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Contents

Foreword

This document is the Publicly Available Specification (PAS) of the TETRAPOL land mobile radio system, which shall provide digital narrow band voice, messaging, and data services. Its main objective is to provide specifications dedicated to the more demanding PMR segment : the public safety. These specifications are also applicable to most PMR networks.

This PAS is a multipart document which consists of:

Part 1 General Network Design

Part 2 Radio Air interface

Part 3 Air Interface Protocol

Part 4 Gateway to X.400 MTA

Part 5 Dispatch Centre interface

Part 6 Line Connected Terminal interface

Part 7 Codec

Part 8 Radio conformance tests

Part 9 Air interface protocol conformance tests

Part 10 Inter System Interface

Part 11 Gateway to PABX, ISDN, PDN

Part 12 Network Management Centre interface

Part 13 User Data Terminal to System Terminal interface

Part 14 System Simulator

Part 15 Gateway to External Data Terminal

Part 16 Security

Part 17 Guide to TETRAPOL features

Part 18 Base station to Radioswitch interface

Part 19 Stand Alone Dispatch Position interface

1. Scope

This PAS describes the BS-BSC interface at reference point R12 (see PAS 0001-1 [1]):

- Clause 4 describes the general organisation of the interface;
- Clause 5 describes the synchronisation interface;
- Clause 6 describes the BSC-TRX interface;
- Clause 7 describes the BS alarm interface.

2. Normative References

This PAS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this PAS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] PAS 0001-1: "TETRAPOL Specifications; General Network design".

[2] ISO 8208 | ITU-T X.25: "Packet Level Protocol for Data Terminal Equipment".

[3] ITU-T Recommendation V.11 / X.27 (1988): "Electrical characteristics of symmetrical connector circuits for transmission by double current up to 10 Mbit/s".

[4] ITU-T Recommendation V.24: "List of definitions for interchange circuits between Data Terminal Equipment (DTE) and Data Circuit terminating Equipment (DCE)".

[5] ISO 3309: "High Level Data Link Control (HDLC) procedures; Frame structure".

[6] PAS 0001-3-3: "TETRAPOL Specifications; Air Interface Protocol; Air Interface Transport Protocol".

[7] PAS 0001-3-4: "TETRAPOL Specifications; Air Interface Protocol; Circuit Mode Air Interface Protocol".

[8] PAS 0001-2: "TETRAPOL Specifications; Radio Air Interface".

3. Definitions and abbreviations

3.1. Definitions

For the purposes of this PAS, the following definitions apply:

Base Network (BN): elementary network which is the smallest entity able to operate in normal network connected mode and to provide all nominal services and features available in normal network connected mode. It includes one RSWN and one or more BSs and corresponds to a geographical subdivision of a Network coverage.

Base Station (BS): Station in the TETRAPOL SwMI interfacing the Terminals on a given site.

Base Station Controller (BSC): Base Station interface to the switching network. This subsystem manages the radio channels and enables the switching network to control the BS while also providing scrambling of the Network voice circuits.

Base Transceiver Station (BTS): Radio subset of the Base Station including the TRX's and the synchronisation equipment.

cell: operational entity through which terminals can be accessed or localised. There are two types of cells: radio cells and line connected cells.

Control Channel (CCH): bi-directional BS-RT physical radio channel used for transmitting signalling and data. Control Channels in a cell include one Main Control Channel (MCCH) and zero, one or several Extended Control Channels (ECCHs).

Fallback mode: for the purposes of this PAS, the term fallback mode shall be understood as BSC-disconnected fallback mode.

Line Access Base Station (LABS): network interface to Line Connected Terminals and to SADPs, also known as Line Connection Interface Unit (LCIU).

line connected cell: a line connected cell is the coverage of a Line Access Base Station.

Line Connected Terminal (LCT): System Terminal (ST) locally or remotely connected to the System through a physical wired connection line. The System interface to LCTs is a Line Access Base Station.

network mode: operational mode where the MS is under coverage and listening to the Network (the MS has a serving cell). The Network is the system fixed infrastructure.

Radio Base Station (RBS): Radio subset of the TETRAPOL SwMI interfacing the Radio Terminals.

radio cell: a cell is the geographical area corresponding to the radio electrical coverage of one Base Station (monosite cell) or of a group of Base Stations synchronised to emit an identical signal (simulcast cell).

Radio Terminal (RT): System Terminal connected to the infrastructure by means of a radio link also known as Mobile Termination Unit or MTU.

System Terminal (ST): service access reference point provided to the user by the System. System terminals are Radio Terminals (RTs) and Line Connected Terminals (LCTs).

Traffic Channel (TCH): bi-directional BS - RT physical radio channel used for transmitting voice or data.

3.2. Abbreviations

For the purposes of this PAS, the following abbreviations apply:

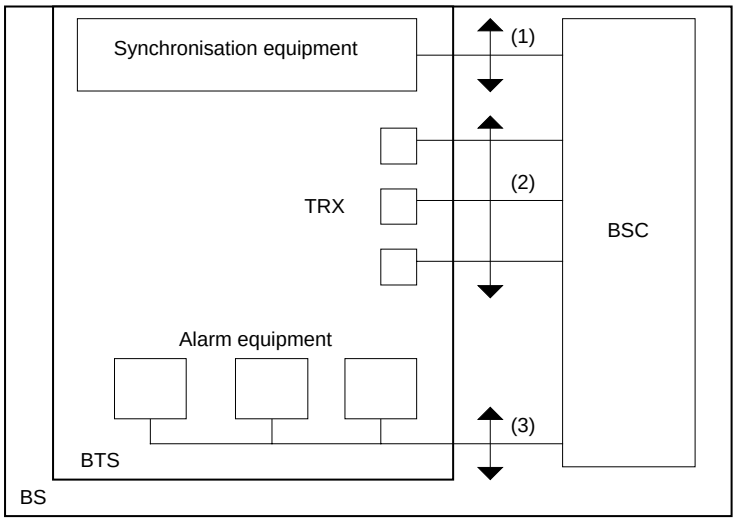
A/I	Air Interface
BCH	Broadcast CHannel
BN	Base Network
BS	Base Station
BSC	Base Station Controller
BTS	Base Transceiver Station
CCH	Control CHannel
CRP	Connection Reference Point
DCH	Data CHannel
DM	Direct Mode
DM/NM	Direct Mode / Network Monitoring
FBM	FallBack Mode
FCS	Frame Control Sequence
FN	Flag Number
HDLC	High level Data Link Control
ISO	International Standard Organisation
ITU-T	International Telecommunication Union - Telecommunication Standardisation Sector
LABS	Line Access Base Station
LAPB	Link Access Protocol B
LCT	Line Connected Terminal
MMI	Man Machine Interface

MS	Mobile Station
PAS	Publicly Available Specification
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PMR	Private Mobile Radiocommunications
PN	Pseudo Noise
PTT	Push-To-Talk
RBS	Radio Base Station
RCH	Random access answer CHannel
Ri	Reference point index i
RP	RePeater
RSW	RadioSWitch
RT	Radio Terminal
SDCH	Signalling and Data CHannel
SDL	Specification and Description Language
SP	Signal Processing
ST	System Terminal
SwMI	Switching and Management Infrastructure
SWR	Standing Wave Ratio
TCH	Traffic Channel
TP	TransPort layer
TRX	Transmitter / Receiver
TTI	Temporary Terminal Identifier
UI	Unumbered Information
UHF	Ultra High Frequency
VCH	Voice CHannel
VHF	Very High Frequency

4. General organisation of the interface

The interface includes 3 distinct and independent parts (see figure 1):

- the synchronisation interface provided by the BS;
- the BSC - TRX interface, on the basis of one data link per channel;
- the BS alarm interface.



