3. Formal requirements

3.1 Type approval

The additional HS and its associated equipment have to be submitted for type approval.

All requirements in Annex 1 and national requirements on measurement reports have to be fulfilled.

ANNEX 12

SPECIFICATION FOR A HANDHELD MOBILE STATION WITH BATTERY SAVING FUNCTION, BMS (OPTION)

1. Definition

A Battery saving Mobile Station (BMS) is defined as a Handheld Mobile Station (HMS) as defined in Annex 3, acting according to NMT Doc 450-1 paragraph 4.3.3.12 and the following requirements.

2. Technical requirements

Due to the nature of the battery saving function some special requirements have to be fulfilled.

2.1 Battery Saving Orders (BSO)

After receiving the additional information $H_1(14)$, $H_2(11)$ and H_7 (addressing actual group according to NMT Doc 450-1 paragraph 4.3.3.12.3) the BMS may close down any desired functions (except the ones stated in section 2.6) for the time determined by H_3 as stated in NMT Doc 450-1 paragraph 4.3.3.12.4.

2.2 Wake up.

2.2.1 End of battery saving period

Immediately after the battery saving period has expired the BMS shall be locked to the same channel on which it was locked before the BSO.

The BMS must, according to the above, memorize the CC channel number and keep an accurate timer running during the battery saving period.

After the battery saving period the BMS shall immediately be able to receive any information on the channel indicated by the memorized CC channel number.

2.2.2 No calling channel present

If the memorized channel number after the sleeping period indicates another channel type than a CC, the BMS shall immediately start searching for a new CC according to the normal procedures.

2.3 Loss of locking

Due to the nature of the battery saving function, the normal evaluation of the channel quality is not possible. The following additional requirements shall apply to NMT Doc 450-3 paragraph 5.2.1.2 " Loss of locking....":

Subparagraph a) The RF-level measured in one awake period shall be regarded as lasting through the following sleeping period, i.e. the sleeping period shall be included in the two minute period.

Subparagraph b) Not affected

Subparagraph c) The sleeping period is logically equivalent to a correct frame.

2.4 Locking to a CC

After locking to a new CC the BMS shall ignore the first received BSO.

2.5 Unsuccessful call attempt or delayed channel order

After reception of frame 2a the BMS shall ignore the first received BSO.

2.6 Permanent functions

2.6.1 The display and visual indicators shall not be affected by the sleeping period. However, an extra indicator to display the battery saving periods is permitted.

2.6.2 The BMS shall always be sensitive to any user initiated operation.

3. Enabling the battery saving function

The battery saving function shall be included in the type approval measurements. It shall be noted in the application for type approval that the manufacturer wishes to have a type approval for the BMS function.

The battery saving function shall be enabled together with the setting of the subscriber number and with the same security precautions.

The user shall not by any means be able to turn off the battery saving function.

The BMS must be operated with a BMS category in the MTX. If not so and the BMS is operated in the system without BMS subscription, it will not function properly.

ANNEX 15

ELECTRICAL INTERFACE USED IN THE TYPE TEST OF THE MS

This annex specifies an electrical interface to be used in the mobile stations in type approval tests. If the indicators of the mobile station are difficult to detect using optical sensors, the MS delivered for type approval tests shall be equipped with an electrical interface.

1. Mechanical construction

The used connector shall be of a D-type, female and 25 pole mounted on the MS or on a cable from the MS.

2. Pin allocation

Pin	Meaning	Function
1	Ground	
2	Control of DUT, bit 0	Power ON/OFF
3	Control of DUT, bit 1	Hook switch ON/OFF
4	Control of DUT, bit 2	Hook switch on handset
5	Control of DUT, bit 3	Hands-Free ON/OFF
6	Control of DUT, bit 4	
7	Control of DUT, bit 5	
8	Control of DUT, bit 6	
9	Control of DUT, bit 7	
	Pins 10, 11, 12, 13 Not specified	
14	Data from DUT, bit 0	ON/OFF hook indication
15	Data from DUT, bit 1	Power ON/OFF indicator
16	Data from DUT, bit 2	Service indicator
17	Data from DUT, bit 3	Call received indicator
18	Data from DUT, bit 4	Roaming alarm indicator
19	Data from DUT, bit 5	Ringing signal ON/OFF
20	Data from DUT, bit 6	Malfunction alarm ON/OFF
21	Data from DUT, bit 7	DDM empty/not empty
	Pins 22, 23, 24, 25 Not specified	
	DUT = Device Under Test	

3. Electrical specifications

The interface uses standard CMOS logic. "5 V supply voltage levels". High level indicates that the function is/should be activated in the MS. Low level indicates that the function is/should be inactivated in the MS.

ANNEX 16

DESCRIPTION OF A RANDOM GENERATOR

As stated in Section 3, the 120 bit SAK has to be generated randomly, with the exception of the most significant bits of K1, K2 and K3 which are set to one. In this Annex a possible method for generating the remaining 117 bits of the SAK is described. It should be noted that there exist better random generators than the one described below. However, they are more complex and probably not suitable for this application.

1. The linear congruential method

The generator for 120 bit integers is based on the well-known linear congruential generator (LCG). A short description of this generator is given here. For more details see D.E. Knuth, The Art of Computer Programming, part 2: Seminumerical Algorithms (Addison-Wesley, Reading Mass., 1981). First of all the following four integers are chosen:

$m > 0$: the modules of the sequence,

$1 < a < m$: the multiplier of the sequence,

$0 \leq c < m$: the increment of the sequence and

$0 < X_0 < m$: the seed of the sequence.

The desired linear congruential sequence (X_n) of random numbers is then obtained by setting

$$X_n := (a*X_{n-1}+c) \bmod m, \; n > 0 \qquad (1)$$

Because the elements of the sequence can only take values between 0 and m - 1, it is clear that after a certain value of n the sequence will repeat itself. This value of n is called the period of the sequence. The following property is of importance.

PROPERTY:

Let m be a prime and assume that $c = 0$, $a > 1$ and $X_0 > 0$. Then the sequence generated by (1) will have period $m - 1$.

In this application the following sequence will be used:

$$X_n := a*X_{n-1} \bmod (2^{127}-1), \; n > 0, \qquad (2)$$

where a and X_0 are chosen randomly.

By the property above this sequence will have a period $2^{127}-2$, which is about $1.7*10^{38}$, because $2^{127}-1$ is a prime. Also it should be noted that arithmetic modulo $2^{127}-1$ is very easy. Let Y be the result of the integer multiplication $a*X_{n-1}$. Clearly Y will consist of at most 254 bits and thus it can be written as

$$Y=Y_1 + 2^{127}*Y_2, 0 \leq Y_1, Y_2 < 2^{127} \quad (3)$$

Because $2^{127} \bmod (2^{127}-1) = 1$, it follows from (2) and (3) that

$$X_n = (Y_1+Y_2) \bmod (2^{127}-1) \quad (4)$$

which is easy to compute.

2. A random generator for 117-bit integers

As stated above, the generator will use the linear congruence sequence.(X_n) defined by (2). The sequence (X_n) consists of 127-bit integers. To reduce these integers to 117-bit integers the following functions will be needed.

Let $0 \leq u < 15$ be an integer. A 127-bit integer is written as

$$X = X_0 + X_1*256 + X_2*256^2 + ...+ X_{15}*256^{15}, \quad (5)$$

where $0 \leq X_i < 256$, i=0, 1...15 are the bytes of X (note that X_{15} is less than 128). The function f_u maps X onto the 117-bit integer that is obtained by deleting the u-th byte of X and the 2 most significant bits of X. The function g_u maps X onto the 10 bit integer obtained by concatenating the u-th byte of X and the 2 most significant bits of X. More precisely,

$$f_u(X): = X_0 + X_1*256 + .. + X_{u-1}*256^{u-1} + X_{u+1}*256^u$$

$$+ X_{u+2}*256^{u+1} + .. +X_{14}*256^{13} + (X_{15} \bmod 32)*256^{14}$$

$$g_u(X): = X_u + (X_{15} \operatorname{div} 32)*256$$

Now let N be the number of keys to be generated and let k, r and s be fixed integers. The random 117-bit integers Z_n (n=1, 2, ...,N) are computed as follows.

INITIALISATION

1. Choose randomly the following integers:

$0 \leq j < k$, $0 \leq u < 15$, $2^{126} \leq a < 2^{127}-1$ and $1 < X_0 < 2^{127}-1$.

2. Make a table V[0...k–1] by defining

$V[0] := X_0$;

$V[i] := X_i = a*X_{i-1} \bmod (2^{127}), 0 < i < k$

STEP FOR $n = -(s-1), -(s-2), ..., 0, 1, ..., N$

1. Let $Y := V(j)$ and compute

$X_{n+k+s-1} := a*X_{n+k+s-2} \bmod (2^{127}-1)$

2. Put $V(j) := X_{n+k+s-1}$

$Z_n := f_u(Y)$

$j := (k*g_u(Y)) \text{ div } 2^{10}$

3. If $(n-s) \bmod r = 0$ then generate a new integer $0 \leq u < 15$.

The steps for $n = -(s-1), -(s-2), ..., 0$ can be seen as part of the initialisation procedure. The parameter k should be odd and of order 100, for example $k = 99$ is a good choice. The parameter can be taken as $s = 3k$. The integer u, $0 \leq u < 15$ is changed after r steps. It is advisable to take r reasonably small say $r = 10$ significant bits of the fraction in milliseconds of the system time of the computer system when a new u has to be generated. The new u is then defined as $u := (15*f) \text{ div } 64$.

The starting values j, a and X_0 should be changed regularly, for example once every three months. A way to generate these values using the system time of the computer system is explained below.

Type the alphabet twice on a terminal and record each time a key is stricken the fraction in milliseconds of the system time. By taking the 6 least significant bits of these fractions one obtains 52 random numbers $d_0, d_1, ..., d_{51}$, with $0 \leq d_i < 64$. We can then define

$a := d_0 + d_1*64 + ... + d_{20}*64^{20} + 2^{126}$,

$X_0 := d_{21} + d_{22}*64 + ... + d_{41}*64^{20} + (d_{42} \bmod 2)*2^{126}$

$j := (k*d_{43}) \text{ div } 64$.

Note that these values must satisfy the conditions stated in block 1 of the initialisation above. If one or more of these values do not satisfy these conditions one can generate new values the same way as described above. Also, one has to check whether the SAKs obtained this way satisfy the conditions of Section 3.

