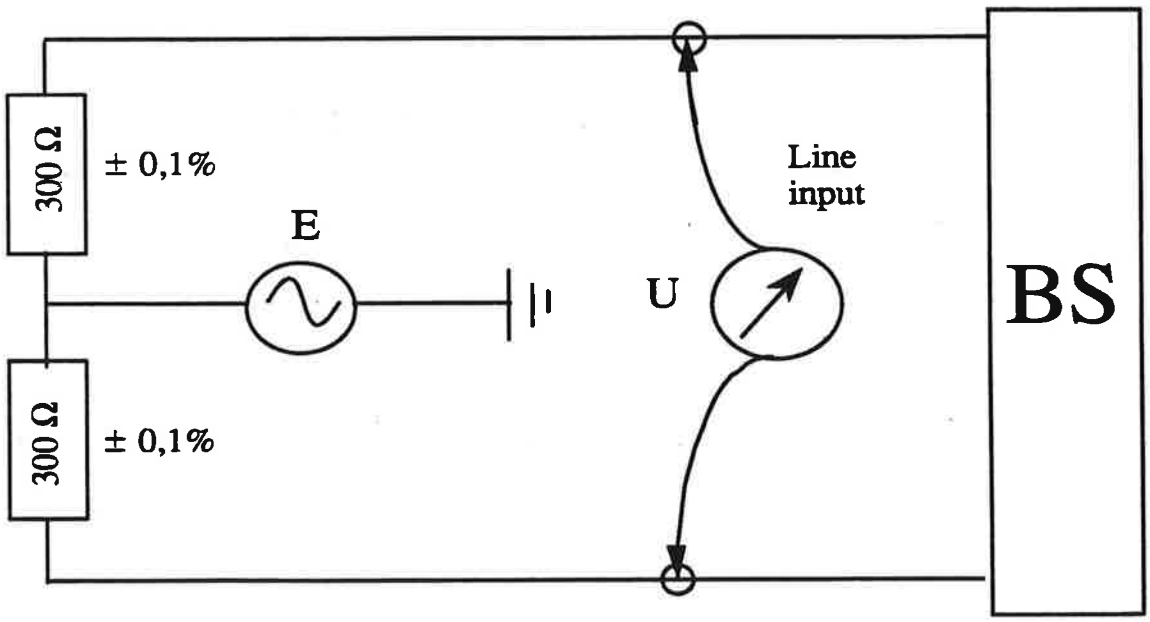


Fig. 4.3

$$\text{Impedance unbalance attenuation} = 20\log \frac{E}{U} \text{ dB}$$

4.21 GROUP DELAY DISTORTION

4.21.1 Definition

Group delay distortion is the maximum difference between the shortest and the longest delay time within a specified modulation frequency range.

4.21.2 Method of measurement

An audio frequency test signal is applied at the line input terminal.
The RF signal produced by the transmitter is applied by means of a suitable coupler to a linear demodulator.

All precautions shall be taken to prevent the measurement result from being affected by group delay distortion in the demodulator.

The frequency of the audio frequency test signal shall be varied while the frequency deviation is maintained constant ± 1,0 kHz and the delay time shall be measured.

The measurement may be carried out by means of a group delay measuring set according to CCITT Recommendation O.81.

4.21.3 Requirements

The group delay distortion shall not exceed:

200 µs within the frequency range 600-3000 Hz but not

60 µs within the frequency range 900-2100 Hz.

4.22 MODULATION DUE TO VIBRATION

4.22.1 Definition

Modulation due to vibration denotes the ability of the transmitter to withstand influence on the radio frequency output signal by mechanical vibrations.

4.22.2 Method of measurement

The radio frequency signal produced by the transmitter shall be applied, by means of a suitable coupler, to a deviation meter. A resistance equal to the normal input impedance of the transmitter shall be applied to the transmitter input. No modulation signal shall be applied to the transmitter.

In transmit condition, the transmitter shall then be vibrated in each of 3 directions:

15-4000 Hz	$1 m/s^2$
sweep rate	1 octave per minute.

During the vibration the frequency deviation of the transmitter output signal shall be measured.

4.22.3 Requirement

The frequency deviation due to vibration shall not exceed ± 0,3 kHz at any vibration frequency.

4.23 INTERFERENCE IN THE Ø-SIGNAL FREQUENCY BAND

4.23.1 Definition

The interference level is the ratio, expressed in dB, of the level of unwanted components of the output signal, caused by the presence of a modulation signal as a result of nonlinearity in the transmitter, to the level of the wanted ø-signal measured at the output of the transmitter.

4.23.2 Method of measurement

The radio frequency signal produced by the transmitter is applied, by means of a suitable coupler, to a linear demodulator equipped with a filter according to the figure below, and measured with a RMS voltmeter.
Alternatively an audio spectrum analyzer may be used.

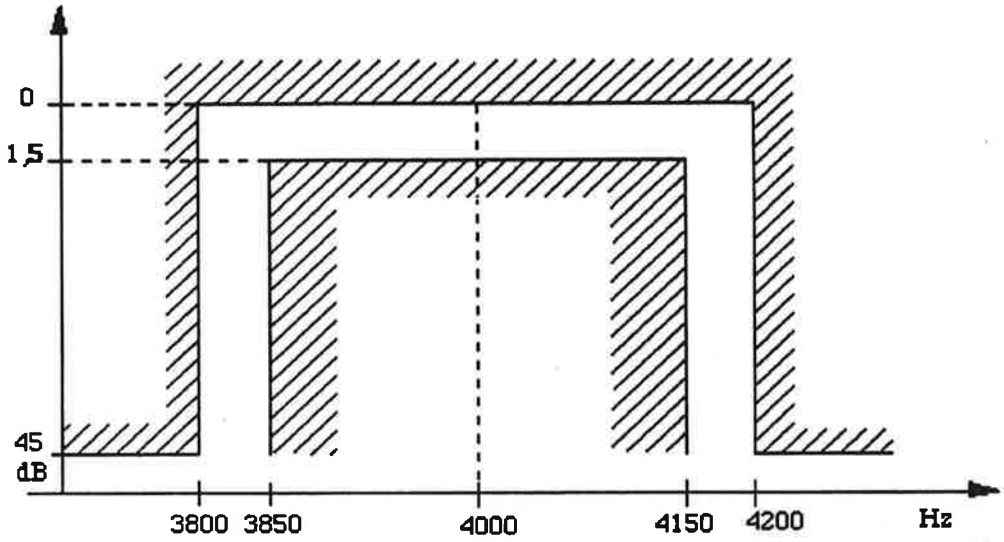


Fig. 4.4

The ø-signal is started corresponding to ± 0,3 KHz deviation and the level of the ø-signal at the output of the linear demodulator (including filter) is measured. Thereafter the sending of ø-signal is stopped.

An audio frequency signal of 1000 Hz is applied to the transmitter line input terminal.

The level is adjusted so that a peak frequency deviation of the RF-carrier of ± 3,0 kHz is obtained. The input level shall be within the range given in paragraph 4.18.3. Now the frequency is varied between 300 and 5000 Hz and the output level of the demodulator is measured.

The measurement is repeated with the level of the modulation input signal increased 6 dB.

4.23.3 Requirement

The interference level in the ø-signal frequency band shall not exceed -15 dB relative to the ø-signal level.

4.24 INFLUENCE ON DEVIATION CAUSED BY HIGH AUDIO FREQUENCIES

4.24.1 Definition

This clause expresses the transmitters capability not to be influenced by any frequencies outside the normal modulation frequencies.

4.24.2 Method of measurement

An audio frequency test signal of 1000 Hz is applied at the transmitter line input terminal. The level of the test signal is adjusted until ± 3,0 kHz deviation is obtained.

The audio level shall be within the range given in paragraph 4.18.3.

Another signal with a level of -20 dB below the test signal of 1000 Hz is then applied at the transmitter line input terminal (see paragraph 4.16.2).
The frequency of this signal varies from 5 kHz to 40 kHz.

4.24.3 Requirements

The resulting deviation shall be within ± (3,0 ± 0,2) kHz.

4.25 SYLLABIC COMPRESSOR REQUIREMENTS

The base station shall be equipped with syllabic compandors. (Reference: Recommendation G.162, CCITT IXth Plenary Assembly, Melbourne, 14-25 November 1988, Blue Book). The compression ratio shall be 2:1. The compressor part shall be located between the line input terminal at the control unit (CU) and the pre-emphasis network.

The compandors shall be activated by CU when the ø-signal is started as ordered from MTX (frame 20A(3) or 20A(14)) or locally at the base station When the ø-signal is started by frame 20A (14) the activation of the compandor shall be delayed 830 ± 30 ms after the end of the received frame 20A (14). The compandors shall be deactivated (bypassed) when the ø-signal is stopped as ordered from MTX (frame 20A(0), 20A(2), 20A(12)) or locally at the base station. For measurement purposes in chapter 4 and 5 it shall be possible to activate/deactivate the compandors irrespective of whether the ø-signal is started or not.

The measurements described in this paragraph shall be performed by using a measuring set-up consisting of four parts (see figure 4.5).

- Coupler/attenuator .
- Deviation meter (modulation analyzer)
- 6 dB/octave de-emhpasis network
- The expander part of a 2:1 syllabic compander with a nominal attack time of 3,0 msec and a nominal recovery time of 13,5 msec. The compandor shall meet the requirements in CCITT Rec. G.162. However, the compandor parameters shall be calibrated to an accuracy in line with laboratory instruments. The expander part shall be based on the integrated circuit NE570.

In paragraph 4.25 the term "reference tone" shall mean a tone, transmitted through the system including the compressor, with a frequency of 1000 Hz and producing a peak frequency deviation of ± 3,0 kHz. The term "reference level" (unaffected level) shall, at any point, mean the level of the test tone at that point. The ø-signal shall not be started during the measurements.

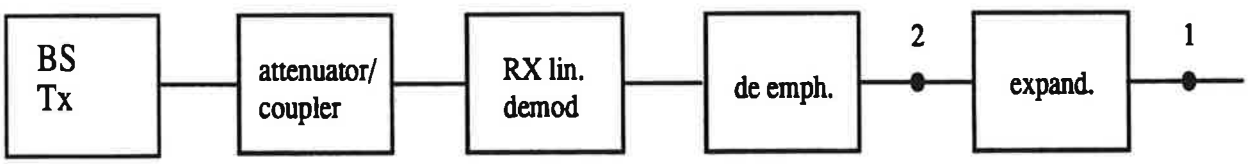


Fig. 4.5 Measuring set-up, "ideal mobile station".

When the compressor is bypassed the normal test modulation of ± 3,0 KHz deviation shall correspond to an audio frequency level of the 1000 Hz tone at the line input terminal 2,2dB below the reference level.
In this way the FFSK-signalling with an audio level of -4,4 dB at the input terminal relative to the reference level shall give the same deviation irrespective of whether the compressor is activated or not.

4.25.1 Compression linearity

4.25.1.1 Definition

The compression linearity is the deviation from the linear relation between the input amplitude of the compressor and the output amplitude of an ideal mobile station.

4.25.1.2 Method of measurement

A test signal with a frequency of 1000 Hz shall be applied to the line input terminal. Its amplitude shall be adjusted to the reference level.
The ratio D0 in dB between the amplitude of the input test signal and the amplitude at Point 1 of the measuring set-up in figure above shall be measured. The input amplitude shall subsequently be varied from +3 dB to -55 dB relative to its initial value. The ratio D between the input and the output amplitudes shall be recorded as a function of input amplitude.

Note The compression ratio of the compressor of the base station is 2:1. This compression ratio is compensated by the expansion ratio of 1:2 of the expander of the measuring set-up.

4.25.1.3 Requirements

The maximum difference between D and D0 shall be ± 1,0 dB.

4.25.2 Transient response of the compressor

4.25.2.1 Definition

The definition of transient response shall be as in CCITT Rec. G.162, clause 7.

4.25.2.2 Method of measurement

The transient response of the compressor shall be measured with a 12 dB step of a test signal of 2000 Hz applied to the line input terminal.
The high and low level of the signal shall be respecitvely -22 dB and -34 dB relative to the reference level.

The envelope of the signal at Point 1 of the measuring set-up shall be recorded for an upward step.
The procedure shall be repeated for a downward step.

Note The high and low level recommended in CCITT Rec. G.162, clause 7, are respectively -4 dB and -16 dB relative to the reference level. The values in this specification are chosen in order to avoid possible peak limiting in the radio path.

4.25.2.3 Requirements

The overshoot (positive or negative) shall be less than 20% of the final value.

4.25.3 Attack time and recovery time of the compressor

4.25.3.1 Definition

The definition of attack time and recovery time shall be as in CCITT Rec. G.162, clause 7.

4.25.3.2 Method of measurement

The attack time and recovery time of the compressor shall be measured with a 12 dB step of test signal of 2000 Hz applied to the line input terminal. The high and low level of the signal shall be -22 dB and -34 dB relative to the reference level.

The envelope of the signal at Point 2 of the measuring set-up shall be recorded for an upward step of the test signal. The attack time as defined in CCITT Rec. G.162, clause 7, shall be measured.
The procedure shall be repeated for a downward step. The recovery time as defined in CCITT Rec. G. 162, clause 7 shall be measured.

4.25.3.3 Requirements

The attack time shall be 3,0 ± 1,0 msec. The recovery time shall be 13,5 ± 5,0 msec.

4.25.4 Harmonic distortion including compressor part

4.25.4.1 Definition

See paragraph 4.15.1.

4.25.4.2 Method of measurement

See paragraph 4.15.2.
The measurement shall be repeated with the compandor activated. The harmonic distortion at Point 1 of the measuring set-up above shall be measured. At 300 Hz and 500 Hz modulation frequency the deviation shall be ± 2,0 kHz and ± 2,5 kHz respectively.

4.25.4.3 Requirement

The harmonic distortion factor shall not exceed 5%.

4.25.5 Transmission idle noise

4.25.5.1 Definition

The transmission idle noise is the psophometrically weighted noise r.m.s amplitude in dB at the output of the ideal mobile station relative to the r.m.s amplitude of the reference tone.

4.25.5.2 Method of measurement

The referece tone shall be applied to the line input terminal, and the reference level at Point 1 of the measuring set up shall be measured. The modulating signal shall be removed and the psophometrically weighted idle noise r.m.s at Point 1 of the measuring set-up shall be measured.

4.25.5.3 Requirement

The psophometrically weighted idle noise r.m.s. amplitude shall not exceed -70dB.

4.26 ATTACK TIME OF LIMITER INCLUDING COMPRESSOR PART

Method of measurement.

The attack time of the limiter shall be measured with 12 dB step of test signal of 2000 Hz applied to the line input terminal. The high and low level of the signal shall be -4 dB and -16 dB relative to the reference level. During measurement the compandor shall be activated.

The envelope of the signal at point 2 of the measuring set-up shall be recorded for an upward step of the test signal. Record the time t at which the voltage has reached 100% ± 10% of its steady state value (see figure below).

The maximum level V_m shall after 10 ms not exceed the level which corresponds 4.7 kHz deviation.

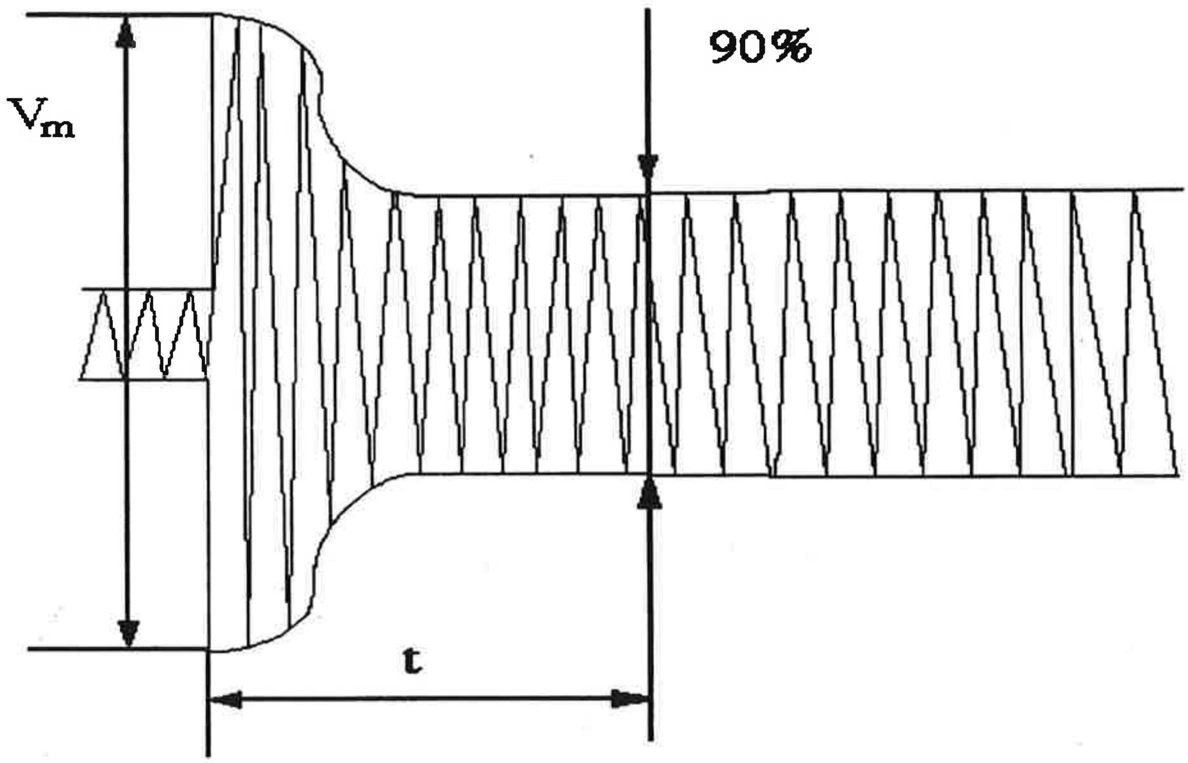


Figure 4.6

Requirement: The time t shall not exceed 50 ms.

5 RECEIVER

For the purpose of simulating duplex operation, all requirements under section 5 shall be fulfilled with an unwanted signal of carrier frequency 45 MHz above the nominal frequency of the receiver and with the level 80 dB(1μV)EMF measured at the receiver antenna input terminal of the cabinet (including receiver multicoupler). The unwanted signal shall be modulated with a 400 Hz tone to a frequency deviation of ± 3,0 kHz. A transmitter according to section 4 of this specification may be used as the unwanted signal source.

Unless otherwise specified all measurements in chapter 5 shall be carried out excluding the syllabic expander (see paragraph 5.25).

For measurements made at the receiver antenna input terminal of the radio cabinet the requirements shall be fulfilled even when all the transmitters in the cabinet are operating.

5.1 FREQUENCY RANGE

Receiver frequency range shall be 890,000-915,000 MHz. Channel separation shall be 25 kHz, with the possibility to use interleaved channels separated 12,5 kHz from the ordinary channels.

5.2 NUMBER OF RF-CHANNELS

The receiver shall be capable of being set to any of the 1999 channels in the frequency range specified in clause 5.1.

The channel setting shall be possible in two different ways:

- locally, by means of channel selector on the control unit (CU);
- remotely from the MTX via the control unit (CU).

The channel setting order from MTX shall override the local channel setting.

5.3 RF-SENSITIVITY

5.3.1 Definition

The sensitivity of the receiver incl. receiver multicoupler is the minimum level of signal (EMF) at the receiver antenna input terminal of the radio cabinet which at the nominal frequency of the receiver and with normal test modulation (2.2.4) of the signal will produce the nominal audio frequency output level (paragraph 5.10.3) and a SND/ND ratio of 20 dB, measured at the line output terminal of the receiver through a psophometric filter.

The SND/ND ratio is the ratio of signal+noise+distortion to noise + distortion.

The frequency characteristics of the 1kHz bandstop filter used in SND/ND measurement shall be such that at the output the attenuation at 1 kHz will be at least 40 dB and that at 2 kHz it shall not exceed 0,6 dB. The filter characteristic shall be flat within 0,6 dB over the ranges of 20 Hz to 500 Hz and 2 kHz to 4 kHz. In the absence of modulation, the filter shall not attenuate the total noise output power by more than 1 dB at the audio-frequency output of the receiver.

5.3.2 Method of measurement

A signal at the nominal frequency of the receiver and with normal test modulation, according to paragraph 2.2.4, shall be applied to the receiver antenna input terminal of the radio cabinet. Thus including the receiver multicoupler and cables in the cabinet. An audio frequency output load and a distortion meter incorporating a 1 kHz band-stop filter and a psophometric telephone weighting network shall be connected to the receiver line output terminal. The test signal input level shall be reduced until a SND/ND ratio of 20 dB is obtained. Where possible, audio-frequency power control shall be adjusted to give the nominal output level at the line output terminal. If this is not possible, the input level is increased until the output power is adjustable to the nominal output level. The test signal input level under these condition is the sensitivity of the receiver.

Under extreme test conditions a variation of the receiver output power of 1 dB from the value obtained under normal test conditions may be allowed.

5.3.3 Requirements

The sensitivity shall not exceed -2 dB (1 µV) EMF under normal test conditions and 0 dB (1 µV) EMF under extreme test conditions. The manufacturer shall state the corresponding RF-level at the input connector of the receiver unit.

5.4 CO-CHANNEL REJECTION

5.4.1 Definition

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

5.4.2 Method of measurement

Two input signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. Thus including receiver multicoupler. The wanted signal shall have normal test modulation. The unwanted signal shall have normal test frequency of 400 Hz to a frequency deviation of ± 3,0 kHz. Both input signals shall be at the nominal frequency of the receiver and the measurement shall be repeated for deplacements of the unwanted signal up to ± 3,4 kHz.

Initially the unwanted signal shall be switched off and the level of the wanted signal shall be adjusted to +1 dB (1 µV)EMF. The unwanted signal shall then be switched on.

The level of the unwanted signal shall be adjusted until the SND/ND ratio, measured at the line output terminal of the receiver through the psophometric filter, is reduced to 20 dB.

The co-channel rejection is expressed as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver antenna input terminal of the radio cabinet for which SND/ND=20 dB at the receiver line output terminal occurs.

5.4.3 Requirements

The co-channel rejection ratio at any of the specified signal displacement shall not be less than -8 dB.

5.5 ADJACENT CHANNEL SELECTIVITY, SELECTIVITY IN THE INTER-LEAVED CHANNEL

5.5.1 Adjacent channel selectivity

5.5.1.1 Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the channel separation (± 25 kHz).

5.5.1.2 Method of measurement

Two signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. Thus including receiver multicoupler. The wanted signal shall be at the nominal frequency of the receiver and be modulated with normal test modulation. The unwanted signal shall be at the nominal frequency of the upper adjacent channel and be modulated with a 400 Hz tone to a frequency deviation of ± 3,0 kHz.

Initially the unwanted signal shall be switched off and the level of the wanted signal shall be adjusted to 1 dB(1µV)EMF. The unwanted signal shall then be switched on and its level adjusted until the SND/ND ratio, measured at the receiver line output terminal through the psophometric filter, is reduced to 20 dB.

The measurement shall be repeated with the unwanted signal at the nominal frequency of the lower adjacent channel.

The adjacent channel selectivity shall be expressed as the lower value of the level in dB(1 µV)EMF of the unwanted signal for the upper and lower adjacent channels.

5.5.1.3 Requirement

The adjacent channel selectivity shall not be less than 75 dB(1µV)EMF under normal and not less than 70 dB(1µV)EMF under extreme test conditions.

5.5.2 Adjacent channel selectivity in the interleaved channel (+12,5 kHz)

5.5.2.1 Definition

The adjacent channel selectivity in the interleaved channel is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs 12,5 kHz in the frequency from the wanted signal.

5.5.2.2 Method of measurement

Two signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. The wanted signal shall be tuned to the nominal frequency of the receiver and be modulated with normal test modulation. The unwanted signal shall be at the nominal frequency of the upper adjacent interleaved channel (+ 12,5 kHz) and be modulated with a 400 Hz tone to a frequency deviation of $\pm$ 3 kHz.

Initially the unwanted signal shall be switched off and the level of the wanted signal shall be adjusted to 1 dB (1 µV) EMF under normal test conditions. The unwanted signal shall then be switched on and its level adjusted until the SND/ND-ratio, measured at the line output terminal, is reduced to 20 dB.

The measurement shall be repeated with the unwanted signal at the nominal frequency of the lower adjacent interleaved channel (-12,5 kHz).

The adjacent channel selectivity in the interleaved channel shall be expressed as the lower value of the level in dB (1 µV) EMF of the unwanted signal for the upper and lower adjacent interleaved channels.

5.5.2.3 Requirement

The adjacent channel selectivity in the interleaved channel shall not be less than 36 dB (1 µV) EMF under normal test conditions.

5.6 SPURIOUS RESPONSE REJECTION

5.6.1 Definition

The spurious response rejection is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted modulated signal at any other frequency at which a response is obtained. The measurement shall include the receiver multicoupler.

5.6.2 Method of measurement

Two input signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. The wanted signal shall be at the nominal frequency of the receiver and be modulated with normal test modulation. Initially the unwanted signal X shall be switched off and the wanted input signal adjusted to 1 dB(1µV)EMF. The unwanted signal shall be switched on and modulated with a 400 Hz tone to a frequency deviation of ± 3,0 kHz. The input level of the unwanted signal shall be 106 dB(1µV)EMF. and its frequency shall be varied at least from 100 kHz to 4000 MHz.

At any frequency at which a response is obtained, the input level of the unwanted signal shall be adjusted until the SND/ND ratio, measured at the line output terminal of the receiver through the psophometric filter, is 20 dB.

The spurious response rejection shall be expressed as the level in dB(1µV)EMF of the unwanted signal at the receiver antenna input terminal of the radio cabinet when the SND/ND ratio of 20 dB, as mentioned above, is obtained.

5.6.3 Requirement

Except for frequencies within the wanted channel and the adjacent channels the spurious response rejection shall not be less than:

75 dB(1µV)EMF for $X \leq 100$ kHz apart from nominal frequency
80 dB(1µV)EMF for $100 \text{ kHz} < X \leq 1$ MHz apart from nominal frequency and
90 dB(1µV)EMF for $1 \text{ MHz} < X \leq 25$ MHz apart from nominal frequency
100 dB(1µV)EMF for $X > 25$ MHz apart from nominal frequency

5.7 INTERMODULATION REJECTION

5.7.1 Definition

The intermodulation rejection is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of two unwanted highlevel signals. The measurement shall include the receiver multicoupler.

5.7.2 Method of measurement

a) Three signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. The wanted signal A shall be at the nominal frequency of the receiver and be modulated with normal test modulation. The unwanted signal B shall be tuned to a frequency 50 kHz above the frequency of the wanted signal and shall be unmodulated. The unwanted signal C shall be tuned to a frequency
100 kHz above the frequency of the wanted signal and be modulated with a 400 Hz tone to a frequency deviation of ± 3,0 kHz.
The level of the wanted signal A shall be adjusted to 1 dB(1µV)EMF.
The levels of the two unwanted signals B and C shall be maintained equal and increased in level until the SND/ND ratio, measured at the line output terminal of the receiver through the psophometric filter, is 20 dB.

The frequencies of signals B and C may be slightly adjusted to get maximum degradation of the SND/ND ratio and their levels adjusted again until the SND/ND ratio is again 20 dB.

The measurement shall be repeated with the two unwanted signals B and C tuned to 50 kHz and 100 kHz respectively below the frequency of the wanted signal.

b) The measurement shall be repeated with the unwanted signals B and C tuned to a frequency respectively 200 kHz and 400 kHz above/below the frequency of the wanted signal.

The intermodulation rejection shall be expressed as the level in dB(1µV)EMF of the unwanted signals at the receiver antenna input terminal of the radio cabinet when the SND/ND ratio of 20 dB, as mentioned above, is obtained.

5.7.3 Requirement

In case a) the intermodulation rejection shall not be less than 75 dB(1µV)EMF.

In case b) the intermodulation rejection shall not be less than 80 dB(1µV)EMF.

5.8 BLOCKING

5.8.1 Definition

Blocking is a change (generally a reduction) in the wanted output power of the receiver or a reduction of the SND/ND ratio due to an unwanted signal at another frequency. The measurement shall include the receiver multicoupler.

5.8.2 Method of measurement

Two input signals shall be applied to the receiver antenna input terminal of the radio cabinet via a combining network. The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation. Initially the unwanted signal shall be switched off and the input level of the wanted signal shall be adjusted to 1 dB(1µV)EMF.

The output power of the wanted signal at the line output terminal of the receiver shall be adjusted to the nominal output level (paragraph 5.10.3). Then the unwanted signal shall be switched on. The unwanted signal shall be unmodulated, and its frequency shall be varied between +1 MHz and +50 MHZ, and also between -1 MHz and -50 MHz, relative to the nominal frequency of the receiver. The input level of the unwanted signal, at all frequencies in the specified ranges, shall be adjusted so that the unwanted signal causes:

a) a reduction of 3 dB in the audio frequency output power of the wanted signal, or

b) a reduction of the SND/ND ratio to 20 dB, measured through a psophometric filter,

whichever occurs first.

This input level is the blocking level at the frequency concerned.

5.8.3 Requirement

The blocking level for any frequency within the specified ranges except at frequencies where spurious responses are found shall not be less than:
95 dB(1μV)EMF between 1 MHz and 2 MHz apart from the nominal frequency, and 100 dB(1μV)EMF between 2 MHz and 50 MHz apart from the nominal frequency.

5.9 SPURIOUS EMISSIONS

5.9.1 Definition

Spurious emissions are any emissions from the receiver.

The level of spurious emissions shall be measured as:

a) their conducted power in an artificial antenna and

b) their effective radiated power when radiated by the cabinet and structure of the equipment (also called "cabinet radiation").

5.9.2 Method of measuring the conducted power

Conducted spurious emissions shall be measured as the power of any discrete signal at the input terminal of the receiver. The receiver input terminal is connected to a spectrum analyzer or selective voltmeter having an input impedance of 50 ohms, and the receiver is switched on.

If the measuring receiver is not calibrated in terms of absolute power, the power of any detected components shall be determined by a substitution method using a signal generator.

The measurement shall be carried out within at least the frequency range 100 kHz to 4000 MHz.

5.9.3 Method of measuring the effective radiated power

On a test site fullfilling the requirements of 2.2.8 the sample shall be placed at the specified height on a non-conducting support. The receiver shall be operated from a power source via a radio-frequency filter to avoid radiation from the power leads. The antenna terminal shall be connected to a 50 ohms resistive load.

Radiation of any spurious components shall be detected by the test antenna and measuring receiver over at least the frequency range from 30 MHz to 4000 MHz. At each frequency at which a spectral component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component shall be determined by a substitution measurement.

The measurement shall be repeated with the test antenna in the orthogonal polarization plane.

5.9.4 Requirement

The power of any spurious emission in the measured range of frequencies shall not exceed 2,0 nW except within the frequency range from 890,000 MHz to 915,000 MHz where the conducted power shall not exceed 0,01 pW and the effective radiated power shall not exceed 2 pW.

5.10 AUDIO FREQUENCY POWER TO LINE, INCLUDING CONTROL UNITS AND MODEM

The receiver line output terminal at the control unit (CU) shall be provided with a six-way socket link and test connector with double U-link plug according to IEC publication 130-12 IEC SO4/PO3 to make it possible to break the line for maintenance measurements.