(1) Synchronisation interface

(2) BSC - TRX interface

(3) BS alarm interface

Figure 1: BSC - BS interfaces

5. Synchronisation interface

The synchronisation interface between BS and BSC shall include two clock signals:

- HSY: 8 kHz signal provided by BS; this signal controls internal clocks of the BSC and clocks of BSC - BS data links;

- HSX: composite signal 20 ms / 4 s provided by BS. This multiplexed signal provides the radio frame synchronisation (20 ms) and the CCH super frame synchronisation (4 s).

The electrical characteristics of these signals shall be consistent with ITU-T V.11 / X.27 [3].

The phase relations of the signals are given in figure 2.

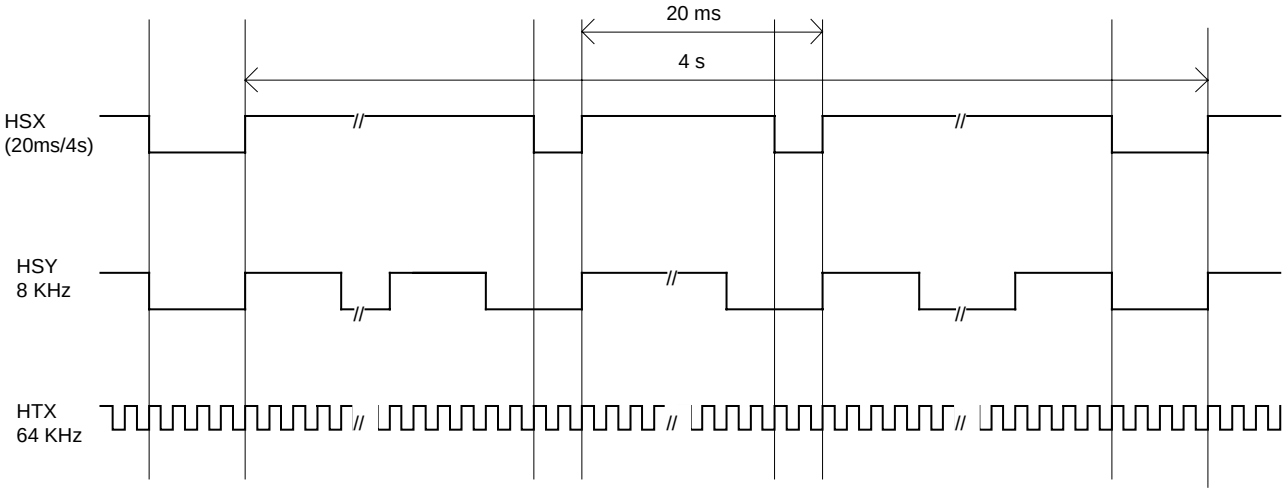


Figure 2: Synchronisation signals phase relations

6. BSC-TRX interface

6.1. Physical layer

The physical interface between BSC and TRX's of a BS is a 2,048 Mbit/s multipoint PCM link. The electrical specifications shall be consistent with ITU-T V.11 / X.27 [3].

The PCM link shall be divided into 32 time slots using separate synchronisation signals.

Time slot 0 shall be reserved for link test, time slots 1 to 31 are available for BSC - TRX interfaces.

6.1.1. PCM link

The PCM link physical interface shall include:

- a 4,096 MHz clock signal giving the bit clock;
- a frame synchronisation signal (125 µs);
- a bi-directional link.

The clock and synchronisation signals shall be provided by the BSC.

All circuits shall be consistent with ITU-T V.11 / X.27 [3].

From BSC point of view, bit 0 of the transmit frame shall be aligned on the frame alignment signal, bit 0 of the received frame shall be 1 bit duration delayed relating to frame alignment signal.

The frame alignment scheme is described in figure 3.

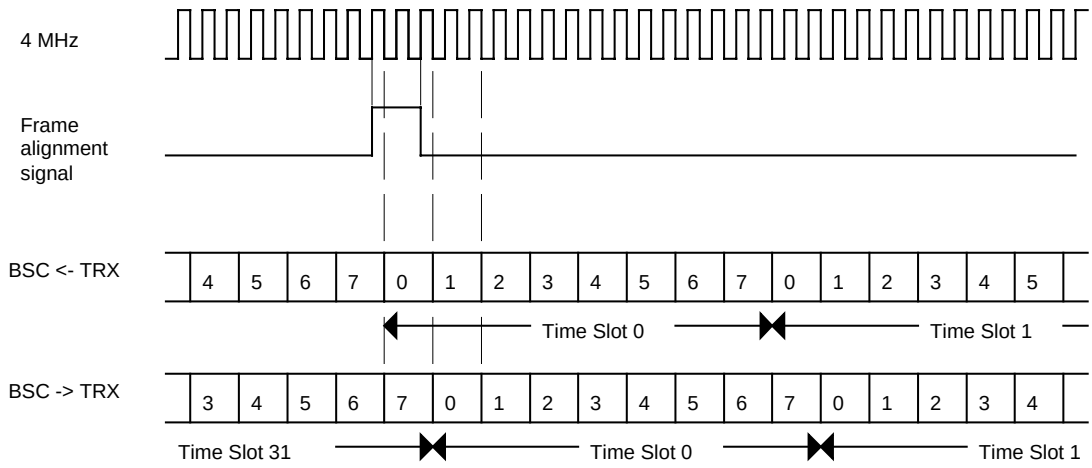


Figure 3: Frame alignment scheme on BSC - TRX PCM link

6.1.2. Multiplexing the BSC-TRX data stream

Four BSC-TRX data streams are multiplexed in a PCM time slot.

Between the BSC and a TRX, a frame shall be transmitted in both direction each 20 ms. The synchronisation reference signal is derived from the HSX composite signal (see Clause 5).

The 20 ms HSX period is divided into four transmission windows of 5 ms each. Each window is statically (after the initialisation phase described in subclause 6.3.3) assigned to a TRX. TRX 0 transmits and receives during the first window, TRX 1 in the second window, etc...

NOTE: The data link on the BSC/TRX interface is seen from the TRX side, the following times are therefore measured on the TRX side.

BSC sends the first bit of the HDLC frame opening flag in the [FR1 , FR2] window (in ms) after the HSX + n 5 ms (n varies from 0 to 3) signal, depending on the submultiplex.

TRX sends the first bit of the HDLC frame opening flag in the [FT1 , FT2] window (in ms), in the first submultiplex after the HSX signal. In the other submultiplex the frame is sent without synchronisation window.

Transmission window values are the following:

TRX to BSC direction:

FT1 = 0
FT2 = 0,5 ms

BSC to TRX direction:

FR1 = 0
FR2 = 1 ms

With regard to the message lengths defined in subclause 6.3, these values correspond to the reception window [FR3, FR4] of the last bit of the next closing flag in all submultiplex in the BSC to TRX direction, and to transmission window [FT3, FT4] in the first submultiplex in TRX to BSC direction.

TRX to BSC direction: total number of octets = 29 octets, 27 of which may include HDLC bit insertion.