ANNEX 17

SPECIFICATION FOR A COMBINED NMT-450/900 MOBILE STATION (CMS)

1 Definition

A combined NMT-450/900 mobile station (CMS) is a car-mounted MS, portable MS or a hand portable MS which can be operated in both NMT-900 and NMT-450 networks. The switching between the networks is automatic with a preference for NMT-900 network. It shall fulfil the requirements stated for NMT-450 mobile stations when functioning in ***450 mode*** and those for NMT-900 mobile stations when in ***900 mode.*** In addition, the requirements and exceptions listed in this annex shall be fulfilled. A CMS has two identities: one for NMT-900 and one for NMT-450.

2. Switching between NMT-450 and NMT-900 networks

The MTXH for a CMS is normally an MTX of an NMT-900 network. It is also possible that the CMS is registered in an NMT-450 MTX but in both cases, operation in the NMT-900 network is preferred when this is available. To prevent frequent roaming and switching between the networks, special channel acceptance criteria are used as defined below. See also Figure 2.

The CMS shall always, also during power off, maintain information on the valid traffic area (Y_2) for both systems separately and the previously selected mode (NMT 450 or NMT 900).

2.1 Operation after switching on power

When the power is switched on, the CMS shall test for NMT-900 as follows.

Definition:

Test for NMT-900: The CMS scans the NMT-900 basic channel band twice using RF level criterion C (full sensitivity) according to NMT Doc 900-3, paragraph 5.2.1.4.1. If an FFSK signal is detected the CMS shall check if there is a match between the received channel number and the synthesizer setting, as well as between the country code received and the stored Y_1. If this is the case the CMS shall stop scanning and the test is considered as successful.

After a successful test for NMT-900, the CMS shall enter the 900 mode.

Definition:

Entering 900 mode: After a successful test for NMT-900 the CMS shall enter the 900 mode in the same way as "power on" after "off condition" is defined in NMT Doc 900-3 paragraph 5.3.1, state 1.1. The MS shall use the identity which it has for the NMT-900 system.

If after two scans, the CMS has not been able to enter the 900 mode (test for NMT-900 unsuccessful), it shall test for NMT-450.

Definition:

Test for NMT-450: The CMS scans twice the NMT-450 band using full sensitivity (NMT Doc 450-3, paragraph 5.2.3.3). Whenever FFSK is detected and a match is obtained between the channel number and the synthesizer setting, as well as between the received country code and the stored Y_1, the test is considered as successful.

If the test for NMT-450 was successful the CMS shall enter the 450 mode.

Definition:

Entering 450 mode: After a successful test for NMT-450 the CMS shall enter the 450 mode in the same way as "power on" is defined in NMT Doc 450-3, paragraph 5.3.2, state 1. The MS shall use the identity which it has for the NMT-450 system.

If after the two scans in the NMT-450 band mentioned above, the CMS has not been able to enter the 450 mode (test for NMT-450 unsuccessful) it shall test for NMT-900 again starting the procedure described in this paragraph from the beginning.

If a hook-off is made during a test sequence the CMS shall return to the mode (450 or 900) which was previously entered.

2.2 Switching from NMT-900 into NMT-450

The CMS can switch into NMT-450 network only outside NMT-900 coverage area or if no NMT-900 signalling can be received.

2.2.1 Loss of NMT-900 reception during stand by

When the CMS has lost locking to a calling channel and no CC has been received in one complete searching procedure, i.e. 1 times 15 scans, it shall test for NMT-450 as defined in 2.1. If this is successful it shall enter the 450 mode. If this is unsuccessful it shall enter the 900 mode (see 2.1).

2.3 Switching from NMT-450 into NMT-900

The CMS can switch from NMT-450 into NMT-900 in four cases:

2.3.1 After a call

After every clearing sequence after a conversation state in 450 mode, a test for NMT-900 is made. If this is successful the CMS shall enter the 900 mode (see 2.1). If not successful, it shall enter stand-by state on the previous CC in 450 mode.

2.3.2 Manual switching

When a hook-off is made during stand-by in the 450 mode and the dialled digits memory is empty, the CMS shall test for NMT-900. If the test is successful it shall enter the 900 mode.

If the test is unsuccessful the CMS shall enter stand-by state on the previous CC in the 450 mode. However, if the roaming alarm indicator was on when the hook-off was made, the CMS shall store the CC number and go to a random channel to search for a TC for manual roaming (scheme A) as stated in NMT Doc 450-3.

2.3.3 No channel order received

The CMS shall test for NMT-900 if it has received its identity in frame 2a twice without receiving frame 2b during 10 seconds (±1 s) after the first received frame 2a. If the test is successful it shall enter the 900 mode. If not, the CMS shall enter state search for CC (450 mode).

2.3.4 After power-on

This is described in paragraph 2.1 above.

2.3.5 Timer control

In the 450 mode, an additional timer is provided. Controlled by this, the MS shall test for NMT-900 every 4 minutes (±20 s) while in stand-by state. If the test is successful it shall enter the 900 mode.

2.4 Switching from NMT-450 into NMT-900, *Alternative to 2.3*

The CMS shall initiate a test for NMT-900 at least every 2 minutes. The test shall be performed continuously or initiated by a timer.

When testing for NMT-900, the CMS shall continue to be active in NMT-450 mode. If the test is successful the CMS shall switch to NMT-900 mode if the CMS is in stand-by state or in search for CC state. If the CMS is in any other state it shall remain in NMT-450 mode.

3. User interface

The user interface of the CMS shall fulfil the requirements for NMT-900 mobile stations as described in NMT Doc 900-3, paragraphs 3 and 4, taking into account the following notes:

Paragraph 3.8. The values of Y_1 mentioned are valid for NMT-900 only. See NMT Doc 450-3 for Y_1 values for NMT-450.

An extra indicator is required for displaying the present mode of the CMS. The recommended symbols for the 450 mode is *450* and for 900 mode *900*, so that there is no confusion between the dialled digits and this indication. During the test for NMT-900 and test for NMT-450, the corresponding symbol shall be on and it shall be flashing.

4. Transmitter power

The overall transmitter power levels for different types of CMSs are the following.

Power bits	MS	HMS
NMT-450 *)		
11	P_H = 15 /7 W ± 1.5 dB	P_H = 1.5 W ± 2.0 dB
10	P_M = 15 W - (10 ± 3) dB	P_M = 1.5 W ± 2.0 dB
01	P_L = 15 W - (20 ± 3) dB	P_L = 1.5 W - (10 ± 3) dB
00	P_L = 15 W - (20 ± 3) dB	P_L = 1.5 W - (10 ± 3) dB
NMT-900 *)		
11	P_H = 6 W ± 2 dB	P_H = 1 W ± 3dB
10	P_H = 6 W ± 2 dB	P_H = 1 W ± 3 dB
01	P_M = 6 W - (8 ± 3) dB	P_M = 1 W ± 3 dB
00	P_L = 6 W - (18 ± 3) dB	P_L = 1 W - (10 ± 3) dB

*) For a portable CMS, the output power can be selected as specified in NMT Doc 450-3, Annex 2 and NMT Doc 900-3, Annex 2.

5. Additional requirements

It shall be possible to disable the 450 mode for each country selector position separately by similar routines as used for programming the subscriber identity. This means that in preselected countries, the CMS shall operate in NMT-900 mode only.

It may be possible for the user to disable the NMT-450 mode, e.g. by disconnecting the NMT-450 transceiver. It may not be possible to use the NMT-450 part of the CMS without the NMT-900 part connected.

6. Possibilities for implementation

It is possible to implement the CMS as an integrated unit or using separate units for the two systems. In both cases, the requirements in this Annex shall be fulfilled.

When using separate units for NMT-450 and NMT-900, four functional signals between the units are needed as described in Figure 1. A common user interface shall be used and a common antenna may be used.

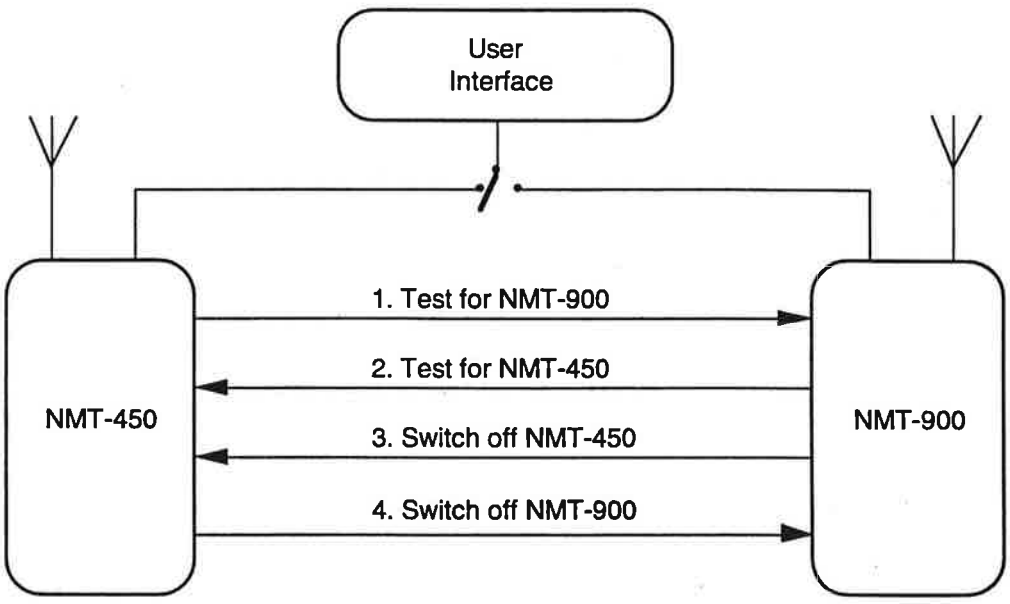


Figure 1. Functional blocks of a CMS using separate units for NMT-450 and NMT-900.

