BRITISH STANDARD

BS EN 50494:2007

Satellite signal distribution over a single coaxial cable in single dwelling installations

The European Standard EN 50494:2007 has the status of a British Standard

ICS 33.060.30; 33.160.01

British Standards

National foreword

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English version

Satellite signal distribution over a single coaxial cable in single dwelling installations

Distribution de signaux satellites
sur un seul câble coaxial
dans les résidences individuelles

Signalverteilung von Satellitensignalen
über ein einziges koaxiales
Kabelverteilnetz

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 206, Consumer equipment for entertainment and information and related sub-systems.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50494 on 2007-03-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2008-05-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2010-03-01

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Introduction

In EN 61319-1:1995 the interfaces for the control and command of the devices associated with the satellite receivers are described in the following clauses:

– Clause 4: Interfaces requirements for polarizer and polar switchers;

– Clause 5: Interfaces requirements for low-noise block converters (LNB).

In these clauses, analogue techniques are described for controlling the LNB and polar switchers.

In EN 61319-1/A11, the “Digital Satellite Equipment Control Bus” (called DiSEqC) is introduced as a single method of communication between the satellite and the peripheral equipment, using only the existing coaxial cables.

The purpose of this document is to introduce a complete system for distributing via a single coaxial cable signals issued from different bands and polarizations to several satellite receivers.

The presented system is intended for single dwelling installation (individual subscriber installations) but in Clause 9 of this document there is also described an optional extension for multiple dwelling installations.

The presented system is scaled for installations in which the number of demodulators is limited to a maximum number of 8 units per output of the Single Cable Interface (hereafter referred to as SCIF) device.

1 Scope

This European Standard describes:

– the system physical structure;

– the system control signals, which implement an extension of the DiSEqC set of commands described in the DiSEqC bus functional specification;

– the definition of identified configurations;

– management of the potential collisions in the control signals traffic.

Figure 1 illustrates the physical system configuration considered in this European Standard.

Several satellite signal demodulators can receive signals from any of the input signal banks of the LNB or the switch; the signals selected by the demodulators (or receivers) are transported via a single cable to these demodulators (receiver 1, receiver 2, receiver N).

To achieve these single cable distributions, the Single Cable Interface (SCIF) (likely embedded in a LNB or a Switch) features some specific functions and characteristics.

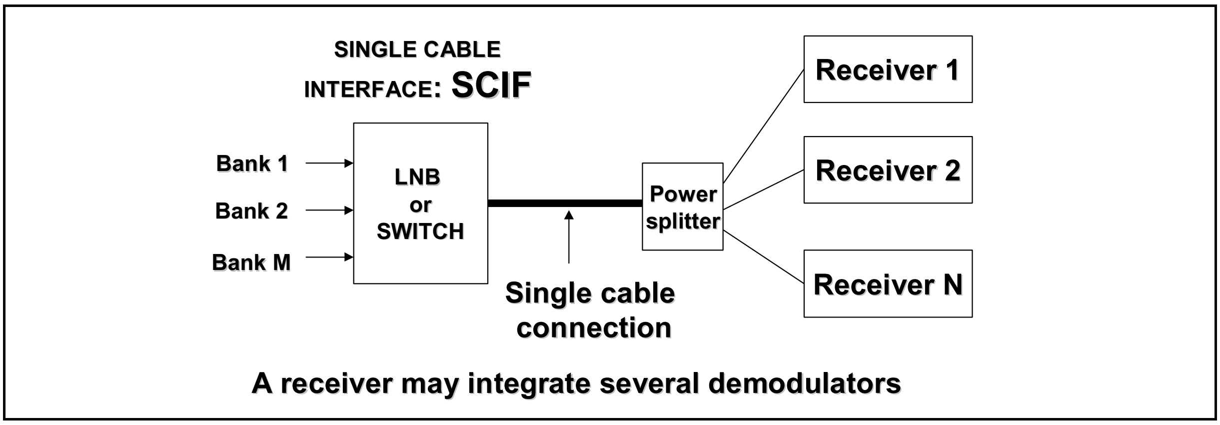

Figure 1 – General architecture of the single cable distribution

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50083-4	Cable networks for television signals, sound signals and interactive services – Part 4: Passive wideband equipment for coaxial cable networks
EN 61319-1:1996 + A11:1999	Interconnections of satellite receiving equipment – Part 1: Europe (IEC 61319-1:1995)
EN ISO/IEC 13818-1	Information technology – Generic coding of moving pictures and associated audio information – Part 1: Systems (ISO/IEC 13818-1)