FT3 = 3,625 ms (without HDLC bit insertion)
FT4 = 4,8 ms (with FT2 and HDLC insertion)

BSC to TRX direction: total number of octets = 26 octets, 24 of which may include HDLC bit insertion.

FR3 = 3,25 ms (without HDLC bit insertion)
FR4 = 4,85 ms (with FR2 and HDLC bit insertion)

6.2. Data link layer

The frame format is consistent with LAPB layer as specified in ITU-T X.25 [2] and ISO 3309 [5].

Each data link corresponds to one radio channel. The data link is connectionless, the link conveys one frame every 20 ms in each direction.

All frames are UI frames.

The spaces between frames are stuffed with flags.

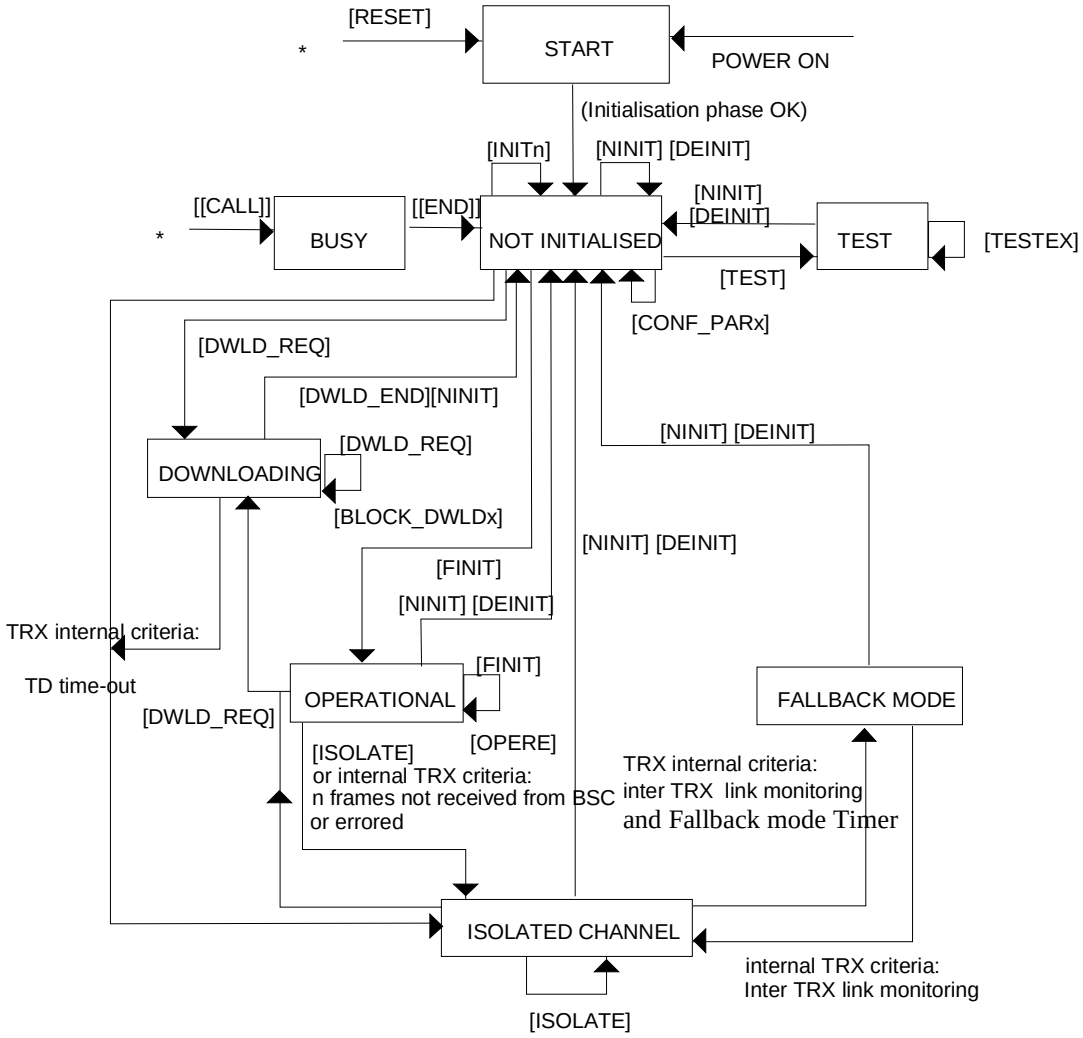
6.3. Application layer

Each applicative message shall be carried in a unique data link layer frame.

Messages are exchanged according to the TRX state.

6.3.1. TRX states

Figure 4 describes the TRX finite state machine as seen from BSC point of view.



* from any state
[ ] = Message received from BSC
[[ ]] = Message received from OPERATOR
The [[CALL]] message can be initiated in any state
The [RESET] instruction can arrive in any state

Figure 4: TRX states

6.3.2. Messages

6.3.2.1. TRX to BSC messages

6.3.2.1.1. WAIT

This message is a waiting indication. It shall contain the number of the last received INIT.

6.3.2.1.2. OPERR

This message shall contain the radio frame received from the air.

6.3.2.1.3. DEINIT_ACK

Deinitialisation acknowledgement.

6.3.2.1.4. TEST_BSC

Test report.

6.3.2.1.5. BUSY

Reserved.

6.3.2.1.6. DWLD_FRAME

This message can transport four kinds of acknowlegment :

DWLD_REQ_ACK : this message is used to acknowledge the TRX software downloading request message.

DWLD_END_ACK : this message is used to acknowledge the TRX software downloading end message.

BLOCK_DWLD_ACK : this message is used for data block acknowledgement during the downloading of the TRX software. It shall contain the number of the last received BLOCK_DWLD.

CONF_PAR_ACK : this message is used for configuration parameters acknowledgement during the transmission of these parametres. It shall contain the number of the last received CONF_PAR.

6.3.2.2. BSC to TRX messages

6.3.2.2.1. NINIT

This message shall change TRX status to NOT INITIALISED and invalidate operationnal parameters. It shall initialise the dialogue between TRX and BSC.

6.3.2.2.2. DEINIT

This message shall change TRX status to NOT INITIALISED and deinitialise the dialogue between TRX and BSC. Receiving DEINIT message, the TRX shall invalidate its static parameters. The TRX is then waiting for NINIT message.

6.3.2.2.3. TESTEX

This message shall trigger test execution in TEST mode.

6.3.2.2.4. INITx

These numbered initialisation messages (x = 1 to N) contain static parameter values. The TRX shall memorise the transmitted parameters.

6.3.2.2.5. FINIT

This message shall terminate the initialisation procedure. It shall validate in the TRX the memorisation of the static parameters conveyed in INITx frames. Receiving FINIT message the TRX shall change its state to OPERATIONAL. FINIT message has no parameters.

6.3.2.2.6. OPERE

This message shall contain the radio frame to send on the air.

6.3.2.2.7. ISOLATE

This message shall change TRX state to ISOLATED CHANNEL. ISOLATE message has no parameters.

6.3.2.2.8. TEST

This message shall change TRX state to TEST.

6.3.2.2.9. RESET

This message is a software reset. It shall reset the TRX board hardware. This message is only transmitted if the dialogue between TRX and BSC has been previously initialised. RESET message shall deinitialise the dialogue between TRX and BSC.

6.3.2.2.10. RESETHW

This message is a TRX hardware reset detected by hardware. This message is only transmitted if the dialogue between TRX and BSC has been previously initialised. RESETHW shall deinitialise the dialogue between TRX and BSC.