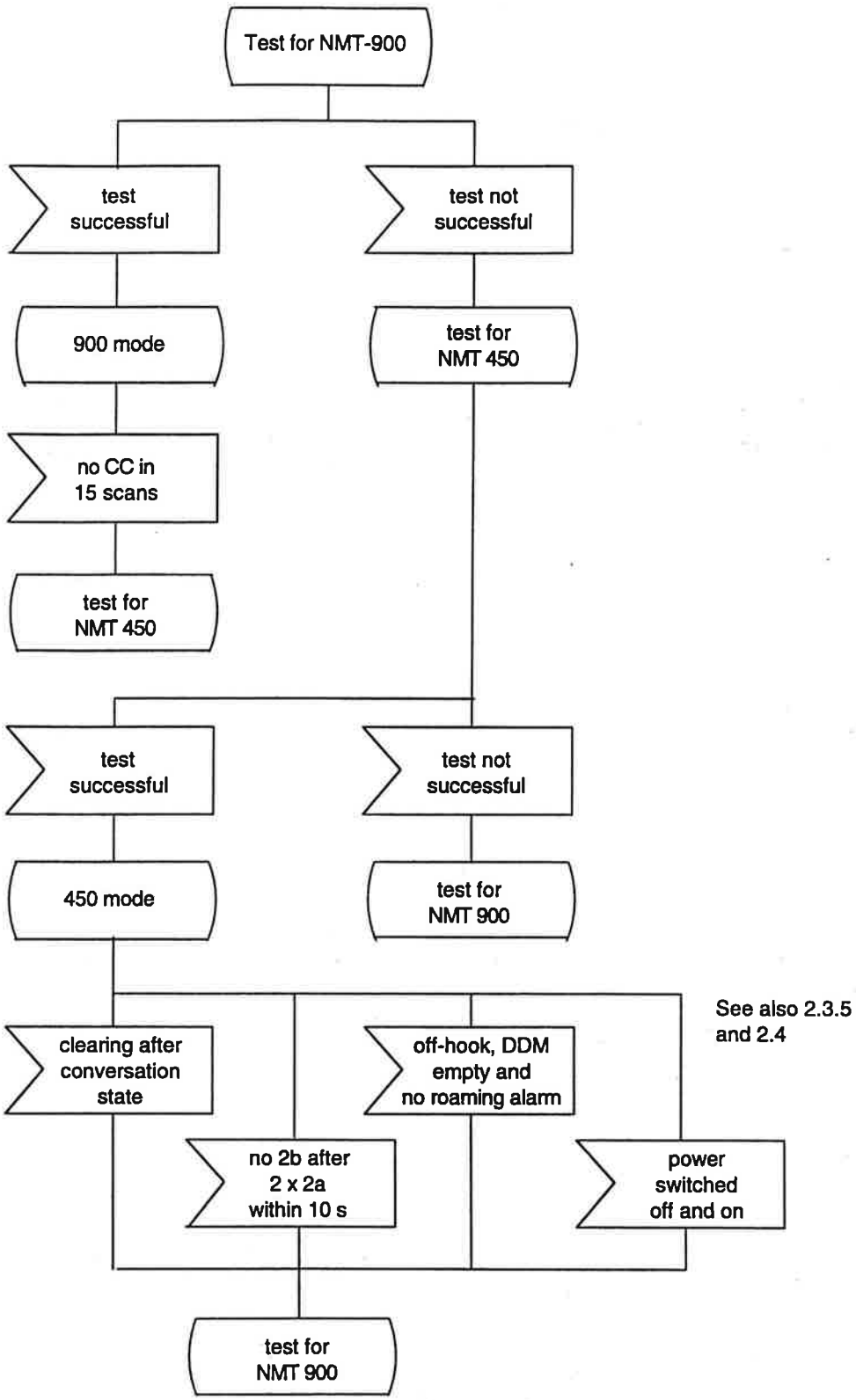


Figure 2. State diagram for switching between NMT-900 and NMT-450 (See definitions in paragraph 2.1)

ANNEX 18

REQUIREMENTS AND TEST CONDITIONS FOR EXTERNAL EQUIPMENT NOT SPECIFIED ELSEWHERE IN THE NMT MS SPECIFICATIONS

1. General

1.1 As it is impossible to cover all external equipment ("EE"), with detailed specifications, this document presents a general test procedure for both manufacturers and administrations.

1.2 Chapter 2 below divides the equipment into six categories to make it easier to determine which tests to carry out.

1.3 Chapter 3 describes the mandatory tests to be carried out by the administration or an authorized laboratory.

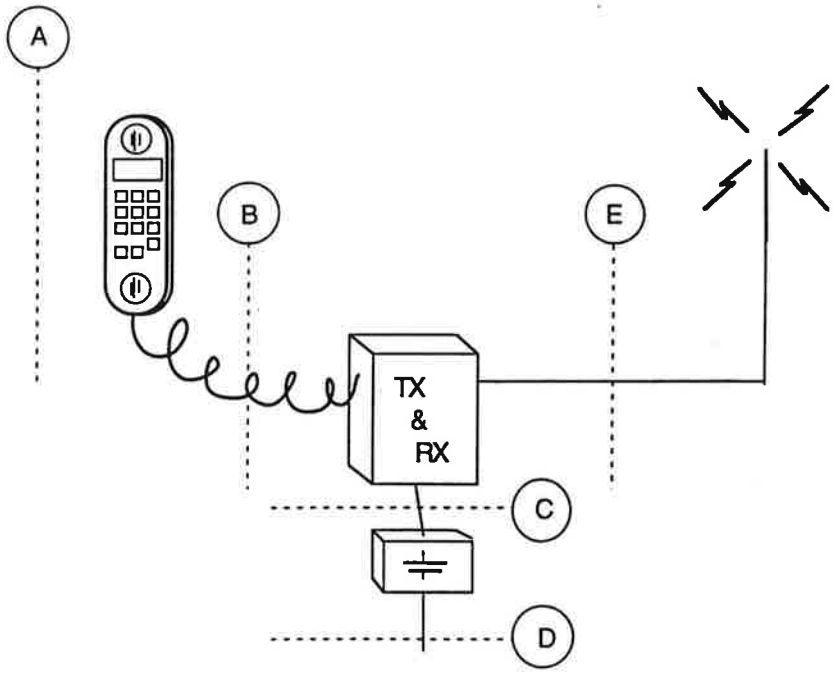
1.4 Enclosure 1 is the measurement report required from the manufacturer when applying for type approval.

1.5 This test specification does not overrule any national regulations such as requirements for acoustic couplers etc.

1.6 The application for approval shall be submitted by the MS-manufacturer. If the EE manufacturer applies for approval, a written acceptance from the MS manufacturer for the actual equipment shall be included. It shall be noted that this specification is ***only*** valid for equipment ***not*** covered by the mobile station specifications.

1.7 Since the performance of future equipment can not be predicted, it is in addition required that the external equipment does not cause any major disadvantages to system user or to the operator.

2. Imaginative interfaces



A) Acoustic interface (tone diallers, modems etc)

B) LF electrical interface

B 1: Equipment able to carry out autonomous operation without mechanical user action e.g. answering machines, voice diallers etc. Also equipment substituting any handset function, e.g. external handset blocking the ordinary handset

B2: Equipment connected in electrical "parallel" with the ordinary equipment and activated by mechanical user choice, e.g. hands free equipment, headset, modems etc

C) PS interface (power supply & battery charging)

D) BC interface (battery charging)

E) Antenna interface

3. Mandatory tests and functional requirements

3.1 General

3.1.1 The EE shall not interfere with any frame signalling procedures specified in NMT Doc 450-1&3 or any states defined in NMT Doc 450-3 Chapter 5. This will not be tested explicitly but any deviation found may result in a withdrawal of the associated MS,s type approval as well as the EE approval itself.

3.1.2 If it is not possible to generate the test modulation signal in the tests "2.2.9 Frequency deviation" and "2.2.11 Adjacent channel power" the test modulation signal shall be that, as agreed between the manufacturer and testing authority, which requires the greatest radio frequency occupied bandwidth. Details on this test modulation signal shall be included in the test report.

3.2 A interface. No NMT-approval needed.

3.2.1 No test

3.3 B 1 interface

3.3.1 NMT Doc 450-3 paragraph 2.2.9 Frequency deviation.

3.3.2 NMT Doc 450-3 paragraph 2.4.3 Interference in the Ø-signal band. (To applicable extent.)

3.3.3 NMT Doc 450-3 paragraph 3.6.2 (DDM) and 4.3 (abbreviated dialling).

3.3.4 NMT Doc 450-3 paragraph 3.9 Visual indicators.

3.3.5 Clearing response to frame 5a (L13/15).

3.3.6 NMT Doc 450-3 paragraph 5.6.6 Autonomous timeout.

3.3.7 The EE shall not interfere with call set-up or interfere audibly with the sound quality during conversation.

3.3.8 The EE may be equipped with automatic call set up and answering facilities.

3.3.9 A normal call e.g. by entering a number in the DDD and DDM and performing "OFF HOOK" shall always be possible.

3.4 B 2 interface

3.4.1 NMT Doc 450-3 paragraph 5.6.6 autonomous timeout.

3.4.2 The EE shall not interfere with call set-up or interfere audibly with the sound quality during conversation.

3.4.3 The EE may be equipped with automatic call set up and answering facilities.

3.4.4 A normal call e.g. by entering a number in the DDD and DDM and performing "OFF HOOK" shall always be possible.

3.5 C interface. No NMT approval needed

3.5.1 The EE shall not interfere with call set-up or interfere audibly with the sound quality during conversation.

3.6 D interface. No NMT-approval needed

3.6.1 No tests.

3.7 E interface

3.7.1 Active equipment.

3.7.1.1 Full RF measurements according to "List of tests for NMT 450", MSg 93-0594 .

3.7.1.2 Logic tests according to converted NMT Doc 900-5 tests for NMT 450.

3.1.2.a2	Search for CC when the RF-level is too low
3.7.1	Change of MS output power level on same channel
3.7.2	Change of MS output power level on TC

3.7.2 Non active equipment.

3.7.2.1 NMT Doc 450-3, Annex 2, paragraph C 3.

Enclosure 1.

Tests to be included in the manufacturers test report for "External equipment not covered by the NMT specifications".

The numbering of the tests is referring to "List of tests for NMT 450" MSg 93-0594 if not specified.

Interface A: No tests needed if not required by national authorities.

Interface B: *Logic tests:*

3.2.1 Successful roaming updating.

3.4.1 Call MTX-MS scheme B with fixed clearing.

3.5.1 Call from MS on traffic channel including MS clearing.

3.6.1 Successful SCIP.

3.9 Autonomous timeout.
NMT Doc 450-3 paragraph 3.6.2 (DDM)
NMT Doc 450-3 paragraph 3.9 (vis. ind.)
NMT Doc 450-3 paragraph 4.3 (abbr. dial.)