"DiSEqC™" Bus Functional Specification Version 4.2, February 25, 1998
http://www.eutelsat.com/satellites/4_5_5.html

3 Acronyms and definitions

3.1 Acronyms

CW	Continuous Wave
DiSEqC	Digital Satellite Equipment Control
LNB	Low Noise Block
LUT	Look-up Table
MDU	Multiple Dwelling Unit
MSB	Most significant bit
ODU	Out-door Unit
PCR	Program clock reference
PWK	Pulse Width Keying
SCIF	Single Cable Interface

SDU Single Dwelling Unit

UB User Band

3.2 Definitions

3.2.1
bank
group of contiguous channels belonging to a polarization and or a band

3.2.2
channel
radio frequency transponder signal

3.2.3
demodulator
electronic device integrating at least a tuner and a demodulator

3.2.4
receiver
electronic equipment embedded in a cabinet and integrating all functions for demodulating and decoding the received satellite signals, a receiver may integrate several demodulators

3.2.5
universal LNB
LNB with the following characteristics: operation in the Ku bands (10,7 GHz → 12,75 GHz); local oscillator frequency is 9,75 GHz for signal frequencies lower than 11,7 GHz and local oscillator frequency is 10,6 GHz otherwise

4 System architecture

In the single coaxial cable distribution system, the bandwidth of the shared coaxial cable is divided into slots (user band: UB). The number of slots Nb_ub varies from one application to another; the number of slots Nb_ub is a characteristic of the SCIF.

The system defined in this standard limits the number of UB slots to 8 (eight) per output of the SCIF.

Each demodulator connected to the single coaxial cable distribution is allocated a UB slot; this allocation is done either in static or other modes.

– Static mode: the allocation of the UB slot is done during the installation of the satellite receiver. Only the static mode is considered in this document.

– Other modes are not described in this document but could be considered in a further release or annex of this document.

After the slot allocation, the tuner of the receiver operates at a single frequency (centre of the slot UB). To select a desired channel (frequency Fd) the demodulator sends a SCIF control signal that provides the following information:

– select the bank (band, feed, polarization) that carries the desired signal.

– select the frequency (Fd) of the desired signal.

– designate the UB slot on which the desired signal is expected.

Figure 2 illustrates the frequency mapping for such a single coaxial cable system.

Figures 3, 4, and 5 illustrate various examples for implementing the single cable distribution system (other application scenarios are possible).

– Figure 3: a single coaxial cable distribution is implemented between a LNB and two demodulators.

– Figure 4: a single coaxial cable distribution is implemented between a double feed LNB and a set of 4 demodulators.

– Figure 5: In an installation that shall serve more than 8 demodulators, a SCIF device with several outputs (Out) is implemented; each output can serve a maximum number of demodulators (Nb_ub). In the illustrated example, there are 2 outputs, each output can serve up to 6 demodulators, the output Out 2 could serve two additional demodulators before reaching the limit of the installed hardware.