A separate output for the supervisory signal shall be available to feed the supervisory signal detector in the control unit. The supervisory signal output shall not be affected by squelch operation.

5.10.1 Definition

This characteristic expresses the ability of the receiver to deliver sufficient audio power to the line.

5.10.2 Method of measurement

A test signal at a level of 60 dB(1 µV)EMF at the nominal frequency of the receiver and having normal test modulation shall be applied to the receiver input. The compandor shall be activated (see paragraph 5.25).

The audio output power shall be measured at the line output terminal to a 600 ohms resistive load.

5.10.3 Requirement

The audio power at the line output terminal shall be settable in steps of 1 dB or less (or continuously) between -21 dBm and -1 dBm.

The nominal output level is -10 dBm.

5.11 LINE OUTPUT IMPEDANCE

The impedance measured at the line output terminal in the frequency range 300-3400 Hz shall not deviate from 600/0° ohms by more than what corresponds to a reflection atenuation of 15 dB.

Where Z_1 = line output impedance.
Z_2 = 600/0° ohm

5.12 IMPEDANCE SYMMETRY

The impedance unbalance attenuation to earth measured at the line output terminal shall not be less than:

46 dB in the frequency range 300-600 Hz
50 dB in the frequency range 600-3400 Hz.

The unbalance attenuation shall be measured as shown in the figure below. Both voltmeters shall have 10 kohm impedance.

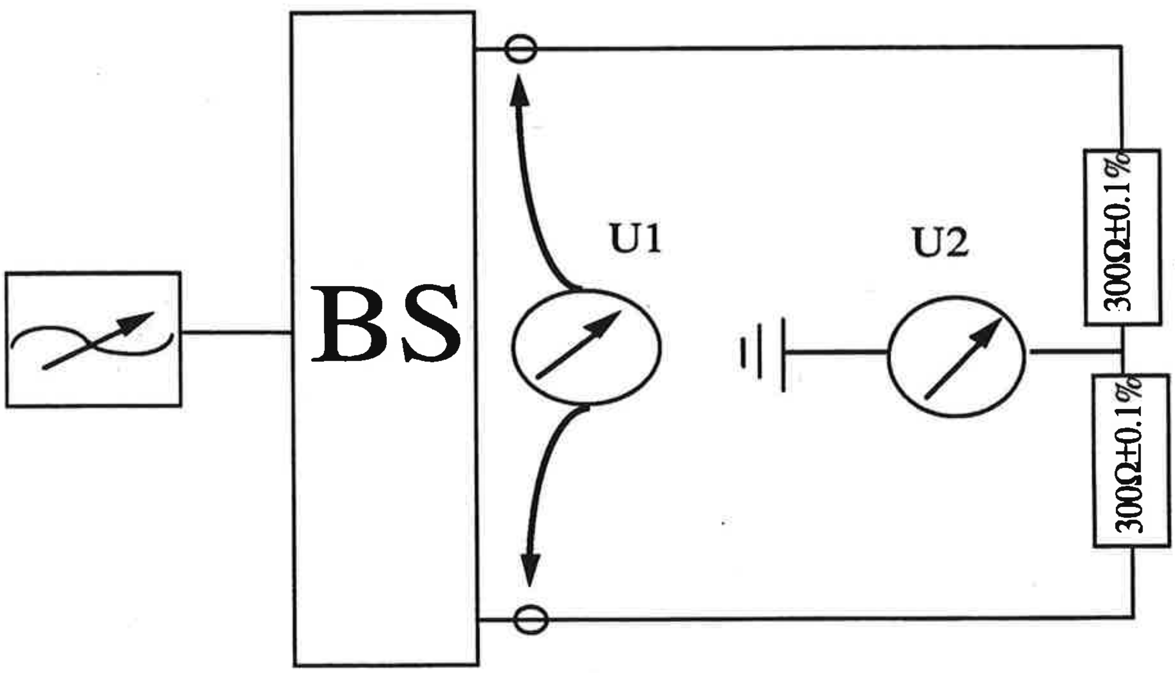


Fig. 5.1

The impedance unbalance attenuation is 20 $\log_{10}$ (U1 /U2) dB.

When performing the measurement, a test signal at a level of 60 dB (1 µV)EMF at the nominal frequency of the receiver and having normal test modulation shall be applied to the receiver input.

5.13 AMPLITUDE CHARACTERISTICS OF THE RECEIVER LIMITER

5.13.1 Definition

The amplitude characteristics of the receiver limiter is the relationship between the radio frequency input level of a specified modulated signal and the audio power at the receiver line output terminal.

5.13.2 Method of measurement

A test signal at a level of -2 dB(1µV)EMF at the nominal frequency of the receiver and having normal test modulation shall be applied to the receiver input. The audio frequency power at the line output terminal shall be adjusted to a level within the range given in paragraph 5.10.3. The input signal shall be increased to 100 dB(1µV)EMF, and the audio frequency output level shall again be measured.

5.13.3 Requirement

For the specified range of radio frequency input level, the change in the audio power at the line output terminal shall not exceed 2 dB between the minimum and maximum output power.

5.14 AM-SUPPRESSION

5.14.1 Definition

AM-suppression is the capability of the receiver to suppress amplitude modulated signals. It is expressed as the ratio in dB of the audio power at the line output terminal with normal test modulation to the audio power with a specified amplitude modulation.

5.14.2 Method of measurement

A test signal at a level of 20 dB(1µV) and 60 dB(1µV)EMF at the nominal frequency of the receiver shall be applied to the receiver input successively.
The signal shall initially have normal test modulation and the line output power shall be set to the nominal output level. The normal test modulation shall then be replaced by amplitude modulation to 30% with a 1000 Hz tone. The audio power shall again be measured. It may be necessary to make this measure ment with a selective voltmeter.

5.14.3 Requirement

The AM-suppression shall not be less than 30 dB.

5.15 AUDIO FREQUENCY RESPONSE OF THE RECEIVER (INCLUDING LINE OUTPUT CIRCUIT)

5.15.1 Definition

The audio frequency response of the receiver expresses the variations in the audio power at the line output terminal as a function of the modulation frequency of the input signal.

5.15.2 Method of measurement

A test signal at a level of 60 dB(1µV)EMF at the nominal frequency of the receiver and having normal test modulation shall be applied to the receiver input.

The audio power shall be adjusted to a level within the range given in paragraph 5.10.3. This setting shall not be altered during the test.

The frequency deviation at 1000 Hz shall then be reduced to ± 1,0 kHz and maintained constant while the modulation frequency is varied at least between 20 Hz and 5000 Hz.

The measurement is repeated with the test signal successively at plus and minus 2,5 kHz from the nominal frequency of the receiver.

5.15.3 Requirement

The audio frequency response shall be within the limits as shown in the figure Fig below.

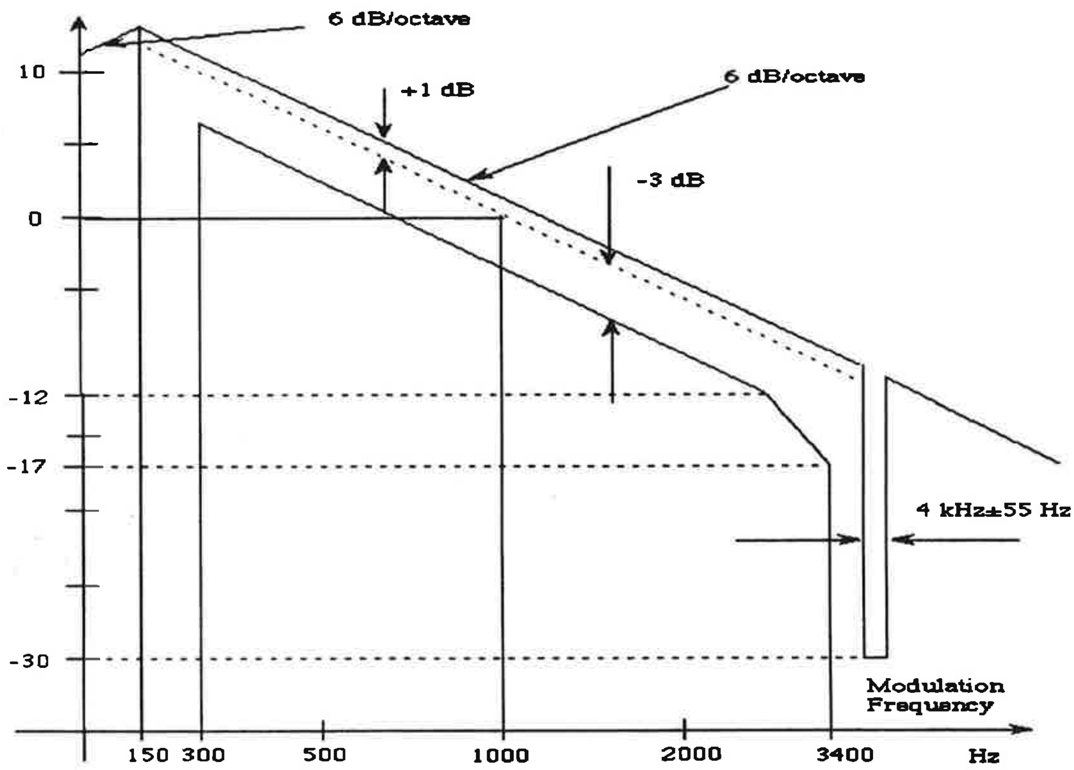


Fig. 5.2

5.16 HARMONIC DISTORTION FACTOR

5.16.1 Definition

The harmonic distortion factor at the line output terminal of the receiver is defined as the ratio, expressed as a percentage, of the r.m.s. voltage of all the harmonic components of the fundamental audio frequency to the total r.m.s. line output voltage.

With the method of measurement described on the next page, in case a distortion meter is used, the hum and noise components are included in the distortion measurement.

5.16.2 Method of measurement

Test signals of 60 dB(1µV)EMF and 100 dB(1µV)EMF at the nominal frequency of the receiver shall be applied successively to the receiver input.

The test signal shall be modulated with a 1000 Hz tone to ± 3,5 kHz frequency deviation and the harmonic distortion is measured at the line output terminal. The measurement shall be repeated with the test signal modulated with a 300 Hz and 500 Hz tone respectively to ± 3,0 kHz frequency deviation.
The audio power at the line output terminal shall be adjusted to deliver a level within the corresponding range as given in paragraph 5.10.3 to a resistive 600 ohms load.

Under extreme test conditions, tests shall be carried out at the nominal frequency of the receiver as well as at ± 1,0 kHz from the nominal frequency. In this case the input signal is modulated only with a 1000 Hz tone to a frequency deviation of ± 3,5 kHz.

5.16.3 Requirement

At all audio frequencies used in the measurement and under all test conditions the harmonic distortion factor shall not exceed 5%.

5.17 RELATIVE AUDIO FREQUENCY INTERMODULATION PRODUCT LEVEL OF THE RECEIVER

5.17.1 Definition

The relative intermodulation product level is the ratio, expressed in decibels, of the level of an unwanted component of the output signal caused by the presence of two unmodulating signals as a result of nonlinearity in the receiver to the level of the greater of the wanted output signals measured at the line output terminal.

5.17.2 Method of measurement

a) Connect the equipment as shown in the figure below.

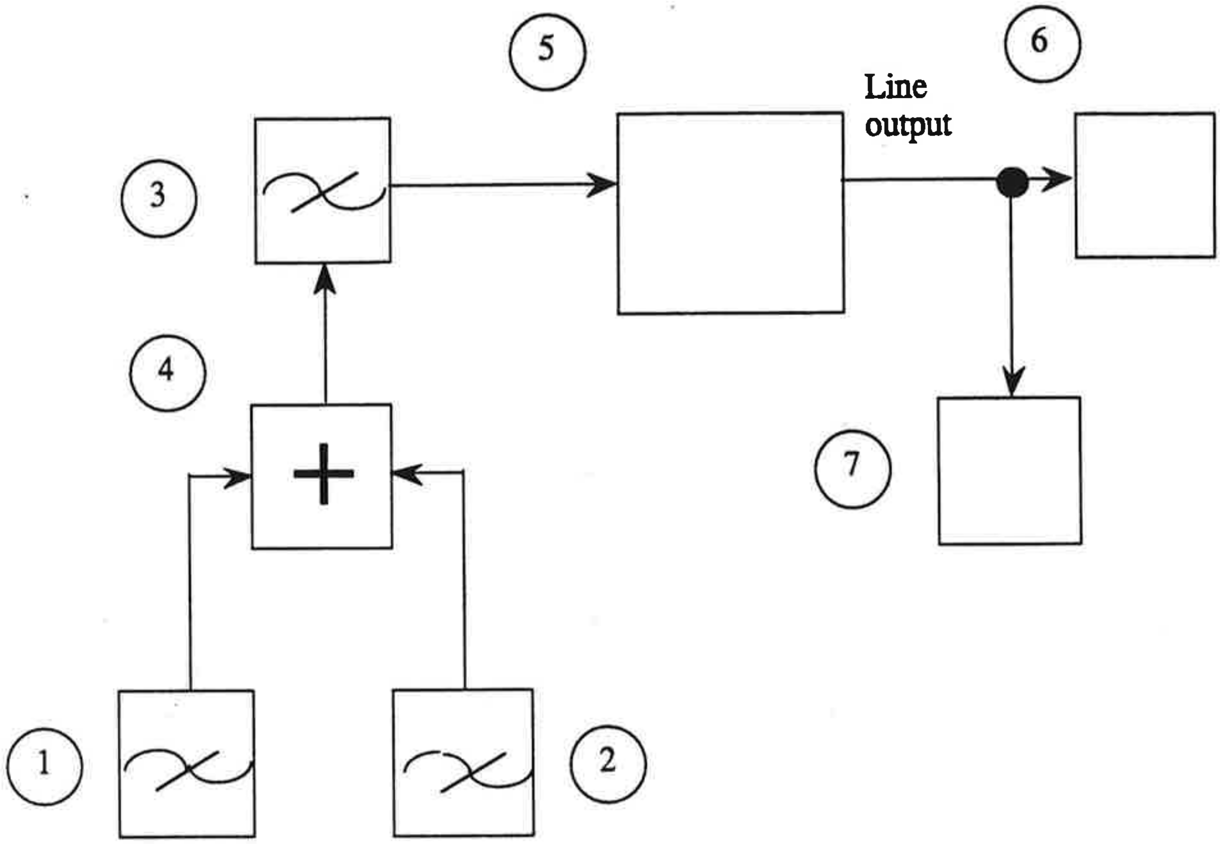


Fig. 5.3

1. Audio-frequency generator A
2. Audio-frequency generator B
3. Radio-frequency signal generator
4. Audio-frequency combining unit
5. Receiver under test
6. Audio-frequency test load
7. Audio-frequency selective voltmeter.

b) Adjust the radio-frequency test signal to the nominal frequency of the receiver and the test signal level successively to 20 dB, 60 dB(1μV)EMF.

c) In the absence of an output from audio-frequency generator B, adjust the audio-frequency generator A to produce a ± 2,5 kHz frequency deviation at a modulation frequency of 1000 Hz. Adjust the audio power at the line output terminal to a level within a range corresponding to the level range given in paragraph 5.10.3. Record the output level of the generator A.

d) Reduce the output of generator A to zero and adjust the output of generator B to produce a ± 2,5 kHz frequency deviation at a modulation frequency of 1500 Hz.

e) Restore the output of generatorA to the level recorded to c) and measure the level of the 1000 Hz component and of the intermodulation products at the line output terminal.

5.17.3 Requirement

The relative audio frequency intermodulation product level shall not exceed -20 dB.

5.18 NOISE AND HUM OF THE RECEIVER

5.18.1 Definition

The "noise and hum" of the receiver is the ratio, expressed in decibels, of the audio frequency noise and hum level resulting from the spurious effects of the power supply system or from other causes, to the audio frequency level produced by RF-signals as specified below and applied to the receiver input.

5.18.2 Method of measurement

a) A test signal at a level of 30 dB(1μV)EMF at the nominal frequency of the receiver and having normal test modulation shall be applied to the receiver input. A 600 ohms resistive load and a psophometric filter shall be connected at the line output terminal. The audio power at the line output terminal shall be adjusted to a level within the range given in paragraph 5.10.3.

   The output voltage is measured with an r.m.s. voltmeter.

   The modulation is then removed and the audio power measurement is repeated.

b) The same method as in case a) above, but without the psophometric filter and using a peak-to-peak voltmeter for the measurement.

c) The measurement according to a) above shall be repeated at a level of 10 dB (1 μV) EMF.

5.18.3 Requirement

In case a) the receiver "noise and hum" ratio shall not exceed -50 dB.

In case b) the receiver "noise and hum" ratio shall not exceed -30 dB.

In case c) the receiver "noise and hum" ratio shall not exceed -30 dB.

5.19 GROUP DELAY DISTORTION

5.19.1 Definition

Group delay distortion is the maximum difference between the shortest and the longest delay time within a specified modulation frequency range.

5.19.2 Method of measurement

A test signal at a level of 60 dB(1 µV) EMF at the nominal frequency of the receiver shall be applied to the receiver. The signal shall be modulated by an audio frequency test signal.

All precautions shall be taken to prevent the measurement from being affected by the group delay distortion in the signal generator.

The frequency of the audio frequency test signal shall be varied while the frequency deviation is maintained constant at ± 3,0 kHz and the delay time is measured at the line output terminal.

The measurement may be carried out by means of a group delay measuring set according to CCITT Recommendation O.81.

5.19.3 Requirement

The group delay distortion shall not exceed:

200 µs within the frequency range 600-3000 Hz but not 60 µs within the frequency range 900-2100 Hz.

5.20 SQUELCH

5.20.1 Squelch opening and closing levels

The squelch opening level measured with an RF test signal with normal test modulation at the receiver antenna input terminal of the radio cabinet shall be -2 dB (1 µV) EMF ± 2 dB at normal test conditions.

The manufacturer shall state the corresponding RF-level at the input connector of the receiver unit.

The squelch opening level shall be adjustable from the front of the cabinet. The adjustment range for squelch opening level shall be at least -4 dB (1 µV) EMF to +4 dB (1 µV) EMF.

At extreme test conditions the opening and closing level shall not differ by more than 2 dB from the levels at normal test conditions.

The squelch closing level shall allways be 1 to 2 dB below the opening level.

The squelch opening and closing levels shall not vary by more than ± 2 dB from the levels obtained with an unmodulated test signal under conditions of receiving a test signal having ± 3 kHz deviation and with a carrier offset of ± 2,5 kHz. The modulation frequency shall be varied between 300-3400 Hz. The supervisory signal shall be included during the measurement.

It shall be possible to switch the squelch on and off locally from the control unit.

5.20.2 Squelch opening and closing delays

5.20.2.1 Definition

The squelch opening and closing delays are the intervals between the time of occurrence of a specified increase or decrease of a modulated radiofrequency input-signal level and the time when the voltage at the line output is 50% of its steady-state unsquelched value.

5.20.2.2 Squelch control by data signal

Single frame data signalling from MTX shall switch the squelch function in and out ordered by frame 20 (see NMT Doc. 900-1).

5.20.2.3 Method of measurement

An oscilloscope shall be connected to the line output terminal connected to a 600 ohms resistive load, and an electrically-operated, single-step attenuator having at least a 30 dB difference in attenuation shall be connected between the radio-frequency signal generator and the receiver.

The operating time of an attenuator shall be short compared with the expected squelch opening and closing times.

The signal generator shall be modulated with normal test modulation.

With the 30 dB step attenuator at the low attenuation value, the test signal shall be adjusted to the nominal frequency of the receiver and to a level of 2 dB above the actual squelch opening level. The measurement shall be repeated at a higher RF-level.

The synchronizing pulse for the calibrated horizontal sweep of the oscilloscope shall be derived form the attenuator activating signal.

The state of the step attenuator shall then be changed from low to high attenuation and after that back to low attenuation again.

Record the squelch opening and closing delays t_o and t_c respectively as the interval between the attenuator activating signal and the time at which the voltage at the line output terminal has reached 50% of its steadystate unsquelched value (see figure below).

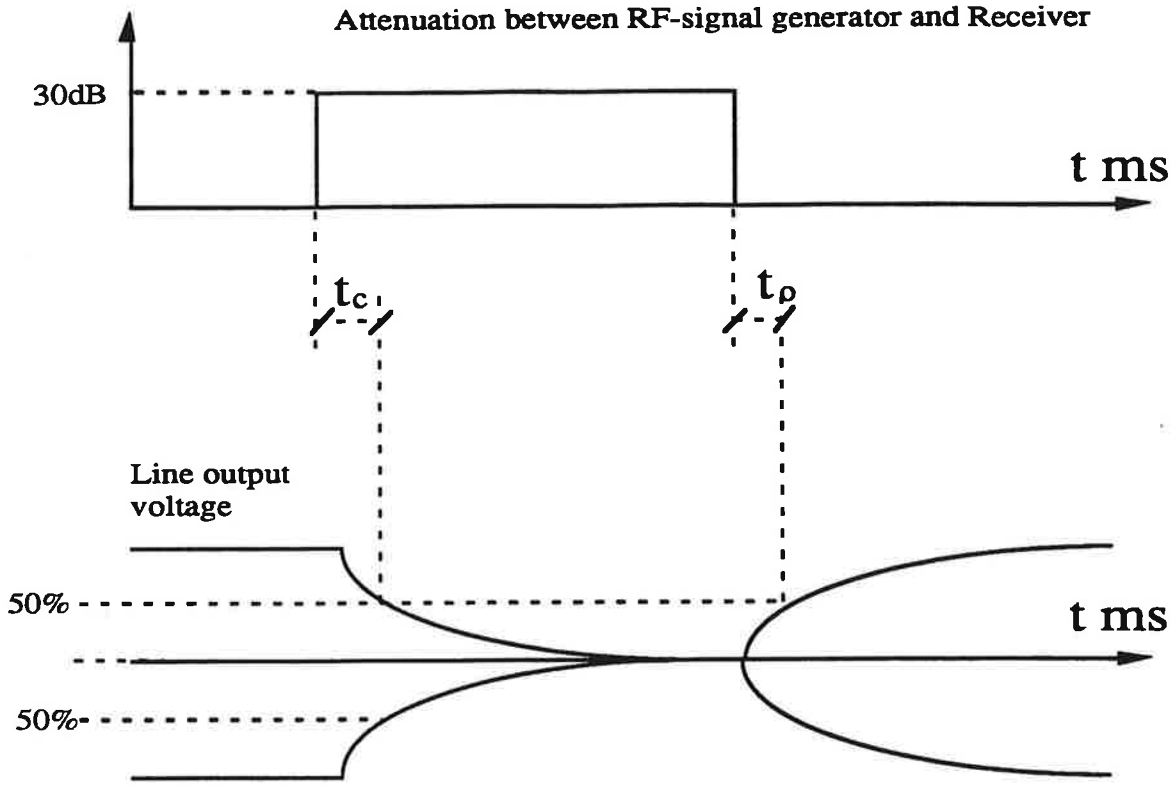


Fig. 5.4

5.20.2.4 Requirement

Opening and closing delay over the whole adjustment range shall be:

Opening delay t_o = 5 +2/-4 ms

Closing delay t_c = 150 $\pm$ 30 ms

5.21 AUDIO OUTPUT DUE TO VIBRATION

5.21.1 <u>Definition</u>

Audio output due to vibration denotes the ability of the receiver to withstand influence on a received radio frequency signal by mechanical vibrations.

5.21.2 Method of measurement

A test signal at a level of 30 dB(1µV)EMF at the nominal frequency of the receiver having normal test modulation shall be applied to the receiver input. A 600 ohms resistive load shall be connected to the line output terminal. The audio power shall be adjusted to a level within the range given in paragraph 5.10.3.

The level of the output signal shall be measured by an r.m.s. voltmeter and the measured level shall be recorded.

The receiver shall then be vibrated in each of 3 directions.

15-4000 Hz	1 m/s^2
sweep rate	1 octave per minut

During the vibration the radio frequency test signal shall be unmodulated and the level of the receiver output signal shall be measured.

5.21.3 Requirement

The audio power at any vibration frequency shall not exceed -20 dB relative to the audio power at normal test modulation without vibration.

5.22 RF-LEVEL INDICATOR

The receiver shall be equipped with a signal strength indicator giving information to CU when the RF-signal exceeds 10 ± 4 dB (1 µV) EMF. See paragraph 8.1.3.2.

5.23 INTERFERENCE IN THE Ø-SIGNAL FREQUENCY BAND

5.23.1 Definition

The interference level is the ratio, expressed in dB, of the level of unwanted components of the output signal, caused by the presence of the modulation in the received signal as a result of nonlinearity in the receiver, to the level of the wanted ø-signal measured at the output of the receiver excluding the filter according to paragraph 5.15.3.

5.23.2 Method of measurement

A filter according to the figure below is applied to receiver output in such a way to exclude the filter for the ø-signal frequency band according pargagraph 5.15.3, and the audio frequency level is measured with a RMS voltmeter. Alternatively an audio spectrum analyzer may be used.

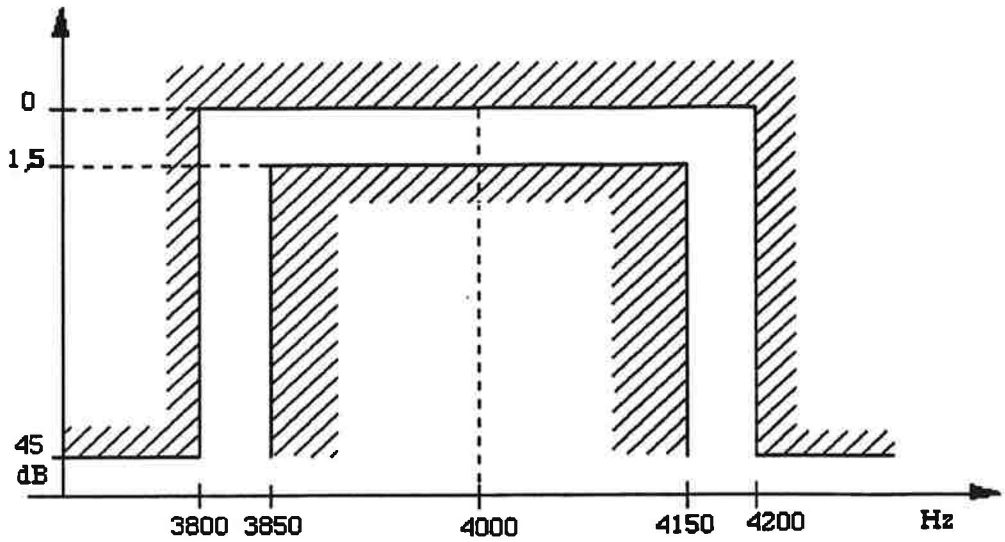


Fig. 5.5

A radio frequency singal at the nominal frequency of the receiver and with a level of 60 dB (1 µV) EMF is applied to the receiver input terminal. The radio frequency signal is modulated with ø-signal to ± 0,3 kHz deviation and the level of the ø-signal is measured. Thereafter the ø-signal modulation is removed.

The receiver input radio frequency signal is then modulated to ± 1,5 kHz deviation and the modulation frequency is varied between 300 Hz and 3400 Hz. The interference in the looped ø-signal channel is measured.

The measurement is repeated at the deviation 3 dB above and 3 dB below ± 1,5 kHz deviation.

5.23.3 Requirement

The interference level in the ø-signal frequency band shall not exceed -10 dB relative to the ø-signal level.

5.24 RELATIVE AUDIO FREQUENCY INTERMODULATION PRODUCT LEVEL IN THE Ø-SIGNAL FREQUENCY BAND

5.24.1 Definition

The relative intermodulation product level is the ratio, expressed in dB, of the level of unwanted components in the ø-signal frequency band caused by the presence of two modulating signals as a result of nonlinearity in the receiver, to the level of the wanted ø-signal measured at the output of the receiver excluding the filter for the ø-signal frequency band according paragraph 5.15.3.

5.24.2 Method of measurement

A filter according to paragraph 5.23.2 is applied to the receiver output in such a way to exclude the filter for the ø-signal frequency band according paragraph 5.15.3, and the audio frequency level is measured with an RMS voltmeter. Alternatively an audio spectrum analyzer may be used.

A radio frequency signal at the nominal frequency of the receiver and with a level of 60 dB (1 µV) EMF is applied to the receiver input terminal. The radio frequency signal is modulated with ø-signal to ± 0,3 kHz deviation and the level of the ø-signal is measured. Thereafter the ø-signal modulation is removed.

Two audio frequency generators, A and B, shall be connected via a combining device to the modulation input of the radio frequency signal generator.

Adjust the radio-frequency test signal to the nominal frequency of the receiver and the test signal level successively to 20 dB and 60 dB (1 µV) EMF.

In the absence of an output from audio-frequency generator B, adjust the audio-frequency generator A to produce a ± 2,1 kHz frequency deviation at a modulation frequency of 1200 Hz. Record the output level of generator A.

Reduce the output of generator A to zero and adjust the output of generator B to produce a ± 2,1 kHz frequency deviation at a modulation frequency of 2800 Hz. Restore the output of generator A to the level recorded and measure the intermodulation products in the ø-signal frequency band.

5.24.3 Requirement

The intermodulation product level in the ø-signal frequency band shall not exceed -10 dB relative to the ø-signal level.

5.25 SYLLABIC EXPANDER REQUIREMENTS

See paragraph 4.25 regarding reference to CCITT Recommendation and the activating/deactivating of the compandors.
The expander shall be located between the de-emphasis network and the line output terminal. The measurements described in this paragraph shall be performed by using a measuring set-up consisting of four parts (see figure below):

- Coupler

- The compressor part of a 2:1 syllabic compander with a nominal attack time of 3.0 msec and a nominal recovery time of 13.5 msec.
  The compandor shall meet the requirements in CCITT Rec.G.162.
  However, the compandor parameters shall be calibrated to an accuracy in line with laboratory instruments. The compressor part shall be based on the integrated circuit NE570.

- A 6 dB/octave pre-emphasis network.

- A linear modulator/radio frequency signal generator providing an FM-modulated radio frequency signal with a peak frequency deviation proportional to its input amplitude. The RF-level at the receiver input terminal shall be 60 dB (1μV) EMF.

In paragraph 5.25 the term "reference tone" shall mean a tone, transmitted through the system, with a frequency of 1000 Hz and producing a peak frequency deviation of ± 3,0 kHz. The term "reference level" (unaffected level) shall, at any point, mean the level of the test tone at that point.

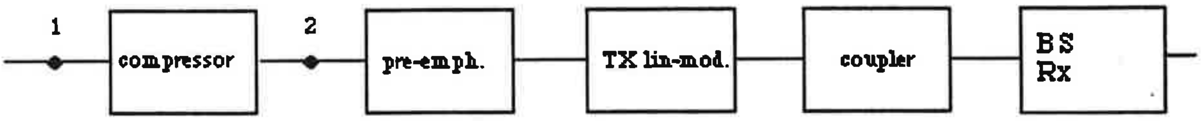


Fig. 5.6

Measuring set-up, "ideal mobile station"

When the expander is bypassed the normal test modulation of ± 3,0 kHz deviation shall correspond to an audio frequency level of the 1000 Hz tone at the line output terminal of 2,2 dB below the reference level.
In this way an RF-signal modulated with the FFSK-signalling (4.2 kHz peak deviation, 1800 Hz tone) shall give the same audio frequency level at the line output terminal irrespective of whether the expander is activated or not.