RF-tests:

2.2.9 Frequency deviation.

2.2.11 Adj. channel power.

2.3.14 Spurious emissions. (Radiated power.)

2.4.3 Interference in the Ø-signal band.

2.4.4 Relative audio frequency intermodulation product level in the Ø-signal band.

Interface C & D:

RF-tests:

2.3.14 Spurious emissions.

2.2.15 Residual modulation.

2.3.19 Noise and hum.

Interface E:

Passive equipment

NMT Doc 450-3, Annex 2 paragraph C 1 and C 2.

2.2.8 Spurious emissions.

2.3.14 Spurious emissions.

Active equipment

RF-tests:

All applicable RF-requirements in NMT Doc 450-3 shall be included in the measurement report.

Logic tests:

3.1.2.a2	Search for CC when the RF-level is too low
3.7.1	Change of MS output power level on same channel
3.7.2	Change of MS output power level on TC

ANNEX 19

REQUIREMENTS CONCERNING SERVICE MODE AND PROGRAMMING MODE IN NMT MOBILE STATIONS

1. General

"SERVICE MODE" An NMT mobile station shall have the ability to go into a "service mode". In this mode it shall be possible to make measurements and service adjustments on hardware.

"PROGRAMMING MODE" An NMT mobile station shall have the ability to go into a "programming mode". In this mode only it shall be possible to program subscriber identity, password ($K_1K_2K_3$) and enable options that influence signalling.

The programming procedures and the tools used for entering above mentioned modes must be presented to the type approval authorities for acceptance before a type approval can be given to the mobile station.

2. Procedures for entering service/programming mode

It shall be possible to go into service/programming mode only with an external device. The facilities for entering service or programming mode are allowed to be in the same or different devices. The device shall be so advanced that it is not simple to operate it by unauthorized personnel. Programming by using ordinary equipment or slightly modified ordinary equipment will not be sufficient. Simple tools with solutions as short circuiting connectors are not sufficient. An identity code of the tool shall be sent to the mobile station when the station has entered the programming mode. The MS shall be provided with a memory for this code. If the number of codes exceeds the storage capability of this code memory,at least last five codes shall be stored in the memory (first in first out). It shall be possible to read the code by the programming device.

It shall not be possible to use the mobile station in normal mode if the service/programming device is connected. Any information that has been entered into the mobile station in service mode must be deleted when returning to normal mode except service adjustments for hardware.

3. Availability of the service/programming device

The service/programming device shall only be available to personnel authorized by the manufacturer and production of such equipment shall be under secured conditions. Each programming device has to be registered by the manufacturer.

A device for entering service mode is mandatory for all mobile stations submitted for type approval.

ANNEX 20

REQUIREMENTS FOR NMT-MOBILE STATION EQUIPPED WITH A CORDLESS HANDSET

GENERAL

An NMT-mobile station equipped with a cordless handset shall fulfil all valid NMT-specifications with the exemptions mentioned below.

The handset interface shall be approved according to national regulations. The use of a mobile station equipped with a cordless handset may be subject to national regulations, and may be subjected to separate national licensing. National regulations may also put restrictions on the possibility to bring and/or use the cordless handset in some countries where roaming normaly would be allowed.

The NMT mobile station shall always send clearing if the handset connection is terminated, independent of the reason.

3.7 Acoustic signals generated by the mobile station

3.7.2 Ringing signal

Due to the nature of the cordless connection the first ringing signal order (frame 5a (L=9)) to the NMT mobile station does not have to be transmitted to the cordless handset.

3.8. Country selector

The country indication in a cordless handset may be automatically switched off 10 seconds after last activation of any control buttons (e.g. to reduce power consumption). The country indication shall be visible to the user as soon as any button is pressed.

3.9 Visual indicators.

The visual indicators in the cordless handset need not be visible in darkness,which means that they need not be illuminated or light emitting. These indicators and dialled digits display in the cordless handset may be automatically switched off after 10 seconds (e.g. to reduce power consumption.) The state of the indicators and the dialled digits display shall be stored, and recalled as soon as any button is pressed. The state of the NMT indicators in the cordless handset shall be updated as often as the cordless connection admits.

ANNEX 21

REQUIREMENTS FOR NMT MOBILE STATIONS WITH FFSK USER DATA FACILITY (DMS)

1. GENERAL

An NMT Mobile Station with FFSK user data transmission and reception facility (DMS) shall fulfil all valid NMT specifications for the Mobile Station and the additional requirements stated here.

The user data facility (1200 bit/s, effective data rate 600 bit/s) is primarily intended for enabling the NMT subscriber to have always access to a number of data services (like text paging, messaging or personal computer) by using the display and push button set of the DMS and to receive messages which are shown on the DMS display. If a connector for external data terminal is provided the facility can also be used for more advanced services. The access to these services can be provided in the fixed network by FFSK modems or e.g. by FFSK gateways to packet data networks.

The FFSK modem of the DMS is used for user data transfer during conversation state only, and in such a way that the transmitted bit sequences never include the NMT frame sync (11100010010). The use of the FFSK modem shall in no way affect the normal operation of an MS. This means that also during user data transfer, any NMT signalling frame shall be detected and proper action taken by the DMS. Transfer of user data takes place on the speech path and is often interrupted by NMT signalling. While data is not sent the speech path is automatically open for conversation.

2. DATA TRANSMISSION CONNECTOR (OPTION)

The DMS can be equipped with a connector for external data devices. It is recommended, for compatibility, that the connector fulfil RS232/V.24 specifications. For HMS equipment other type of connectors may be more practical. The data stream through this connector appears on the radio path divided in seven-bit slots in a frame structure described further in this document. Only data bits are sent on the radio path. Bit locations not used in the end of the data part of the frame are filled with zeroes. Because start, stop and parity bits are stripped before sending and added after reception, the maximum data rate of 600 bit/s will be increased to 857 bit/s at the RS232 connector with 7-bit data (8-bit data: 750 bit/s).

3. KEYBOARD AND DISPLAY

The DMS keyboard shall provide a means to key in numbers 0, 1, 2, 3, ..., 9, characters # and * and space and also letters A, B, C, ...W, X, Y, Z, Å, Ä (or æ) and Ö (or Ø). Only upper case letters are required as a minimum. Full stop (.) is recommended. Coding of these characters shall be in accordance with ISO-S/F 7-bit character set. A button or function for transmitting the text on the display shall be provided. When using an external keyboard, all ISO-S/F 7-bit characters (with possible national modifications) are used.

In reception, however, it shall be possible for the DMS to display all the characters in the ISO-S/F (or national) 7 bit character set. The minimum recommended size of the display is 10 characters but larger is preferred. It shall be possible to scan or scroll the display through the received characters.

When the key for transmitting the characters on the DMS display is pressed a Carriage Return (13) is added after the last character. If the DMS display is empty when the key is pressed a Carriage Return is sent.

4. RECEPTION BUFFER SIZE

When receiving characters, the DMS shall be able to store at least 255 characters for the display but 1 kbyte buffer is recommended as a minimum (24 x 40 char.).

5. FRAME STRUCTURE

A frame of FFSK data (DT frame) consists of a bit synchronization sequence of 15 bits (101010...), a frame synchronization word of 11 bits (00101000111), a Label (dsppnnn) and 8 data words of 7 bits starting with bits '11' to eliminate frame synchronization patterns of NMT signalling (of data signalling as well):

101010101010101 00101000111 dsppnnn 11 xxxxxxx 11 xxxxxxx 11 xxxxxxx ... 11 xxxxxxx 11 xxxxxxx 11 ccccccc 11 ccccccc 11 cc

The first 7-bit word (dsppnnn) after the synchronization part is the Label of the frame giving information on direction of data transmission (d), frame type (pp) and frame number (nnn). All through the data connection, the value of the direction bit d sent is constant and set by the terminal which starts by transmitting the first frame. The other end then selects the opposite value (1 or 0) of d received in the first accepted DT frame, assuming that it has not sent any DT frames yet during the data connection. Parameter d is used for disregarding own frames which are echoed back from the network. The default value for the transmitted d is 0 for a terminal (DMS) initiating a call and 1 when answering a call.

Bit s is transmitted as a '1' in user data frames. Value 0 is reserved for indicating optional control data in a DT frame.

After the 7-bit data words (xxxxxxx) there is a 16-bit Checksum (ccc...) which is calculated from all the 7-bit information words (9 x 7 = 63 bits). For calculation, 16 zeros are appended to the end of the 63 information bits and modulo 2 division is made using generator polynomial $x^{16}+x^{12}+x^5+1$. The 16-bit remainder is the Checksum (ccc...). This simple method catches all single and double errors, all errors with an odd number of bits, all error bursts of 16 or less bits, 99.997% of 17-bit error bursts and 99.998% of 18-bit or longer bursts. No forward error correction is used.

Acknowledgement frames (RR/NR below) only have parity bits (cc, odd number of ones gives c = 1) for the two 7-bit Labels. The synchronization and information parts are transmitted twice with the bit sync only before the first frame sync. When DT frames are transmitted continuously (e.g. DT(1)...DT(4), DT(5),DT(2),DT(3)... DT(6)...) the bit synchronization part is sent only in the first frame.

5.1. Data Transmission Frame, DT

A Data Transmission Frame, (DT) carries user data as 7-bit words (xxxxxxx, MSB first). A DT has a length of 8 characters. If arbitrary transparant data (divided in 7-bit slots) is sent, the remaining bit positions of the frame are filled with zeroes. The Label is defined below.

- d	Direction of data flow
-s	User/Control Data selection
-pp = 11	Prefix for a DT
-nnn = 000 ... 111	Number of frame, DT(0)...DT(7)

5.2. Ready to Receive, RR

101010101010101 00101000111 dsppnnn 11 dsppnnn 11 cc 00101000111 dsppnnn 11 dsppnnn 11 cc

number of a possible DT which can be received.

-d	Direction of frame
- s = 1	spare
-pp = 01	Prefix for an RR
-nnn = 000 ... 111	Number of a DT which can be received next, RR(0)...RR(7)

5.3. Not Ready, NR

101010101010101 00101000111 dsppnnn 11 dsppnnn 11 cc 00101000111 dsppnnn 11 dsppnnn 11 cc

This frame is sent if no more data can be received for the moment. It gives the number of the first DT which could not be received and was omitted, and at the same time acknowledges the previous DT frame. The reason for an NR can be e.g. a full receiving buffer. It should not be sent often in normal operation because it will cause a pause in data transfer. The data transmission can be continued by sending an RR or a DT.

- d	Direction of frame
-s = 1	spare
-pp = 10	Prefix for an NR
-nnn = 000 ... 111	Number of the first DT which could not be received, NR(0)...NR(7)

6. DATA TRANSFER PROTOCOL

A simple protocol where both ends operate symmetrically is used

for occupying the DMS processor time during conversation state as little as possible.