6.3.2.2.11. DWLD_REQ

This message shall change TRX status to DOWNLOADING. It shall also cause the erasing of the previous TRX software in order to replace it with a new one.

6.3.2.2.12. BLOCK_DWLDx

This numbered message (x =0 to 255, x is used as a cyclic value) contains a block of software to download in the TRX. The TRX shall memorise the software.

6.3.2.2.13. DWLD_END

This message shall change TRX status to NOT INITIALISED. This message causes the TRX reset and the start of the new downloading software. It deinitialises the dialogue between TRX and BSC.

6.3.2.2.14. CONF_PARx

This numbered message (x =0 to 255) contains a block of configuration parameters for the TRX. The TRX shall first delete the previous parameters ant then memorises this parameters.

6.3.3. Dialogue opening and initialisation

BSC and TRX initialisation processes shall be independent.

At the end of the start routine (selftest), TRX status shall change to NOT INITIALISED.

TRX shall monitor PCM time slot 1 to 32 until it recognises its own address in received HDLC frames.

The BSC shall start and shall send NINIT frames. BSC shall continue to send NINIT frame every 20 ms until TRX answers with a WAIT0 message.

NINIT frames contain the PCM time slot number and submultiplex to be used by TRX and BSC to continue dialogue.

When TRX receives an NINIT message, it shall acknowledge it with a WAIT0 message. The WAIT0 message shall be sent on the PCM time slot and the submultiplex indicated in the NINIT message.

BSC then shall send INITx message to TRX to load static parameter values, with X = 1 to n ($7 \leq n \leq 22$). TRX shall acknowledge each INITx message by a WAITx message.

After BSC has supplied TRX with all the static parameters to be used, it shall send FINIT message to terminate the initialisation phase. TRX state shall then change to OPERATIONAL.

TRX shall return OPERR messages and BSC then shall send OPERE messages.

TRX shall detect RESET messages, regardless of its state (other than START state), as soon as the BSC - TRX dialogue is initialised.

6.3.4. Link monitoring

From any state, after the dialogue between BSC and TRX has been initialised, the TRX can detect by an internal criteria a link fault with the BSC (n frames not received from the BSC or errored), in this case the TRX shall stop sending messages to the BSC and change to the state ISOLATED channel. TRX shall monitor PCM time slot 1 to 32 until it recognises its own address in received HDLC frames. Only the message NINIT will authorise the TRX to start sending messages to the BSC.

6.3.5. Downloading software

From NOT INITIALISED or OPERATIONAL state, the TRX shall accept the DWLD_REQ message. In NOT INITIALISED state, this message only occurs after the NINIT frame if the TRX software is not the right one (the marking information are not the rigth one) or if the TRX asks for a new one (for example if there's no valid software) in the WAIT 0 frame.

The BSC continues to send DWLD_REQ frame every 20 ms until the TRX anwers with the DWLD_REQ_ACK frame. This frame shall be sent on the PCM time and submultiplex given by the DWLD_REQ message.

Then downloading really starts and BSC sends every software block in BLOCK_DWLD x with x = 0 to 255. TRX shall acknowledge each BLOCK_DWLD x by a OTHER (BLOCK_DWLD_ACK x) message.

BSC sends BLOCK_DWLD x frames until there is no more software to download. Then it shall send a DWLD_END frame to terminate the downloading phase. TRX state shall change to NOT INITIALISED and TRX shall reply by sending a DWLD_END_ACK frame. The TRX shall restart with the new software.

A TRX which doesn't accept downloading shall indicate this in the NINIT frame. In that case, the BSC never tries to begin the downloading protocol.

6.3.6. Transferring configuration parameters

In the NOT INITIALISED state, the TRX shall ask to BSC the transmission of the radio configuration parameters in the WAIT 0 frame. Inspite of replying with the INIT 1 frame (usual protocol), the BSC shall send then the parameters by sending a CONF_PARx frame with x = 0 to 255.

The BSC continues to send CONF_PARX frame every 20 ms until the TRX anwers with the OTHER (CONF_PAR_ACK x) frame.

When all the parameters were sent, the BSC restarts the usual initialisation protocol by sending INIT 1 frame.

A TRX which doesn't accept downloading shall indicate this in the NINIT frame. In that case, the BSC never tries to begin the transfer of the configuration parameters.

6.3.7. List of messages

Table 1 summarises the BSC-TRX messages.

MESSAGES	BSC → TRX	TRX → BSC
RESETHW	X	
NINIT	X	
INIT	X	
FINIT	X	
OPERE	X	
ISOLATE	X	
RESET	X	
DEINIT	X	
TEST	X	
TESTEX	X	
DWLD_REQ	X	
BLOCK_DWLD	X	
DWLD_END	X	
CONF_PAR	X	
WAIT		X
OPERR		X
DEINIT_ACK		X
TEST_BSC		X
BUSY		X
DWLD_FRAME		X

Table 1: Message list

6.3.8. Messages processing in each TRX state

The TRX states are:

- START;
- NOT INITIALISED;
- OPERATIONAL;
- ISOLATED CHANNEL;
- FALLBACK MODE;
- TEST;
- DOWNLOADING;
- BUSY.

6.3.8.1. START state

In this state TRX shall not send messages to BSC and shall ignore BSC messages.

TRX shall execute its startup routine. If unsuccessful, it shall remain in START status.

6.3.8.2. NOT INITIALISED state

TRX shall go into NOT INITIALISED state when the TRX startup phase is successful, or when it receives a DEINIT message from BSC.

This state allows the TRX to receive dialogue initialisation parameters in NINIT message (dedicated PCM time slot and submultiplex numbers), other operationnal parameters in INITx messages (including fallback mode parameters), configuration parameters in CONF_PARx messages and DWLD_REQ message to start downloading the software.

No more than 16 channels can be initialised in fallback mode.

In this state, TRX shall only accept NINIT, INIT, FINIT, DEINIT, TEST, DWLD_REQ, CONF_PAR messages and shall return a software alarm in response to any other message.

TRX sets timer TD and resets it whenever a message is received from BSC. On TD expiration [10 s], TRX state changes to ISOLATED CHANNEL.

When TRX receives INITx, it shall return WAITx frames to BSC. Parameter x is the number of the last received INITx message.

When TRX receives CONF_PARx, it shall return CONF_PAR_ACKx frames to BSC. Parameter x is the number of the last received CONF_PARx message.

6.3.8.3. OPERATIONAL state

This is the normal TRX working state, where the TRX is controlled by its BSC.

In this state, BSC sends:

OPERE: Operational transmission message containing:
- Information to send, scrambling parameter;
- Radio control state (transmitter ON/OFF);
- Demodulation parameters for the next frame (demodulation, scrambling status).

The TRX replies with:

OPERR: Operational reception message containing received information and signal processing quality value.

In this state, the BSC may also send:

NINIT: order to change state with dialogue reinitialisation parameters.

ISOLATE: order to change to ISOLATED CHANNEL state.

There is an internal criterion to change state to ISOLATED channel which is bad reception of frames from BSC (typical value: 10 frames)

DEINIT: order to deinitialise the dialogue.

The TRX shall reply with:

DEINIT_ACK: DEINIT acknowledgement message. TRX shall then stop sending messages to BSC.

DWLD_REQ: order to change state to DOWNLOADING in order to download a new software. There is no answer to this frame in that state.