5.25.1 Expansion linearity

5.25.1.1 Definition

The expansion linearity is the deviation from the linear relation between the input amplitude of an ideal mobile station and the output amplitude of the expander of the base station.

5.25.1.2 Method of measurement

A test signal with a frequency of 1000 Hz shall be applied to Point 1 of the measuring set-up in figure 5.6. Its amplitude shall be adjusted to the reference level. The ratio D0 in dB between the amplitude of the input set signal and the amplitude of the signal at the line output terminal shall be measured. The input level shall subsequently be varied from +3 dB to -55 dB relative to its initial value. The ratio D between the input amplitude and the output amplitude shall be recorded as a function of input amplitude.

Note. The expansion ratio of the expander of the base station is 1:2. This expansion ratio is compensated by the compression ratio of 2:1 of the compressor of the measuring set-up.

5.25.1.3 Requirements

The maximum difference between D and D0 shall be ± 1,0 dB.

5.25.2 Transient response of the expander

5.25.2.1 Definition

The definition of transient response shall be as in CCITT Rec.G.162, clause 7.

5.25.2.2 Method of measurement

The transient response of the expander shall be measured with a 12 dB step of a test tone of 2000 Hz applied to Point 1 of the measuring set-up.
The high and low level of the signal shall be respectively -22 dB and -34 dB relative to the reference level.

The envelope of the signal at the line output terminal shall be recorded for an upward step.

The procedure shall be repeated for a downward step.

Note: The high and low level recommended in CCITT Rec.G.162, clause 7 are respectively -4 dB and -16 dB relative to the reference level. The values in this specification are chosen in order to avoid possible peak limiting in the radio path.

5.25.2.3 Requirements

The overshoot (positive or negative) shall in both of the above cases be less than 20% of the final value.

5.25.3 Receive harmonic distortion

5.25.3.1 Definition

See paragraph 5.16.1.

5.25.3.2 Method of measurement

See paragraph 5.16.2.
The measurement shall be repeated with the compandor activated, and using the measuring set-up above. The harmonic distortion at the line output terminal shall be measured. With 300 Hz and 500 Hz tone the frequency deviation shall be ± 2,0 kHz and ± 2,5 kHz respectively.

5.25.3.3 Requirement

The harmonic distortion factor shall not exceed 5%.

5.25.4 Receive idle noise

5.25.4.1 Definition

The receive idle noise is the psophometrically weighted noise RMS amplitude in dB at the line output terminal, when the modulating signal to the ideal mobile station is removed, relative to the RMS amplitude of the reference tone.

5.25.4.2 Method of measurement

The base station receiver shall be connected to the measuring set-up in figure 5.6 and the ideal mobile station modulated with the reference tone.
The corresponding reference level at the line output terminal is measured.
The modulating signal is then removed and the psophometrically weighted idle noise RMS at the line output terminal is measured.

5.25.4.3 Requirment

The psophometrically weighted idle noise RMS amplitude shall not exceed -70 dB.

5.26 DIVERSITY (OPTION)

5.26.1 Definition

The diversity gain is verified by checking that the frame reception probability is not degraded when the diversity is introduced at the same time as the input signal strength level is lowered.

5.26.2 Method of measurement

A carrier with a nominal frequency of a BS receiver shall be applied to the radio cabinet antenna inputs via a divider and two Rayleigh fading simulators.
The input signal shall be modulated with a continuous stream of frame 10b (see para 2.2.4.2). For each measurement 1000 frames shall be sent.

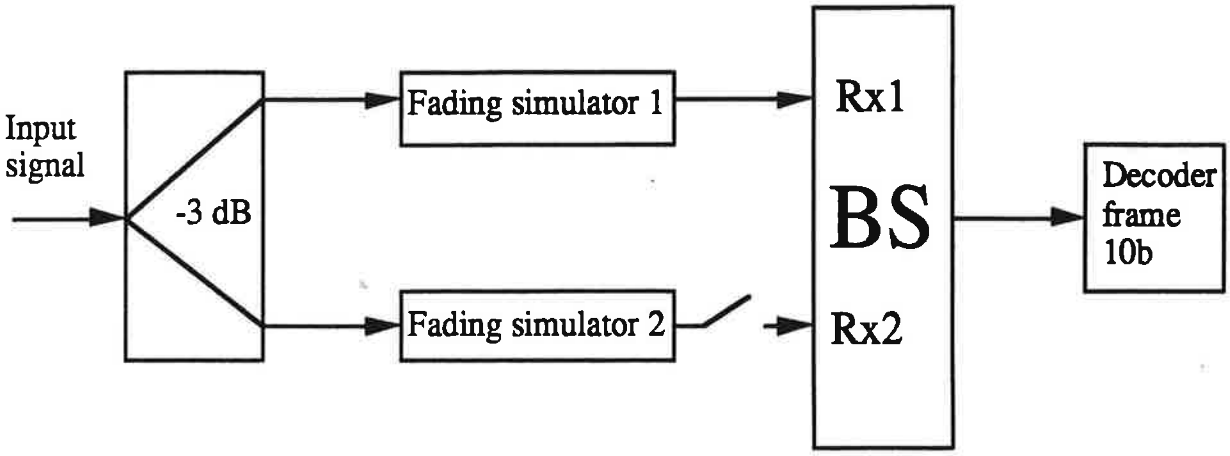


Fig. 5.7

The LF signal at the line output of the receiver shall be analyzed via the demodulator (see para 4.6.1 NMT-doc 900-1) and a decoder.
The received frames are corrected if necessary and possible, according to specification in Doc 900-1.

The fraction of correct frames received (including the corrected frames) related to total number of sent frames is calculated and noted.
The measurement shall be performed for two cases.

- First one of the two simulators shall be connected to the antenna input of one of the receiver units. In this case the RMS level of the RF-signal at the input shall be 8 dB (1µV) EMF (-105 dBm). This shall be done for both the receiver units, one at a time.

- Thereafter the two fading simulators shall be connected to one input terminal each. In this case the input RMS level shall be 3 dB (1µV) E.M.F. (-110 dBm) at both input terminals.

All the measurements shall be performed for fading speeds of 3, 50 and 100 km/h and the correlation between the fading simulators shall be 0,8.

The frame reception probabilities with one and two receivers connected are compared for each fading speed.

5.26.3 Requirement

For each fading speed the frame reception probability when two receivers (diversity) are used, may not be lower than in any of the cases when one receiver is used

5.26.4 Other requirements for the diversity receiver.

For the diversity reception the measurements of para 5.1-5.25 and 5.27 are repeated by coupling the RF-signals to both receiver branches via 3 dB-coupler, at the two input terminals of the radio cabinet. The specified RF-signal levels shall be measured after the 3 dB coupler, at the two input terminals of the radio cabinet.

When using the diversity equipment with only one RF-branch connected the ordinary receiver requirements shall be fulfilled. This shall be valid for both the RF-branches.

5.27 SR-FACILITIES IN THE RECEIVER

The receiver shall include signal strength measurement facilities according to section 7, except the requirements for channel switching time, para 7.2.2 and the ø-signal measurement described in para 7.2.3.

The signal strength from the MS is measured and evaluated in relation to the limits given by MTX in frames 20 (A=14) or 20(A=15) according to NMT Doc. 900-1 para 4.3.3.10.2. The evaluation is started by the frames 20 (A=3) or 20 (A=14) and stopped by the frames 20 (A=0), 20 (A=2) and 20 (A=12).

The signal strength shall be related to the receiver antenna input terminal of the radio cabinet. Regarding the tolerances for the specified 1_H- and 1_L-limits these shall be in accordance to paragraph 7.2.3.

In case of fading, these limits shall be widened by the fading margin specified in paragraph 5.28.1.

Specification for signalling of handover request and RF-link disconnection is stated in paragraph 8.2.

From the outset high level and low level limits must also be settable locally at the base station (same alternatives as in NMT Doc. 900-1, para 4.3.3.10.2). The limits set must be maintained after power-off and shall not be overruled by the information from the MTX. When the MTX has got the ability to set 1_H and 1_L the base station function is changed locally so that the MTX order overrules the limits set locally.

For diversity reception the SR-alarm limits shall be based on the combined receiver input RF-signal level.

5.28 INFLUENCE OF FADING.

5.28.1 Signal strength alarm fading margin.

5.28.1.1 Definition

Signal strength fading margin is the rms value of the BS receiver RF-input signal level under Rayleigh fading conditions relative to the corresponding value without fading for the CU to send the quality level alarms (A7 or A8) due to signal strength to MTX.

5.28.1.2 Method of measurement

The alarm level l_H and l_L shall be set to values according to NMT doc 900-1 paragraph 4.3.3.10.2, e.g. l_H =30 dBµV (-83 dBm) and
l_L =0 dBµV (-113 dBm).
Thereafter a start order e.g. frame 20 (A=14) is sent. Adjust the RF level until the frame 25 (A=7)/25 (A=8) is obtained with a success rate of 80 % without fading, see up-down method below. The frame must be received within the time limits in paragraph 8.2. This RMS level is noted. Before the next measurement the channel unit is reset by frame 20 (A=2).

The measurement shall be repeated with the Rayleigh fading simulator set to 3, 50 and 100 km/h. The RMS levels for 80 % success rate are noted.

For diversity reception the measurements shall be done for one as well as simultaneosly for both receiver branches. The RF-signal is coupled to both antenna input terminals of the radio cabinet via a 3 dB coupler and two fading simulators. The correlation between the simulators shall be 0,8.

Measurement method to be used.

<u>Up-down method</u>

The up-down method is an extension of the first multiple success method. Following the procedure to establish the N:th consecutive success, an up-down method procedure is performed in order that the averaged RIL (Receiver Input Level) values approach more closely the RIL_{wanted} . Essentially a fixed number of trials T are conducted and for each trial the input signal is increased by one step in the event of failure and reduced by one step in the event of N consecutive successes.
The figure illustrates the case for N=3 and T=20 and a step size of 1 dB.

The estimate of RIL_{wanted} is determined by averaging the RIL values corresponding to the trials underlined in the figure. That is, the value of the first multiple success and the levels resulting from each step change only.

For the measurement N=3 and T=20 is applied.

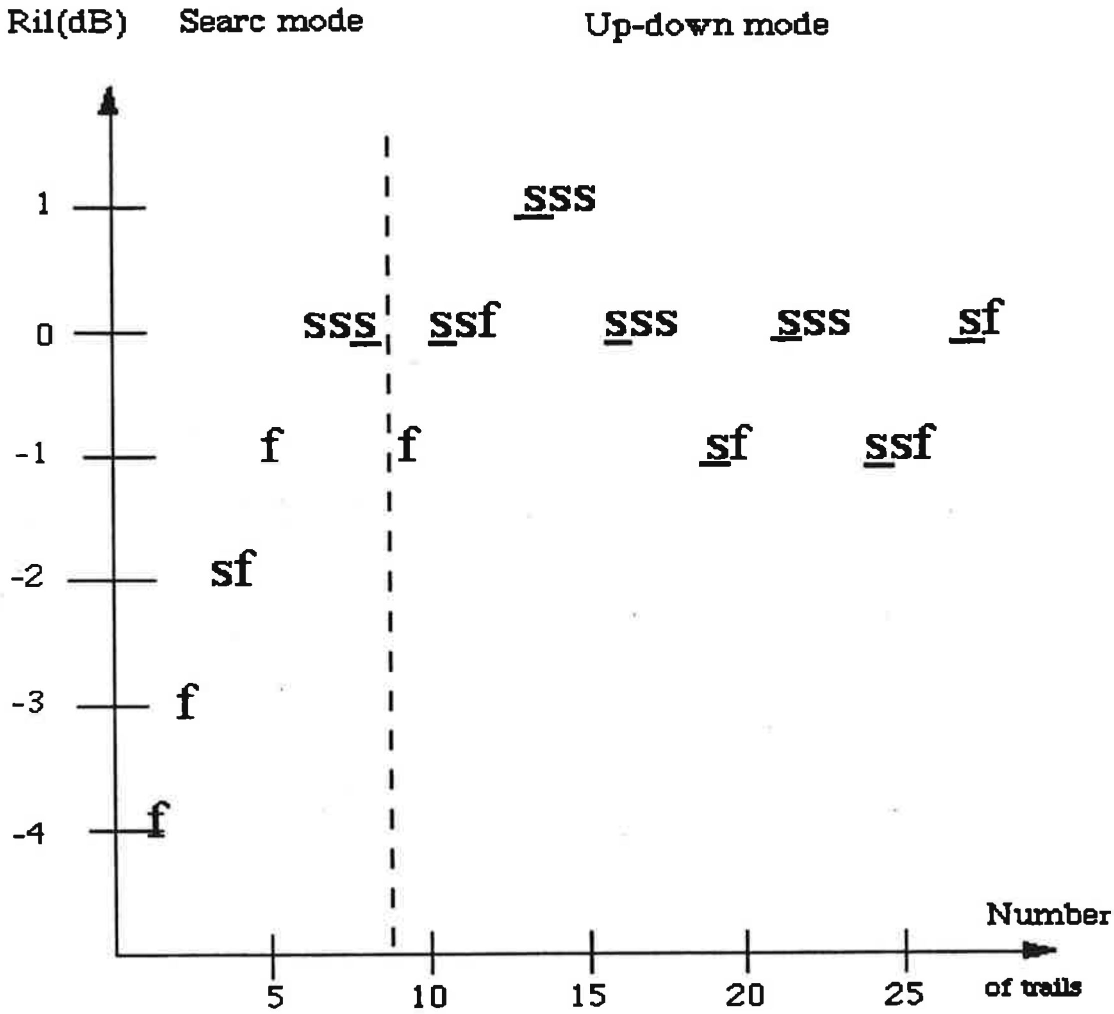


Fig. 5.8

5.28.1.3 Requirement

The signal strength fading margin shall not exceed 3 dB.

For diversity reception the requirement for measurements with one branch as well as with two branches simultaneously are the same referred to one of the receiver RF-input terminals (see paragraph 2.2.5).

5.28.2 Signal strength result (frame 26) fading margin

5.28.2.1 Definition

Signal strength result fading margin is the change in the mean value of the Rout when the signal strength is measured under fading conditions relative to the Rout when the measuring is done without fading.
The rms value of the RF-signal to SR is kept constant under both conditions.

5.28.2.2 Method of measurement

A signal of carrier frequency equal to the nominal frequency of the SR and modulated with normal test modulation (see para 2.2.4.1) shall be applied to the SR RF-input terminal througt a Rayleigh fading simulator.

Without fading the RF-level to SR shall be adjusted to give R(n1) R(n2) = 28. The rms level to SR is now measured with a true RMS power meter and noted. The fading simulator is now set to fading speed of 3, 50 and
100 km/h and the RF rms level to SR is adjusted to a level 1 dB above the rms-level to SR without fading.

For diversite reception the measurements are done for one branch as well as simultanously for both receiver branches by coupling the RF-signal to both SR RF-input terminals (see para 2.2.5) via 3-dB-coupler and another uncorrelated Rayleigh fading simulator.

The measurements are repeated for R(n1) R(n2) = 14.

For each case 1000 signal strength measurements results, R_{out}, shall be stored. Calculate mean value, upper and lower decile.

5.28.2.3 Requirement

The difference in mean value of R_{out} with and without fading (fading margin) shall not exceed 2 units.

For diversity reception the requirement for measurement with one branch as well as with two branches simultaneously are the same referred to one of the receiver input terminals (see para 2.2.5).

5.28.3 Signal strength result deviation

5.28.3.1 Definition and Method of measurement

The method of measurement is equal to measuring signal strength result fading margin, see para 5.28.2.

The calculated upper and lower decile from measurements in para 5.28.2.2 are used. The difference between the deciles are calculated.

5.28.3.2 Requirement

Fading speed (km/h)	3	50	100
Output deviation max dB	12	5	4

5.28.4 Supervisory (ø-) signal fading margin.

5.28.4.1 Definition

Supervisory signal fading margin is the rms value fo the BS receiver RF-input signal level under Rayleigh fading conditions relative to the corresponding value without fading for the CU to send the quality alarm
level 1 resp. 2 (20(A=7) resp. (A=8)) due to signal to noise ratio to MTX.

5.28.4.2 Method of measurement

Each measurement is started by adjusting the RF-level. Thereafter a start order is sent e.g. frame 20 (A=14).

If frame 25 (A=7)/25 (A=8) is received within the specified time limits in para 8.2, the response is positive.
Before the next measurement the equipment is reset by frame 20 (A=2). Other method giving equal result may be used.

A signal of carrier frequency equal to the nominal frequency of the BS receiver and modulated only with a supervisory tone (see paragraph 4.9) shall be applied to the receiver RF-input terminal throuth a Rayleigh fading simulator.

The receiver RF-input level of this signal shall be set so that the quality alarm level 1(A7) is obtained with a success rate of 80% without fading, see paragraph 5.28.1.2, Up-down method.

The measurement shall be repeated with a Rayleigh fading simulator set of simulated vehicle speeds of 3, 50 and 100 km/h. These rms levels are noted.

For diversity reception the measurements are done for one branch as well as simulataneously for both receiver branches by coupling the RF-signal to both receiver RF-input terminals (see paragraph 2.2.5) via 3-dB-coupler and another uncorrelated Rayleigh fading simulator.

The measurements are repeated for quality alarm level 2 (A8).

5.28.4.3 Requirement

The supervisory signal fading margin shall not exceed 7 dB.

For diversity reception the requirement for measurement with one branch the margin shall not exceed 7 dB, and with two branches simultaneously the margin shall not exceed 4 dB reffered to one of the receiver RF-input terminals (see paragraph 2.2.5).

The requirements specified in the paragraph shall be fulfilled by both the digital and analogue supervisory signal (DSS and ASS)

5.28.5 SR C/I-ratio for supervisory (ø-) signal detection

5.28.5.1 Definition

SR C/I-ratio for supervisory signal detection is a measure of the BS receiver capability to detect the correct supervisory signal on the wanted signal in presence of an unwanted signal with a different supervisory signal, both under Rayleigh fading conditions.

5.28.5.2 Method of measurement

The two input signal shall be connected to the BS receiver antenna input terminal of the cabinet via each uncorrelated fading simulator and combining network. Both signals shall be modulated only with each supervisory signal (see paragraph 4.9). Both signals shall be at the nominal carrier frequency of the receiver.

Initially the unwanted signal I shall be switched off, and the wanted signal C RMS levels shall be approximately 20 dB (1µV) EMF (-93 dBm) on the antenna input terminal.

The unwanted signal I shall then be switched on, and the RMS RF-input level adjusted to 3 dB below the RF level of the signal C (C/I-ratio 3 dB).

Continuous SR measurements orders are sent to the equipment. The responses are analyzed and the number of responses indicating correct ø-signal divided by total number of responses are noted (minimum 1000 responses analyzed).

The measurements shall be performed without fading as well as with fading set for simulated vehicle speeds of 3, 50 and 100 km/h. Uncorrelated Rayleigh fading simulators shall be used.

The measurements are repeated with the RF-signal level of I adjusted to 4 dB above the RF-signal level of C (C/I-ratio -4 dB).

For diversity reception the measurements shall be performed for one branch as well as for both the receiver branches by coupling the two RF-signals C and I to both receiver RF-input terminals (according to para 2.2.5) via 3 dB-couplers and another set of uncorrelated Rayleigh fading simulators.

The measurements are repeated with the unwanted signal at the upper and lower adjacent interleaved channels (±12.5 kHz).

In this case the RMS RF level of signal C is adjusted to 10 dB (1µV) EMF (-103 dBm) and the C/I_a -ratios -30 dB and -40 dB are measured.

5.28.5.3 Requirements

The equipment shall nominally change from indicating correct ø-signal to incorrect at a C/I-ratio of 0 dB in the case of co-channel interference.

At the co-channel C/I-ratio of 3 dB the responses of the SR-measurement order shall at least indicate correct ø-signal for 80% of the measurements.

At the co-channel C/I-ratio of -4 dB the responses of the SR-measurement order shall at most indicate correct ø-signal for 20% of the measurements.
The equipment shall nominally change from indicating correct ø-signal to incorrect at a C/I-ratio of -35 dB in the case of adjacent interleaved channel interference.

At the adjacent interleaved channel C/I-ratio of - 30 dB the responses of the SR-measurement order shall at least indicate correct ø-signal for 80% of the measurements.

At the adjacent interleaved channel C/I-ratio of - 40 dB the responses of the SR-measurement order shall at most indicate correct ø-signal for 20% of the measurements.

The requirements are valid with and without fading.

5.29 CO-CHANNEL REJECTION AND ADJACENT CHANNEL SELECTIVITY UNDER INFLUENCE OF FADING.

5.29.1 Method of measurement.

A wanted and an unwanted signal shall be applied to the receiver antenna input terminal of the radio cabinet through two independent Rayleigh fading simulators via a combining network , see figure.

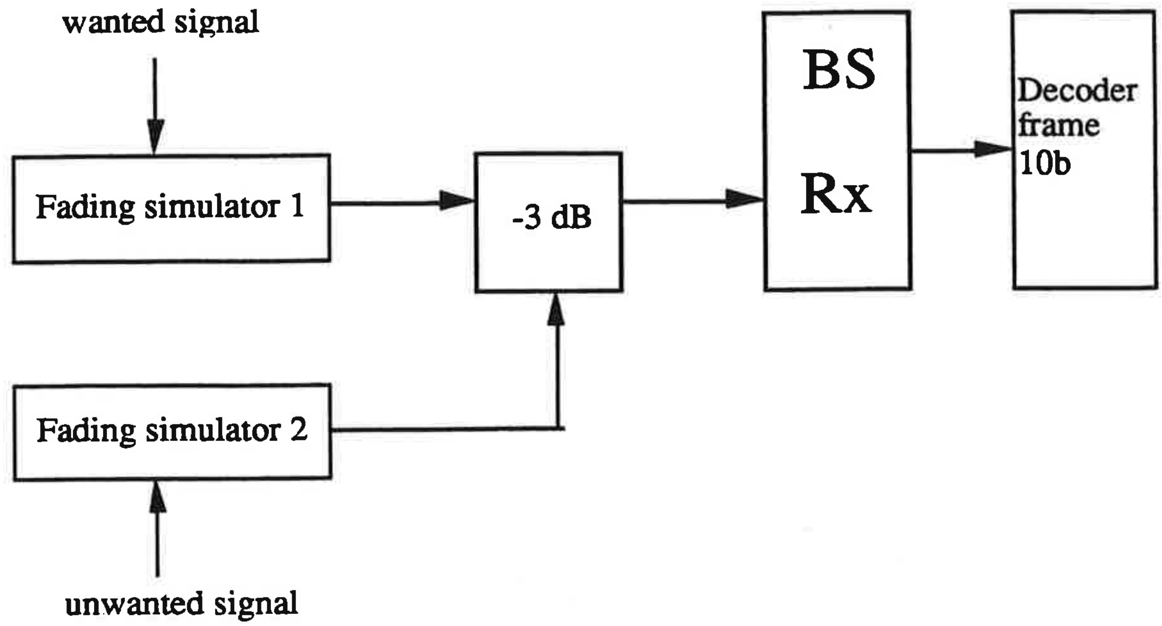


Fig. 5.9

The wanted signal shall be modulated with a continuous stream of frame 10b (see para 2.2.4.2). The unwanted signal shall be modulated (see para 2.2.4.2) with continuous pseudo-random bitstream of the 511 bits defined in CCITT Recomendation V.52. For each measurement 1000 frames shall be sent.

The LF signal at the line output of the receiver shall be analyzed via the demodulator (see para 4.6.1 in Doc-1) and decoder.
The received frames are corrected if necessary and possible, according to specification in Doc 900-1. The frame reception probability of the wanted signal shall be measured as the fraction of correct frames 10b received (including the corrected frames) related to the total number of sent frames.

The RMS-level of the wanted signal shall be adjusted to 20 dB (1 µV) EMF (-93 dBm) and the level of the unwanted signal shall be adjusted until a frame reception probability of 95% is obtained.

The measurement shall be made for the speed of 50 km/h and the corresponding level of the unwanted signal is noted (see para 2.2.5)

The measurements shall be made with co-channel and adjacent interleaved channel (±12.5 kHz) as unwanted signal.

5.29.2 Requirements

Co-channel interference:
RMS-level of the unwanted signal shall not be less than 0 dB (1µV) EMF (-113 dBm).

Adjacent channel (12.5 kHz) interference:
RMS-level of the unwanted signal shall not be less than 20 dB (1µV) EMF (-93 dBm) for upper and lower adjacent interleaved channels.

6 SIGNALLING BETWEEN MTX AND BASE STATION

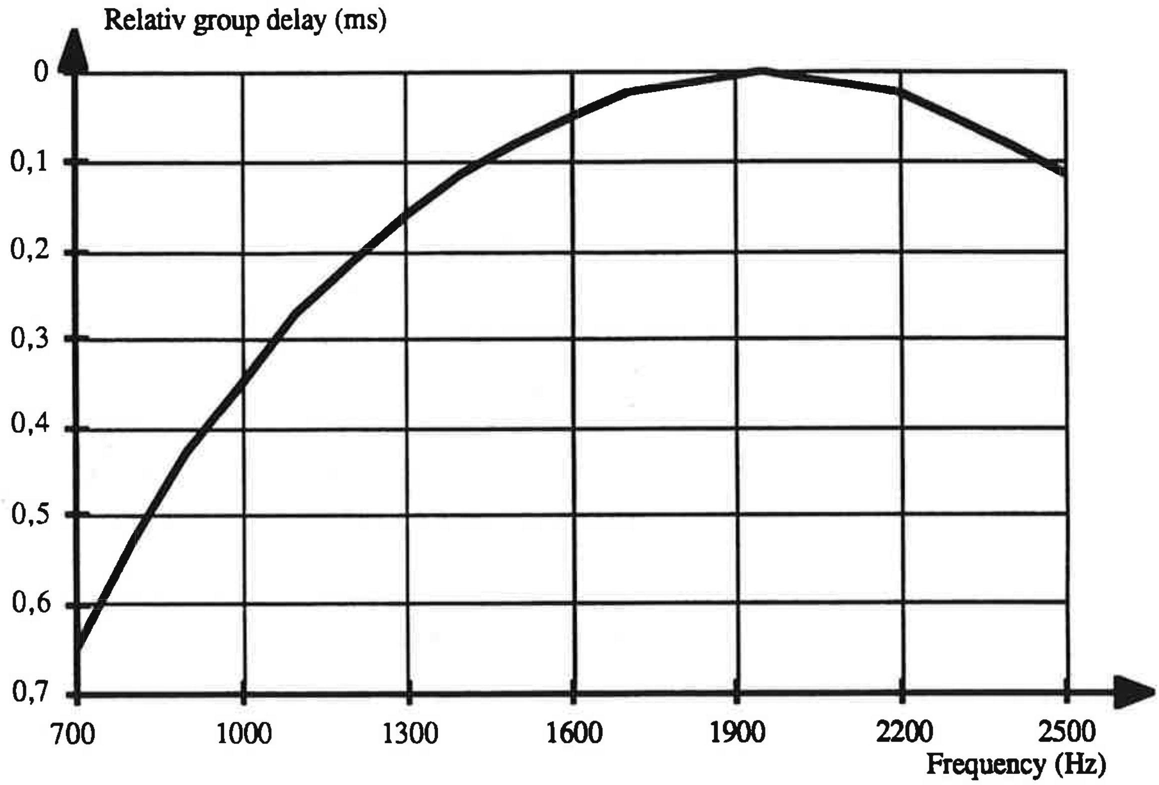
The signalling between MTX and BS can be divided into two different types:

- individual remote control of each radio channel such as start and stop of transmitter, channel setting, start and stop of supervisory signal and fault alarm via channel line and CU;

- remote control of signal strength measurements as controlled by SU.

The signalling between MTX and SU shall be possible both via a separate data line and via any of the channel lines through the CU. Data signal levels at BS are specified in NMT Doc. 900-1, clause 4.6. The specified levels correspond to the normal data test modulation, see paragraph 2.2.4.2 in this document.

The requirement for the bit error rate of the demodulator in the BS modem shall be according to fig.4.6.7 in NMT Doc. 900-1 with the values for S/N ratio increased by 3dB. The requirements shall also be fulfilled at a group delay distorsion according to the figure below.



1Fig. 6.1

For further information about the signalling system refer to NMT Doc. 900-1.

7 SIGNAL STRENGTH RECEIVER (SR)

7.1 GENERAL

The base station is equipped with an all-channel signal strength measuring receiver which is controlled from the MTX via the supervisory unit (SU) at the base station. The SU receives the measuring command (frame 21b or 21c) and switches the SR to channel Na Nb Nc ordered by MTX.

Besides the requirements in this section 7, the Signal strength receiver (SR) shall fulfil the requirements in section 5 "Receiver".

7.2 SPECIAL REQUIREMENTS

7.2.1 Channel setting

The channel setting of the SR shall be remotely controlled from the SU.

7.2.2 Channel switching time

The switching time between arbitrary channels shall not exceed 40 ms (see clause 9.1.1) as defined in the figure below.

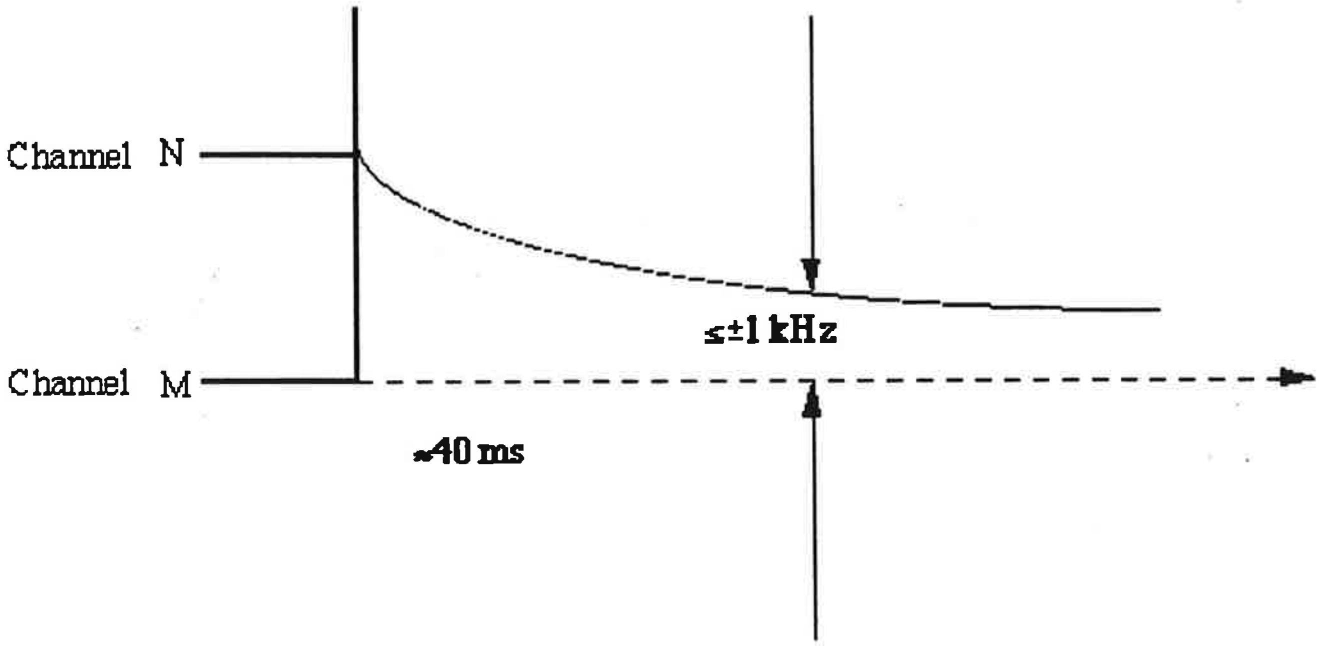


Fig. 7.1

M and N may be any of the base station receive frequencies.