6.1. Starting and Ending a Data Transfer

In conversation state, a DMS is always capable of receiving user data frames (DT, RR, NR). The transmission of data starts directly by DT frames by using the push button set. If no user data frames at all are and have been received during the conversation state the attempt to transfer DT frames is stopped after 20 seconds. New attempt can be started manually.

The data connection ends when the call is cleared.

6.2 User Data Transfer Sequence

A typical data transfer sequence is as follows:

1.	DT(0)		1. First data frame is sent.
	DT(1)	RR(1) 2.	
	DT(2)	RR(2)	2. First data frame has been
	DT(3)	RR(3)	received correctly and next
	DT(4)	RR(4)	one (already started) can
	DT(5)	NR(5) 3.	be received.
	DT(5)	4.	3. The receiving end indicates
	DT(6)	NR(5)	that no more data can be
			received for the moment.
		RR(5) 5.	4. New attempt to transmit is
	DT(5)		not accepted.
	DT(6)	RR(6)	
	DT(7)	RR(7)	5. Data can be received again
	DT(0)	RR(0)	starting with DT(5).
6.	DT(1)	RR(1)	
		RR(2)	6. End of data block.
		DT(0) 7.	7. Data transmission to the
	RR(1)	DT(1)	other direction starts.
	RR(2)		

When having transmitted frame DT(N) the next data frame DT(N+1) can be transmitted immediately, i.e. before RR(N+1) is received.

6.3 Acceptance of Frames

A DT frame is accepted as a correctly received frame if the Label is meaningful and the Checksum is correct. Both values for bit s shall be accepted. An RR/NR frame is accepted if in the former or latter part of the frame the two Labels are equal and meaningful and the corresponding parity bits are correct. Bits '11' between data bits and check bits need not be correctly received. When a direction bit (d) with a wrong value is received, reception of the frame is stopped and reception of a new frame must be possible within 7 ms (start of bit sync) after receiving the Label with the wrong value of d. Note that the Checksum is not used if a wrong value of d is detected.

6.4. Signalling in Non-ideal Conditions

Up to four successive DT frames can be sent without receiving the corresponding RR/NR frames. Not every RR has to be received: RR(N) only indicates that DT frames up to DT(N-1) have been received correctly and transmission can continue in numerical order with frames DT(N)...DT(N+3). The last frame in every block of DT frames has to be acknowledged. A block means here the amount of DT frames which are to be sent before e.g. a user action or receiving an answer (DTs).

If the acknowledgements (RR/NR) for more than three consecutive DTs are missing signalling is continued by retransmitting after the last acknowledged DT frame.

6.5. Flow Diagram and Timing

The Flow diagram for FFSK user data is presented in Figure 1. The whole sequence is overruled by functions of the DMS due to possible NMT signalling frames received or user actions, as specified in the NMT specifications. Values for NTX, NRX and N are added modulo 8.

Acknowledgement frames RR/NR are transmitted 22.5 ± 2 ms after reception of a DT frame. However, in case an RR/NR follows another frame (DT/RR/NR) it is sent with no delay immediately after the previous frame if possible. When a DT frame follows directly another frame no bit synchronization is sent. An RR/NR frame is always sent with the bit synchronization (see Figure 2).

If a sequence of DT(N) to DT(N+3) has to be repeated four times, an interval of 81 ms with no FFSK is inserted after each repeated frame (4 gaps). In this case, each frame after a gap includes the bit synchronization part.

It is necessary that all frames (DT/RR/NR) correctly received, not only the latest, are dealt with according to the flow diagram. It is possible that two frames (end of a DT and an RR/NR) are received during the transmission of one DT.

6.6. Splitting

The speech path shall be closed in both directions when the transmission of a data frame (DT/RR/NR) starts. It shall stay closed for 200 ± 15 ms. This possibility to automatic switch between data and speech is recommended also when using the external connector (RS232).

7. USER DATA SECURITY

The FFSK user data transfer provides an optional internal scrambling facility (see paragraph 10). The specified scrambling method, though considered very effective in mobile use, may be further boosted by additional end to end encryption of data in the application when the connector for external data equipment is used.

8. ADDITIONAL FUNCTIONS

8.1. Identity Check

In 7-bit format, the DMS can be forced to send its identifier *!MSI!*$I_1I_2I_3I_4I_5I_6I_7$ followed by a Carriage Return (13) by sending to it a specified command in a DT frame (user data). Characters MS identify the data terminal type ('MS' for the DMS). For the DMS, I_1...I_7 are equal to Z X_1 X_2 X_3 X_4 X_5 X_6. Note that values for digits I_1...I_7 are used according to ISO 7-bit character set. In some data services, this function can be used as an additional check for authorization. The command is followed by a Carriage Return (13) and has the following format: *?MSI?*. It occupies one DT frame. This message is not shown on the DMS display when received.

8.2. Automatic Answer

If automatic answer function has been activated the DMS goes electrically off-hook after receiving ringing order(s). The number of ringings before answer may be presetable by the user. The DMS may have a possibility to answer by a preprogrammable message (DT frames) after automatic answer. The automatic answer can be indicated to the caller by sending Control Frame CT84 (filled with NULs, see 10.9.), preceded by RAND if scrambling is implemented (Paragraph 10). This will trigger the transmission of (ID and RAND plus) the telephone number of the calling DMS terminal (CT84, see 10.9.) followed by a user data message (DT frames) if any.

off button is pressed (before fixed clearing). Manual hook-off shall stop the transmission of the preprogrammed message. If manual hook-off is made before automatic answer, the preprogrammed message is not sent. If no manual hook-off is made and no user data frames (DT/RR/NR) are received within 3-20 s after automatic answer, the DMS shall go on-hook.

The automatic answer function shall be clearly indicated when active. It shall be possible to deactivate the function.

8.3. Controlling the Display

In 7-bit format, some special characters in the ISO 7-bit character set are reserved for controlling the MS display. To be able to clear the display and put new text into the display and into the receiving buffer if full, character FF (12, Form Feed) is used. This clears the display and sets the cursor in the upper left position as well as clears the receiving buffer. A continuously changing display can be implemented this way..

Data received during previous calls should not be cleared in the memory.

To be able to also use data services not specially planned for a small display, a window technique should be used: a window of the size of the display is moved across the page received. For continuous reading of the text, the next line should appear at the end of the previous one if the window is moved behind the end of the line (over a Carriage Return, CR = 13).

In some data services, it is useful to know the size of the MS display. A command for this has the format: *?DSZ?* (+CR). The answer to this is: *!DSZ!*CCCXLLL (+CR). CCC indicates characters per line and LLL is the number of lines in the display (decimal values 000...999).

9. OPTIONAL CONTROL DATA

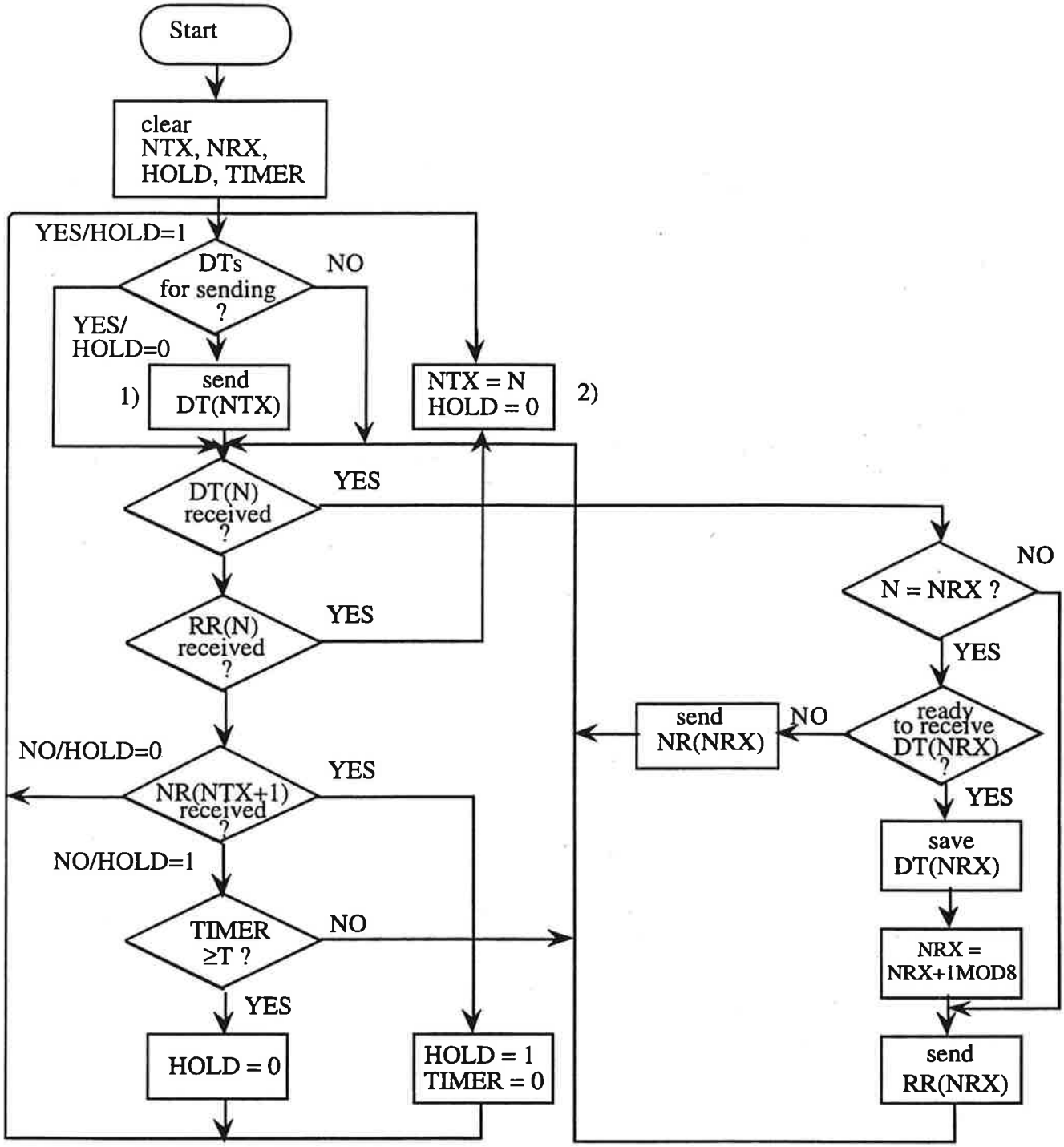
A control channel can be provided for data transfer for special purposes in addition and as an alternative to the user data channel. Its capacity is partly reserved for functions to be specified later and partly for non-standard applications defined by the manufacturer.