The TRX shall ignore any other message.

6.3.8.4. ISOLATED CHANNEL state

The TRX shall change to this state when a TRX-BSC link fault is detected, or on receipt of ISOLATE message from BSC.

If the dialogue between BSC and TRX has been initialised previously and is still OK, TRX shall keep on sending OPERR messages.

TRX shall only accept NINIT, DEINIT and ISOLATE messages and shall ignore any other message.

The internal criteria for changing the TRX to FALLBACK MODE state is based on inter-TRX link monitoring, and on the static and dynamic fallback mode parameters memorised by TRX from INIT messages.

6.3.8.5. FALLBACK MODE state

The TRX shall change to this state only when all the TRXs attached to the radio set detect a problem on their BSC link. The typical time between the detection of the problem and the begin of the FALLBACK MODE is 45 seconds.

If the dialogue between BSC and TRX has been previously initialised and is still OK, TRX shall keep on sending OPERR messages.

TRX shall only accept NINIT and DEINIT messages and shall ignore any other message.

The internal criteria for changing to ISOLATED CHANNEL state are determined by inter TRX link monitoring.

6.3.8.6. TEST state

TEST state is a specific TRX state for tests initiated by BSC.

In this state, TRX shall execute TESTEX messages and shall ignore all messages other than NINIT and DEINIT.

TRX shall send an uninterrupted sequence of TEST_BSC messages to BSC.

6.3.8.7. DOWNLOADING state

TRX shall go into DOWNLOADING state when the TRX receives a DWLD_REQ frame.

This state allows the TRX to receive a new software in BLOCK_DWLD messages.

In this state, TRX shall only accept DWLD_REQ, DWLD_END, NINIT, BLOCK_DWLDx messages and shall return a software alarm in response to any other message.

TRX sets timer TD and resets it whenever a message is received from BSC. On TD expiration [10 s], TRX state changes to ISOLATED CHANNEL.

When TRX receives BLOCK_DWLDx, it shall return OTHER (BLOCK_DWL_DACKx) frames to BSC. Parameter x is the number of the last received BLOCK_DWLDx message.

When TRX receives DWLD_END message, it shall go into NOT INITIALISED state and restart with the new downloaded software.

When TRX receives NINIT message, it shall go into NOT INITIALISED state and restart.

6.3.8.8. BUSY state

BUSY is a special TRX state for debugging initiated by a local operator (MMI).

In this state, TRX shall no longer accept BSC messages and shall execute the tests initiated by the local operator (MMI). If the dialogue between TRX and BSC has been previously initialised and is still OK, TRX shall send an uninterrupted sequence of OPERR messages to BSC.

On exiting this state, when local session in closed, TRX shall change to NOT INITIALISED state and shall send WAIT0 frames to BSC if the dialogue between BSC and TRX has been previously initialised and is still OK.

6.3.8.9. TRX behaviour receiving errored messages

When TRX receives a message with:

- Address field not compliant; or,
- Control field not compliant; or,
- Message type field not defined.

it shall return an error indication in the status and management field of the next frame.

6.3.8.10. TRX behaviour detecting software alarm

If TRX detects a software alarm, it shall send an alarm indication to BSC in the status and management field of the next frame.

6.3.9. Messages format

Any bit not defined in the present paragraph shall be reserved for future use.

All the applicative messages are carried in HDLC frame format compliant with ISO 3309 [5].

- 1 Flag octet;
- 1 Address octet;
- 1 Control octet;
- 1 Information field, defined below, containing 23 octets (TRX to BSC direction) and 20 octets (BSC to TRX direction);
- 1 Frame Control Sequence (FCS) in 2 octets;
- 1 Flag octet.

The following conventions are used in descriptions:

b_7: Most significant bit;

b_0: Least significant bit.

6.3.9.1. Address field

Each TRX has its own address determined by its physical identifier in 5 bits: ID = xxxxx.

In a BS configuration with agile TRX, an xxxxx = 00000 identifier indicates frequency agile TRX.

TRX to BSC address:
100x xxxx: TRX uses its physical identifier to address BSC

BSC to TRX address:
010x xxxx: BSC uses the physical identifier to address TRX
000x xxxx: BSC triggers a RESETHW on the TRX with that physical identifier (BSC shall have initialised TRX dialogue).

TRX shall only accept a hardware reset after 4 consecutive "RESETHW" messages received in one frame every 20 ms. A "RESETHW" frame starts with a flag octet followed by hardware reset address octet.

All other field address formats in the TRX to BSC direction are ignored.

6.3.9.2. Control field

The most significant bit of the Control field is used to acknowledge the last frame. This acknowledgement is used for link monitoring only.

The Control field format is the following:

$\{b_7, b_6, b_5, b_4, b_3, b_2, b_1, b_0\}$ = A 0 0 1 0 0 1 1

A = 1: Acknowledgement of last received frame

A = 0: Last expected frame not received

6.3.9.3. BSC to TRX messages information field

The information field contains:

- a status and management field: Octets 1 to 2;
- a message type field: Octet 2;
- a parameter field: Octets 3 to 20.

6.3.9.3.1. Status and management field

Octet 1: Frame number
$\{b_7, ..., b_0\}$ from 0 to 199.

Octet 2: instructions for radio equipment in fallback mode (dynamic parameters)
$\{b_7, b_6\}$ = 1 x: no Fallback mode authorised

0 0: CCH fallback mode type channel
0 1: TCH fallback mode type channel
When dynamic parameters are modified, the new values are stored in backed up memory.
b_5 and b_4 not used.

6.3.9.3.2. Message type field

Octet 2:

	b_3	b_2	b_1	b_0
NINIT	0	0	0	1
INIT	0	0	1	0

FINIT	0	0	1	1
OPERE	0	1	0	0
ISOLATE	0	1	0	1
RESET	0	1	1	0
DEINIT	0	1	1	1
TEST	1	0	0	0
TESTEX	1	0	0	1
DWLD_REQ	1	0	1	0
BLOCK_DWLD	1	0	1	1
DWLD_END	1	1	0	0
CONF_PAR	1	1	0	1

6.3.9.3.3. Parameter field

FINIT message
None (TRX stores static and dynamic fallback mode parameters on receipt of this message).

ISOLATE message
None.

RESET message
None.

DESINIT message
None.

TEST message
None.

NINIT message
Octet 3: Interface version number
$\{b_3, b_2, b_1, b_0\}$ = system version number = default = 0

Octet 4: PCM time slot number
Coding: $\{b_4 , ... , b_0\}$: number from 0 to 31

Octet 5: Submultiplex number in PCM time slot
Coding: $\{b_1 , b_0\}$ number from 0 to 3

Octet 6: Cel type
b_0 : 0 normal cel,
1 simulcast cel

INIT messages
Octet 3: number of INIT message, from 1 to N.

INIT 1: Static parameters for operational state and fallback mode

Octets 4 to 13: Stuffing frame for radio transmissions in operational status and CCH fallback mode.
In CCH fallback mode, the TRX sends this frame 98 times after sending the 2 BCH-CCH fallback frames, and varies the last 5 octets with a PN sequence.

Octet 4: Stuffing frame operation code:
$\{b_7 , ... b_0\} = \{0\ 0\ 0\ 1\ 0\ 0\ 0\ 0\}$

Octets 5 to 13: Data frame contents
66 right aligned bits = $\{b_1 , b_0\}$ in octet 5 for the 2 Flag Number (FN) bits described in PAS 0001-3-3 [6] ($b_0 = FN_0$, $b_1 = FN_1$) + octets 6 to 13;
+ 2 frame Associated Signalling Bits (ASB): $\{b_7, b_6\}$ in octet 5 (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).