7.2.3 Signal strength measurement output

The signal strength measurement output (R_{out}) as a function of the out RF input signal level at the receiver antenna input terminal of the cabinet U_{RF} shall have a characteristic as below:

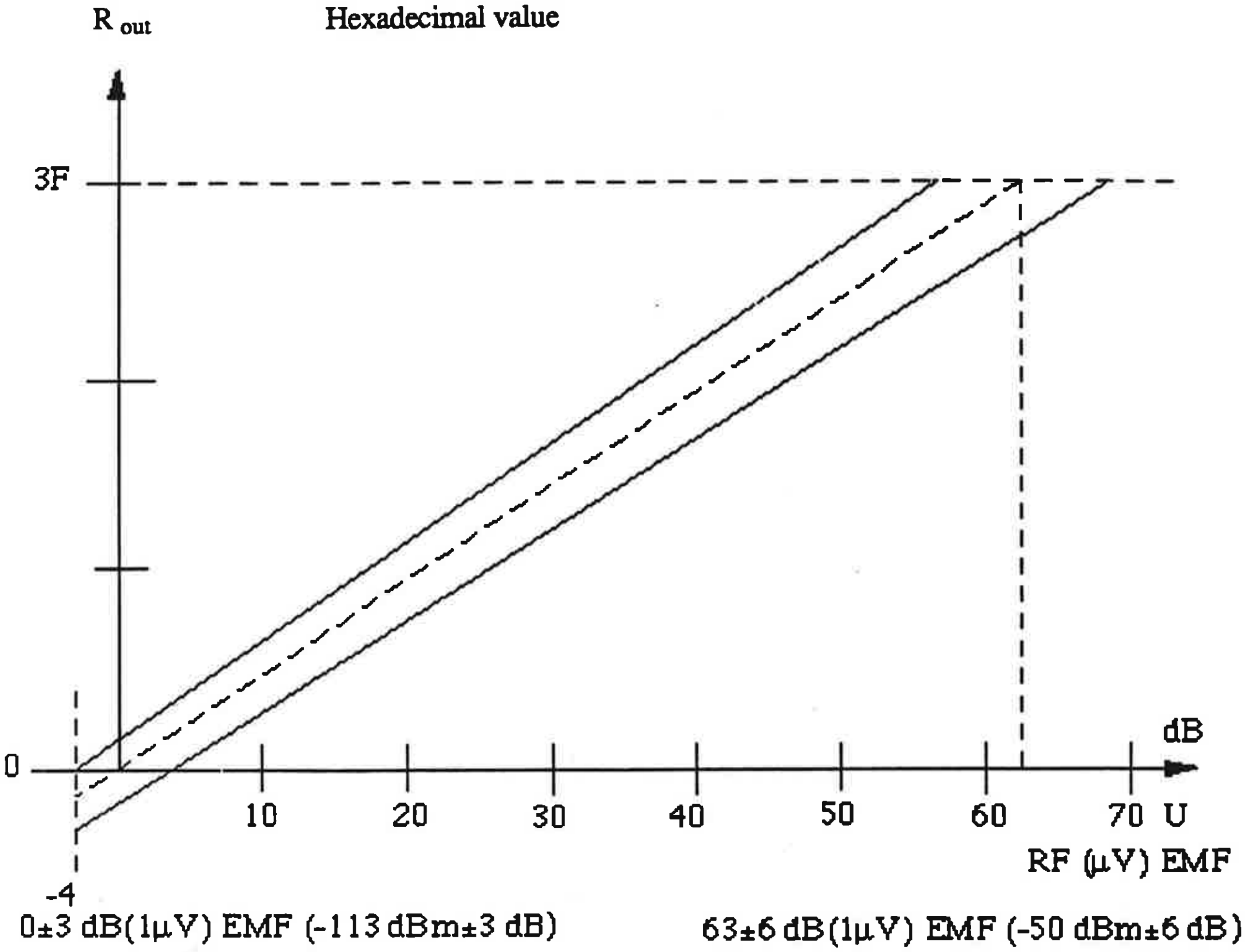


Fig. 7.2

All values below 0 ± 3 dB (1µV) EMF (-113 dBm ± 3 dB) shall be sent as 0 (hexadecimal value) and all the values above 63 ± 6 dB (1µV) EMF (-50 dBm ± 6 dB) shall be sent as 3F (hexadecimal value) to the MTX.

The level -4 dB (1µV) EMF is used only in connection with sending l_L (ref para. 5.27).

At RF-signal levels below squelch opening level according to clause 5.20 (at squelch closed condition) Rout=0.

The received ø-signal frequency looped by the actual MS shall be detected (see clause 9.1.1).

If no fø-info is sent from MTX to BS (fø coded 0000=$fø_i$) in frame 21 b and 21 c the measured signal strength Rout shall be sent and the information about ø-signal in frame 26 shall be coded as 0000.

7.2.4 RX used as Signal strength receiver

If a fault occurs in the SR it shall be possible to remotely from MTX to order any of the receivers (RX) to opterate as an SR. When the CU/RX receives a signalstrength measurement order frame 21b or 21c with N_1 N_2 N_3 equal to FFF the RX shall start acting as an SR, and return the measurement result in frame 26. In other respects the transformed channel unit CU/RX/TX shall be idled corresponding to frame 20A(0). If the same CU/RX/TX again receives another activation order from the MTX it shall operate as an ordinary channel.

It is also allowed to utilize the RX as SR when receiving signalstrength measurement orders with N_1 N_2 N_3 equal to any ordinary channel number. Thus there are no requirement for interconnection between CU and the ordinary SU/SR in this case.

In this case the Channel unit except the RX shall maintain the status before the measurement order, and will operate as idle, free marked traffic channel or traffic channel actually used. The RX shall have returned to the channel, as ordered in the latest received frame 20A (14) or 20A (15), within 277 ms (2 frames) after the end of the last signalstrength measurement order.

When a channel receiver is used as signal strength receiver the mean value of the signal strength shall be measured for a period of 100 ms and be quantified according to paragraph 7.2.3 Only the analogue ø-signal specified in paragraph 8.1.5 (never the digital ø-signal, paragraph 8.3) will be possible to detect with the RX.

8 CONTROL UNIT (CU)

8.1 BASIC FUNCTIONS

The control unit shall provide functions for the actual channel, and be interface between MTX and channel equipment.

The CU shall also be able to transfer data information between SU/SR and MTX. Data signalling from SU/SR to MTX (frames 26 and 28) shall be transferred by that CU which is latest used by MTX for the signal strength measurement order.

In the signalling from CU to MTX the channel number N_1 N_2 N_3 shall be in accordance to the channel number used by MTX in frame 20A (14) and 20A (15), start transmitter. If the channel number register is empty (e.g. after power start up) the channel number $N_1 = N_2 = N_3 = 0$ or the number copied from the local channel number switch shall be used.

If an acknowledgement to an order from MTX is specified, it shall have been sent within 200 ms measured from the end of the order frame.

At signalling from CU to MTX the radio receiver speech output shall be muted. The signalling from MTX to CU is allowed to pass to the mobile stations. The muting shall also be performed when receiving frame 20A(0) or 20A(2). The muting shall be deactivated when receiving frame 20 A(14) or 20 A(15)

8.1.1 Channel activation ordered by MTX, acknowledge and ø-signal alarm from BS

The CU shall activate the channel equipment as ordered by MTX in frame 20 and send the acknowledgement (frame 25) according to NMT Doc. 900-1, clause 4.3.3.6. Frame 25 shall contain the same fø as given in frame 20 from MTX.

The acknowledgement shall be response on the received order regardless of the actual state of the BS.

One frame 15 (idle) shall be sent before frame 25 A(8) for synchronization purposes, see doc. 900-1 clause 4.4.2.1.

8.1.2 Management/maintenance ordered by MTX

The CU shall activate the BS equipment as ordered by MTX in frame 22 and send acknowledgement (frame 27) according to NMT Doc. 900-1, clauses 4.3.3.7 and 4.3.3.8.

8.1.3 Fault alarms via CU

The coding and meaning of the alarms are specified in NMT Doc. 900-1, clause 4.3.3.9.

One frame 15 (idle) shall be sent before frame 28 (alarm) for synchronization purposes. There shall be no space between the frames.

When sending frame 28 containing blocking (V1(6)) the BS shall idle the channel. This corresponds to reception of frame 20A (0).

8.1.3.1 NMT alarms

When a fault occurs, the CU shall send fault alarm once to MTX (one frame 28) at:

- TX-antenna fault, when the VSWR (measured reflection attenuation) measured at the TX-antenna terminal of the radio cabinet exceeds a preset level. There shall be two levels and they shall be adjustable within the reflection attenuation range 21,0 dB (VSWR 1,2) and 2,0 dB (VSWR 9,0). It shall be possible to suppress the fault level 1 and level 2 alarms independently. The alarm interface between CU and transmitter combiner is specified in paragraph 3.1.14.

  Note 1. See clause 3.1.13 "Test features".

  Note 2. Fault alarm shall be sent on all affected channels.

- Combiner alarm level 1 when the reflection attenuation at the transmitter output is less than a preset level 3,0 dB ± 1 dB. The fault alarm shall be sent only on the corresponding channel.

  Alternative method for combiner alarm level 1:

  Combiner alarm level 1 when the attenuation of the combiner filter exceeds a preset level (decreased output power from the combiner filter relative to TX output power). Level shall be adjustable within the attenuation range 3,0 dB - 15,0 dB. The fault alarm shall be sent only on the corresponding channel.

- Combiner alarm level 2 when the reflection attenuation at the transmitter combiner filter is less than a preset level 4,0 dB. The fault alarm shall be sent only on the corresponding channel.

- RX-antenna fault, when the VSWR (measured reflection attenuation) at the RX-antenna terminal of the radio cabinet exceeds a preset level. There shall be two levels and they shall be adjustable within the reflection attenuation range 21,0 dB (VSWR 1,2 dB) and 2,0 dB (VSWR 9,0). It shall be possible to suppress the fault level 1 and level 2 alarms independently.

  In case of diversity both RX-antennas shall be supervised.

  Note 1. See clause 3.2.16 "RX-antenna supervision".

- Transmitter fault level 1, when the carrier output power is below a preset level 1. The level 1 shall be adjustable within the range (-15 dB, -3 dB) relative to nominal output power.

- Transmitter fault level 2, inter alia when:

  - the carrier output power is below a preset level 2. The level 2 shall be adjustable within the range (-15 dB, -3 dB) relative to nominal output power.

  - the synthesized frequency is unlocked (not during channel switching time and power start up period).

  - any of DC-voltages is below a preset level.

- Deviation fault. This alarm is sent if the modulating signal level in the TX-modulation has decreased below a preset level (relative to the incoming signal). The incoming signal is detected by the following criteria:
  TX activated and no deviation for at least 5 of the last 10 frames sent from the MTX. The frames detected shall contain correct N_1 N_2 N_3.

- Receiver fault, inter alia when:

  - the synthesized frequency is unlocked (not during channel switching time and power start up period).

  - any of DC-voltages is below a preset level.

- Redundant master oscillator fault. This alarm is sent if the frequency stability requirements are still fulfilled. In other case transmitter fault alarm level 2 and RX-alarm are sent from all channels connected to the master oscillator.

- Cooling fan fault. This alarm shall be sent only on affected channels.

- Power supply fault, inter alia when any of the output voltages are below a preset level.

  Note 1. The fault alarm shall be sent on all channels which are connected to this power supply.

  Note 2. Power supply fault shall not cause any other alarms.

- Redundant power supply fault. This alarm is sent if full operation of channels connected to this power supply is possible.

- Receiver multicoupler fault, inter alia when power failure or amplifier failure occurs.

  Note 1. See clause 3.2.14.

  Note 2. Fault alarm shall be sent on all channels, even in other cabinets which are connected to this receiver multicoupler.

- Redundant amplifier fault in the receiver multicoupler.

- Temperature fault, inter alia when the temperature in transmitter is above preset level.

- CU fault, if possible.

  Note See clause 8.1.6

- Supervisory signal test loop fault alarm according to paragraph 8.1.5.4.

- SU/SR faults, see chapter 9.

- Channel unit fault (level 2). (OPTION)

This alarm is sent in case of integrated channel unit (TX, RX and CU in same unit) when one (or more) of the following alarms occurs:

- TX 2 alarm
- RX-alarm
- CU-alarm
- ø-loop-alarm
- Deviation alarm

In this case the alarm register (below) is a requirement.

- Alarm register. (OPTION)

  The channel unit shall have an alarm register where the detailed information of at least ten latest alarms can be found locally or remotely via modem and PC. It shall be possible to erase this alarm register by local or remote control. If channel unit fault option is used this alarm register function is a requirement.

- In case of diversity (option) the following alarms shall be sent:

  - If a fault occur in one of the receiver multicouplers the "redundant amplifier fault in the receiver multicoupler" shall be sent on all channels even in other cabinets which are connected to this receiver multicoupler.

  - If a fault occur in one of the branches in the receiver the "diversity alarm" shall be sent only on the corresponding channel.

- Alarms for missing CC and AC/TC

  Note. See clause 11.

8.1.3.2 RF receiver blocking alarm

This alarm shall be activated if i.e. a faulty MS transmits continously on a calling channel, a combined calling and traffic channel, free marked traffic channel, access channel or an idle channel.

The CU shall send the alarm (frame 28) to MTX if the following conditions are fulfilled:

The ø-signal test loop (See 8.1.5.4) is connected and at the same time information from the RX indicates a received RF-signal above a certain level for more than the last t minutes . t shall be setable between 1 and 30 minutes. See clause 5.22.

If the RF-signal decreases below the alarm level for more than t minutes CU sends frame 28, "RF receiver blocking alarm ceasing", to MTX

Frame 22 V_1 (3) shall suppress the RF receiver blocking alarm and frame 22 V_1 (12) cancels the suppression.

This alarm shall not be indicated on the basestation.

The MS fault alarm may be sent again after an alarm ceasing without alarm reset.

8.1.3.3 House alarms

In addition to alarms above shall following alarms be sent to MTX:

- Mains break-down alarm.
- Mains break-down at channel with battery back-up.

Mains break-down shall not cause any other alarm.

- Mains return alarm. Ref paragraph 4.3.3. In case a) the alarm shall be delayed until the frequency error is equal or less than $\pm$ 2,5 kHz (maximum 4 minutes).
  In case b) this alarm shall be delayed 40 seconds after power on or mains return.
- Fire alarm.
- Intruder alarm.
- Obstruction light alarm.
- Environment temperature alarm.

It shall be possible to take in use at least two spare house alarms which are coded as V_1 (10)V_2 (1)V_3 (6) and V_1 (10)V_2 (1)V_3 (7). The interface for house alarms shall be the same as for transmitter combiner by means of relay contacts (alarm = relay closed). The relay contacts are mostly not connected to ground. The mains breakdown alarm relay contact will be closed within 30 ms from the mains break-down.

The alarms concerning mains break-down at the base station shall be sent to MTX on all the lines which are influenced of the fault, including the dataline (if the SU/SR are influenced). The information in frame 28 includes order to MTX to block the channel, V_1 (6)V_2 (1)V_3 (1). That is, at base station, without battery back-up this alarm shall be sent on all the lines.

At some base station sites battery back-up may be used for some of the channels and SU/SR. In this case "mains break-down alarm on channel with battery back-up" (V_1 (10)V_2 (1)V_3 (5)) shall be sent on the corresponding lines.
As an alternative at the base station channels with battery back-up, the following meanings of the alarms may be used:

- Mains break-down alarm: the battery voltage is below 41 $\pm$ 2 V
- Mains return alarm: the battery voltage has returned above 46 $\pm$ 1 V.

At mains interruptions the BS shall automatically restart when the mains return (see also clause 1.3.14.7) and send the "Mains return alarm".
Whenever the "Mains return alarm" is sent, the CU shall reset all the alarm indications according to paragraph 8.1.3.6. The same shall happen when the power is switched on.

8.1.3.4 External alarms

It shall be possible to take in use at least four spare external alarms which are coded as V_1 (10)V_2 (8)V_3 (X), where X = 8 ... 11. The interface for external alarms shall be the same as for transmitter combiner by means of relay contacts (alarm = relay closed). The relay contacts are mostly not connected to ground.

Futhermore the following alarms are defined

- Alarm unit alarm.
- MUX alarm.

8.1.3.5 Alarm indication

At least NMT alarms sent to MTX shall be indicated at the base station. The indication should point out the faulty units.

All the alarm indicators shall be red. If the two alarmlevels are indicated by a single indicator, alarmlevel one shall be flashing and alarmlevel two shall be continuous indicated.

8.1.3.6 Alarm reset

All the alarm indications shall be reset by order from MTX (frame 22V_1 (1), 22V_1 (2) or frame 20A(2)) or by local control. Frame 22 or 20 from MTX shall be acknowledged by frame 27 or 25. If the fault(s) remains, the CU shall thereafter send the alarm(s) frame 15 and 28 to the MTX.
This makes it possible to see if an alarm state has been changed.

8.1.4 Channel setting, remotely controlled from MTX

The CU shall set the frequency in accordance to the digits N_1 N_2 N_3 and most significant bit in Y_1 in frame 20 A(15) "Start BS transmitter" and 20 A (14). If N_1 N_2 N_3 falls outside the NMT band (1999 channels), the transmitter shall not be started. In this case, the order shall not be acknowledged.

8.1.5 Supervisory signal (ø-signal)

8.1.5.1 Generation

The CU shall generate the supervisory signal as ordered from the MTX (Frame 20 A (3) or A (14) start, A (12) stop). The frequencies ($f_ø$) used for the supervisory signal are given below. The frequency setting of the supervisory signal shall be remotely controlled from MTX (frame 20) or by local setting.

Frequency	1:	3955 ± 5 Hz
	2:	3985 ± 5 Hz
	3:	4015 ± 5 Hz
	4:	4045 ± 5 Hz

The frequency deviation shall be ± (0,3 ± 0,03) kHz.

The time between the end of send supervisory signal order and the setting of the ø-signal shall be max. 50 ms. In the case of a change in the ø-signal frequency a response of max. 100 ms is accepted.

When frame 20 A (14) has been received from MTX the start of ø-signal and switch squelch function out shall be delayed until the carrier from the MS opens the squelch.

8.1.5.2 Detection

The CU shall detect the supervisory signal, looped in the mobile station and shall evaluate its signal-to-noise ratio and compare it with limits which correspond to signal-to-noise ratios S/N, psophometrically measured at normal test modulation in speech channel given below.

Limit	S/N ratio in speech channel (psophometric)
1	30 dB (adjustable between 10 and 40 dB)
2	0 dB (adjustable between -5 and + 10 dB.)

When testing the limit setting, the speech channel shall be unmodulated.
Specifiction for signalling of handover request and RF-link disconnection is stated in paragraph 8.2.
When the frame 20 A (14) has been received from MTX the start of ø-signal and switch squelch function out shall be delayed until the carrier from the MS opens the squelch.

The ø-signal detector shall measure the S/N of the looped ø-signal. The ø-signal shall be measured within the frequency range $f_ø$ ± 5 Hz (3dB bandwidth), and the noise at least within the ø frequency range $f_ø$ ± 100 Hz but not outside the frequency range 3800 to 4200 Hz (35 dB bandwidth).

8.1.5.3 Transmission of ø-signal on channels activated as CC, TC, AC or CC/TC.

The CU shall transmit the ø-signal without evaluation of the S/N-ratio as long as it detects frame 1, 2, 3d or 4. The ø-signal frequency shall be the same as ordered in the last received "start ø-signal order" (frame 20 A (3) or 20 A (14)).

It shall be indicated locally that the CU transmits ø-signal without evaluation of the S/N-ratio.

If CU has no information about ø-signal frequency ("empty ø-signalnumber register" for example after power start up) no ø-signal shall be transmitted.

8.1.5.4 Ø-signal test loop

The ø-signal test loop is intended for testing the ø-signal generator and detector. At the test the generator output shall be connected to the detector input. If an unnormal ø-signal level or S/N-ratio is measured, ø-signal failure alarm (frame 28) shall be sent to MTX. When the ø-signal is not activated, the ø-signal test loop shall be connected.
The ø-signal test loop shall allways be connected except when ø-signal generation and detection are activated according received order from MTX (frame 20 A (3) or 20 A (14)).

8.1.6 Channel line loop

The CU shall loop the transmitter line input to the corresponding receiver line output as ordered from the MTX (frame 20 A (5)) and when such faults occur in the CU that no frames can be sent to MTX. The loop shall also be connected when the power is not applied to CU (with modem) but not before a possible alarm frame has been sent.

The attenuation in the loop connection shall not exceed 0,5 dB.

The group delay distortion in the loop connection shall not exceed 40 µs within the frequency range 900 - 2100 Hz.

The channel line loop shall be connected/disconnected within 100 ms after received order.

8.1.7 Local control

The CU shall provide local controls as

- start and stop of transmitter;
- channel setting of transmitter and receiver;
- squelch on/off of receiver;
- activating RF test loop;
- activating ø-signal and selection of ø-signal frequency;
- resetting alarms;
- sending blocking/deblocking order to MTX (frame 28). Locally blocked channel shall be indicated.
- activating channel selftest
- activating compandor.

Some of the local controls may be placed on other base station units.

The indicator colours on BS unit panels shall be as follows:

Alarms	red
Tx-carrier	green
Squelch open	green
Power on	yellow
Local blocking sent to MTX	red
RF-test-loop on	red
ø-signal activated	green or actual ø-signal number
Compandor activated	green

The signalling from the MTX shall override the local control.

It shall be possible to set channels (one or all at the same time) into preblock mode, i.e. channels where traffic occurs are automatically local-blocked when the channel is released (criteria: internal ø-signal test loop is connected). CC, AC, TC and idle channels shall be local-blocked immediately.

Preblock state shall be indicated i.e. with flashing (repeatedly) channel number display at the channel unit.

8.1.8 Line test connectors

The CU-panel or modem panel shall be provided with a line test socket/connector according to IEC Publication 130-12 IEC- SO4/PO3 (see paragraph 4.18 and 5.10).

8.1.9 Service functions

Measurements with built-in instruments shall be possible for active circuits and supply voltages. In addition to important functional values the built-in instruments shall show e.g.:

- transmitter output power;
- reflected power from the antenna/combiner;
- received RF-level;
- receiver discriminator;
- line input and output levels. The instrument shall indicate the average value in all voltage level measurements.

The measuring accuracy shall be enough for good maintainability.

The instruments may be common for several transmitters and receiver units. It shall be possible to measure the ø-signal frequency and level via terminals on one of the panels. The base station shall be equipped with handset (with push-to-talk switch) or loudspeaker (with volume control).

8.1.10 Channel selftest

The CU shall perform a channel selftest as ordered from the MTX (frame 22 V_1 (4), acknowledge frame 27 V_1 (5)) or when initiated locally at the base station. In the selftest the CU shall:

- start the transmitter
- activate the RF-test loop and compander
- send a 1200 Hz testsignal from the CU, corresponding to $\pm$ 3 kHz deviation, through the RF-test loop and compandor and back to the CU where it is evaluated
- start the ø-signal and evaluate the result
- initiate a signal strength measurement in the actual receiver on the used radio channel and evaluate the result.

In case of diversity the two receiver branches shall be tested separately, but in sequence for each selftest order. The measurement period can be up to 7 sec.

Within 5 s after the selftest was initiated or when a fault is detected the CU shall stop the ø-signal, stop the test signal, deactivate the RF test loop and compandor and stop the transmitter and send the appropriate result to MTX.
The CU shall not send frame 25 or frame 26 to the MTX during the selftest. The CU shall send the alarm frame 28, V_1 (10)V_2 (15)V_3 (2), "selftest failed" if one or several of the following conditions occure:

- the level of the detected test signal deviates more than X dB from the expected. X shall be adjustable from 3 to 8 dB, nominal 6 dB.
- the criteria for sending frame 25A(8) is fullfilled
- the signal strength, measured by the actual receiver, is below 2 dB (1µV) EMF or above 14 dB (1 µV) EMF.

In other case the frame 27 V_1 (6) "selftest completed" is sent.

The multicoupler shall be included in the measurement.

If the selftest is locally initiated the result shall be indicated at the base station, but not sent to the MTX.

RX-antenna supervision may be a part of the selftest.

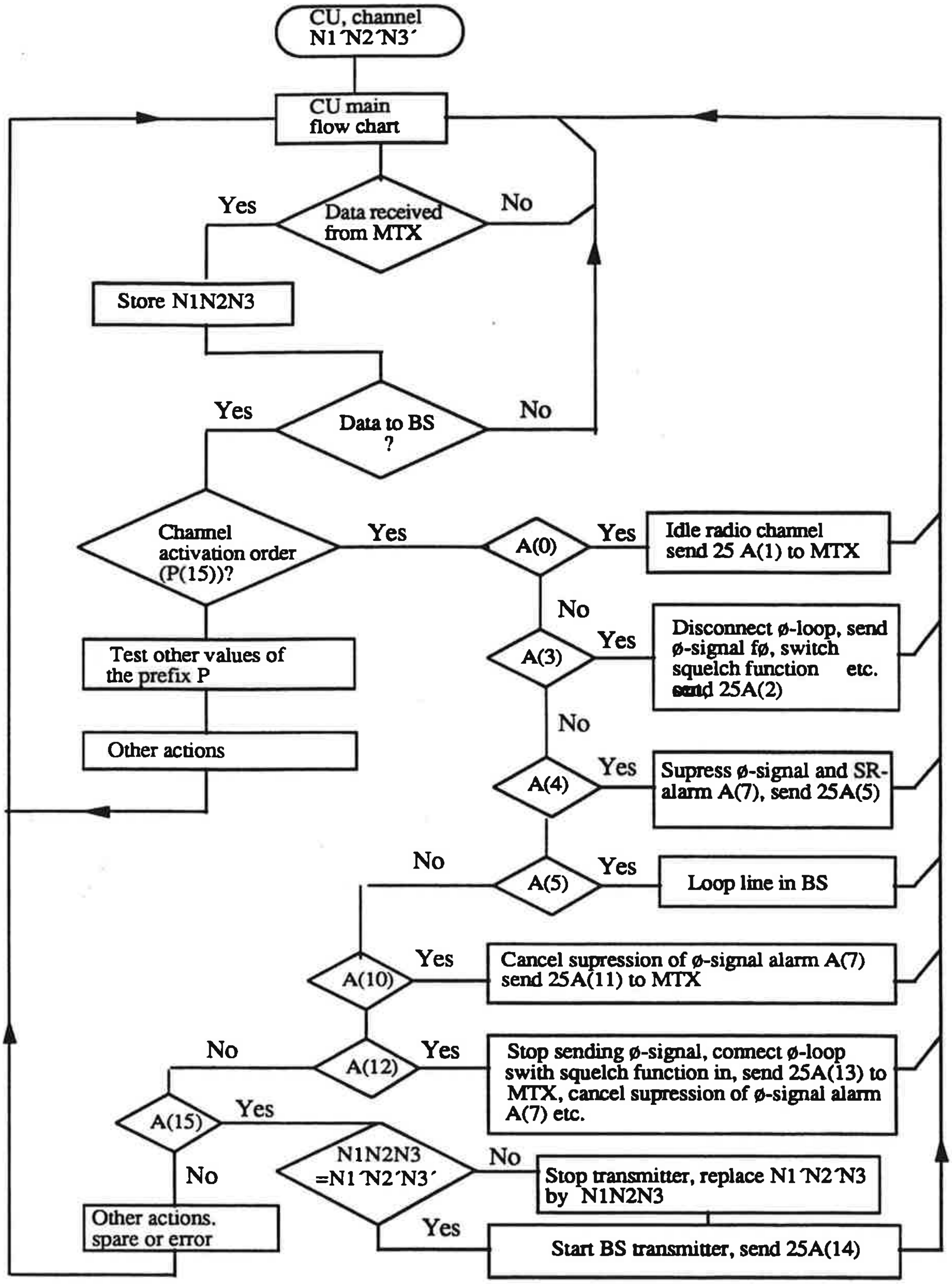
8.1.11 Signal strength receiver (SR) selftest.

It is recommended also to have a selftest function even for the common signal strength receiver function. This can be ordered from one or several CU's and be added to the selftest for the actual channel.

It must be taken into account that no collission with the normal signal strength measurement in the SU/SR as ordered from the MTX is allowed.

8.1.12 Control unit flow chart

Example of handling the channel activation order (frame 20).



Fig, 8.1

8.2 SIGNALLING OF HANDOVER REQUEST AND RF-LINK DISCONNECTION

Handover request (frame 25 A(7)) and RF-link disconnection (frame 25 A(8)) may be initiated either by the supervision of the RF-signal in the receiver or from the evaluation of the S/N ratio of the supervisory signal in the CU.

When handover request is initiated the reason for the message is sent to MTX in frame 25 A(7).When RF-link disconnection is initated the reason for the message is sent to MTX in frame 25 A(8).
The reason for sending the message is coded as a cause (C) value in the frames 25A(7) and 25A(8). The cause value is specified in paragraph 4.3.3.10.3 in NMT Doc 900-1.

8.2.1 Criteria for signalling handover request or RF-link disconnection.

8.2.1.1 Evaluation of the S/N ratio of the supervisory signal.

The definition of the limits mentioned below is stated in paragraph 8.1.5.2.

S/N ratio in speech channel	criterion
Above the first limit for more than 3 s during the last 10 s.	A
Below the first limit for more than 7 s during the last 10 s but above the second limit for more than 1 s period during the last 20 s.	B
Not above second limit for more than 1 s during the last 20 s.	C
Not above second limit the first 3s after reception of frame 20 A(3).	D

Note: When the ø-signal has been started by the frame 20A(14) there is no 3 s evaluation period.

8.2.1.2 Supervision of the RF-signal in the receiver.

The limits referred to below are defined in paragraph 5.27.