Bit s in the DT frame Label is used for selection between user data and control data. If s equals 1 the data part of the frame is received as user data. Value s = 0 indicates that the frame data part is for special use and shall not normally be displayed. In this case, the 56 bits of the data part (xxx...) in a DT frame are regarded as control data (8 x 7 bits):

C D_1 D_2 D_3 D_4 D_5 D_6 D_7

Parameter C (7 bits) defines the message and control data type (e.g. data scrambler handshaking) and D_1...D_7 (7 x 7 bits) give additional data if required. Values C = 120 to 127 together with any values for D_1 to D_7 are intended for manufacturer dependent non-standard applications. Values C = 0 to 119 are reserved for applications to be specified later. Parameter C always follows next to the Label in each DT frame with control data. Control data and user data cannot be included in one DT frame simultaneously.

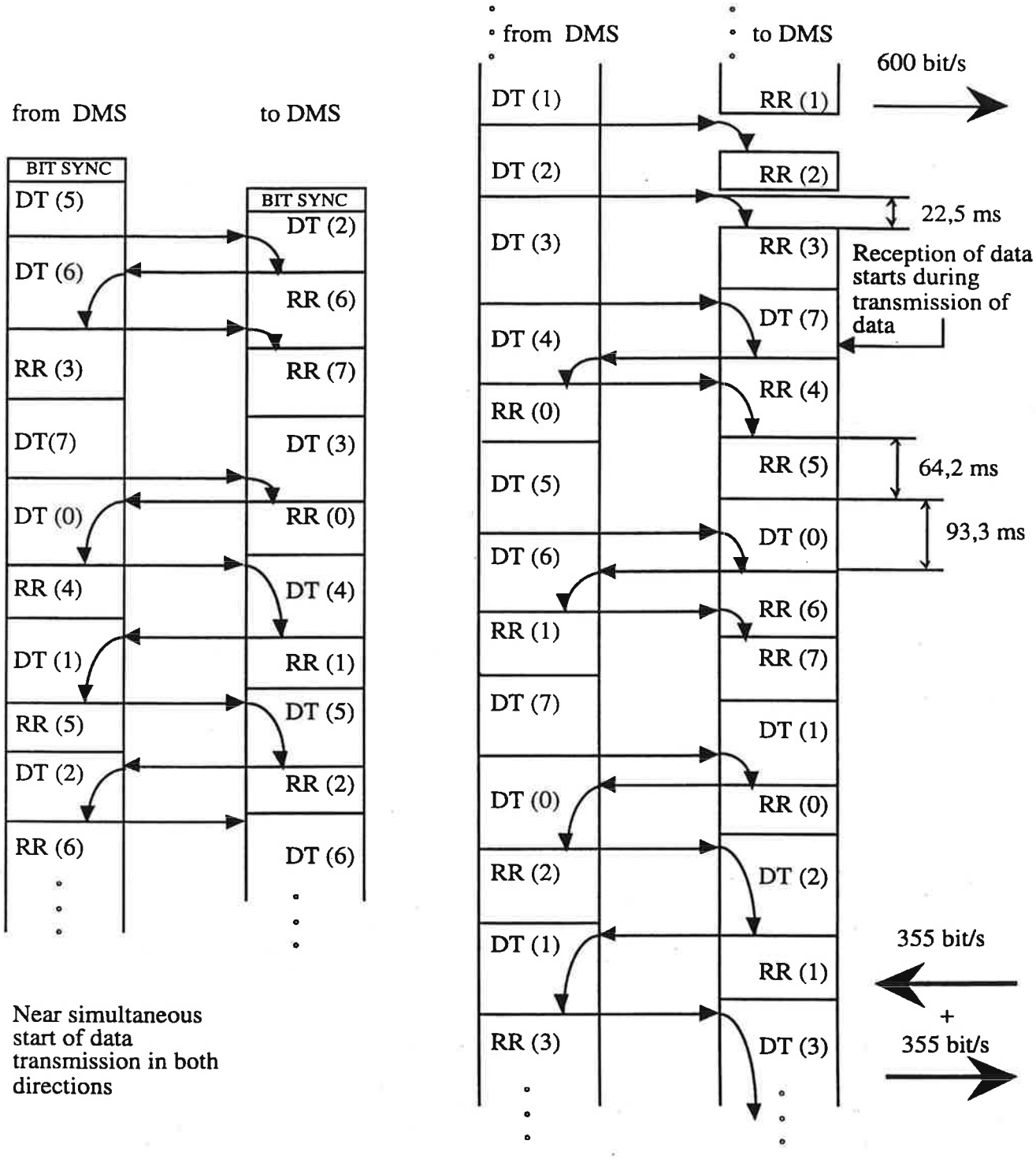
In the flow diagram (Figure 1), no difference is made between user data and control data: any DT frame may contain either type of data. In acknowledgement frames (RR/NR), bit s is always sent as 1".



1) DT(NTX) to DT(NTX+3) are put to repeated transmission. Transmission of frames continues in numerical order.

2) Received values N = NTX to NTX+4 refer to the 4 frames under transmission and to the next one. Values N = NTX-1 to NTX-3 refer to previous frames. If previous frames with these values do not exist, transmission of DTs is restarted with NTX = N.

Figure 1. Flow diagram for FFSK user data transfer. T = 3 s.



Each RR has a bit synchronization though not shown.

RR only updates parameters (NTX, HOLD) when received.

Figure 2. Two examples of duplex data transmission.

10. DATA SCRAMBLING METHOD FOR THE DMS (OPTION)

10.1 General

To be able to access public data networks and private data bases where subscriber identities, passwords and other confidential information are transferred, data scrambling is often desired. The method described here provides basic scrambling only and has been designed for implementation also in hand portable equipment (HMS). However, it makes it very difficult for a third party to read the information exchanged between two DMS terminals on the radio path. If utmost security is required more advanced data encryption methods (e.g. DES) shall be used in addition in specific applications.

At the beginning of the data connection, both DMS terminals send random numbers ($RAND_A$ and $RAND_B$) to each other. These random numbers are used at both ends to calculate data scrambling masks (k_i). Using k_i the data can be scrambled and descrambled at both ends but not by a third party who does not know k_i. In addition, a scrambling key (K_S) is used in generating k_i. Because different scrambling keys can be used for different DMSs, the identity of the calling DMS is sent at the beginning of the connection. This requires key management which is not described in this document.

10.2 Operation

The scrambling key K_S is entered into the DMS by using the keyboard. The length of K_S is 32 bits and it is entered as 8 hexadecimal characters using the DMS keyboard.

The scrambling is activated at the beginning of the data connection and it is maintained throughout the connection. All user data (not control data) is scrambled after exchanging RANDs.

The DMS terminal requesting scrambling sends RAND before data frames (DTs). This also indicates whether 8-bit data or 7-bit data is used. If a DMS terminal has the scrambling function it shall be capable of sending its ID and facilitating 7-bit format and optionally 8-bit format. In case of a positive response to the RAND (see paragraph 10.6), the random numbers are exchanged and scrambling is started. The terminal initiating the call sends ID before RAND. If a DMS terminal has not the scrambling facility, the RAND will be acknowledged by standard RR frames (s=1), no scrambling is started and 7-bit format is used.

10.3 Definition of RAND and ID Control Data Frames (CT) and MASK

Reception of RAND triggers the transmission of the first frame(s): The A-subscriber terminal shall send ID+RAND and the B-subscriber terminal just RAND (never ID). If answer is made automatically, RAND is sent even if there is no data for sending. The three first characters (7 or 8-bit in binary, depending on format in use) of the first DT frame during the call are used as a mask (MASK = S1 S2 S3) for the rest of the characters.

Frame C D_1 D_2 D_3 D_4 D_5 D_6 D_7 (see paragraph 9)

RAND 82 $A_1'A_1$ $A_2'A_2$ $A_3'A_3$ 7/8, where

$A_1'A_1...A_3'A_3$ is a 24-bit random number RAND where $A_1'...A_3'$ (x000000) carry the MSBs (x above) of the 8-bit numbers R_1 R_2 R_3, and

7/8 is ISO character 7 or 8 corresponding the character length in DT frames.

ID 73 I_1 I_2 I_3 I_4 I_5 I_6 I_7, where

$I_1...I_7$ = Z X_1 X_2 X_3 X_4 X_5 X_6 for the DMS. For terminals without NMT identity, Z = 'F'. (Identity can also be obtained scrambled with user data by using command *?MSI?* etc.).

Note: The remaining bits (0's) in $A_1'...A_3'$ may later be specified to have values different from zero.

10.4 The Scrambling Method

10.4.1 The Scrambling Key Ks

The additional scrambling key can be divided in 4 parts:

$K_S = K_{S1}$ K_{S2} K_{S3} K_{S4} (4 x 8 bits)

The length of each part is 8 bits. If no K_S has been entered into the DMS terminal, four last dialled digits when initiating a call, or four last digits of the DMS identity when receiving a call, are used according to ISO 7-bit character set with leading '0' 7-bit characters if required. A leading zero is added to each character (0xxxxxxx).

10.4.2 The Random Numbers

A random number RAND is sent from the DMS at the beginning of the data transmission. The random number is divided in three parts:

$RAND = R_1\ R_2\ R_3$ (3 x 8 bits)

A random number, MASK, is sent in the first DT frame when the actual scrambled data transmission starts. The three first characters, $S_1\ S_2\ S_3$ in binary, of the first DT frame are sent scrambled and shall be descrambled when received assuming zero values for them in the scrambling and descrambling algorithm. The fourth character sent or received is the first of actual data.

$MASK = S_1\ S_2\ S_3$ (3 x 8 bits or 3 x 7 bits)

Values $S_1 ... S_3$ (non zero) are selected arbitrary for masking the data bytes to follow. They are normally different in the two directions.