See SDCH stuffing frame format in PAS 0001-3-3 [6].

INIT 2: Radio parameters for operational state and fallback mode

Octet 4: Operation code for radio parameters:
$\{b_7 , ... b_0\} = \{0\ 1\ 0\ 1\ 0\ 0\ 0\ 0\}$

Octet 5: Transmission power in operational state:
$\{b_2, b_1, b_0\}$ =
1 1 1: 25 W +/- 2dB
1 1 0: 15 W +/- 2dB
1 0 0: 6 W+/- 2dB
0 1 0: 2,4 W +/- 2dB
0 0 0: 1 W +/- 2dB

Octet 6: Transmission power in fallback mode
$\{b_2, b_1, b_0\}$: 3 significant bits, coding identical to octet 5

Octet 7: Scrambling parameter in CCH fallback mode (transmission and reception)

Octet 8: Scrambling parameter in TCH fallback mode (transmission and reception)

Octet 9: Origin channel number
b_0: Origin of channel number command
= 0: not controlled by BSC (octet 10 and 11 not significant)
= 1: controlled by BSC (octet 10 and 11 significant), all TRXs other than agile TRXs ignore this field.
$\{b_7,..., b_1\}$: reserved.

Octet 10 to 11: System channel number
in 16 bits, octet 10 (most significant bits) and octet 11 (least significant bits).

INIT 3: Static parameters for operational state and fallback mode.

Octets 4 to 13: End of speech frame detected by TRX at end of alternate voice transmission for operational status and TCH fallback mode.

Octet 4: Operation code for end of speech frames:
$\{b_7 , ... b_0\} = \{0\ 0\ 1\ 1\ 0\ 0\ 0\ 0\}$

Octets 5 to 9: End of speech frame contents
The field values are defined in PAS 0001-3-4 [7].

Octet 5: UI_VCH command field (see UI_VCH field defined in PAS 0001-3-3 [6], subclause 7.5.4.3)

Octet 6: End of speech 1 operation code (see CODOP field defined in PAS 0001-3-4 [7])

Octet 7: End of speech 2 operation code (see CODOP field defined in PAS 0001-3-4 [7])

Octet 8: End of speech 3 operation code (see CODOP field defined in PAS 0001-3-4 [7])

Octet 9: Flag Number (FN) and Associated Signalling Bits (ASB) with end of speech frames.
FN: $\{b_1 , b_0\}$ in octet 9 ($b_0 = FN_0$, $b_1 = FN_1$, see PAS 0001-3-3 [6]);
ASB: $\{b_7, b_6\}$ in octet 9, (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).

INIT 4: Static parameters for operational state and fallback mode.
Octets 4 to 13: Forced listening frame for radio transmission, frame used by TRX on a TCH in fallback mode in case of bad frame reception during speech transmission.

Octet 4: Operation code of forced listening frame:
$\{b_7 , ... b_0\} = \{0\ 1\ 0\ 0\ 0\ 0\ 0\ 0\}$

Octet 5 to 13: Data frame contents:

66 right-aligned bits: {b_1 , b_0} in octet 5 for the 2 Flag Number (FN) bits described in PAS 0001-3-3 [6] ($b_0 = FN_0$, $b_1 = FN_1$) + octets 6 to 13;
+ 2 Associated Signalling Bits (ASB): {b_7, b_6} in octet 5, (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).
The different frame fields are defined in PAS 0001-3-4 [9].

INIT 5: Static fallback mode parameters.

Octets 4 to 13: Channel free frame for radio transmissions in TCH fallback mode (frame used by TRX outside speech transmission phases).

Octet 4: Operation code for channel free frame:

{b_7 , ... b_0} = {0 0 1 0 0 0 0 0}

Octets 5 to 13: Data frame contents:

66 right-aligned bits:
{b_1, b_0} in octet 5 for FN for the 2 Flag Number (FN) bits described in PAS 0001-3-3 [6] ($b_0 = FN_0$, $b_1 = FN_1$) + octets 6 to 13;
+ 2 Associated Signalling Bits (ASB): {b_7, b_6} in octet 5, (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).
The different frame fields are defined in PAS 0001-3-4 [7].

INIT 6: Static fallback mode parameters.

Octets 4 to 13: BCH-CCH fallback mode start frame.

Octet 4: Operation code of BCH-CCH fallback mode frame:

{b_7 , ... b_0} = {1 0 0 0 0 0 0 0}

Octet 5 to 13: BCH-CCH fallback mode start frame contents.

66 right-aligned bits:
{b_1 , b_0} in octet 5 for FN for the 2 Flag Number (FN) bits described in PAS 0001-3-3 [6] ($b_0 = FN_0$, $b_1 = FN_1$) + octets 6 to 13;
+ 2 Associated Signalling Bits (ASB): {b_7, b_6} in octet 5, (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).

INIT N: ($7 \leq N \leq 22$) Static fallback mode parameters.

Octets 4 to 13: BCH-CCH fallback mode frame number (N-7)

Octet 4: Operation code of the BCH-CCH fallback mode frame:

{b_7 , ... b_0} = (N-7)

Octets 5 to 13: BCH-CCH fallback mode frame contents.

66 right-aligned bits: {b_1 , b_0} in octet 5 for FN for the 2 Flag Number (FN) bits described in PAS 0001-3-3 [6] ($b_0 = FN_0$, $b_1 = FN_1$) + octets 6 to 13
+ 2 Associated Signalling Bits (ASB) {b_7, b_6} in octet 5, (b_7: ASB Y, b_6: ASB X, see PAS 0001-3-3 [6]).

OPERE message

Octet 3: Information on the frame to transmit and instructions for the next received frame.

b_7 = Transmission power ON/OFF (1 = ON, 0 = OFF)
{b_6, b_5} Associated Signalling Bits (ASB) for the voice or data frame to transmit: (b_6: ASB Y, b_5: ASB X, see PAS 0001-3-3 [6]).
{b_4, b_3, b_2}: Demodulator instruction for the next received radio frame:
000: sliding window modem operating mode
001: Forced sliding window synchronisation selection mode.
010: fixed date synchronisation acquisition.
011: RACH frame reception.

{b_1, b_0}: type of frame to transmit
00: Voice frame
01: Data frames
1x: SCH/TI frame

Octets 4 to 18: Contents determined by frame type.

Voice frame:
120 bits in octets 4 to 18

Data frame:
66 right-aligned bits:
{b_1, b_0} in octet 10 FN + octets 11 to 18
{b_7, b_6} in octet 4: reserved
{b_3 , b_2 , b_1 , b_0} in octet 4: number of CCH fallback mode frame to use.
Dynamic parameters for fallback mode, TRX stores modified parameters in backed up memory.

SCH/TI frame:
16 bits:
octets 17 (most significant bit) and 18 (least significant bit),
bit b_7 in octet 17 is not significant.
The SCH/TI sequence contains the TTI address whose format is defined in PAS 0001-3-3 [6].

Octet 19: Transmission scrambling parameter from 0 to 127.

Octet 20: Reception scrambling parameter from 0 to 127 for the next received radio frame.

TESTEX message

Octet 3: Test number
0 None
N $N \neq 0$, test number N

Octets 4 to 20: Test parameters.