Mean value	criterion
Received signal strength averaged over 5 s is above the higher limit.	E
Received signal strength averaged over 5 s is below the higher limit but above the lower limit.	F
Received signal strength averaged over 20 s is below the lower limit.	G

8.2.2 Signalling

Criterion fulfilled	Message to MTX	Cause value (C) in frame
A	No message	
B	Handover request if handover request has not been sent to MTX within the last t seconds (t shall be setable either to 20 or 60 s at the basestation).	0001
C	RF-link disconnection, if RF-link disconnection hasn't been sent to MTX within the last 20 seconds.	0001
D	RF-link disconnection	1001
E	No message	
F	Handover request, if handover request has not been sent to MTX within the last t seconds (t shall be setable to 20 or 60 s at the basestation)	0010
G	RF-link disconnection, if RF-link disconnection has not been sent to MTX within the last 20 seconds.	0010

Criterion fulfilled	Message to MTX	Cause value (C) in frame
B and F	Handover request, if handover request has not been sent to MTX within the last t seconds (t shall be setable to 20 or 60 s at the basestation).	0011
C and G	RF-link disconnection if RF-link disconnection has not been sent to MTX within the last 20 seconds.	0011
A and (F or G)	The message sent and cause value shall be as stated above for criterion F or G depending on which of them that is fulfilled.	
E and (B or C)	The message sent and cause value shall be as stated above for criterion B or C depending on which of them that is fulfilled.	

Example The lines in the picture below, represent the time a criterion is fulfilled (the evaluation time is not included). The arrows below the picture illustrate when a message is sent to the MTX.

Repetition time t is 20 sec. in figure below.

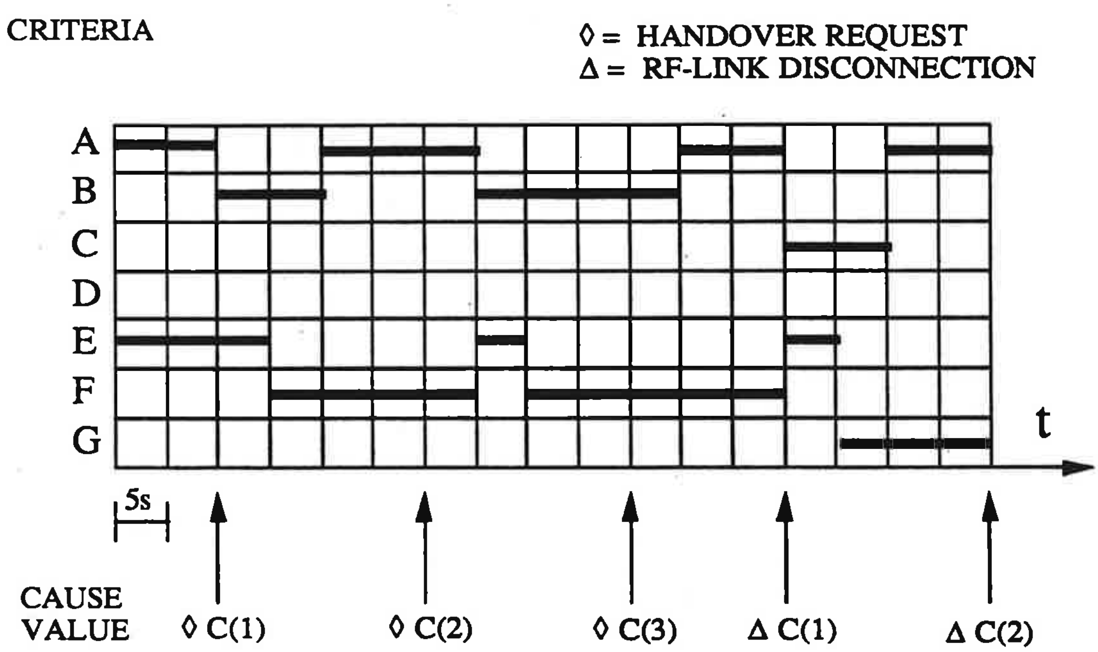


Fig. 8.2

8.3 DIGITAL SUPERVISORY SIGNAL (OPTION)

This paragraph is an additional requirement to paragraph 8.1.5.

8.3.1 General

The digital supervisory signal (DSS) consists of a cyclic data stream which is modulated by MSK modulation onto the transmitter in the supervisory signal band. It will be used both for call supervision and radio signal identification. The identification is accomplished by correlating to a cyclic code word corresponding to a reference number given by the MTX in the frames 20 or 21 to the BS. The identification demands a detection period of at least 310 msec during a signal strength measurement. The actual signal strength measurement (specified in § 15.) need not to be synchronous with the identification procedure.

The outline for actions based on the supervisory signal is as follows:

- the DSS is used for detection of handover request alarms and in the case of a strong interference it also detects rf link disconnection alarm.

- the signal to noise ratio S/N in the supervisory channel is measured and determines the switching between the DSS and an associated ASS (analogue supervisory signal) .

- the ASS is used for detection of supervisory signal alarms as described in §8.1.5.2.

8.3.2 Encoder and control

In order to be able to transmit different supervisory signals at different base stations, every datastream corresponds to a reference number sent from the MTX to the BS in the F_1 F_2 position of the frames 20A(3) and 20A(14).

The implementation of digital supervisory signal leads to changes in coding of frame 20 (A=3 or 14), 21b, 21c, 25 (A=2 and 6) and 26 specified in NMT Doc.900-1.

Also the coding of the datastream corresponding to F_1 F_2 is given in NMT Doc.900-1.

8.3.3 Modulator

The CU shall generate a modulated signal as supervisory signal. The modulation method is MSK with a modulation rate of 100 bps ± 0,01 bps. The carrier frequencies are 4000 Hz ± (25 ± 1) Hz with the lower frequency for logical "one" and the higher for "zero". The bit frequency for the two frequencies shall be derived from the same source.
The modulation of this signal to the transmitter shall be started as ordered from the MTX (frame 20 A(3) or A(14)). The coding of the signal is derived from F_1 F_2 in the frame according to para 8.3.2.

The frequency deviation of the transmitter caused by this signal shall be ± (0.3 ± 0.03) kHz.

The time between the end of the order send supervisory signal and the setting of the supervisory signal shall be max 50 ms. In the case of a change in the supervisory signal coding a response of 200 ms is accepted. When frame 20 A(14) has been received from MTX the start of supervisory signal detection and switch squelch function out shall be delayed until the carrier from the MS opens the squelch.

8.3.4 Demodulator

The demodulator will consist of two detectors - one for the evaluation of the bit-error-ratio and one for the evaluation of the signal-to-noise ratio in the supervisory signal channel.

8.3.4.1 Bit-error-detector

The performance of the bit-error-detector, when connected to a reference data transmitter, shall generate a bit error rate within or following the curves indicated in the figure below.

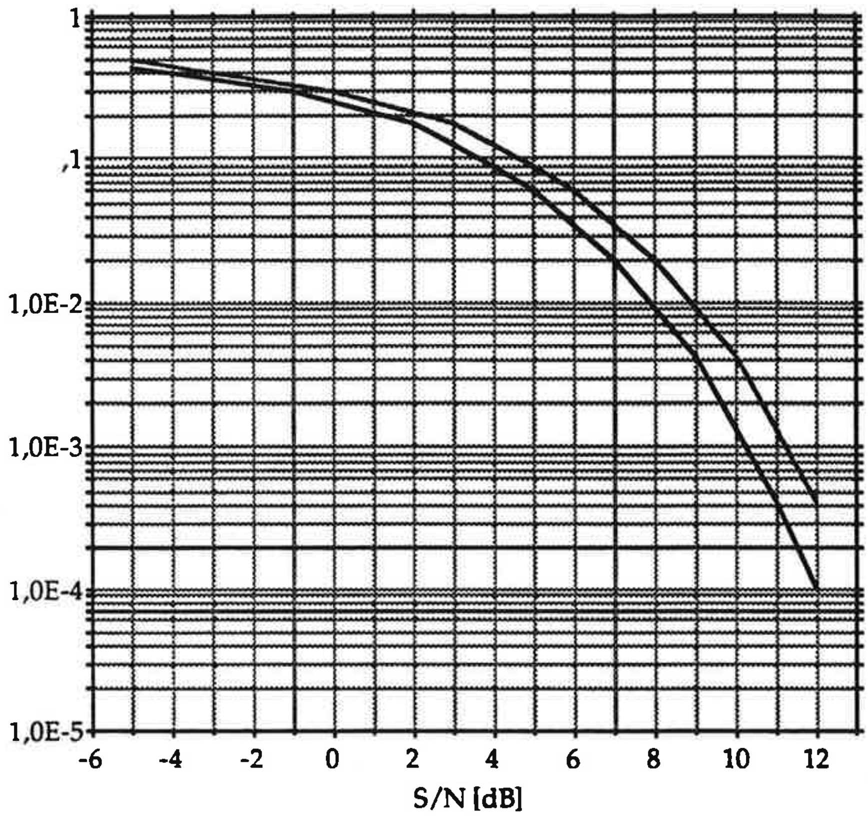


Figure 8.3 Error rate versus signal to noise S/N at input. S/N measured in bit rate band width (100 Hz) for noise with an even distribution from 3400 - 5600 Hz.

8.3.4.2 Signal-to-noise-detector

The signal-to-noise-detector shall measure the signal-to-noise-ratio S/N of the looped supervisory signal. The supervisory signal shall be measured within the frequency range $f_ø \pm 5$ Hz (3 dB bandwidth), and the noise at least within the frequency range $f_ø \pm 100$ Hz, but not outside the frequency range 3800 - 4200 Hz (35 dB bandwidth).

8.3.5 Decoders and responses

The CU shall be able to evaluate and take actions on criterias based on the bit-error-ratio and the signal-to-noise ratio on the supervisory signal channel. The actions to be taken are described below.

8.3.5.1 DSS alarm conditions

The bit-error-detector shall detect the digital supervisory signal looped in the mobile station, evaluate its bit error ratio, and compare it with two bit error ratios

- limit 1a, which corresponds to a signal-to-noise ratio S/N, psophometrically measured at normal test modulation in the speech channel

- and limit 1b, which is a fixed bit error ratio.

BER limit	Alarm	S/N ratio in speech channel (psophometric)
Limit 1a	Handover Request	30 dB
Limit 1b	Rf Link Disconnection	

- Limit 1a is the the bit error rate criteria for the alarm handover request. Limit 1a shall be adjustable in steps of 0.001 from 0 to 0.30. The measured bit error rate shall be the moving average evaluated over the time frame T_{1a} . T_{1a} shall be adjustable in steps of 1 sec. between 1 sec. and 20 sec, i.e. 100 bits to 2000 bits with a baudrate of 100 bps.

  The evaluation procedure of the Handover Request alarm follows in two steps as below

  1. If the bit error ratio, evaluated over the last T_{1a} seconds, exceeds limit 1a then wait ΔT_{1a} seconds

  2. If the bit error ratio, evaluated over the last T_{1a} seconds, still exceeds limit 1a then send alarm handover request - frame 25A(7).

  ΔT_{1a} is the standby time for handover request as explained above. ΔT_{1a} shall be adjustable in steps of 1 second between 0 and 20 seconds.

The handover request alarm (frame 25A(7)) to MTX shall be repeated after t second periods as long as this alarm condition does exist. The time t shall be settable to 20 seconds or to 60 seconds at the base station.

- Limit 1b is the bit error rate criteria for the alarm RF Link- disconnection, and is fixed to 0.35. The measured bit error rate shall be the moving average evaluated over 20 seconds. If the bit error ratio equals or exceeds limit 1b then send alarm RF Link- Disconnection - frame 25A(8). Limit 1b is used for detecting interference.

  The RF Link-disconnection alarm (frame 25A(8)) to MTX shall be repeated every 20 seconds as long as this alarm condition is detected.

If no digital signal (S/N ratio below limit 2 (§8.1.5.2)) is detected on the supervisory signal channel within 3 seconds after the reception of frame 20 A(3) from the MTX, RF Link-disconnection (frame 25 A(8)) shall be sent to MTX.

When the supervisory signal has been started by frame 20 A(14) there is no 3 second evaluation period as above. When the frame 20 A(14) has been received from the MTX the start of supervisory signal and switch squelch function out shall be delayed until the carrier from the MS opens the squelch.

8.3.5.2 Switching between DSS and ASS

The signal-to-noise-detector shall detect the supervisory signal, looped in the mobile station, evaluate the S/N ratio in the supervisory signal channel and compare it to a certain S/N limit. Since the S/N ratio is used for switching between the DSS and an associated ASS, the S/N ratio has to be evaluated both for the DSS and for the ASS. There are two S/N limits, limit 2a and limit 2b, each corresponding to a specified S/N ratio in the speech channel (psophometric).

S/N limit	Corresponding S/N ratio (psophometric) in speech channel
Limit 2a	18 dB (adjustable between 5 and 30)
Limit 2b	22 dB (adjustable between limit 2a and 30)

Limit 2a and 2b will not trigger the alarm. In stead one of the following actions are taken.

S/N ratio in supervisory signal channel	Action
Not above limit 2a for more than t_{2a} seconds during the last T_{2a} seconds.	Switch from DSS to a specified ASS.
Not below limit 2b for more than t_{2b} seconds during the last T_{2b} seconds.	Switch from ASS to the specified DSS (previously ordered by the MTX)

T_{2a}, T_{2b}, t_{2a} and t_{2b} shall individually be adjustable from 1 to 20 seconds in steps of 1 second.

The DSS's are divided into four groups. Each group corresponds to a certain ASS which determines the switching between the DSS and the ASS.

1.ASS #1	corresponds to	DSS #11, #16, #21 - #26
2.ASS #2	- " -	DSS #0 , #1, #4 - #10
3.ASS #3	- " -	DSS #14, #27 - #34
4.ASS #4	- " -	DSS #2, #3, #12, #13, #15, #17 - #20

The periodicity of the transmission of handover request alarms and RF link-disconnection alarms (frames 25A(7) and 25A(8)) shall not be disturbed by the switching between ASS and DSS.

8.3.5.3 ASS alarm conditions

The ASS is used for detection of handover request alarm and RF link-disconnection alarm as described in §8.1.5.2.

8.3.6 <u>Transmission of supervisory signals on channels activated as CC, TC ,AC or CC/TC.</u>

The CU shall transmit the supervisory signal without evaluation of the bit error ratio as long as it detects frame 1, 2, 3d or 4. The supervisory signal message sequence shall be the same as ordered in the last received channel activation order (frame 20 A(3) or 20 A(14)).

If the CU has no information about the supervisory signal (empty supervisory signal number register) no supervisory signal shall be transmitted. It shall be indicated locally that the CU transmitts supervisory signal without evaluation of BER and S/N ratio.

8.3.7 <u>Supervisory signal test loop.</u>

The supervisory signal test loop is intended for testing the supervisory signal generator and the detectors. During the test the generator output shall be connected to the detector input. If an unnormal bit error ratio or an unnormal signal to noise ratio is detected, supervisory signal failure alarm (frame 28) shall be sent to MTX. The supervisory signal test loop shall always be connected except when the supervisory signal is activated by a channel activation order from MTX (frame 20 A(3) or 20 A(14)). The supervisory signal message sequence transmitted in the test loop shall be the same as ordered in the last received channel activation order (frame 20 A(3) or 20 A(14)). The loop tested is the test loop for the supervisory signal, ASS or DSS, activated by the last received channel activation order (frame 20 A(3) or 20 A(14)). When testing the detector for the DSS, the associated ASS detector shall also periodically be tested as described in §8.1.5.4.

8.3.8 Signal Strength Measurement

The switching between ASS and DSS has implications on the functionality of the 300 msec. SR unit.

During a signal strength measurement the DSS or the associated ASS shall be identified and the response returned to the MTX within 553 msec. If correct supervisory signal is identified, the DSS or the associated ASS, the DSS identity (F_1 F_2) is returned to the MTX in frame 26. If the sequence is found incorrect the code (F_1 F_2) = (0000 0101) shall be returned. The decoder shall be able to detect and identify any cyclic shift of the DSS sequence corresponding to the reference number (F_1 F_2) in frame 21b or 21c from the MTX. The decision rule for correct sequence shall be the number of bit errors ≤ 5 $[(d_{min} -1)/2]$.

9 SUPERVISORY UNIT (SU)

9.1 BASIC FUNCTIONS

The SU provides function for signal strength measurements and interface between the signal strength receiver on the one side and MTX or CU on the other side. The SU shall not be used for communication between MTX and MS.

The functions in SU may be implemented in SR or vice versa.

9.1.1 Signal strength measurements and ø-signal frequency detection

SU receives the measuring order from MTX via channel line and CU or via data line and switches the SR to the ordered channel N_a N_b N_c (frame 21b or 21c) according to section 7. The ø-signal frequency number fø is indicated in these frames.

The average signal strength shall be measured for a time period of 100+20/-5 ms and shall be quantified in 64 levels. The quantified binary value, representing the RF input level, shall be sent to MTX.
The figure in clause 7.2.3 shows the relation between RF input level at the antenna input terminal of the cabinet and the coded value (hexadecimal) with given tolerances.

That is, as an example, with an RF-input level at 34 dB (1µV) EMF the nominal coded value sent to MTX shall be (R_1 (2) R_2 (0)) equal to
0010 0010.

The total time for SR channel switching, ø-signal frequency detection and evaluation of the average signal strength value shall not exceed 138 ms (one frame).

The signal strength measurement result (frame 26) shall have been sent from base station equipment to MTX within 415 ms (3 frames) measured from the end of received signal strength measurement order (frame 21b or 21c) at the base station.

If the detected ø-signal frequency number fø is incorrect the result R_1R_2 and fø=0101 (ø-signal incorrect) shall be sent.

If no ø-signal number is given in frame 21 b and 21 c the measured result R_1 R_2 and fø= 0000 shall be sent to MTX.

Measurement orders may be given in a continuous string of frames 21b or 21c. In that case also the measurement results shall be sent to the MTX as a continuous string of frames 26. There shall be no space between the frames and the results must be sent in the same order as the corresponding measurement orders have come.

Signal strength measurement results shall be sent to MTX via the same line as the corresponding signal strength measurement order.

9.1.2 Fault alarm via SU

When a fault occurs, the SU shall send a fault alarm once to MTX (one frame 28) at:

- SU fault, if possible;

Note: see clause 9.1.3, Data line loop.

- signal strength receiver fault, interalia when:

-- The synthesized frequency is unlocked (not during channel switching time and power start-up-period);

-- any of the DC-voltages is below a preset level.

At least fault alarms listed above and sent to MTX shall be indicated at the base station. The indication should point out the faulty units.

When data line is connected to the SU and a common power supply fault occures which influence on SU/SR the SU shall send "Power supply fault" on the data line.

Regarding "Mains break down alarm" and "Mains return alarm" the SU shall send the alarms on the data line corresponding to paragraph 8.1.3.3.

One frame 15 (idle) shall be sent before frame 28 (alarm) for synchronization purposes. There shall be no space between the frames.

In case there is no separate data line, the SR and SU alarm shall be sent once via that CU through which the first measuring order is received after the fault occurred.

If the fault alarm is sent via CU on channel line, blocking order V_1 (6) shall be replaced by V_1 (12).

If alarm reset, frame 22(V_1=2), is sent via CU and channel line remaining SU and SR alarm shall be sent via the same line.

9.1.3 Data line loop

At faults in SU (including the data line modem) the data line input shall be connected to the data line output. The loop shall also be connected when the power is not applied to SU (with modem) but not before a possible alarm frame has been sent. On the other hand the loop shall be connected/disconnected within 100 ms after received order (i.e. frame 20A(5)/20A(0)).

The attenuation in the loop connection shall not exceed 0,5 dB.

The group delay distortion in the loop connection shall not exceed 40 us within the frequency range 900-2100 Hz. If there is an indication of the "loop-on" condition, it shall be red.

9.1.4 Data line test connector

The SU-panel or modem panel shall be provided with a line test socket/connector according the IEC Publication 130-12IEC-SO4/PO3
(see paragraph 8.1.8)

9.1.5 RX used as SR.

See paragraph 7.2.4. If the RX is used as SR also for signal strength measurement orders sent from MTX on idle, free marked traffic channel and traffic channel actually used there is no requirement for interconnection between the CU's and the ordinary SU/SR.
In this case the ordinary SU/SR will communicate with MTX only via the dedicated data line for signal strength measurement.

10 RF TEST LOOP

The RF test loop is intended for testing each individual channel equipment one at a time.

The RF test loop consists interalia of an oscillator with a frequency of 45 MHz and a mixer by means of which the transmitter frequency can be converted to the corresponding receiver frequency.

The attenuation in the RF test loop shall be such as to give a level of 8 dB(1 μV)EMF at the receiver input. The level shall be adjustable within the range 3 dB(1 μV) to 13 dB(1 μV)EMF.

When the RF test loop is not activated, the signal level measured at the receiver input shall not exceed -27 dB (1 μV)EMF at any frequency.

The RF test loop shall be controlled by the MTX via actual channel line and CU. The measurement itself is performed by MTX. The RF test loop may be common for several equipments.

The output from the transmitter to the RF test loop shall be available for local measurements of carrier frequency. The level at this output shall be at least -30 dBm.

The RF test loop shall be connected/disconnected within 100 ms after received order.

It is recommended that there are two lamp indicators on the RF test loop. One yellow indicator indicates that the unit has power and one red indicator indicates that the RF test loop is activated.

11. SUPERVISION OF FREE MARKED CC AND AC/TC (OPTION)

The BS shall supervise that there always is at least one free marked CC and one TC or AC at the actual basestation site. The supervision shall include at least 40 channels.

If dedicated frequency bands for CC and AC/TC are used, the supervision shall normally only include the channels inside the actual bands. This setting may be done locally and/or remotely by use of the channel information and the additional information given in the frames from the MTX to MS.

If free marked CC or AC/TC is not found inside the dedicated frequency band, the whole BASIC band shall be scanned before any alarm is sent to the MTX.

If free marked CC-indication or related signalling sent from the MTX (frame 1a, 1a', 1a", 1b, 2a, 2b, 2c, 2d, 2e, 2f) is not detected at any of the channels of the BS for more than 90% of the last time "t", the BS shall send one alarm to the MTX (frame 28, "Missing CC-indication"). The time "t" shall be settable in steps of 30 seconds starting from 30 secs. to 5 minutes.

If free marked AC- or TC-indication or related signalling sent from the MTX (frame 1b, 4, 4b, 3a, 3b, 3c, 3d) can not be detected according the limits given above the BS shall send one alarm against the MTX (frame 28, "Missing AC/TC-indication").

The alarm shall be sent on two channels with respect to redundancy.

If the BS again detects the actual frames for at least 90 % of the time "t" the BS shall send frame 28, "Missing CC-indication ceasing" and "Missing AC/TC-indication ceasing" at the same channels.

The alarm may be sent again after an alarm ceasing without first initiating alarm reset.

The alarm(s) shall not be indicated on the base station.

The supervision of the actual channel shall be suppressed by initiating "Local blocking", and activated by "Local deblocking".

The supervision shall be suppressed when receiving the frame 22V1(7) from the MTX. The suppression shall be cancelled when receiving the frame 22V1(10).

The supervision may be implemented as a S/W-solution in the base stations. If so, it is important that supervision of the actual transmitters output power and modulation is included.

The supervision of free marked CC and TC/AC may also be implemented in such a way that it could be added to older BS-equipments which do not have this function (i.e. by use of RF-monitoring and the external alarm inputs).

12 DIGITAL INTERFACE (OPTION)

The Base Station may as an option include a 2048 kbit/s PCM interface equipment.

In this case the Base Station shall be equipped with a PCM interface to multiplex the audio output and inputs in the Base Station to a 2.048 Mbit/s HDB 3 code (High Density Bipolar, 3. order) line.

The maximum of speech channels which shall be connected to the 2048 kbit/s line is 30.

The PCM interface equipment shall fulfil the following CCITT (blue book) recommendations :

- G. 703 Physical/Electrical characteristics of hierarchical digital interface
- G. 704 Functional characteristics of interface associated with network nodes (basic frame structure)
- G. 706 Frame synchronization etc.
- G. 711 Pulse code modulation (PCM) of voice frequencies
- G. 712 Performance characteristics of PCM channel between 4-wire interface at voice frequencies
- G. 713 Performance characteristics of PCM channel between 2-wire interface at voice frequencies
- G. 714 Separate characteristics of a 4-wire interface of the transmit and receive directions
- G. 732 Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s
- G. 735 Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s and offering digital access at 384 kbit/s and/or synchronous digital access at 64 kbit/s
- G. 823 The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy

It shall be possible to select the time slots for each channel in the 2048 kbit/s signal.

The equipment shall include a digital 2048 kbit/s through connection (multidrop) so that unused 64 kbit/s channels at the 2048 kbit/s line can also be distributed to other Base Station and/or system.

The PCM interface shall be able to transfer mains break-down alarm in the case where mains break-down occurs.

The PCM interface shall be equipped with an internal alarm indication.

13 REMOTE CONTROL (OPTION)

Remote control interface shall offer facilities for remote control of the Base Station.

The remote control interface is either directly connected to a PC via a V.24 interface or connected to a PC via a telephone modem.

With the remote control interface and IBM AT/XT PC or other compatible, it should be possible to control the Base Station.

On call establishment it shall be possible to identify the manufacturer and the communications protocol.

The remote control interface shall be fitted with some kind of protection to prevent unauthorized person from getting access to the Base Station.
The method used shall be agreed by the operator.

As a minimum it shall be possible to carry out the same adjustments and measurements on the Base Station as it is possible in local control (see paragraph 8.1.7) and in service functions (see paragraph 8.1.9).

It shall be possible to have the type (designation) number, the serial number and software version over the V.24 interface (other item e.g. last day of warranty may also be included).

It shall be possible to change settings in the Base Station equipment.
It shall be possible to transfer measurement points from the equipment to the PC.

It shall be possible to download software via the remote control from the PC. The protocol used for downloading can be manufactur dependent.

It shall be possible to connect several cells on the same position (site) to the same modem.

For communication through the switched telephone network the speed of the modem shall be at least 1200 baud.

If the Base Station is equipped with a digital interface (see paragraph 12), it shall also be possible to transfer the remote control communication through this. It shall be possible to place the communication in an arbitrary time slot, except slot 16.

14 HANDOVER REQUEST CHANNEL (HC) (OPTION)

14.1 GENERAL

This paragraph specifies a new interface in the BS and the signalling made via the interface. The interface shall be able to handle up to four 1200 baud FFSK channels, HC. These HC's shall exist together with the normal TC's and DC's without affecting them. Each HC shall be able to handle up to 64 channels, but it shall also be possible to use two or more HC's to handle 64 channels. The modulation method used is specified in NMT Doc 900-1 paragraph 4.6.

A continuous stream of frames shall be sent from the BS to MTX (accepted that the BS also sends continuously frames towards the SSE) via the HC/HC's. This shall be fulfilled by sending idle frames (frame 15) at the HC/HC's in case no other message shall be sent.

The message handover request shall be sent via HC instead of via the actual TC and therefore the channels are named "Handover request Channels". The coding of the handover request message is depending of channel type used (frame 25 on actual TC and frame 41 on HC.

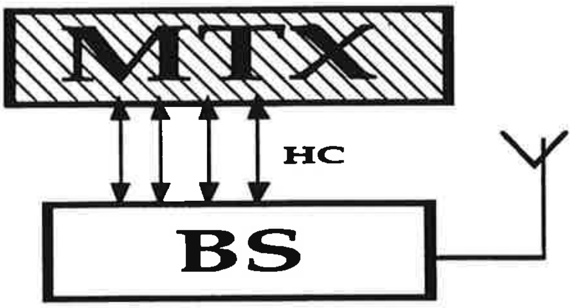


Figure 14.1 System structure with HC.

When a scanning supervisory equipment, SSE, is implemented in the system, the signalling between BS and SSE shall be made via another HC/HC's than the one/ones defined for handover request. The HC/HC's used for handover request can be connected either directly to MTX (figure 14.2) or to SSE (figure 14.3). The functionality in the BS of sending handover request via HC is independent of whether HC is terminated in MTX or SSE.

It shall be possible to send both handover request and other signalling information between BS and SSE via the same HC. This situation occurs if only one HC is available in the system and it is connected to the SSE. The handover request messages shall have the highest priority.

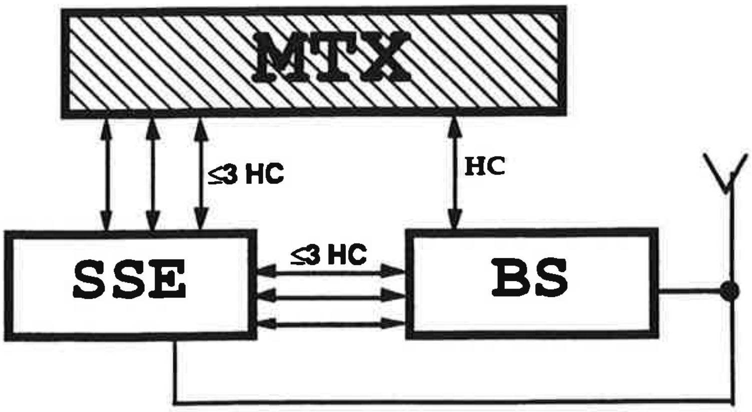


Figure 14.2 **System structure with SSE implemented and at least one HC is connected directly between BS and MTX.**

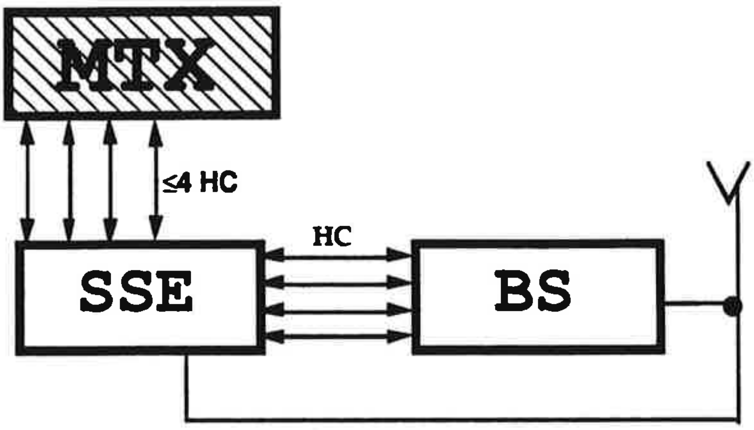


Figure 14.3 **System structure with SSE implemented and no HC is connected directly between BS and MTX.**

14.2 ADDRESSING UNITS AT BS VIA HC FROM SSE.

The channel-units at BS shall be given an identity number at the installation. The leftmost channel-unit at the top of the cabinet shall have the identity number 1 and the next unit to the right number 2 and so on.

When a radio channel number is allocated to the unit the interface equipment shall use N_a N_b N_c for addressing.

In case no radio channel is allocated to the unit, the interface equipment at the BS shall use the identity number in the message for the internal addressing. The correlation between identity number and the internal physical address shall be stored in the BS.

The interface equipment shall also be able to receive frames from channel-units and send the frames further to the SSE or MTX via the HC. The interface equipment shall be able to translate the internal physical address into the identity number.

14.3 SIGNALLING

The signalling made via the HC shall use 1200 baud signalling equipment, which shall fulfil the requirements in paragraph 6. The formats of the messages and the coding are specified in NMT.Doc 900-1.

14.3.1 Signalling procedures between BS and MTX.

14.3.1.1 Handover request

This procedure is used to initiate a handover attempt in the MTX. The acknowledge (frame 46) shall be received within a time T (T = 240 ± 5.0 ms), measured from the time when the handover request message (frame 41) has been sent.