10.4.3 The Algorithm

At the beginning of the data connection, the DMS terminals exchange RANDs ($RAND_A$ from DMS_A and $RAND_B$ from DMS_B):

$RAND_A = R_{A1}\ R_{A2}\ R_{A3}$ (3 x 8 bits)
$RAND_B = R_{B1}\ R_{B2}\ R_{B3}$ (3 x 8 bits)

At both ends, a calculation is made:

$K_1 = R_{A1}\ XOR\ R_{B1}\ XOR\ K_{S1}$ (8 bits)
$K_2 = R_{A2}\ XOR\ R_{B2}\ XOR\ K_{S2}$ (8 bits)
$K_3 = R_{A3}\ XOR\ R_{B3}\ XOR\ K_{S3}$ (8 bits).

The transmitted Q_i ($i = 1,2,3,...$) are scrambled:

$Q_i = M_i\ XOR\ k_i\ XOR\ S_j$ (8 bits), $i = 1,2,3..., j = (i-1)\ MOD\ 3 + 1$

where M_i is the character to be scrambled,
k_i is obtained as described below.

$k_i = x_i\ XOR\ y_i\ XOR\ z_i\ XOR\ e_i$ (8 bits), $i = 1,2,3,...$

where
$x_{i+1} = (81 * x_i + 73)\ MOD\ 100, \quad x_0 = K_1$
$y_{i+1} = (167 * y_i + 83)\ MOD\ 99, \quad y_0 = K_2$
$z_{i+1} = (14 * z_i + 157)\ MOD\ 169, \quad z_0 = K_3.$
$e_{i+1} = (43 * e_i + 39)\ MOD\ 49, \quad e_0 = K_{S4}.$

Calculation for descrambling (in reception) is done independently of scrambling but with the same keys. It is similar except for:

$M_i = Q_i$ XOR k_i XOR S_j (8 bits), i = 1,2,3,..., j = (i-1) MOD 3 + 1

In case of 7-bit data the MSBs are omitted in Q_i and M_i.

In a DT user data frame, NUL characters (binary 0000000 or 00000000) are not scrambled (and i NOT incremented) but are transmitted as NUL characters. Also, if scrambling a character leads to a zero (equal to NUL), the character is not scrambled (i will be incremented however). In descrambling, NULs are received as NULs and if descrambling of a character leads to a NUL it is not descrambled but taken as received.

In the implementation, lists of pre-calculated values for x_i, y_i z_i and e_i can be used instead of real time calculation if required. Then, the starting points x_0, y_0, z_0 and e_0 in the sequences of numbers (lists) are the values obtained from K_1, K_2, K_3 and K_{S4} for the four lists respectively. Note that for the first character sent, i = 1. Lengths of the four lists are 100, 99, 169 and 49 bytes.

10.5 Entering the Additional Scrambling Key into the DMS

The scrambling key to be entered into the DMS is:

$K_S = K_{S1}\ K_{S2}\ K_{S3}\ K_{S4}$ (4 x 8 bits)

This is entered as 8 hexadecimal characters of 4 bits e.g. by using the DMS keyboard. The key may be attached to a dialled digit memory location together with the telephone number and to the automatic answer function when desired.

10.6 Procedures

At the beginning of the call, a DMS requesting scrambling always sends a CT with RAND before any DTs. ID is sent before RAND by the A-subscriber terminal. No DTs can be sent before RANDs have been exchanged: transmitted and acknowledged. If RAND and a positive response (RR(N) with bit s=0 and N one greater than in the RAND transmitted) are received, transmission of scrambled DTs may start. If a negative response (RR(N) with bit s=1 and N one larger than in the RAND transmitted) is received, DTs are sent without scrambling. A typical sequence (as a result of the DMS specification, Fig.1) of the first frames is:

	Transmitted		Received
	ID	CT(0)	
	RAND	CT(1)	RR(1)
	RAND	CT(1)	RRp(2) Positive Response (s=0) *)
			CT(0) RAND
		RRp(1)	RRp(2)
Scrambled data		DT(2)	CT(0) RAND
(+ MASK)		RRp(1)	RRp(3)
Scrambled data		DT(3)	RRp(4)
		DT(4)	RRp(5)
		etc.	
or:	ID	CT(0)	
	RAND	CT(1)	RR(1)
	RAND	CT(1)	RR(2) Negative response (s=1)
Data without		DT(2)	RR(2)
scrambling		DT(3)	RR(3)
		DT(4)	RR(4)
		DT(5)	RR(5)
		etc.	

*) Note that with a poor signal RR(0) with s=1 may be received before a positive response (s=0). Data can only be sent (scrambled) or displayed (descrambled) either 1) after receiving a negative response to RAND or 2) after receiving both RAND and a positive response. NR(N) is not sent here while waiting.

When RS232C connector is used, CT(0) with ID may be sent by the A-subscriber terminal continuously to test when the connection between the DMS terminals is established. In this case, RAND shall be sent only after reception of an RR.

10.7 7/8-bit Format Selection

If scrambling has been requested by the DMS (RAND sent), the transmission of DTs may start only after receiving a RAND and a positive response or after receiving a negative response (no scrambling) to the RAND sent. If the DMS is set to operate in 8-bit format it shall transmit the RAND with 8-bit format indication (D_7='8') but the received RAND determines the format: if a RAND with an indication on 7-bit format (D_7='7') is received, 7-bit format (default) shall be used. A positive response is sent to both indications if the DMS has the scrambling facility. A negative response will be transmitted if scrambling is not implemented in the DMS. To summarise, parameter D_7 in the RAND frame:

Transmitted	Received	Format used
D7 = '7'	D7 = '7' + pos.resp.	7-bit, scrambling
D7 = '7'	D7 = '8' + pos.resp.	7-bit, scrambling
D7 = '8'	D7 = '7'+ pos.resp.	7-bit, scrambling
D7 = '8'	D7 = '8'+ pos. resp.	8-bit, scrambling
D7 = '7'or '8' negative response		7-bit, no scrambling

In the 8-bit format, the first 7-bit slot of a DT contains the MSBs (mmmmmmm) of the 7 bytes (xxxxxxx) in the same order:

101010101010101 00101000111 dsppnnn 11 mmmmmmm 11 xxxxxxx 11

xxxxxxx ... 11 xxxxxxx 11 xxxxxxx 11 ccccccc 11 ccccccc 11 cc

When the 8-bit format is active (in use) the DMS shall be fully transparent to data. That is, even if strings *?MSI?* and *?DSZ?* are received they are passed through and no responses to them are sent.

10.8 Dealing with NUL Characters

A DMS with scrambling facility should also be capable of transferring NUL characters via the external connector when provided. As the DT frame length is fixed and NUL characters are used for filling the last unused locations of the frame, those NUL characters which are intended for transmission cannot be situated as the last characters of the frame. In cases where this would happen, a new DT frame shall be started with the NUL as the first character. Examples of single DT frames (8-bit format):

Frame Content (X=NUL)	Transmitted characters (X=NUL)
1 2 3 4 5 X X	1 2 3 4 5
1 X 2 3 X 4 X	1 X 2 3 X 4
X X X X 1 2 3	X X X X 1 2 3
X 1 2 3 X X X	X 1 2 3
X X X X X X X	X

10.9 Control Data Transmission Frames (CT)

A Control Frame is similar to a User Data Frame (DT) except for bit s which is 0 for a CT. Acknowledgements (RR/NR) concerned, no difference is made between DTs and CTs. However, to a RAND, a positive response can be given by resetting bit s in all following RR/NRs. CTs always use 7-bit format and are not scrambled.

In addition to RAND and ID, other CTs have been specified:

Frame	C D_1 D_2 D_3 D_4 D_5 D_6 D_7 (= Info part, 8 x 7 bits)	
CT0	0 NUL NUL... NUL	Idle Control Frame. Data part has only NULs (binary zeros). CT0 can be optionally used for checking if RR/NRs can be received (data link exists).
CT84	84 N N N N N N N 84 N N N N N<CR>NUL	CT84 can optionally be used to send the complete telephone number (NNN..., ISO 7-bit format) of the A-subscriber, as programmed by the user into the DMS, followed by a Carriage Return. Several frames with C=84 may be used. A CT84 with D1...D7 = NUL can be used to indicate automatic answer and as a telephone number request by the B-subscriber terminal.

ANNEX 22

MOBILE STATION INTEGRATED WITH A PORTABLE DATA TERMINAL OR PERSONAL COMPUTER.(CTMS)

A DEFINITION

A CTMS is defined as a single (i.e. non-separable) easily carried unit combining the NMT transceiver with computer-terminal or PC facilities. The CTMS contains its own visual display, operating controls and antenna.

B TECHNICAL REQUIREMENTS

A CTMS shall fulfil the requirements for an ordinary mobile station with the following exceptions and additional requirements. (The paragraph numbering below is referring to the main NMT Doc 450-3.) All paragraphs marked with * apply only to CTMS with output power limited to 1.5 W. (I.e. based on the HMS specification.)

1 GENERAL

1.3.5 Extreme test conditions

The user interface of the CTMS (e.g. display, keypad and acoustic devices) is not required to remain functional outside the normal test conditions described in NMT Doc 450-3 paragraph 1.3.4.
When applying for Type Test it shall be stated by the manufacturer within what temperature & humidity range the complete CTMS is designed to work.
Testing in extreme conditions shall nevertheless be carried out where such tests are specified in NMT Doc 450-3. However all testing outside the range specified by the manufacturer, is then carried out through a test terminal according to paragraph 1.3.2.1.

2 TRANSCEIVER UNIT

2.2.4 Transmitter carrier power

The available steady-state carrier output power at the antenna terminal may be limited to 1.5 W ± 2 dB

2.2.5 Transmitter carrier control

If the output power is limited, the transmitter shall still be capable of changing the transmitter carrier output power as controlled by the Logic and Control Unit to -10 dB ± 3 dB (low power) relative to nominal carrier output power 1.5 W (high and medium power) at normal and extreme test conditions. However, at any test condition the carrier output power shall not deviate more than 3 dB between any arbitrary radio channel.

2.2.9 Frequency deviation

2.2.11 Adjacent channel power

If it is not possible to apply the test modulation signal in the tests "2.2.9 Frequency deviation" and "2.2.11 Adjacent channel power" the test modulation signal shall be that, as agreed between the manufacturer and testing authority, which requires the greatest radio frequency occupied bandwidth. Details on this test modulation signal shall be included in the test report.

2.3.7.1 RF-sensitivity *

The maximum RF signal level difference between any arbitrary channels to get the same SINAD(P)-ratio shall not exceed 3 dB at any test condition.

2.3.9 Adjacent channel selectivity *

The adjacent channel selectivity shall not be less than 67 dB under normal test conditions and 60 dB under extreme test conditions.

2.3.11 Spurious response rejection *

The spurious response rejection shall be at least 67 dB. .