Test parameters can include information concerning the test mode.

DWLD_REQ message
Octet 3: Interface version number
{b_3, b_2, b_1, b_0} = system version number = default = 0

Octet 4: PCM time slot number
Coding: {b_4 , ... , b_0}: number from 0 to 31

Octet 5: Submultiplex number in PCM time slot
Coding: {b_1 , b_0} number from 0 to 3

BLOCK_DWLD messages
Octet 3: number of BLOCK_DWLD message, from 0 to 255.
Octet 4 to 20: 17 octets of the downloaded software.

DWLD_END message
None.

CONF_PAR messages
Octet 3: number of CONF_PAR message, from 0 to 255.
Octet 4 to 20: 17 octets of configuration parameters.

6.3.9.4. TRX to BSC messages information field

The information field contains:

- A status and management field: Octets 1, 2, 3, 4, 5;
- A message type field: Octet 5;
- A parameter field: Octets 6 to 23.

6.3.9.4.1. Status and management field

Octet 1: frame number from 0 to 199

Octet 2 and 3: System channel number

16 bits in octet 3 (most significant) and octet 4 (least significant). BSC generates an alarm if it receives a channel number different from the one conveyed in INIT 2 message.

Octet 4: Alarm state

b_7 = Alarm type:

0: hardware alarm
1: software exception

if b_7 = 1, {b_0..b_6} indicate the number of the software alarm defined for TRX. Number 0 is reserved for error indications in messages received from BSC.

if b_7 = 0, {b_0..b_6} indicate individual hardware alarm

0: Normal state
1: Alarm state

b_0 = Transmission synthesiser lock (maintained alarm)

b_1 = Reception synthesiser lock (maintained alarm)

b_2 = Power Amplifier temperature (maintained alarm)

b_3 = Output power (maintained alarm)

b_4 = Read/write problem in backed up memory (non maintained alarm)

b_5 and b_6 = not used

If a hardware alarm is encountered, software exceptions are not reported.

NOTE: Octets 2, 3 and 4 are not significant in BUSY messages.

Octet 5: Radio control status:

b_7: transmitter status

0 : Transmitter off
1 : Transmitter on

b_6: agile TRX capability

0: not agile
1: agile

{b_5 , b_4 , b_3}: TRX state

000: START
001: NOT INITIALISED
010: OPERATIONAL
011: ISOLATED CHANNEL
100: FALLBACK MODE
101: DOWNLOADING
110: BUSY
111: TEST

6.3.9.4.2. Message type field

Octet 5:

	b_2	b_1	b_0
WAIT	0	0	0
OPERR	0	0	1
DEINIT_ACK	0	1	0
DWLD_FRAME	0	1	1
TEST_BSC	1	0	0
BUSY	1	0	1

6.3.9.4.3. Parameter field

OPERR message

Octet 6: Frame type and quality

{b_6, b_5}: voice or data frame Associated Signalling Bits (ASB)

(b_6: ASB Y, b_5: ASB X, see PAS 0001-3-3 [6]).

b_4: demodulation quality or RACH selection

0: bad quality or demodulator is in synchronisation search state
1: good quality

b_3: RACH frame collision indicator (1 if collision, else 0), significant if bit b_4 = 0

{b_1, b_0}: frame type

00: voice
01: data
1x: RACH

{b_2, b_1}: demodulator state

00: synchronisation search
10: demodulation
x1: RACH

Summary:

b_4	b_2	b_1	b_0	
1	1	0	1	good data frame
1	1	0	0	good voice frame
1	x	1	x	good RACH frame
0	1	0	x	bad frame
0	x	1	x	bad RACH frame
0	0	0	x	synchronisation search

Octets 7 to 21: received radio frame (see PAS 0001-2 [8])

Speech frame: 120 bits in octets 7 to 21

Data frames:
66 right-aligned bits:
{b_1, b_0} in octet 13 FN + octets 14 to 21;
Reserved {b_7, b_6} in octet 7

RACH frame:
Coding 14 right-aligned bits
{b_5,..,b_0} as most significant bits in octet 20 + least significant bits in octet 21, corresponding to the 14 RACH access bits, see PAS 0001-3-3 [6].

Octet 22: Parameter x - Received power or maximum power between power levels received on the 2 receivers in case of antenna diversity, expressed in dBm, equals (-53 - x) dBm ± 3 dB, x varies from -2 to 127 (signed octet).

Octet 23: Decoding quality from 0 to 127, always valid.

DEINIT_ACK message

None.
The parameters are not significant.

TEST_BSC message

Octet 6: test number
0: Indicates no test or end of test
N ≠ 0: Test number acknowledgement message

BUSY message

None.
The parameters are not significant.

WAIT message

Initialisation message acknowledgements.
Is also used to send TRX module software and hardware version markers to BSC at regular intervals, regardless of WAIT frames numbers.

Octet 6: Number of last received initialisation message or 0 when the WAIT message is not returned in response to an initialisation message.

Octet 7: TRX downloading possibility and type of marker
b_7: Downloadable TRX

0: TRX isn't downloadable
1: TRX is downloadable

b_6: Request for configuration parameters

0: parameters aren't requested
1: parameters are requested

{b_5,..,b_0} type of marker
000000 : TRX hardware version marker (only for MC 9600 configuration)

000001 : FEPROM boot software version marker

000010 : nominal software version marker

Other values : not significant.

Octets 8 to 22 : marker according to type

Type 0 : hardware marker : 8 ASCII characters with following format :

Octet 8 : frequency band
« U » : UHF (380-512 Mhz)
« V » : VHF (reserved)

Octet 9 : frequency sub-band
« A » : variante A
« B » : variante B
« C » : variante C
« D » : variante D

Octets 10 to 11 : board hardware iteration identification
« 00 » : IT0
« 01 » : IT1
« 02 » : IT2
« 2A » : IT2 modified
« 03 » : IT3
« 04 » : IT4
« 05 » : IT5

Octets 12 to 13 : technical stage identification

Octets 14 to 15 : technical version identification

Types 1 and 2 : boot or nominal software version marker

Octet 8 : demodulation type (significant if type 2, not significant if type 1)
Octets 9 to 10 : technical stage identification
Octets 11 to 12 : technical version identification
Octets 13 to 14 : technical iteration identification
Octets 15 to 20 : date of generation DDMMYY
Octets 21 to 22 : hour of generation : HH

For downloading requirement, the TRX always sends the software 2 marking information in the WAIT 0 message.

DWLD_FRAME message

Octet 6: Message subtype:

	b2	b1	b0
BLOCK_DWLD _ACK	0	0	1
CONF_PAR_ACK	0	1	0
DWLD_REQ_ACK	0	1	1
DWLD_END_ACK	1	0	0

Octet 7: Number of last received message if the subtype is BLOCK_DWLD_ACK et CONF_PAR_ACK

6.3.10. Message Numbering

Each frame is assigned a modulo 200 number in the 4 second superframe, defined by HSX signal (see Clause 5). The BSC defines the number by selecting an arbitrary HSX phase relation. It is indicated in the state and management field of each BSC → TRX message in the BSC → RT direction.

When it detects a break in the sequence of frames, the signal processing unit compensates for this break with a one frame delay. When it does not receive any frame over a 20 ms period, the signal processing unit maintains the segment counter internally.

The segment numbers in the uplink direction are selected so that frames with identical numbers in each direction are present on the radio channel nearly simultaneously.