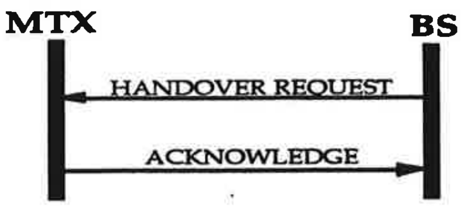


Figure 14.4

14.3.2 Signalling procedures between BS and SSE.

14.3.2.1 Start/Stop of a call.

This procedure is used to inform the SSE when a call is started at a channel in the BS (frame 50).

Figure 14.5

This procedure is used to inform the SSE when and how a call is terminated at a channel in the BS (frame 50).

Figure 14.6

14.3.2.2 Traffic status report.

This procedure is used to inform the SSE when a channel is defined as CC or AC/free TC (frame 50).

Figure 14.7

14.3.2.3 Channel activation

This procedure is used to start/stop the transmitter of a specified channel unit. The acknowledge (frame 52) shall have been sent within a time T ($T=200 \pm 5.0$ ms) measured from the time when the channel activation message (frame 51) has been received.

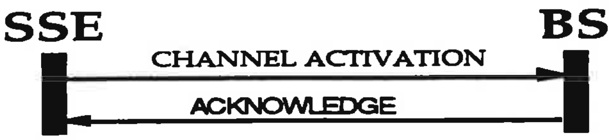


Figure 14.8

14.4 O&M HANDLING OF THE HC.

The format of the messages described in this paragraph and the coding are specified in NMT.Doc 900-1.

14.4.1 <u>Initialization of HC.</u>

The BS shall receive information via the remote control whether one or more HC is in operation and where they terminate. A priority list for the HC's shall be given to the BS via the remote control. The list shall contain information about the order to take the HC's, which are connected, in use for signalling.

HC/HC's connected directly to MTX can only be used for handover request and O&M messages. If the HC terminates in SSE, the channel can be used both for handover request messages and signalling between BS and SSE.

14.4.2 <u>Fault handling</u>

The BS shall give either a faulty HC level 1 or level 2 alarm depending of the fault at the HC. The "Faulty HC level 1" alarm shall be an indication that there are problems with a HC (messages are being lost) but the channel can still be used.

The level 2 alarm is used when a HC cannot be used for signalling. The signalling of the alarms and messages are specified in para 14.4.5. The alarm shall indicate which of the HC that is faulty.

14.4.2.1 HC/HC's used for handover request.

The HC/HC's used for handover request is supervised by checking the acknowledge of the handover request message. The acknowledge of a handover request message shall have been received at the BS within a time T (T=240 ± 5.0 ms), measured from the time when the handover request message has been sent from the BS. In case the BS sends handover request continuously a maximum of two more handover request messages may have been sent from the BS. This implies that a function to store up to three handover request messages has to be implemented in the BS in order to be able to check the acknowledge message.

In case no handover request message has been sent via HC during the last 10s a test message (handover request with TCno coded as FFF) shall be sent. An acknowledge (frame 46) of the test message shall be sent from the MTX.

If two successively acknowledges are lost the HC is regarded as faulty. The BS shall then use the next HC connected according to the priority list. In case no other HC is available the BS shall send handover request (frame 25 A(7)) via the actual traffic channel.

The test message shall be sent every 10 s over the "faulty" HC. If the BS has not received 16 succesively acknowledges the BS shall give an "Faulty HC level 2" alarm. The HC is in order again when 16 successively acknowledges of test messages have been received at the BS. The BS shall then send a "Cease faulty HC level 2" message. The handover request message (frame 41) shall then be sent over the HC again.

A counter, R_{count} ,is implemented in order to control the sending of "Faulty HC level 1" alarm. The counter shall be increased by one if an acknowledge is lost and decreased by one if 10 successively acknowledges have been received at the BS, but $R_{count} \geq 0$. A "Faulty HC level 1" alarm shall be sent when R_{count} exceeds 16 and a "Cease faulty HC level 1" message shall be sent when R_{count} has decreased to 0 again. The R_{count} shall be made equal to 0 when the BS sends "Cease faulty HC level 2" alarm.

14.4.2.2 HC/HC's used for signalling between SSE and BS.

The HC/HC's used for signalling between SSE and BS are checked with specified intervals T_{sup} . The interval shall be settable, via the remote control, between 0 and 12 hours in steps of 30 min. The supervision shall be made by a special frame ("supervision", frame 54) with acknowledge (frame 55).

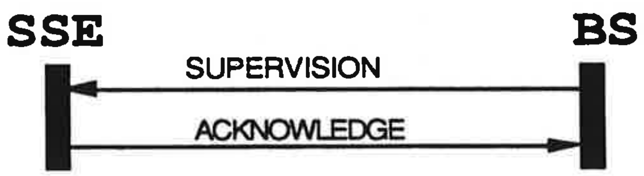


Figure 14.9

The acknowledge shall have been received at the BS within a time T (T=240 ± 5.0 ms), measured from the time when the supervision message has been sent from the BS.

In case no acknowledge is received within the specified time a new supervision message shall have been sent 415 ms after the first message was sent. If the BS does not receive an acknowledge of the last message within the specified time then the HC is faulty. The BS shall then use the next HC connected to SSE according to the priority list.

The supervision message shall be sent every 10 s over the "faulty" HC. If the BS has not received 16 succesively acknowledges the BS shall give a "Faulty HC level 2" alarm.

The HC is in order again when 16 successively acknowledges of supervision messages have been received at the BS. The BS shall then send a "Cease faulty HC level 2" message. The signalling between BS and SSE shall then continue over the HC again.

A counter, R_{count} ,is implemented in order to control the sending of "Faulty HC level 1" alarm. The counter shall be increased by one if an acknowledge is lost and decreased by one if 10 successively acknowledges have been received at the BS, but $R_{count} \geq 0$. A "Faulty HC level 1" alarm shall be sent when R_{count} exceeds 16 and a "Cease faulty HC level 1" message shall be sent when R_{count} has decreased to 0 again. The R_{count} shall be made equal to 0 when the BS sends "Cease faulty HC level 2" alarm.

14.4.2.3 HC used for handover request and signalling betwen BS and SSE.

In case of the same HC is used both for handover request and signalling between BS and SSE, the supervision shall be made as though only handover request was sent via the HC.

14.4.3 Capacity supervision

The capacity of the HC/HC's available for handover request is not enough if more than 10 handover request messages have to be queued. If this situation occurs the BS shall start to send handover request (frame 25) via the actual TC until the capacity of the HC/HC's is enough again. The BS shall give a "Not enough capacity for handover request" alarm (see 14.4.5) if the capacity is too low during 15 of 30 minutes. The alarm shall only be sent once. When the capacity has been enough during 30 minutes a "Cease not enough capacity for handover request" message shall be sent.

When more than 10 messages have to be queued, the capacity of the HC/HC's available for signalling between BS and SSE is not enough. The BS shall give a "Not enough capacity for signalling between BS and SSE" alarm (see 14.4.5) if the capacity is too low during 15 of 30 minutes. The alarm shall only be sent once. When the capacity has been enough during 30 minutes a "Cease not enough capacity for signalling between BS and SSE" message shall be sent.

14.4.4 Maintenance

It shall be possible to send maintenance messages from the MTX and get acknowledges from the BS. The messages needed for the HC channel are a selection of the messages needed for maintenance of the DC
(frame 20, 22, 25 and 27).

The BS shall be able to send maintenance information to the MTX
(frame 28).

14.4.5 Sending of alarm.

The "Faulty HC level 1" alarm and the "Cease faulty HC level 1" message shall be sent via the actual HC. The "Faulty HC level 1" alarm shall be repeated once after 10 s, measured from the time when the first one was sent
A "Faulty HC level 2" alarm shall be sent via another HC connected than the faulty one. In case no other HC is connected, the alarm shall be sent via a TC or DC. The "Cease faulty HC level 2" message shall be sent via the actual HC. If the alarm is caused by capacity problems, the alarm shall be sent via the actual HC or another HC connected.

The alarms and messages (frame 28) and the coding of V-parameters are specified in NMT.Doc 900-1.

15 SIGNAL STRENGTH MEASUREMENT (OPTION)

The method for signal strength measurement and ø-signal detection described in paragraphs 7 and 9.1.1. shall be replaced by this chapter.

The mean value of the signal strength shall be measured for a time period of 300 ms and shall be quantified in 64 levels. All the values below 0 ± 3 dB (1 μV) EMF (-113 dBm ± 3 dB) shall be coded as 0000 0000 (R_1 (0)R_2 (0)) and all the values above 63 ± 6 dB (1 μV) EMF (-50 dBm ± 6 dB) shall be coded as 0011 1111 (R_1 (3)R_2 (15)).

The signal strength output shall fulfil the specification stated in para 7.2.3, both with and without fading. The signal strength measuring receiver shall fulfil the requirements in paragraph 5.1-5.13, 5.21, 5.23-5.24, 5.28-5.29 and the general idea of para 5.26 i.e. a diversity gain of 5 dB.

The base station receives the measuring order (frame 21b or 21c) from MTX via idle traffic channel, actual channel or data channel.
The signal strength measurement result (frame 26) shall then have been sent from the base station equipment to MTX within 553 ms from the reception of the measurement order.

Signal strength measurement results shall be sent to MTX via the same connection as the corresponding signal strength measurement orders.
Measurement orders may be given in a continuous stream of frames 21b or 21c. In this case also the measurement results shall be sent to the MTX as a continuous stream of frames 26. There shall be no space between the frames and the result must be sent in the same order as the corresponding measurement orders have been received.

When an analogue supervisory signal (ASS) is used, the received ASS looped by the actual MS shall be detected. If the detected ASS is incorrect, then the measured signal strength and information that the ø-signal is incorrect ($f_ø$=0101) shall be sent. If no ø-signal number is given in the frame 21b and 21c then $f_ø$=0000 and the measured result R_1 R_2 shall be sent to MTX.

When a digital supervisory signal (DSS) is used, the received DSS looped by the actual MS shall be detected. If the detected DSS is incorrect, then the measured signal strength and information that the ø-signal are incorrect (F_1 F_2=0000 0101) shall be sent. If no ø-signal number is given in the frame 21b and 21c then F_1 F_2=0000 0000 and the measured result R_1 R_2 shall be sent to MTX. The decision rules for detection of DSS are specified in para 8.3.

16 COMBINER, ALTERNATIVE EQUIPMENT

Possible to select between 16.1 and 16.2 or 16.3.

16.1 ACTIVE COMBINER (OPTION)

Paragraph 3.1 is valid with the following additions:

In case of an integrated and/or active combiner para 3.1.7 shall be exchanged with the specification according to para 4.4.3 "Carrier power".

The attenuation specified in para 3.1.12 shall be measured between any amplifier output and the combiner output.

Fault alarms defined in 3.1.13 (e.g. power failure) shall be given to the CU of each affected channel.

16.2 AUTOMATIC TUNED COMBINER (fast version) OPTION

16.2.1 General requirements from the NMT recommendations

The requirements stated in paragraph 3.1 shall be fulfilled by the equipment.

The equipment shall comply with the reliability requirements specified in paragraph 1.3.7. It will belong to group B equipment, and the MTBF shall be based on a retuning occurrance of 60 times per hour.

In order to be able to replace 3 dB couplers, at connection of a number of transmitters in areas with small cell basestations, it is required that the power loss from any of the input terminals to the output terminal, isolators included, does not exceed 5,0 dB at combining 16 (preferably 32) transmitters at minimum with a frequency separation of 300 kHz.

16.2.2 Power requirements

The equipment shall operate with correct tuned channels at input levels of the following range in two different segments.

(+10 dBm to +30 dBm) (+25 dBm to +45 dBm)

Input levels below 0 dBm, +15 dBm respectively shall be treated as transmitter in off condition, at which the combiner resets according to time limits given in the control unit. The segments will be chosen at installation.

16.2.3 Requirements for tuning time

The total time needed for tuning the transmitter and the combiner at start of the transmitter shall not exceed 138 ms, measured according to para 4.5. This time

includes the carrier rise time at carrier on. At channel order to a randomly chosen channel the power shall be applied to the antenna within one frame time after order from MTX, corresponding to one idle frame in the signalling.

16.2.4 Functions in the control unit

The combining equipment shall in normal operation have the possibility to tune to the actual frequency of the transmitter by the incoming RF-signal, or by control from the channel unit.

Following functions shall be fulfilled by control signals by every single cavity unit:

1. The cavity is immediately tuned outside the frequency band and will follow the transmitter to the new channel at carrier on.

2. Cavity is locked outside the frequency band as long as the control signal is active.

3. Cavity is locked to latest tuned channel, independent of TX carrier frequency.

   [Frequency band for 935 - 960 MHz].

When no control signal has been activated the cavity shall stay tuned to the last frequency a time T after TX carrier has been switched off. The time T shall be programmable in steps in the interval (10 min, 24 h).

This means that it can be selected for how long time a cavity stays tuned at the frequency, before another cavity can be tuned to the same frequency without any interference. The position of the combiner outside frequency band, below or above will be chosen at installation.

16.2.5 Alarms

Alarm shall be given if improper operation occurs according to paragraph 3.1.14 (Combiner alarm).

Combiner alarm level 1 and level 2 shall exist.

Alarm level 2 shall be sent when major fault occurs. The alarm shall be sent on the corresponding channel.

16.2.6 Power supply

The combiner unit shall be supplied from all the power supplies in cabinet, which supplies the transmitters connected to the combiner. The combiner shall not lose its tuning at short mains interruptions.

16.3 AUTOMATIC TUNED COMBINER (slow version) OPTION

16.3.1 General Requirements

The requirements stated in paragraph 3.1 shall be fulfiled by the equipment.

The equipment shall comply with the reliability requirements specified in paragraph 1.3.7. it will belong to group B equipment.

In order to be able to replace 3 dB couplers, at connection of a number of transmitters in areas with small cell basestations, it is required that the power loss from any of the input terminals to the output terminal, isolators included, does not exceed 5,0 dB at combining 16 (preferably 32) transmitters at minimum with a frequency separation of 300 kHz.

16.3.2 See paragraph 16.2.2.

16.3.3 As paragrah 16.2.3 except for the tuning time which is 5 s instead of 138 ms.

16.3.4 See paragraph 16.2.4.

16.3.5 See paragraph 16.2.5.

16.3.6 See paragraph 16.2.6.

1984-05-17

Doc. 900-4

ANNEX 1

A calculation of some critical parameters in the combining equipment (Clause 3) in relation to the transmitter/ receiver-requirements (Clause 4 and 5).

1. SUMMARY OF RF-REQUIREMENTS FOR TRANSMITTER (Clause 4)

(§4.4)	RF carrier power: Pout =	
	25W $\pm$ 1 dB 6W $\pm$ 1 dB 1,5W $\pm$ 1 dB	+ 44 dBm + 38 dBm + 32 dBm
(§4.5)	Carrier off conditions for	
	$f = f_0$: $\leq$ 0,25 μW $f \neq f_0$: $\leq$ 2,0 nW	- 36 dBm - 57 dBm
	f_0 is nominal transmitter frequency.	
(§4.6)	Spurious emissions at	
	100 kHz - 4000 MHz: $\leq$ 0,25 μW except $f_0 \pm$ 50 kHz: $\leq$ 1,0 μW	- 36 dBm - 30 dBm
(§4.7)	Intermodulation attenuation:	
	$A_T \geq$ 15 dB	
	A_{TOdd} (5.th and higher/ 890,0 - 915,0 MHz) $\geq$ 40 dB	
(§4.12)	Adjacent channel power:	
	$f_0 \pm$ 25 kHz: $\leq$ - 70 dB/Pout	- 26 dBm
	Power in interleaved channel:	
	$f_0 \pm$ 12,5 kHz: $\leq$ - 40 dB/Pout	+ 4 dBm
(§4.13)	Noise power within receiver band	
	890,0 - 915,0 MHz: $\leq$ 2,0 nW	- 57 dBm

2. SUMMARY OF RF-REQUIREMENTS FOR RECEIVER (clause 5) AND RECEIVERMULTICOUPLER (clause 3.2)

		dBm	dB(1µV)EMF
(§5.3)	RF-sensitivity: ≤ -2 dB(1 µV)E.M.F	- 115	- 2
(§5.4)	Co-channel rejection: ≥ - 8 dB/rel. 5.3	- 123	- 10
(§5.5)	Adjacent channel and intermediate frequency selectivity:		
	f_0 ± 25 kHz	- 38	+ 75
	f_0 ± 12,5 kHz:	- 77	+ 36
	f_0 is nominal receiver frequency.		
(§5.6)	Spurious response rejection,		
	f_0 ± x, x ≤ 100 kHz:	- 38	+ 75
	f_0 ± x, 100 kHz < x ≤ 1 MHz	- 33	+ 80
	f_0 ± x, 1 MHz < x ≤ 25 MHz:	- 23	+ 90
	f_0 ± x, x > 25 MHz:	- 13	+ 100
(§5.7)	Intermodulation rejection for unwanted testsignals at		
	f_0 ± x, 50 kHz ≤ x < 200 kHz:	- 38	+ 75
	f_0 ± x, x ≥ 200 kHz:	- 33	+ 80
(§5.8)	Blocking,		
	f_0 ± x, 1 MHz ≤ x < 2 MHz:	- 18	+ 95
	f_0 ± x, 2 MHz ≤ x ≤ 50 MHz:	- 13	+ 100
(§5.9)	Spurious emissions at		
	890,0 - 915,0 MHz: ≤ 0,01 pW:	- 110	
	100 kHz - 4000 MHz elsewhere: ≤ 2,0 nW	- 57	

DB - BUDGET for critical parameters in combining equipment in relation to transmitter/receiver-requirements

3. TRANSMITTER COMBINER (clause 3.1..)

3A Primary requirement: Transmitter intermod. attenuation of odd order within receiver-band

	RF-carrier power at the input of combiner:			+44 dBm
(§3.1.9)	Isolation combiner for f ≥ 475 kHz: Isolation combiner for f ≥ 20 MHz:	80 dB	55 dB	
(§4.7)	5.th and higher odd order intermod. attenuation in receiver band (890,0 - 915,0 MHz):		40 dB	
	3.th order intermod. attenuation in receiver band:	15 dB		
	IM in receiver band at the input of combiner:			-51 dBm
(§3.1.12)	Attenuation of receiver-frequency through the combiner:		55 dB	
(§3.1.9)	IM in receiver band at combiner output:			-106 dBm
	Attenuation between transmitter/receiver-antennas (including antenna cables):		30 dB	
	IM in receiver band at receiver antenna input terminal of the radio cabinet,:			-136 dBm
(§5.4)	Co channel rejection at receiver antenna input terminal:			-123 dBm
	Additional margin to prevent reduction in quality:		10 dB	
	Requirement for IM in receiver band at receiver antenna input terminal:			-133 dBm

3B	<u>Primary requirement: Transmitter intermod. attenuation outside receiver band</u>		
	RF-carrier power at the input of combiner:		+ 44 dBm
(§3.1.9)	Isolation combiner:	55 dB	
(§4.7)	Intermodulation attenuation:	15 dB	
(§3.1.9)	IM at the input of combiner:		- 26 dBm
	Min. attenuation of IM through the combiner:	10 dB	
(§3.1.9)	IM at combiner output terminal:		<u>-36 dBm</u>
3C	<u>Primary requirement: Noise within receiver band</u>		
(§4.13)	Noise power:		- 57 dBm
(§3.1.12)	Attenuation of receiver-frequency through the combiner:	55 dB	
	Attenuation between transmitter/receiver-antennas:	30 dB	
	Noise power from transmitter at receiver antenna input terminal:		<u>-142 dBm</u>
	Co-channel rejection:		-123 dBm
	Additional margin:	10 dB	
	Compensation for 1 - 16 transmitters:	ca. 9 dB	
	Requirement to noise power from 1 transmitter:		<u>-142 dBm</u>

4. RECEIVER MULTICOUPLER (clause 3.2..)

4A Primary requirement: RF-carrier power and input filter at receiver multicoupler

	RF-carrier power at the input of combiner:		+ 44 dBm
(§3.1.7)	Attenuation through the combiner, typical:	3 dB	
	Attenuation between trans./receiver-antennas:	30 dB	
(§3.2.6)	Attenuation of transmitter-frequency through input filter:	60 dB	
	Carrier power from transmitter at receiver input:		-49 dBm
(Note)	"Intermodulation rejection":		-33 dBm

The attenuation of 60 dB through the input filter is maintained as additional margin and to protect against other communication-systems on the same site.

4B Primary requirement: Spurious emissions from receiver within receiver band

(§5.9)	Spurious emissions from receiver within receiver band:		- 110 dBm
(§3.2.8)	Isolation multicoupler:	30 dB	
	Spurious from one receiver at another receiver input:		- 140 dBm
(Note)	"Co-channel rejection":		- 123 dBm
	Additional margin:	10 dB	
	Compensation for 1- 16 receivers:	Ca: 7 dB	
	Requirement to noise power from 1 receiver:		- 140 dBm

Note: The intermod. rejection and co-channel rejection at the input connector of the receiver unit will depend on the attenuation between receiver antenna input terminal and actual receiver unit.

DRAFT ANNEX 2 to NMT DOC.900-4, 1992-10-01

ANNEX 2 TO NMT DOC. 900-4

Technical spedification for the scanning supervisory equipment

DRAFT TECHNICAL SPECIFICATION FOR THE SCANNING SUPERVISORY EQUIPMENT, SSE.

CONTENTS.

1 GENERAL

1.1 INTRODUCTION

This annex specifies a scanning supervisory equipment (SSE) for the Nordic Mobile Telephone network (NMT 900). The equipment is primary aimed to be placed at base station sites.

The basic function of the scanning supervisory equipment is to continuously supervise channels in the system and initiate handover attempts in the mobile telephone exchange.

The SSE will be connected to the mobile telephone exchange (MTX) through dedicated FFSK-channels called "Handover request Channels" (HC), figure 1.

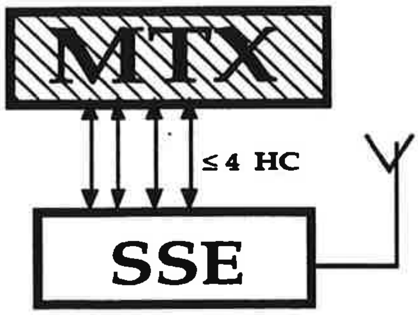


Figure 1. System structure with HC.

The scanning supervisory equipment may also be connected to basestations which have an HC-interface implemented, figure 2 and 3.

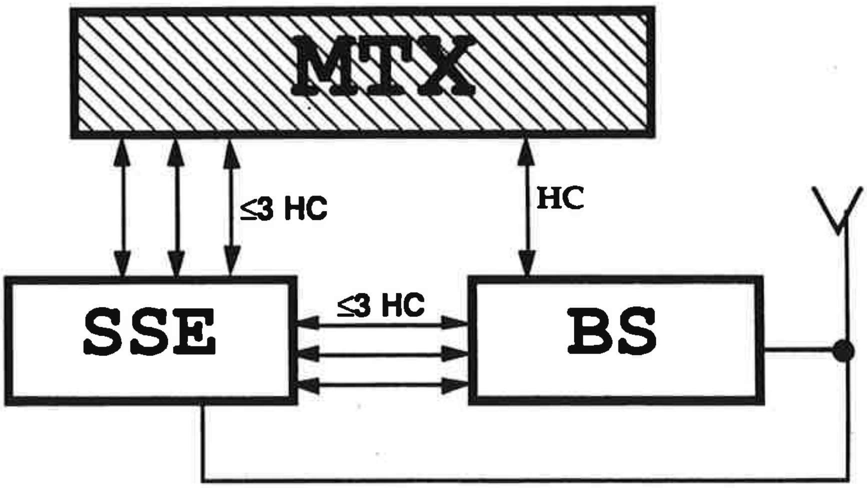


Figure 2. System structure with SSE implemented and at least one HC is connected directly between BS and MTX.

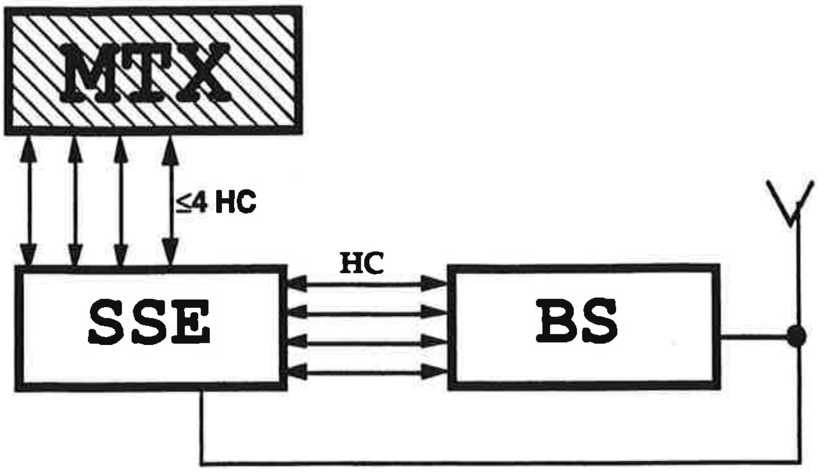


Figure 3. System structure with SSE implemented and no HC is connected directly between BS and MTX.

The SSE may be divided into different functional entities. The primary entities are:

* Radio
This entity shall provide radio receiving equipment for specified frequency band. It consists of two functional parts:

* Scanner: Measures mean signal strength on a number of defined channels every second.

* Supervisory signal detector:
Detects NMT supervisory signal on specific channels at order from logic unit.

* Database
This entity shall contain information of each channel in the system and the information shall be updated continuously. The information is mainly static parameters, signal strength values, timers and statistical counters.

* Signalling interface
This entity shall provide functions for communication with the other parts in the NMT-system (mobile telephone exchange, MTX, and basestations, BS). The signalling system used is the NMT 1200 baud fast frequency shift keying, FFSK. The Handover request Channel, HC, and Data Channel, DC, shall be used for the signalling, figure 1 and 2.

* Evaluation
This is a functional entity which primary shall:
- control the scanning.
- process the measurement results.
- evaluate the results and take the decision whether any action shall be taken.

* O&M
This entity shall primary provide following functions:
- to supervise the handover request channels.
- to supervise the functionality of the SSE-unit.
- to receive and send information via remote control interface.
- a testmode.

* Statistics
This entity provides statistical counters for signal strength and different events for all the channels.

A general description of the NMT system is given in NMT DOC.900-1.

References made to paragraphs in NMT DOC.900-1 and 900-4 includes valid Addendums to these paragraphs.

1.2 ABBREVIATIONS

ASS	Analogue supervisory signal
BS	Base station
DC	Data channel
DSS	Digital supervisory signal
FFSK	Fast frequency shift exchange
MTX	Mobile telephone exchange
ø-signal	Supervisory signal

1.3 GENERAL SPECIFICATIONS.

1.3.1 Cabinet radiation.

The radiated power from the SSE and connected cables shall not exceed 2,0 nW in the frequency band 30-4000 MHz.

1.3.2 Ability to withstand electromatic fields.

The SSE shall fulfil the requirements according to paragraph 1.3.6 in NMT DOC.900-4.

1.3.3 Reliability.

The SSE shall comply with the requirements according to Group B (50.000 hours) in paragraph 1.3.7 in NMT DOC.900-4.

1.3.4 Safety requirements.

The SSE shall fulfil the requirements according to paragraph 1.3.9 in NMT DOC.900-4.

1.3.5 Power source.

The SSE shall be capable of being supplied either directly from the mains or from an external battery with buffer according to paragraph 1.3.10 in NMT DOC.900-4.

If the SSE is delivered from the same manufacturer as the basestation equipment at the actual site the SSE may be supplied from the power distribution in the basestation cabinet.

1.3.6 Marking of the equipment.

The SSE shall be marked according to paragraph 1.3.11 in NMT DOC.900-4.

1.3.7 Construction.

The SSE shall preferably be designed to fit into a cabinet with standard 490 mm (19") rack mounting. The maximum depth shall be 300 mm. All installation and maintenance of the SSE shall be possible to perform from the front of the cabinet.

The cables used shall be of flame retardant halogen freecable type, fulfilling the requirements according to paragraph 1.3.14.9 in NMT DOC.900-4.

1.3.8 Environmental requirements.

The SSE shall fulfil all requiremets regarding temperature range, power source voltage etc. according to paragraph 1.3.14 in NMT DOC.900-4.

1.3.9 Power supply radiation.

The SSE shall fulfil the requirements according to paragraph 1.3.15a in NMT DOC.900-4.

1.3.10 Acoustic noise.

The SSE shall fulfil the requirements according to paragraph 1.3.15b in NMT DOC.900-4.

1.3.11 Noise from DC power supply.

The SSE shall fulfil the requirements according to paragraph 1.3.16 in NMT DOC.900-4.

1.3.12 Hysteresious function of DC-power supply.

The SSE shall fulfil the requirements according to paragraph 1.3.17 in NMT DOC.900-4.

1.3.13 Crosstalk

The SSE shall fulfil the requirements according to paragraph 1.3.3 in NMT DOC.900-4.

2 TEST CONDITIONS AND GENERAL CONDITIONS.

The conditions shall be according to the following relevant parts in NMT DOC.900-4:

- paragraph 2.1	Power sources and ambient temperatures.
- paragraph 2.2.1	Continuous operation
- paragraph 2.2.4	Modulation
- paragraph 2.2.5	Arrangements for test signals applied to the receiver input.
- paragraph 2.2.8	Test site and general arrangement for measurements involving the use of radiated fields.

3 RADIO INTERFACE

3.1 SIGNAL STRENGTH MEASUREMENT RADIO INTERFACE.

3.1.1 Frequency range.

The SSE shall fulfil the requirements according to paragraph 5.1 in NMT DOC.900-4.

3.1.2 <u>Number of RF-channels and scanning speed.</u>

The receiver shall be capable of being set to any of the 1999 channels in the frequency range specified in paragraph 3.1.1.

The SSE shall be able to scan a subset of these channels that not are in a successive order. If the scanner has a capacity of at least 800 channels per second this requirement need not to be fulfilled. The channels can then be scanned in successive order.

The SSE shall be able to scan at least 30, but normally 200, channels per second with the in 3.1.3 given accuracy. The capacity shall be expandable to at least 800 channels, preferably 1999 channels, per second by adding additional receivers (if neccessary).

Note: The requirement, that the tolerance shall be fulfilled during fading (se below), implies that a number of samples, distibuted in time, are needed for each channel.

3.1.3 <u>RF-sensitivity.</u>

The requirements on RF-sensitivity of the SSE shall be based on the fact that the signal strenght measurement result from scanning a channel not shall be affected (still be within tolerance limits) by RF-signals at other channels or fading environment (paragraph 3.1.4, 3.1.5, 3.1.7). The measured signal strength output (R(n1)R(n2)) from one scaning cycle (paragraph 9), shall represent the RMS-mean signal strength during the last second at the channel.

The signal strength measurement output from one 1 sec. scanning cycle as a function of the RF-input signal level at the receiver antenna input terminal of the cabinet shall have a characteristic as below under static conditions. Under fading conditions the requirements shall be fulfilled for the mean value of a great amount of results from 1 sec. scanning cycles.

The curve shall have a positive differential coefficient which implies that the signal strength measurement output at low RF input signal level shall not exceed the measurement output at higher RF input signal levels.