2.4.3 Interference in the Ø-signal frequency band *

The interference level in the looped Ø-signal channel shall not exceed in case a) -5 dB and in case b) -10 dB relative to the signal level.

2.4.4 Relative frequency intermodulation product level in the Ø-signal band *

The intermodulation product level in the looped Ø-signal channel shall not exceed -5 dB relative to the Ø-signal level.

3 OPERATIONAL CONTROLS UNIT (OCU)

3.3 Handset

A handset is optional on the CTMS.

If a handset or any other form of acoustical coupler is to be marketed together with the CTMS, it shall fullfill applicable acoustical requirements as specified in NMT Doc 450-3 Chapter 2.

3.4 "Hands-Free" operation - "Hands-Free" button

"Hands-Free" operation need not be foreseen. In case "Hands-Free" facilities are provided, all the requirements in paragraph 3.4 shall be fulfilled.

3.9 Visual indicators

The visual indicators need not be visible in darkness, which means that they need not be illuminated or light emitting.

The indicators need not to be coloured.

The NMT indicators need not be continously visible. However the user shall always have an easy possibility to enable the NMT indicators if he so desires.

If the CTMS enter the "Roaming Alarm" state, the roaming alarm indicator shall unconditionally appear to the user.
The visual roaming alarm indicator may be replaced by an acoustic signal. In any case it shall remain active until roaming updating has been performed or the user actively cancels the indication.

4 OPERATIONAL PROCEDURES

This chapter is changed in accordance to changes in NMT Doc 450-3, Chapter 4.

The CTMS may be equipped with automatic call set-up and answering facilities.

During manual call set-up, answering and terminating, **if provided**, the CTMS shall fulfill all operational requirements for an ordinary MS. However the enabling of call set-up procedures may be through equipment specific operations.

In other states, the meaning of the push-button set may be changed. However the user shall always have a one-step access to the "on-hook" function.

6 SYSTEM TESTS

6.4 Functional test

The functional tests are carried out on the test site mentioned in paragraph 1.3.11 at various RF signal levels.

C ADDITIONAL TECHNICAL REQUIREMENTS

1 Antenna efficiency, transmitter

When measuring the effective radiated power the test site mentioned in paragraph 1.3.11 shall be used.

The CTMS with its antenna shall be rotated in the horizontal plane 0-360° and the height of the test antenna shall be varied in the range from 1 to 4 m to obtain the maximum level on the test receiver. The test antenna shall be vertically polarized.

The effective radiated power Pr is determined by substitution measurement.

With the test antenna in the position giving maximum level on the test receiver, the CTMS shall be rotated 0-360° in the horizontal plane and the level on the test receiver recorded.

Requirement: Pr shall in the maximum direction not be less than 3 dB below the power measured in an artificial antenna.

2 Receiver sensitivity degradation, Antenna-efficiency, receiver

When measuring the receiver part of the CTMS the test site mentioned in paragraph 1.3.11 shall be used.

The CTMS with its antenna and the test antenna shall be in the position giving maximum level on the test receiver, see paragraph 1 above.

The CTMS shall be in the condition of receiving ringing order. The reference field strength, Eo, is the lowest level when the CTMS generates ringing locally as a response of frame 5a (L=9) with 95% reception probability.

The CTMS shall then be in the speech condition and the lowest field strength for a successful switching call in progress, Es, shall be noted. The level Es is the lowest signal level for which switching call in progress is successful with 95% probability during speech condition.

Requirement: The difference Es-Eo shall not be more than 3 dB.

This requirement shall be fulfilled independent of the CTMS output power level.

3 Use of CTMS in vehicles.

The CTMS may be connected to an external antenna, external handset and the power source of the vehicle. In case it is not possible to use the operational and control buttons when the CTMS is connected, another operational and control unit shall be used. The built-in batteries may be charged from the power source. When the CTMS is connected to external antenna, handset or operational and control unit, the corresponding devices in the CTMS shall be made inoperable.

Auxiliaries to CTMS which makes it possible or easier to use the equipment in vehicles are called "car mounting kit" in the following text.

The combination of CTMS and its car mounting kit shall fulfil the specifications given in NMT Doc 450-3 and Annex 3. The antenna terminal of the mounting kit towards the car antenna (corresponds to antenna interface E in Annex 18) is used as antenna terminal for measurements when testing a car mounting kit.

D SPECIAL TYPE TESTING- & OPERATIONAL REQUIREMENTS

To accomodate the relaxations from the ordinary MS-specification, the following requirements shall apply:

1 The unit integrating a NMT transceiver and a computer terminal/PC is regarded as one single unit i.e. the whole unit shall be submitted to all tests described in NMT Doc 450-3 and relevant annexes.

2 If the NMT transceiver is separated from the rest of the equipment by the user, it shall become inoperable by all means.

3 All NMT functionalities, including keyboard operations and visual indication, shall be unchangeable by the user, e.g. no local or host application software shall interfere with the type approved functionalities.

4 The requirements in Annex 1 to NMT Doc 450-3, shall apply i.e. one NMT type designation shall be applied to the whole unit.

5 It shall be certified in written form that the handling & performance of the NMT radio interface & signalling is not changeable, relative to the type approved version, by any user action whatsoever. See figure 1 below!

6 The CTMS may utilize the BMS functionality. see Annex 12 to NMT Doc 450-3.

7 The modulation method of the modem and the data transfer protocol shall not be of such a type that it is interfering with the NMT-specific FFSK system data signalling.

8 The CTMS shall have a connector for an external antenna. This connector shall be accessible to the user.

9 All requirements in Annex 19 remains valid for the CTMS and may not be replaced by any integrated functionalities.

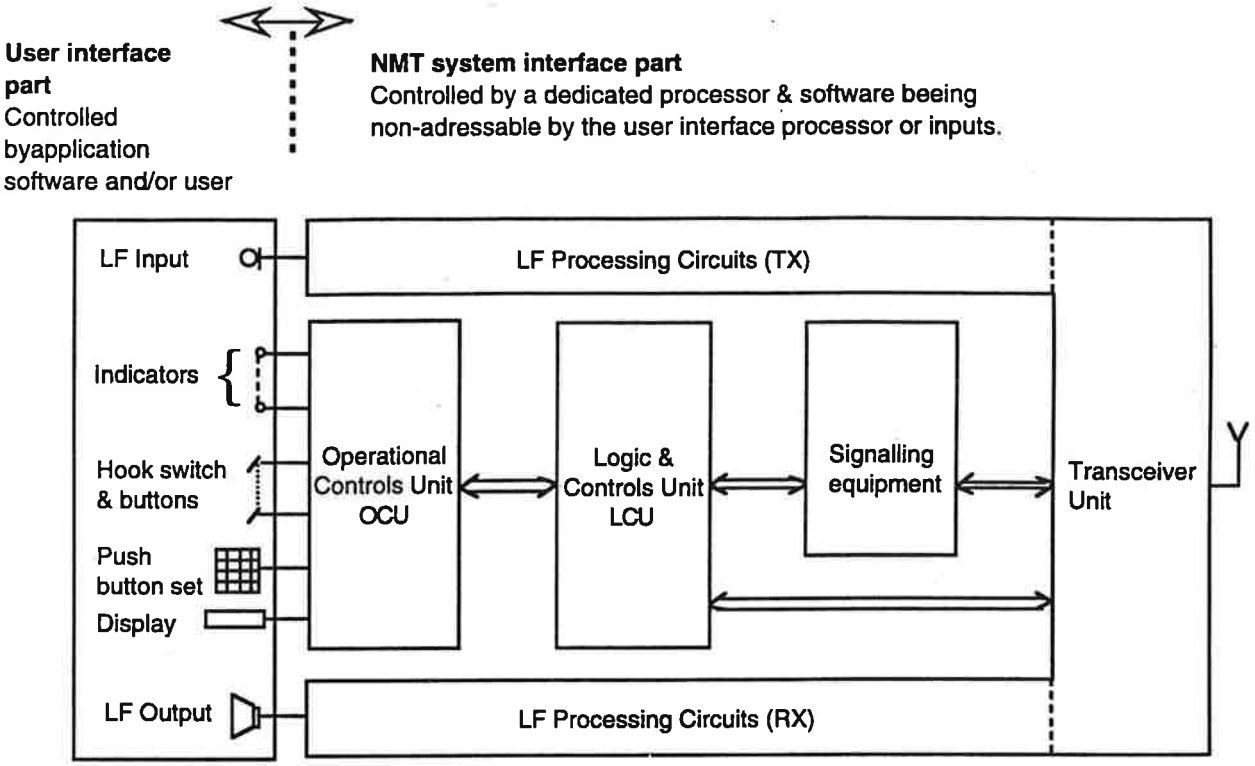


Fig.1 Logical split between NMT system part and User interface part of the CTMS

ANNEX 23 (OPTION)

Specification for the bar coding of subscription management related information

A SCOPE

This Annex specifies the bar coding of the information related to the MS type designation and later transferred to the subscription management system (SMS) upon opening a subscription to the network. The code is of a type that can be transferred via telefax to the SMS or via a light-pen data transfer system.

No part of this annex overrules the requirements in the other parts of NMT Doc 450-3 or NMT Doc 900-3 e.g. the type designation shall be visually readable together with serial number while the NMT-SIS reference number shall be electronically readable from the MS.

B TECHNICAL REQUIREMENTS

1 Contents

1.1 The information shall consist of:

i) Manufacturer & Type designation, including version number (See Annex 1)

This field is a character exact representation of the type designation i.e. it is corresponding to one type of MS only. If the manufacturers name is to be part of the type designation it shall be included.

ii) Serial number.

No information such as "Snr" shall be included. Every character in this field is to be understood as part of the serial number.

iii) NMT SIS reference number (See NMT Doc 900-3 paragraph 4.5)

This field shall only contain the relevant 18 characters, but may be split by "DOT" according to the structure of the reference number.

2 Type of code

2.1 The code used shall be EDI Code 39

2.2 An example of the code is shown below

MAKE A/S ABCD 900 EF 1

SNR:123456789

SIS REF NO: 1234.123456.12345.123

3 Placement and use

3.1 Use

The code is likely to be placed on the subscription form by the means of a self adhesive sticker or by reading it with a light pen thus transferring it electronically.

3.2 Placing

The code shall either be placed directly on the MS or on the package. It is recommended to enclose a duplicate which, in size, is suitable for fax transmission.

NOTE: Any mismatch between the code and the actual hardware will not be identified before the user attempts to use the MS.