With regard to the HSX timing signal, this corresponds to message N leaving the BSC in the [FR1, FR2] submultiplex window, and message (N-4) leaving TRX in the [FT1, FT2] window for the first submultiplex, and without windows in other submultiplex.

More particularly the OPERE message (BSC → TRX) number N contains demodulation information for the RT → TRX radio segment N.

7. BS and external alarm interface

7.1. Purpose

The alarm interface takes place between the BSC and several pieces of alarm equipment. This equipment may be internal alarm equipment providing BS alarms or external equipment providing site level alarms.

7.2. Physical layer

The BS alarm link is a 0,3 to 9,6 Kbit/s asynchronous bi-directional point to multipoint link. The electrical specification shall be consistent with ITU-T V.11 / X.27 [3].

The junction circuits Tx and Rx are used.

The wiring scheme is given in figure 5.

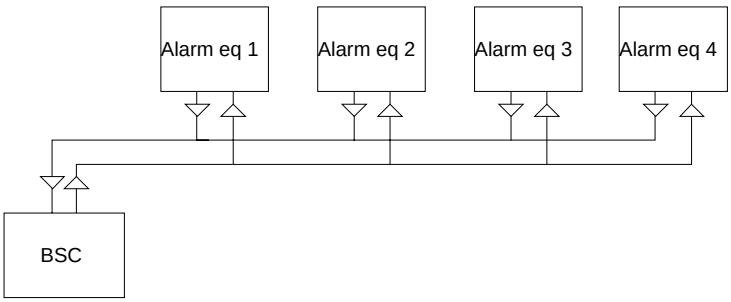


Figure 5: Alarm link wiring

7.3. Data link layer

7.3.1. Frame format

The character format shall be 8 bits, 1 start, 1 stop.

The least significant bit of a character shall be transmitted first.

The frame format is given in the figure 6.

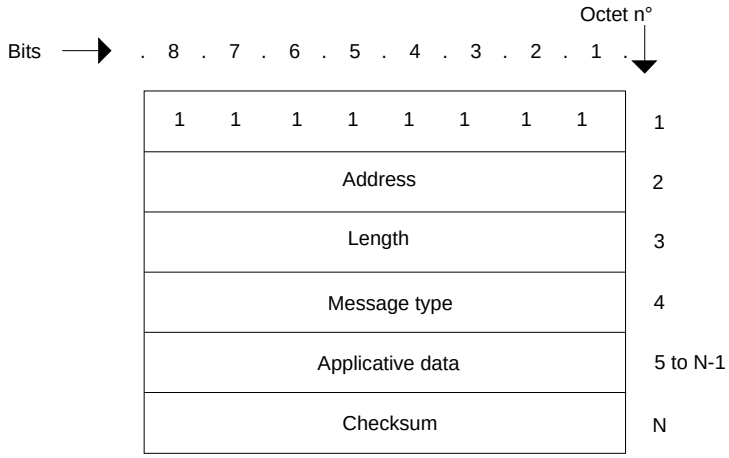


Figure 6: BS alarm interface frame structure

7.3.2. Information elements

The first octet of a frame shall be a frame alignment flag. All bits shall be set to 1 (Hexa value FF). All the other octets in the frame shall have the most significant bit set to 0 (Hexa values from 0 to 7F).

Address octet shall identify the multipoint address. It is the address of an alarm equipment. It is the destination address for a BSC polling message or the origin address for an answer message. It has the following value according to the equipment:

- Internal BS alarm equipment #1: 64; Hexa-value 0x40
- Internal BS alarm equipment #2: 65; Hexa-value 0x41
- Internal BS alarm equipment #3: 66; Hexa-value 0x42
- External additional alarm equipment #1: 32; Hexa-value 0x20
- External additional alarm equipment #2: 33; Hexa-value 0x21

The maximum number of internal alarm pieces of equipment of a BS is 3. The maximum number of external alarm pieces of equipment is 2.

In case of the one-board BSC, the maximum number of internal alarm pieces of equipement is 2, and the maximum number of Alarm board is also 2.

The one-board BSC uses the same interface and the same physical layer for the alarm link. Then the address octet for the alarm equipements has the following value:

- Internal BS alarm equipment #1: 64; Hexa-value 0x40
- Internal BS alarm equipment #2: 65; Hexa-value 0x41
- Alarm board #1: 32; Hexa-value 0x20
- Alarm board #2: 33; Hexa-value 0x21

Length octet shall give the frame length from length octet included (octet #3) to checksum octet included. The frame length value is comprised between 3 and 127.

Message type octet has the following value:

- 0: BS alarm polling from BSC;
- 1: BS alarm answer from BS;
- 2: reserved;
- 3: reserved;
- 4: reserved;
- 5: reserved.

Data octets: variable length data carrying applicative information, may be empty.

Checksum octet: the checksum is a bit-to-bit XOR computed from octet #2 (Address octet) to the last data octet.

7.3.3. Protocol

A flag octet (Hex FF) shall indicate the beginning of a frame. All previously received octets shall be ignored. If a frame is partially received when a flag is received, the incomplete frame shall be ignored and the flag shall initiate the reception of a new frame. This case may occurs if the length octet of a frame is corrupted.

During the reception of a frame, if an octet with the most significant bit set to 1 is received, the frame and all the octets received until the next flag shall be ignored.

A frame with an incorrect checksum shall be ignored.

The BSC shall poll successively all alarm pieces of equipment. The polling period is T1. The addressed equipment shall answer before a time out, the other pieces of equipment shall ignore the frame. The time out value is T2.

The BSC shall verify the address of the answering equipment. If the answering equipment address is different from the polled address, the frame shall be ignored by the BSC.

If a correct answer is not received at time out, the BSC shall keep on polling the equipment in its normal cycle.

7.3.4. Parameters

The timer values used in the protocol shall be customised.

T1: polling period of the BSC (typical value: [2s]).

T2: answer wait time out (typical value: [2s]).

7.4. Application layer

Each alarm message sent by an alarm equipment is carried in a unique frame of the data link layer.

Alarm information is carried in the data octets of the frame.

The alarms are provided under the form of a bitmap. Each bit indicates the state of the corresponding alarm.

The number of alarm equipment, the number of alarm per equipment and their signification depends on the architecture of the BS.

Internal alarms should apply to fan units, power converters, synchronisation equipment's, amplifiers, coupling units, Standing Wave Ratio (SWR), etc...

External alarms should apply to site alarms: intrusion, fire detection, air conditioning, etc...

History

Document history		
Date	**Status**	**Comment**
15 July 1996	Version 0.0.1	First version
31 July 1996	Version 0.1.0	Update following review
19 September 1996	Version 0.1.1	Precisions about alarm interface
11 October 1996	Version 0.1.2	BSC-TRX interface completed
15 November 1996	Version 0.1.3	Editorial. Version for review
25 November 1996	Version 0.1.4	External version for Acropol
16 December 1996	Version 0.1.5	External version for ITU
30 May 1997	Version 0.2.0	Update after review
27 july 1999	Version 0.2.1	Modification for downloading
26 august 1999	Version 0.2.2	Modification after review
18 November 1999	Version 0.2.3	Modification for one-board BSC
7 December 1999	Version 0.2.4	Modification after review
09 December 1999	Version 1.0.0	TETRAPOL TWG review
17 December 1999	Version 1.0.1	TETRAPOL TWG approval