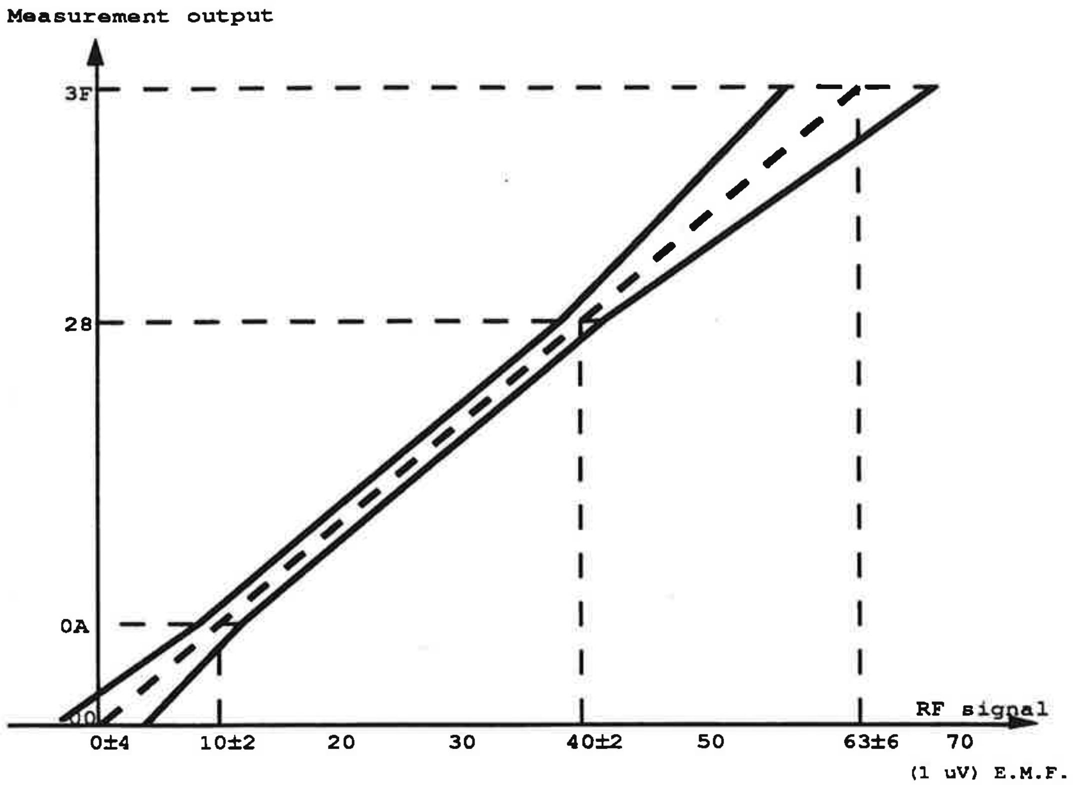


Figure 4.

3.1.4 Selectivity under influence of an unwanted signal.

3.1.4.1 Definition

The selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal.

3.1.4.2 Static conditions

3.1.4.2.1 Method of measurement

Two signals shall be applied to the receiver antenna input terminal of the SSE via a combining network. The wanted signal shall be at the nominal frequency of the receiver and be modulated with normal test modulation. The unwanted signal shall be modulated with a 400 Hz tone to a frequency deviation of ± 3,0 kHz. The distance in frequence between the wanted and unwanted signal is specified below.

3.1.4.2.2 Measurement of the adjacent and interleaved channel selectivity.

The measurement shall be made with the unwanted signal at the nominal frequency ± 12,5 kHz (upper and lower interleaved channel) and ± 25 kHz (upper and lower adjacent channel) apart from the nominal frequency.

Initially the unwanted signal shall be switched off and the level of the wanted signal shall be adjusted to 1 dB (1µV) EMF (-112 dBm). The unwanted signal shall then be switched on and its level adjusted until the signal strength measurement result of the wanted signal is outside the allowed tolerances according to paragraph 3.1.3.

The channel selectivity shall be expressed as the lower value in dB (1µV) EMF of the unwanted signal for each "frequency pair" (±12,5 kHz and ±25 kHz).

3.1.4.2.3 Measurement of the blocking/spurious response at other frequencies.

The frequency of the unwanted signal shall be varied at least from 25 kHz to 4000 MHz apart from the nominal frequency of the wanted signal.

The input level of the unwanted signal, X, shall be 106 dB (1µV) EMF (-7 dBm) while its frequency is varied in the frequency range. At any frequency at which a response is obtained the input level of the unwanted signal shall be adjusted until the signal strength measurement result of the wanted signal is inside the allowed tolerances according to paragraph 3.1.3.

The selectivity shall be expressed as the level (in dB (1µV) EMF) where the signal strength measurement result is inside the allowed tolerances, as described above, again.

3.1.4.2.4 Requirement

The selectivity (in dB (1µV) EMF) under static conditions shall not be less than:

Frequency (kHz)	Selectivity	
	Normal test	Extreme test
±12,5	36	
±25	75	70
25<X≤100	75	
100<X≤1000	80	
1000<X≤25000	90	
X>25000	100	

3.1.4.3 Fading conditions.

3.1.4.3.1 Method of measurement

A wanted and an unwanted signal shall be applied to the receiver antenna input terminal of the SSE, through two independent Rayleigh fading simulators via a combining network.

The RMS-level of the wanted signal shall be adjusted to 20 dB (1µV) EMF (-93 dBm). The level of the unwanted signal shall be adjusted until the signal strength measurement result of the wanted signal is outside the allowed tolerances according to paragraph 3.1.3.The RMS-level of the unwanted signal is noted (see paragraph 2.2.5 in NMT DOC.900-4). The measurement shall be repeated a great amount of times and the mean value of the noted values is calculated.

The measurements shall be made for the speed of 50 km/h and with the adjacent interleaved channel (±12.5 kHz) as unwanted signal.

3.1.4.3.2 Requirement

The selectivity shall fulfil the requirements in paragraph 5.29.2 in NMT DOC.900-4.

3.1.5 <u>Intermodulation rejection.</u>

3.1.5.1 Definition

The SSE shall fulfil the definition according to paragraph 5.7.1 in NMT DOC.900-4.

3.1.5.2 Method of measurement

The method used shall be according to paragraph 5.7.2 NMT DOC.900-4 with the following exception:

- The last sentence in the second section under alternative a) is changed to:

  ....The levels of the two unwanted signals B and C shall be maintained equal and increased in level until the signal strength measurement result of the wanted signal is outside the allowed tolerances according to paragraph 3.1.3.

- The second section under alternative a) is removed.

- The last section under alternative b) is changed to:

  The intermodulation rejection....input terminal when the signal strength measurement result is outside the allowed tolerances.

3.1.5.3 Requirement

The SSE shall fulfil the requirement according to paragraph 5.7.3 NMT DOC.900-4.

3.1.6 Spurious emission.

The SSE shall fulfil the requirements according to paragraph 5.9 NMT DOC.900-4.

3.1.7 Deviation of the signal strength measurement result due to fading.

3.1.7.1 Definition

The deviation of the signal strength measurement result due to fading, is the difference between the signal strength output without fading and the deciles of the measurements with fading defined below.

3.1.7.2 Method of measurement

A signal shall be applied to the SSE RF-input terminal through a Rayleigh fading simulator.

Without fading the RF-level of the signal to the SSE shall be adjusted to give a signal strength measurement output equal to 28 (i.e. R(n1)R(n2)=28). The RMS-level of the signal to the SSE is measured with a true RMS-power meter and noted.

The fading simulator is now set to fading speed of 3, 50 and 100 km/h. The RMS-level of the signal to the SSE is adjusted to a level 1 dB above the RMS-level to the SSE without fading.

The measurements are repeated for R(n1)R(n2)=14.

For each case 1000 signal strength measurement results shall be stored. Calculate upper and lower decile.

3.1.7.3 Requirement

Fading speed (km/h)	Max output deviation (unit)
3	±6
50	±3
100	±3

3.2 Ø-SIGNAL DETECTOR RADIO INTERFACE

3.2.1 General

The ø-signal detector shall be able to determine the modulated ø-signal at a given radio channel. In case of ASS the ø-signal frequency or in case of DSS the code detected according to paragraph 11. The detection of ASS and DSS shall be made in parallel. This paragraph specifies the requirements of the radio interface.

The ø-signal receiver shall fulfil the requirements for a normal channel receiver according to paragraph 5 NMT DOC.900-4 except for the paragraphs 5.10, 5.11, 5.12, 5.20, 5.22, 5.25, 5.26, and 5.27 NMT DOC.900-4.

3.2.2 Requirements of the ASS detector.

The ASS is generated according to paragraph 8.1.5.1 NMT DOC.900-4.

The ø-signal shall be measured within the frequency range $f_ø$ ±5 Hz (3 dB bandwidth).

The decision criteria for detection of an ASS is that the received frequency deviation shall be att least ± 150 Hz.

3.2.3 Requirements of the DSS detector.

The detector for DSS shall comply with paragraph 8.3 NMT DOC.900-4. It shall be able to receive a arbitrary bit sequence and evaluate which F_1 F_2 it shall be referred to. The decision rule for valid sequence shall be the number of bit errors ≤ 5 ((d_{min} -1)/2). If the decision rule is not fulfilled for any of the defined F_1F_2 no DSS is detected.

3.2.3.1 Demodulator

The demodulator shall fulfil the requirements according to paragraph 8.3.4 NMT DOC.900-4

4. BS INTERFACE.

4.1 GENERAL

This paragraph specifies the interface between SSE and the BS equipment. The interface shall be able to handle up to four 1200 baud FFSK channels (Handover request channels, HC). The signalling equipment used is specified in paragraph 4.6 NMT DOC. 900-1.

Data signal levels at SSE are specified in paragraph 4.6 NMT DOC. 900-1. The specified levels corresponds to the normal data test modulation (paragraph 2.2.4.2 NMT DOC.900-4).

The requirement for the bit error rate of the demodulator in the SSE-modem shall be according to figure 4.6.7 NMT DOC. 900-1 with the values for S/N-ratio increased by 3 dB. The requirements shall also be fulfilled at a group delay distortion according to figure in paragraph 6 NMT DOC.900-4.

Communication can only be established to BS equipment which have an HC-interface implemented.

4.2 ADDRESSING UNITS AT BS VIA HC FROM SSE

It shall be possible to address physical units at the BS from SSE according to paragraph 14.2 NMT DOC.900-4.

4.3 AUDIO FREQUENCY POWER TO LINE, INCLUDING MODEM.

The SSE line input and output terminal shall be provided with a six-way socket link and test connector with double U-link plug according to paragraph 5.10 (4.18) NMT DOC.900-4, to make it possible to break the line for maintenance measurements.

4.4 LINE OUTPUT AND INPUT IMPEDANCE.

The SSE shall fulfil the requirements according to paragraph 5.11 and 4.19 NMT DOC.900-4.

4.5 IMPEDANCE SYMMETRY.

The SSE shall fulfil the requirements according to paragraph 5.12 (4.20) NMT DOC.900-4.

5. MTX INTERFACE.

5.1 GENERAL

This paragraph specifies the interface between SSE and MTX. The interface shall be able to handle up to four 1200 baud FFSK channels (Handover request channels, HC). The signalling equipment used is specified in paragraph 4.6 NMT DOC. 900-1.

Data signal levels at SSE are specified in paragraph 4.6 NMT DOC. 900-1. The specified levels corresponds to the normal data test modulation (paragraph 2.2.4.2 NMT DOC.900-4).

The requirement for the bit error rate of the demodulator in the SSE-modem shall be according to figure 4.6.7 NMT DOC. 900-1 with the values for S/N-ratio increased by 3 dB. The requirements shall also be fulfilled at a group delay distortion according to figure in paragraph 6 NMT DOC.900-4.

A continuous stream of frames shall be sent from the SSE to MTX. This shall be fulfilled by sending idle frames (frame 15) in case no other message shall be sent.

5.2 AUDIO FREQUENCY POWER TO LINE, INCLUDING MODEM.

The SSE line output and input terminal shall be provided with a six-way socket link and test connector with double U-link plug according to paragraph 5.10 (4.18) NMT DOC.900-4, to make it possible to break the line for maintenance measurements.

5.3 LINE OUTPUT AND INPUT IMPEDANCE.

The SSE shall fulfil the requirements according to paragraph 5.11 and 4.19 NMT DOC.900-4.

5.4 IMPEDANCE SYMMETRY.

The SSE shall fulfil the requirements according to paragraph 5.12 (4.20) NMT DOC.900-4.

6. DATA CHANNEL INTERFACE (OPTION)

6.1 GENERAL

The purpose of this interface is that the SSE shall be able to "listen" to the signalling made via the data channel, DC, from the MTX to the BS.

The SSE shall "register" all signal strength measurement orders (frame 21b) sent via DC. The information in these frames may be used to update the scanning groups in the SSE according to paragraph 8.

The SSE shall have the capacity to "listen" to up to four DC with full load (seven measurement orders per second). The requirements for the DC are specified in NMT DOC. 900-1.

6.2 DATA LINE TEST CONNECTOR

The SSE shall be provided with a line test socket/connector. according to paragraph 9.1.4 NMT DOC.900-4.

7. SIGNALLING BETWEEN BS AND MTX VIA SSE.

It shall be possible to send messages between BS and MTX via HC through SSE. This situation occurs when there are no HC's connected directly between the BS and MTX. The messages concerned are:

- Handover Request (frame 41)
- Other maintainance information (frame 28).

These messages from the BS, aimed for the MTX, shall have higher priority to be sent to the MTX, than messages that are initiated internally in the SSE.

The SSE shall send acknowledge of frame 41 (see paragraph 14.2.1), but only if the SSE is possible to send the message further to the MTX (i.e. SSE has at least one HC connected to the MTX and in function).

8. PARAMETERS STORED FOR EACH CHANNEL.

8.1 GENERAL

For each of the available channels (paragraph 3.1.2), a set of individual data and parameters must be setable and stored. For practical reasons the channels are put together in groups. Each group has a set of data in common. The number of channels in a group shall not be limited. The definition of a channel in a specific group consist of the channel number, N_a N_b N_c, and the corresponding supervisory signal number, F_1 F_2 .

Four different types of groups are defined: Own channels, Neighbouring channels, Adaptive channels and Not to scan channels.

There are also some parameters that are in common for all channels, global parameters.

8.2 OWN CHANNEL GROUP

This group is used for defining the channels present on the own basestation. Two methods for entering the channels are possible:

Method A:	The SSE receives information via the remote control interface (paragraph 13.1).
Method B:	The channels are entered via channel information messages (frame 50) sent from the BS via HC.

Information of the ø-signal number used at own BS is always received via remote control.

The following parameters are available for this group:

Meaning	Parameter	Values
* Entering channels to the group via remote control interface ("No" implies from BS)	remote control	Yes/No
* Communication with BS via HC	BS_com	Yes/No
* Channels in the group shall be scanned	scan	Yes/No
* Fast scan shall always be used	always	Yes/No
* Scanning suppressed if not active info from BS	suppress	Yes/No
* Base station number (only for reference)	B_1 B_2 B_3	0-4095
* Parameter to send in frame 42	G	0,1,2,4 or 8

*	Level for sending handover request (frame 41)	L_{H41} L_{L41}	0-63 0-63
*	Level for sending power regulation message (frame 42)	L_{power}	0-63
*	Level for fast scanning	L_{fast}	0-63
*	Level for slow scanning	L_{slow}	0-63
*	Level to decide whether a new call has began	L_{new}	0-63
*	Filter to be used to evaluate handover request (frame 41) (The output is RES_{HR})	FIR_{HR}	0-15
*	Filter to be used to evaluate power regulation message (frame42) (The output is RES_{power})	FIR_{power}	0-15
*	Number of saved values among which the largest one shall be selected. The selected value (V_{slow}) shall be used to decide whether a call shall be transferred from fast to slow scanning.	NR_{slow}	1-10
*	Number of saved values among which the largest one shall be selected. The selected value (V_{new}) shall be used to decide whether a new call has began	NR_{new}	1-10
*	Maximum allowed ouput power of the mobilestations	power	low, medium, high or "not used"
*	Time for inhibit sending frame 42	T_{rep42}	5-60 s
*	Time for inhibit sending frame 41	T_{rep41}	5-60 s

8.3 NEIGHBOURING CHANNEL GROUP

At least 32 different groups of this type shall be possible to define. Each group is aimed to correspond to a part of or a whole neighbouring basestation. If this type of group is used, the channels are always entered via O&M interface.
The following parameters are available for this group:

Meaning	Parameter	Values
* Base station number (only used for reference)	$B_1B_2B_2$	0-4095
* Fast scan shall always be used	always	Yes/No
* Frame 42b shall be sent instead of frame 42	send_42b	Yes/no
* ø-signal shall always be checked before sending frame 42 or 42b	check	Yes/no
* Alternative A of parameter to send in frame 42	G_A	0,1,2,4, or 8
* Alternative B of parameter to send in frame 42	G_B	0,1,2,4, or 8
* Level for sending handover offer message (frame 42) with G-value according to alternative A	L_{HOA}	0-63
* Level for sending handover offer message (frame 42) with G-value according to alternative B	L_{HOB}	0-63
* Level for fast scanning	L_{fast}	0-63
* Level for slow scanning	L_{slow}	0-63
* Level to decide whether a new call has began	L_{new}	0-63
* Filter to be used to evaluate handover offer message (frame 42) with G-value according to alternative A (Output is RES_{HOA})	FIR_{HOA}	0-15
* Filter to be used to evaluate handover offer message (frame 42) with G-value according to alternative B (Output is RES_{HOB})	FIR_{HOB}	0-15

* Number of saved values among which the largest one shall be picked. The picked value (V_{slow}) shall be used to decide whether a call shall be transferred from fast to slow scanning.	NR_{slow}	1-10
* Number of saved values among which the largest one shall be picked. The picked value (V_{new}) shall be used to evaluate whether a new call has began	NR_{new}	1-10
* Maximum allowed ouput power of the mobilestations	power	low, medium, high or "not used"
* Time for inhibit sending frame 42	T_{rep42}	5-60 s

8.4 ADAPTIVE CHANNEL GROUP

This group are used in the same way as the previous type of group. There are two different solutions for updating this list:

Solution A: The special feature is that it is updated with channel numbers in an automatic way by listening on the Data channels of the own basestation (if an DC-interface according to paragraph 6 is implemented). This will contain information of the neighbouring basestations channels together with the supervisory signal number.

Solution B: Use very slow scanning for updating the list. This scanner will scan all channels every few minutes. All channels with a measured signal above a certain limit are entered into this group. If a channel is present in any of the other groups, it shall not be entered into this group.

The following parameters are available for this group:

Meaning	Parameter	Values
* New channels entered from Data channel	DC_enter	Yes/No
* New channels entered from very slow scanner	scan_enter	Yes/No

*	Fast scan shall always be used	always	Yes/No
*	ø-signal shall always be checked before sending frame 42 or 42b.	check	Yes/no
*	Frame 42b shall be sent instead of frame 42	send_42b	Yes/no
*	Alternative A of parameter to send in frame 42	G_A	0,1,2,4, or 8
*	Alternative B of parameter to send in frame 42	G_B	0,1,2,4, or 8
*	Level for sending handover offer message (frame 42) with G-value according to alternative A	L_{HOA}	0-63
*	Level for sending handover offer message (frame 42) with G-value according to alternative B	L_{HOB}	0-63
*	Level for fast scanning L_{fast}	0-63	
*	Level for slow scanning	L_{slow}	0-63
*	Level to decide whether a new call has began	L_{new}	0-63
*	Level to decide whether a call shall be transferred from <u>very</u> slow scanning to slow scanning.	L_{scan}	0-63
*	Filter to be used to evaluate handover offer message (frame 42) with G-value according to alternative A (Output is RES_{HOA})	FIR_{HOA}	0-15
*	Filter to be used to evaluate handover offer message (frame 42) with G-value according to alternative B (Output is RES_{HOB})	FIR_{HOB}	0-15
*	Number of saved values among which the largest one shall be picked. The picked value (V_{slow}) shall be used to decide whether a call shall be transferred from fast to slow scanning.	NR_{slow}	1-10

* Number of saved values among which the largest one shall be picked. The picked value (V_{new}) shall be used to evaluate whether a new call has began	NR_{new}	1-10
* Number of saved values among which the largest one shall be picked. The picked value (V_{scan}) shall be used to evaluate whether a call shall be transferred from very slow scanning to slow scanning	NR_{scan}	1-10
* Maximum allowed ouput power of the mobilestations	power	low, medium, high or "not used"
* Time for inhibit sending frame 42	T_{rep42}	5-60 s

8.5 "NOT TO SCAN" CHANNEL GROUP

This group is only used to inhibit certain channels from being automatically entered in the Adaptive channels group. The channel numbers for this group is entered via O&M interface.

8.6 GLOBAL PARAMETERS

The global parameters shall be used for all channels independently of which group the channel belong to.

Meaning	Parameter	Values
* Maximum time for a call to stay in ø-signal detection queue	$T_{ø\text{-queue}}$	0-5 s
* Indicator whether both ASS and DSS are used in the environment. (Yes implies that both ASS and DSS are used)	DSS_area	Yes/No

8.7 GLOBAL SETTING OF PARAMETERS

The following parameters shall be possible to set for all groups at the same time: Always, send_42b, G_A , G_B , L_{HOA} , L_{HOB} , L_{fast} , L_{slow} , L_{new} , FIR_{HOA} , FIR_{HOB} , NR_{slow} , NR_{new} , T_{rep42} , Check.

The parameters L_{HOA} , L_{HOB} , L_{fast} , L_{slow} , L_{new} shall be compensated using the "power" parameter defined for each group. The compensation is made by adding a value from the table below to the globally set value before storing it for the specific channel group.

Power in "own"group	Power in group to compensate			
	High	Med	Low	Not used
High	0	-8	-18	0
Medium	8	0	-10	0
Low	18	10	0	0
Not used	0	0	0	0

9. SCANNING

9.1 GENERAL

A subset of the available channels (see paragraph 3.1.2) shall be scanned regularly. The channels to be scanned are divided into two types:

Fast scanning: Channels that are scanned every second.

Slow scanning: Channels that are scanned approximately every ten seconds (depending on scanner capacity).

Channels subject to fast and slow scanning or not subject to scanning at all, is selected per every individual channel according to the rules presented in paragraph 9.6.

If a scanner with enough capacity is used, i.e. all channels are scanned every second, see para 3.1.2. In this case, irrelevant parts of this chapter may be disregarded.

9.2 SCANNING CYCLE

The scanning cycle is normally 1 s. During the 1 s cycle, signal strength is measured on all fast scan channels. The remaining capacity of the 1 s cycle is used to measure the slow scan channels. When measuring the slow scan channels, the channels with the oldest measurements are given the highest priority, and the fresher the measurement is, the lower is the priority.

9.3 MEASUREMENT RESULT

9.3.1 Fast scan channels

Results from the measurements are stored for 10 s. This implies that, for each channel in the group, 10 measurement results are stored. Each result consist of 6 bits (values 0 to 63).

After every measurement, a possible change to slow scan is evaluated, regarding the 10 measurement results. The rules for this is described in paragraph 9.6. If the change is made, all the measurement results, except the latest, are discarded.

9.3.2 Slow scan channels

The measurement results are only used to decide a possible change to fast scan. The measurement result is stored until the next measurement is performed. If a change is decided, the measurement result shall be stored as the most recent value. The other positions in the fast scan result array, are set to zero.

9.4 ERROR SITUATION: LOW CAPACITY OF THE SCANNER

All alarms are sent in frame 28. The coding of the information in the frame are specified in NMT.Doc 900-1.

9.4.1 Fast scanning

If not all fast scan channels can be measured during the 1 s scan period, a "Fast scan alarm" shall be sent to the MTX. The scanning shall continue for all the fast scan channels. The cycle time will hence be more than the stipulated 1 s.

After the above alarm has been released, a "Fast scan alarm ceasing" shall be sent when the fast scan channels occupies less than 95% of the capacity of the scanner.

9.4.2 Slow scanning

If not all slow scan channels with measurements older than 15 seconds can be measured during one 1 s scan cycle, a "Slow scan alarm" shall be sent to MTX. After sending this alarm, a "Slow scan alarm ceasing" shall be sent when all slow scan channels have been measured during the last 10 seconds.

9.5 PROCESSING OF MEASUREMENT RESULTS

A number of FIR-filters (at least 16 possible) shall be defined in the SSE via remote control. Each filter consist of an array of 10 factors, setable in steps of 1% (100 steps). The sum of the elements in the array shall be 100%. This array is used for weighting the measurement result array from the fast scan channels.

When using the filter, each of the measurement result are multiplied with the corresponding weight. The resulting products are summed and the sum is called RES_x , where x implies in which evaluation the sum shall be used (i.e. x=HR implies that the sum shall be used to evaluate whether a handover request message shall be sent). RES_x is then compared to a parameter (defined in paragraph 10). After this the value RES_x is discarded.

Special filter

Special filters are used for:

* change from fast to slow scan, defined in parameter NR_{slow} .
* indication of an interruption in the call (that a new call has started on the channel), defined in parameter NR_{NEW} .
* change from very slow scan to slow scan, defined in parameter NR_{scan} .

The result is called V_x (where x indicates which filter has been used, i.e. x=slow, new or scan) and defined as equal to the largest of the latest individual results. It is compared with the threshold values defined in paragraph 8. After this use, the value of V_x is discarded.

Example:

NR_{slow}=5 implies that V_{slow} will contain the largest of the 5 latest measurement results.

9.6 PROCEDURES TO INCLUDE CHANNELS INTO SCANNING SEQUENCE.

9.6.1 General procedure

Normally all channels defined in the SSE are subject to slow scanning at startup. They are moved to fast scan if the measured value is greater than the threshold value L_{fast}. When subject to fast scanning an evaluation is performed every second whether to take any action. This is described in Paragraph 11. One of the possible actions to take is to move the channel to slow scanning.
Below is mentioned some exceptions. The groups are defined in paragraph 8.

9.6.2 Own channel group

9.6.2.1 SSE with link to BS

In this case a HC channel is setup between the SSE and BS, and the BS sends information about the active channels. By a parameter it shall be possible to decide whether to use this information or not. If the procedure is to be used it will work as follows:

When the SSE receives a channel information message (frame 50) with start of a call, this channel shall be included in the fast scanning procedure. When the same message is received with call termination (parameter I=4 or 8) the channel shall be transferred to slow scanning.

The normal criterias for change between fast and slow scan groups are active as a backup, since the SSE does not monitor the proper functioning of the HC towards the BS.

9.6.2.2 SSE without link to BS.

If no signalling channel is setup between SSE and BS, the general procedure (paragraph 9.6.1) shall be used to include channels into scanning sequence.

9.6.2.3 Other scanning parameters

Depending on network planning it is in some cases not necessary to scan the own channels at all. For this reason a yes/no parameter shall be implemented.
Also depending on network planning it is sometimes necessary to have very good control of the own channels, i.e. always scan the channels fast. Also for this reason a yes/no parameter shall be implemented.

9.6.3 Neighbouring channel group.

For these channels, the general scanning procedure (paragraph 9.6.1) is used. The only exception is if a parameter is set that indicates that the channels always shall be subject to fast scanning.

9.6.4 Adaptive channel group

The channels within the adaptive channel group are treated in the same way as the channels in the neighbouring channel group. If a channels belongs to one of the other groups it shall not be included in this group.

9.6.5 Not to scan channel group

These channels will not be treated at all by the SSE. The reason for the group is that the channels shall not be included in the adaptive channel group.

10 Ø-SIGNAL DETECTION

10.1 GENERAL

Before the handover offer message is sent to MTX, the equipment shall have the possibility to check the ø-signal frequency in case of ASS, or the code in case of DSS. If this check shall be carried out shall be set by the parameter "check", which is set per group, or if G=8.

10.2 EQUIPMENT FOR Ø-SIGNAL DETECTION

The detection and evaluation of the ø-signal shall be accomplished by separate receivers equipped with detectors for both ASS and DSS. The number of receivers connected will depend on the need of capacity for detection. The capacity shall be expandable by adding additional receivers.
The requirements for the radio interface of this receiver and the detectors are given in paragraph 3.2.

10.3 DETECTION PROCEDURE

If the criteria for handover offer is fulfilled for a channel and the detection parameter "check" is set to "yes" or G=8, a ø-signal detection shall be made. The receiver is ordered to the channel. Both detectors are connected and the channel is observed.

The detection shall be made according to appendix 1E.

10.3.1 A DSS detected.

The detected value, F_1F_2, shall always be returned.

10.3.2 An ASS is detected.

The detected value, F_1 F_2 , shall be returned if:

- no F_1 F_2 is defined for the channel and the parameter "DSS_area" is set to "no".
- the detected ASS does not match the defined F_1 F_2 and the parameter "DSS_area" is set to "no".
- an analogue F_1 F_2 is defined for the channel and it corresponds with the detected.

The defined value, F_1 F_2, shall be returned if:

- a digital F_1 F_2 is defined for the channel and the detected ASS corresponds to the associated ASS according to paragraph 8.3.5.2
NMT DOC.900-4.

Otherwise the F_1 F_2 is returned as 00000000.

10.4 DETECTION TIME

10.4.1 ASS

The detection time for ASS shall be set to 310 ms. If any of the four ASS signals are detected for 200 ms this shall be reported to the logic and the detection shall be stopped, both for ASS and DSS. If this is not fulfilled within 310 ms it shall be reported to the logic that no ASS is found and the detection shall be stopped.

10.4.2 DSS

For the DSS a bit sequence of 31 bits shall be collected and this stream shall be compared with the 35 possible combinations and their cyclic shifts (paragraph 8.3.2 NMT DOC.900-4).

10.5 DETECTION CAPACITY

The detector shall be able to handle at least 3 measurement orders per second at arbitary channels. The delay time for the response of each measurement order shall be maximum 650 ms. It shall be able to expand the capacity up to 12 measurement orders per second.

At overload there shall be a queue for ø-signal detection orders. Maximum queuing time shall be settable by a global parameter, $T_{ø\text{-queue}}$. When a detection order is taken out of the queue due to max queuing time, an alarm is sent (paragraph 13.4.2) and the value G8 will be changed to G4 in the handover offer message. A supervision function shall be implemented, which will cause a statistic for the overflow (paragraph 12.6.1).

11 EVALUATION OF MEASUREMENTS RESULT

11.1 GENERAL

As a process parallel to the updating of the measurement values for each channel an evaluation is performed. In this evaluation the channels are treated in different ways depending of group belonging and scanning speed for actual channel.

The evaluation shall be started within 100 ms after a new measurement result has been obtained from the scanning equipment.

For slow scan channels a simple comparison of the measured value to a threshold set for each group is made. The channel shall be moved to the fast scanning group if the threshold is exceeded (see paragraph 9.6).

For the fast scan channels more complicated evaluation and action schemes are followed. The scheme is chosen depending on group belonging (appendix 1A).

11.2 EVALUATION OF CHANNELS PRESENT IN MORE THAN ONE OF THE GROUPS

A specific channel (radio frequency) can be present in more than one of the channel groups defined above. A compilation of the parameters for the different groups shall then be made in order to have a well defined set of parameters for each channel when the evaluation of measurements will take place.

A single channel can be present in one or more of the neighbouring channel groups, in the own channel group and in the "not to scan" channel group. A channel can not (by definition) be present in the adaptive channel group at the same time as in another group.

11.2.1 "Not to scan" channel group

The presence in "not to scan" channel group is ignored if the channel is present in any other group.

11.2.2 Own channel group

If a channel is present in the own channel group, presence in any other group shall be ignored. The evaluation of measurement results shall follow the scheme for own channel group (appendix 1C) and the parameters set in the other (neighbouring channels) groups will not be used.

11.2.3 Neighbouring channels group

If a channel is present in more than one neighbouring channel group, a compilation of the parameters set in the different groups are made at start up of SSE. The result of the compilation is a new set of parameters which are valid for the channel. These parameters shall be used when evaluating the measurement results. The evaluation shall follow the scheme for the neighbouring channels group (appendix 1D).

Parameter	Rule
Always	YES if yes in any of the groups, else NO
send_42b	set to NO
G_A	Select lowest value
G_B	Select lowest value
L_{HOA}	Select lowest value
L_{HOB}	Select lowest value
L_{fast}	Select lowest value
L_{slow}	Select lowest value
L_{new}	Select lowest value
FIR_{HOA}	Select from same group as L_{HOA}
FIR_{HOB}	Select from same group as L_{HOB}
NR_{slow}	Select highest value
NR_{new}	Select highest value
T_{rep42}	Select lowest value
F_1F_2	Set to "not defined"
Check	Set to YES

The parameters B_1 B_2 B_3 and "power" are not used in the evaluation process.

11.3 EVALUATION OF CHANNEL IN OWN CHANNELGROUP

Change to slow scan if $V_{slow} < L_{slow}$.
Change to fast scan if "measured value" > L_{fast} .
Handover request, frame 41, sent if $RES_{HR} < L_{H41}$ and $RES_{HR} > L_{L41}$.
Power regulation, frame 42, sent if $RES_{power} > L_{power}$.

11.3.1 General

The channels belonging to the BS to which the HC's in the SSE is associated, have to be treated with another procedure during scanning than channels belonging to other BS's. The channels can also be included or excluded from the scanning depending on the HC information received from the BS if such a link is established.

The purpose of scanning these channels is to generate either handover requests or power regulation messages to the MTX.

11.3.2 Procedure to send Handover Request

The evaluation whether a handover request message shall be sent or not, is only performed for channels in fast scan mode.

If the output from filter according to FIR_{HR} , RES_{HR} , exceeds L_{L41} but is below L_{H41} , a handover request message (frame 41) shall be sent for this channel to the MTX. If a handover request message has been sent during last T_{rep41} s, another handover request message will wait until the timer has expired (and $L_{L41} > RES_{HR} > L_{H41}$).

Timer for T_{rep41} , T_1 , shall be reset if BS sends information about stop of call, output from NR_{new} , V_{new} , decreases below L_{new} ($V_{new} < L_{new}$) or a handover request message has been sent.

11.3.3 Procedure to send power regulation message

If a channel is in fast scan mode, the SSE evaluates if a power regulation order shall be sent to MTX. The evaluation is made by the filter FIR_{power} in own channel group. The output, RES_{power}, is then compared with the level L_{power} and the power regulation message (frame 42) is sent when the output exceeds L_{power} ($RES_{power} > L_{power}$).

Timer for T_{rep42} , T_2 , shall be reset if BS sends information about stop of call, output from NR_{new} , V_{new} , decreases below L_{new} ($V_{new} < L_{new}$) or a handover offer message has been sent.

11.4 EVALUATION OF CHANNELS IN NEIGHBOURING CHANNELGROUP.

Change to slow scan if $V_{slow} < L_{slow}$.
Change to fast scan if "measured value" > L_{fast} .
Handover offer, frame 42, sent if $RES_{HO} > L_{HO}$.

11.4.1 General

The purpose of scanning the channels in this group is to generate handover offer messages.

Each group is divided into two subgroups (A and B). The G-value and parameters used in the evaluation of whether handover offer shall be sent or not, are set per subgroup (paragraph 8.3).

11.4.2 Procedure to send handover offer message.

The SSE performs evaluation of whether a handover offer message shall be sent or not, for channels in the fast scan mode.

The channels shall be evaluated first according to the parameters in subgroup A. If the requirements according to subgroup A are not fulfilled, then an evaluation according to the parameters in subgroup B shall be made.

If the output from filter according to FIR_{HOx} , RES_{HOx} , (where x=A or B depending on subgroup) exceeds L_{HOx} a handover offer (frame 42 or 42b) shall be sent for this channel to the MTX. If a handover offer message has been sent during last T_{rep42} s, another handover offer message will wait until the timer has expired (and $RES_{HOx} > L_{HOx}$).

Timer for T_{rep42} ,T_2 , shall be reset if a new call ha started ($V_{new} < L_{new}$) and when a handover offer has been sent.

11.5 EVALUATION OF CHANNELS IN ADAPTIVE CHANNELGROUP.

Change to slow scan if $V_{slow} < L_{slow}$.
Change to slow scan from very slow scan if "measured value" > L_{scan} .
Change to fast scan if "measured value" > L_{fast} .
Handover offer, frame 42, sent if $RES_{HO} > L_{HO}$.

11.5.1 General

The evaluation shall be made exactly as for channels belongning to "neighbouring channel group" (paragraph 11.4)

12. STATISTICS

12.1 GENERAL

The SSE shall be able to compile the statistic information defined below.
In case of mains breakdown it is accepted that the statistical information may be lost. The clock function shall not be influenced by mains breakdown.

The parameters for the compilation of statistic information shall be settable via remote control. It shall be possible to transfer the stored statistic information in the SSE via remote control (see paragraph 13.1) to a PC.

All the statistical information shall be measured during the same defined intervals. It shall be possible to define up to two different intervals during a 24 hours timeperiod.

The information shall be stored during 48 hours after the measurements has ended, thereafter the "buffers" may be reset.

Example: Measurements shall be performed 06.00-12.00 and 12.00-17.00.
The buffer containing the results from meaurement between 06.00 and 12.00 will be reset at 12.00 two days later.
The buffer containing the results from meaurement between 12.00 and 17.00 will be reset at 17.00 two days later.

12.2 SIGNAL STRENGTH MEASUREMENT OUTPUT.

The SSE shall log all the signal strength measurement output with timemark from the scanning cycle (paragraph 9) on up to 32 channels during the last 6 hours during the specified measuring interval. It shall be indicated whether the channel was in the fast or slow scanning group when the measurement was made.

12.3 DURATION OF CALLS AT OWN BS

If the SSE communicates with the BS via HC, the SSE receives information of when a call is started and ended. This information shall be compiled into four goups (with settable time intervals) per channel. The groups are:

Group	Lower limit	Upper limit
1	0	30 s (settable 0-60)
2	30 (settable 0-60)	90 s (settable 0-120)
3	90 (settable 60-120)	120 s (settable 0-180)
4	120 (settable 0-180)	

The SSE shall also calculate the average time for calls at the BS.

12.4 SIGNALLING LOAD OF HANDOVER MESSAGES.

The number of handover request messages (initiated in the SSE) that have been sent for each traffic channel shall be stored.

The total number of handover offer messages that have been sent for each channel group (neighbouring or adaptive) shall be counted. It shall be one counter for each G-value, which implies that there are 5 counters/channel group.

The number of messages from the BS aimed for the MTX which are sent through SSE (paragraph 7) shall be counted.

12.5 SIGNAL STRENGTH DENSITY

The SSE shall calculate the number of signal strength measurements outputs per channel group for each possible level in interval of 1 dB.

Example: 5 measurements at 5 dBµV.

10 measurements at 34 dBµV.

and so on

12.6 Ø-SIGNAL DETECTOR .

12.6.1 Capacity

The number of handover offer messages in which the G-value has been changed from 8 to 4 due to overflow in the ø-signal detector shall be counted.

12.6.2 Detection statistics

The SSE shall log all ø-signal detection results (channel number, detected ø-signal and RES_{HO}), for up to 6 hours of continuous detection results (12 measurements per second)

13 OPERATION AND MAINTENANCE.

13.1 REMOTE CONTROL

The SSE shall be equiped with a remote control interface according to paragraph 13 NMT DOC.900-4.

All parameters and settings of the SSE shall be possible to change via this interface. Statistics, the channel numbers in the adaptive channel group and certain other information contained in the SSE shall be possible to read out.

13.2 O&M HANDLING OF HC/HC's USED BETWEEN SSE AND BS

13.2.1 Initiation of HC

The SSE shall receive information via the remote control whether one or more HC is in operation.

13.2.2 Line supervision

The supervision of HC/HC's used between SSE and BS are controlled from the BS (see pararaph 14.4.2.2 NMT DOC.900-4).

The supervision shall be made by sending a special frame from the BS with acknowledge from the SSE (frame 54 and 55). The acknowledge shall have been sent within 200±5 ms, measured from the time when frame 54 has been received.

The SSE shall receive information via the remote control whether a HC/HC's are faulty and when they are in order again.

13.3 O&M HANDLING OF HC/HC's USED BETWEEN SSE AND MTX

13.3.1 Initiation of HC

The SSE shall receive information via the remote control whether one or more HC is in operation. A priority list for the HC's shall be given to the SSE via the remote control. The list shall contain information about the order to take the HC's, which are connected, in use for signalling.

13.3.2 Line supervision

The HC/HC's used between SSE and MTX are supervised by checking the acknowledge of the handover request/offer messages. The acknowledge of a handover request/offer message shall have been received at the SSE within a time T (T=240 ± 5.0 ms), measured from the time when the handover request/offer message has been sent from the SSE. In case the SSE sends handover request/offer continuously a maximum of two more handover request/offer messages may have been sent from the SSE. This implies that a function to store up to three handover request/offer messages has to be implemented in the SSE in order to be able to check the acknowledge message.
In case no handover request/offer message has been sent via HC during the last 10 s a test message (handover request with TCno coded as FFF) shall be sent. An acknowledge (frame 46) of the test message shall be sent from the MTX.
If two successively acknowledges are lost the HC is regarded as faulty. The SSE shall then use the next HC connected according to the priority list. In case no other HC is available the SSE has to stop sending handover request/offer until at least one HC is in order again.

The test message shall be sent every 10 s over the "faulty" HC. If the SSE has not received 16 successively acknowledges the SSE shall give an "Faulty HC level 2, SSE" alarm. The HC is in order again when 16 successively acknowledges of test messages have been received at the SSE. The SSE shall then send a "Cease faulty HC level 2, SSE" message. The handover request/offer message shall then be sent over the HC again.

A counter, R_{count}, is implemented in order to control the sending of "Faulty HC level 1, SSE" alarm. The counter shall be increased by one if an acknowledge is lost and decreased by one if 10 successively acknowledges have been received at the SSE but R_{count} 0. A "Faulty HC level 1, SSE" alarm shall be sent when R_{count} exceeds 16 and a "Cease faulty HC level 1, SSE" message shall be sent when R_{count} has decreased to 0 again. The R_{count} shall be made equal to 0 when the SSE sends "Cease faulty HC level 2, SSE" alarm.

13.3.3 Capacity supervision

The capacity of the HC/HC's available is not enough if more than 10 messages (handover request and handover offer) have to be queued.

The SSE shall give an "Not enough capacity for signalling between SSE and MTX" alarm (see 13.3.5) if the capacity is to low during 15 of 30 minutes. The alarm shall only be sent once. When the capacity has been enough during 30 minutes a "Cease not enough capacity for signalling between SSE and MTX" message shall be sent.

13.3.4 Maintenance

The SSE shall fulfil the requirements specified in NMT DOC.900-1.

13.3.5 Sending of alarm

The SSE shall fulfil the requirements specified in paragraph 14.4.5 NMT DOC.900-4 for sending "Faulty HC level 1, SSE" and the "Cease faulty HC level 1, SSE".

A "Faulty HC level 2, SSE" alarm shall be sent via another HC connected than the faulty one. In case no other HC is connected the alarm cannot be sent. The "Cease HC faulty HC level 2, SSE" message shall be sent via the actual HC.

Any alarms or messages caused by capacity problems (paragraph 13.3.3) shall be sent via the actual HC or another HC connected to the MTX.

The messages and alarms shall have higher priority than other signalling between SSE and MTX.

13.4 O&M HANDLING OF THE SSE

All alarms and O&M-messages shall be sent in frame 28. The coding of the information is specified in paragraph 14.4.2.3.

13.4.1 SSE supervision

The function is to be decided by suplier.

13.4.2 Ø-signal detector supervision.

The capacity of the ø-signal detector is not enough if an ø-signal detection order has to be queued longer than a defined time (parameter $T_{ø\text{-queue}}$). The SSE shall give an "SSE faulty alarm level 1" if the capacity is too low during 15 of 30 minutes. The alarm shall only be sent once. When the capacity has been enough during 30 minutes a "Cease faulty SSE alarm level 1" shall be sent.

13.4.3 Sending of alarm

The alarms shall be sent via one of the HC's between the SSE and MTX. The alarms shall have higher priority than other signalling between SSE and MTX.

13.5 TEST MODE

It shall be possible to set the SSE in test mode via remote control. The purpose of the testmode is to have a possiblity to change "unsettable" information. The SSE shall function as normal but the following actions shall also be possible to perform:

- Add or remove channels in the two scanning groups via remote control.
- Change the signal strength measurement results of a specific channel.
- t.d.b

When ending the test mode function the parameters in the SSE shall be restored to the setting according to the situation before entering the test mode.

14 SIGNALLING SYSTEM

14.1 GENERAL

The signalling made via the HC shall use 1200 baud signalling equipment, which shall fulfill the requirements in paragraph 6 NMT DOC.900-4. The formats of the messages and the coding are specified in NMT.Doc 900-1.

Alarms shall have the highest priority of all messages sent via any HC from SSE. Messages received from BS aimed for MTX shall have higher priority to be sent to MTX, than messages which are initiated internally in the SSE.

14.2 SIGNALLING PROCEDURES

14.2.1 Signalling procedures between SSE and BS

The SSE shall be able to handle the signalling procedures specified in paragraph 14.3.2 NMT DOC.900-4.

The SSE shall also be able to handle messages from BS aimed for MTX according to following signalling procedures.

14.2.1.1 Handover request

This procedure is used when the SSE receives a handover request message (frame 41) from BS. This message is always aimed for MTX. An acknowledge (frame 46) shall have been sent within 200±5 ms, measured from the time when the handover request message has been received. The acknowledge shall only be sent if the SSE can send the handover request message further to the MTX (i.e. at least one HC is connected and in order between SSE and MTX).

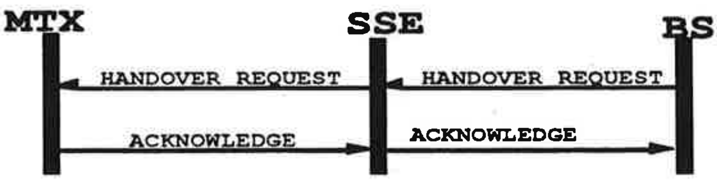


Figure 5

Figure 5

14.2.1.2 O&M messages

This procedure is used when the SSE receives O&M messages (frame 28) from BS, which are aimed for MTX. The SSE shall send the message further to MTX without sending any acknowledge to the BS.

Figure 6

14.2.2 Signalling procedures between SSE and MTX

14.2.2.1 Handover request

This procedure is used to initiate an handover attempt in the MTX. The acknowledge (frame 46)shall be received within a time T (T=240 ± 5.0 ms), measured from the time when the handover request message (frame 41) has been sent.

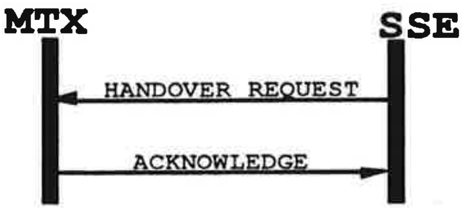


Figure 7

14.2.2.2 Handover offer

This procedure is used to inform the MTX that a BS can capture a specific call. The MTX performs a handover attempt on the call. The kind of handover attempt that shall be made is controlled by the G-parameter in the message. The acknowledge (frame 47) shall be received within a time T (T=240±5.0 ms), measured from the time when the handover offer message (frame 42 or 42b) has been sent.

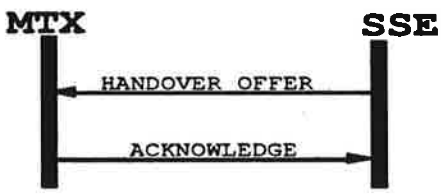
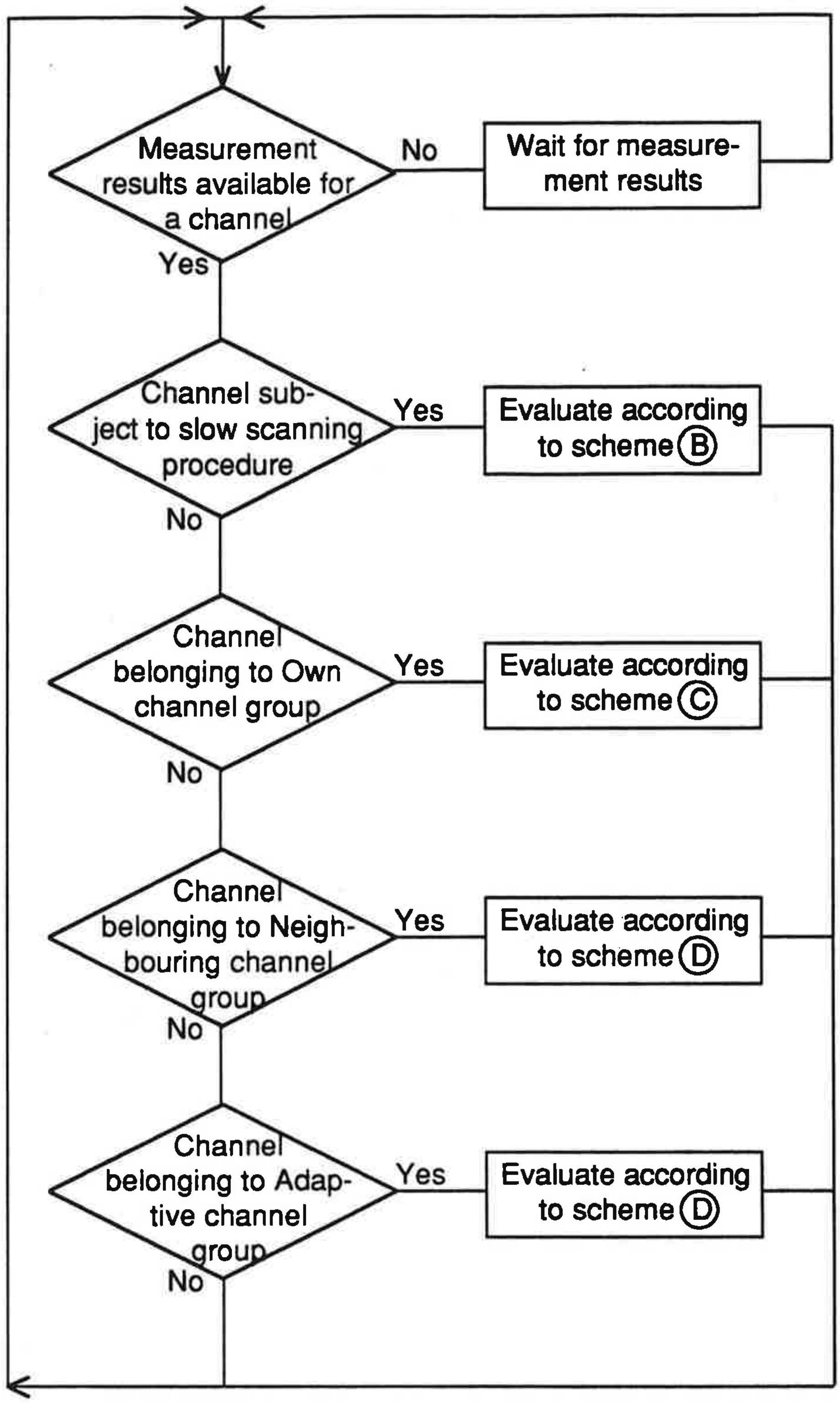


Figure 8

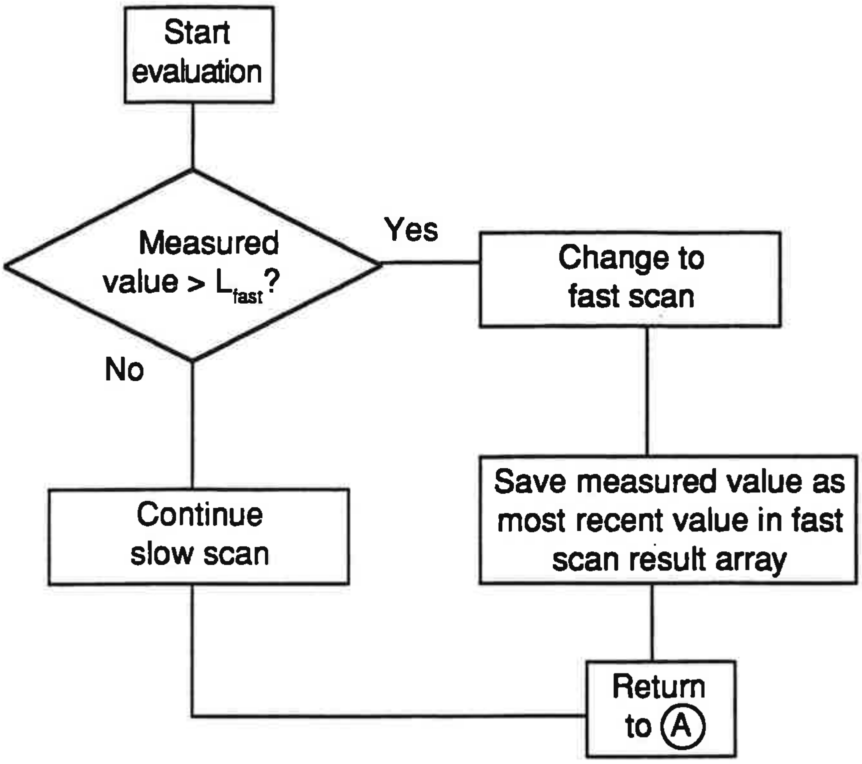
(A) Evaluation of measurement results, general procedure

When measurements are received from the scanner the evaluation shall start within 100 ms. The scheme below describes how to select procedure for the different channels.



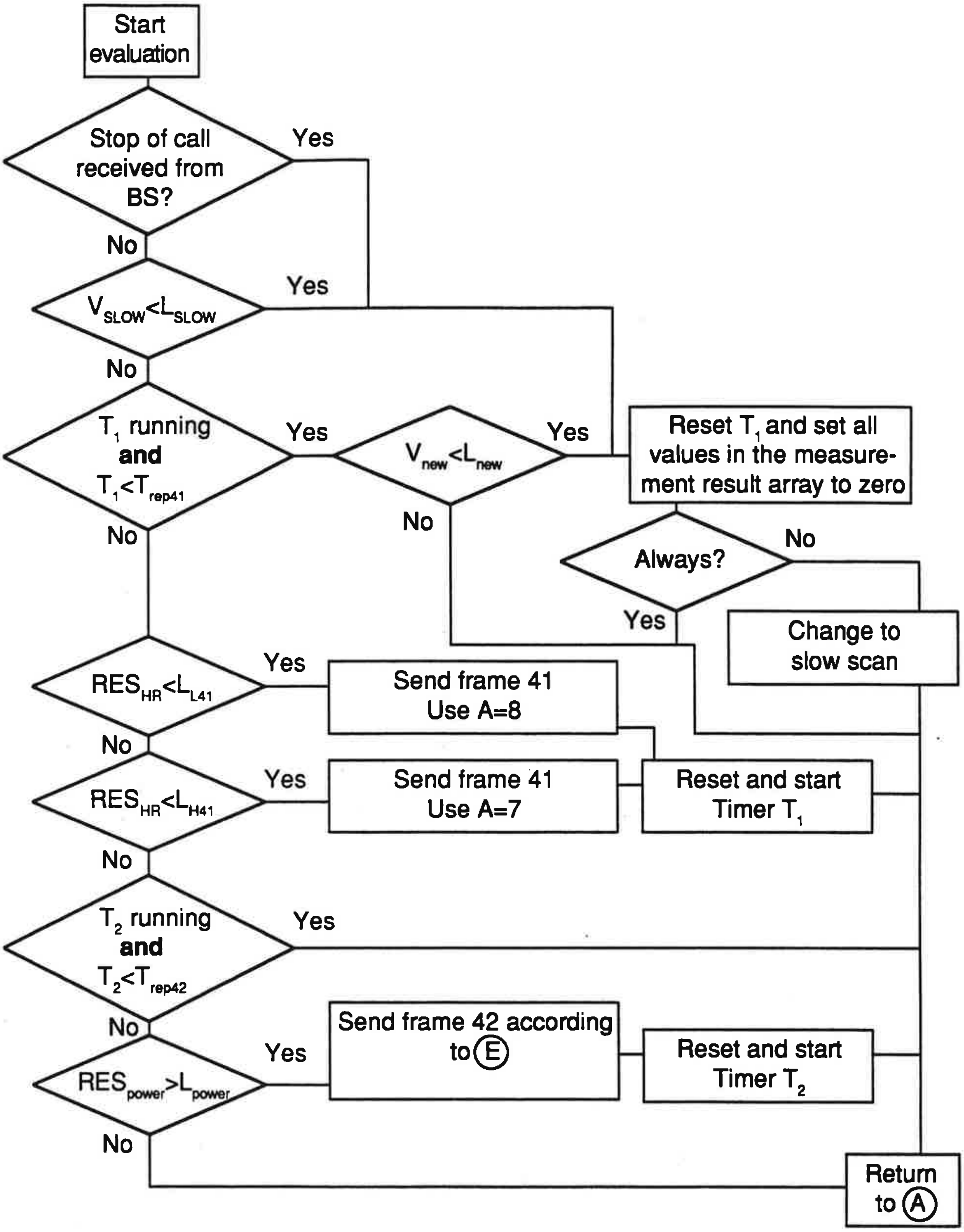
(B) Evaluation of measurement result for slow scan channels in all channel groups

The evaluation procedure below is performed for each channel after every measurement on that channel, that is approximately every 10 seconds.



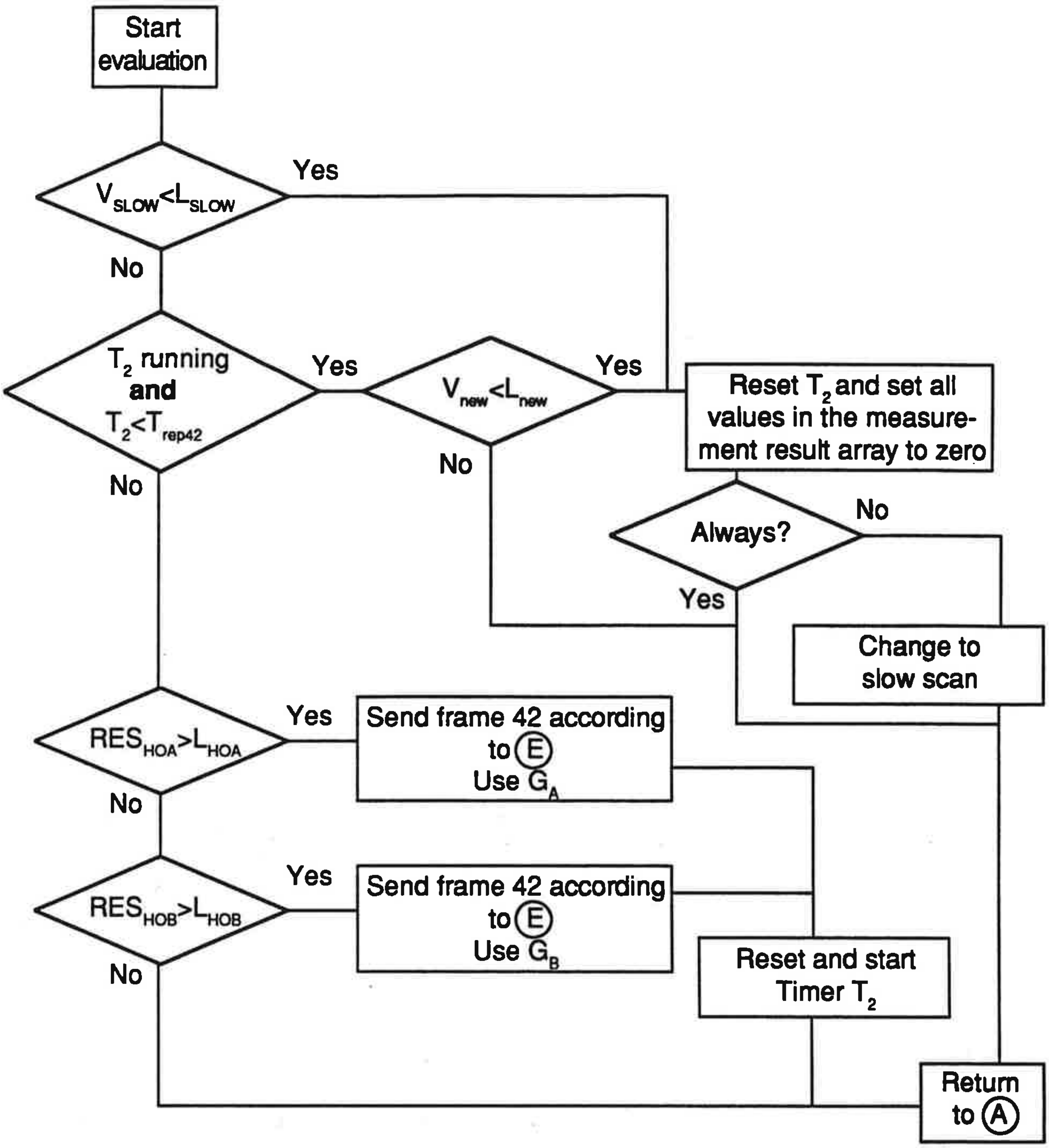
Ⓒ Evaluation of measurement result for fast scan channels in Own channel groups

The evaluation procedure below is performed for each channel after every 1 s scanning cycle. Timer T_1 and T_2 are individual to each channel.



(D) Evaluation of measurement result for fast scan channels in Adaptive and Neighbouring channel groups

The evaluation procedure below is performed for each channel after every 1 s scanning cycle. Timer T_2 is individual to each channel.



(E) Procedure for sending of Handover offer (frame 42) including verification of supervisory signal, F_1F_2

The procedure below is used when it, according to scheme C or D is decided to send a frame 42 for a specific channel. Input data is F_1F_2 stored or not stored for the channel, G-value set for the channel group (can be two different, G_A or G_B), and the parameter, "check" for each channel group stating that a check of F_1F_2 always shall be made before sending a frame 42. For each channel group also a parameter is present, stating whether frame 42b shall be used in stead of frame 42.

- A table is defined in paragraph 8.3.5.2 in NMT DOC. 900-4 of defined DSS values and corresponding ASS values. The table shall be used in the comparison between defined and detected F_1F_2.