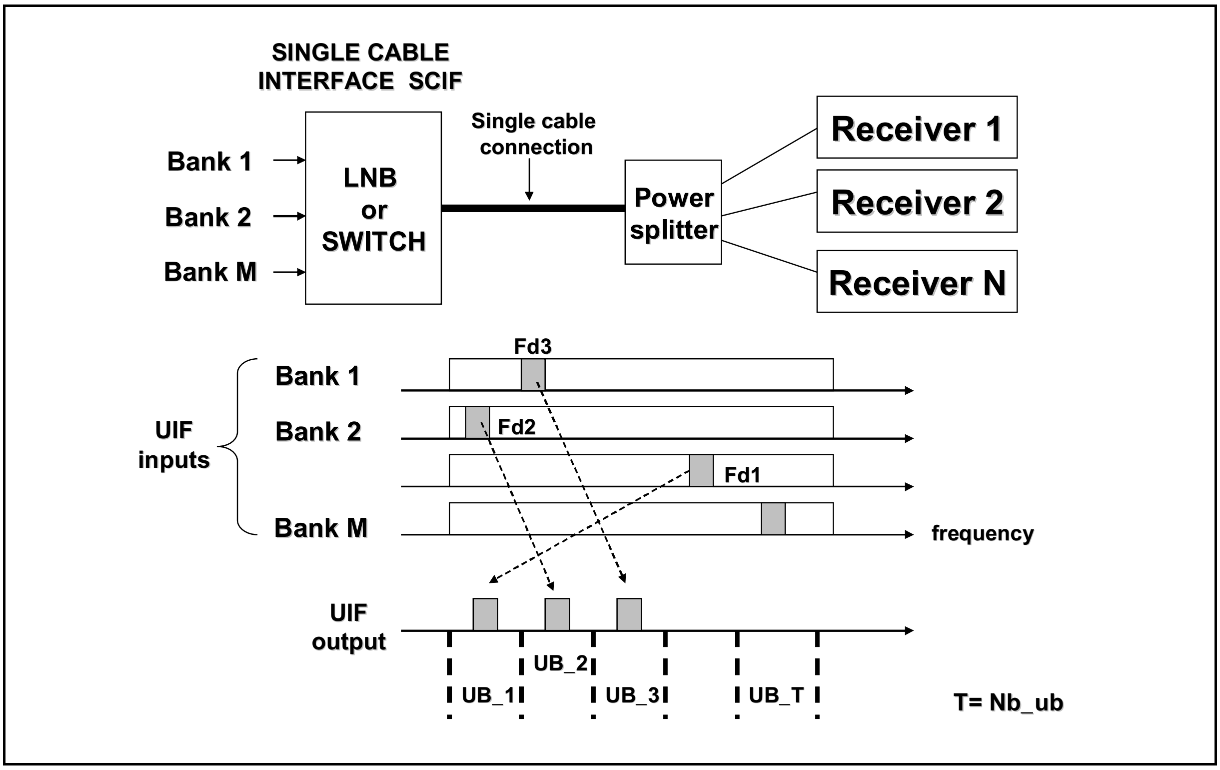

Figure 2 – General system operation and UB slot frequency mapping

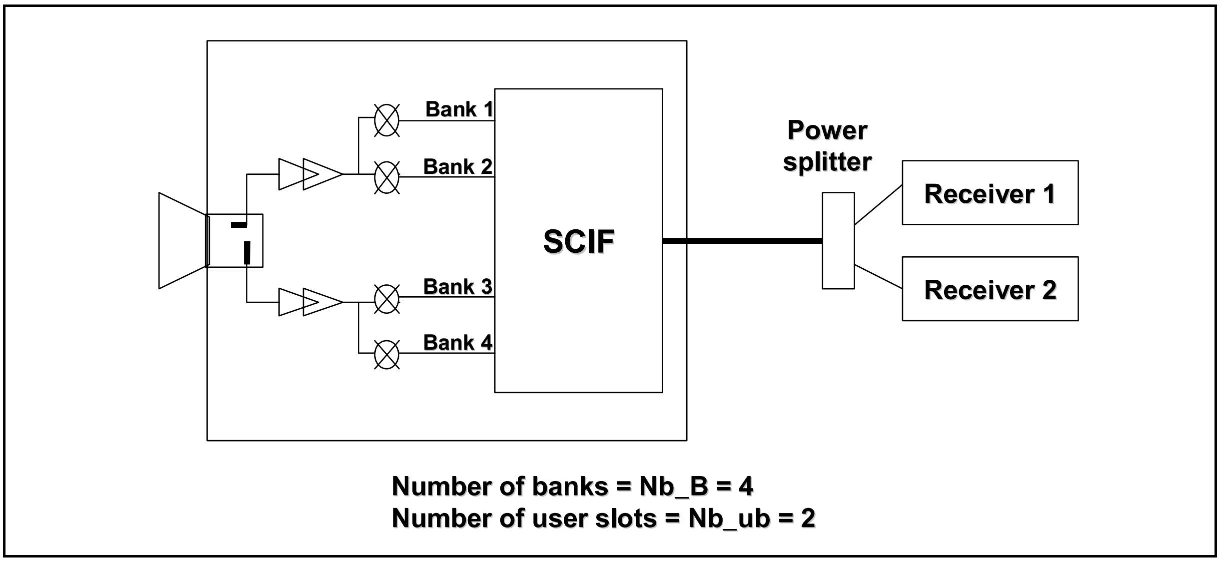

Figure 3 – Installation example, system with two UB slots

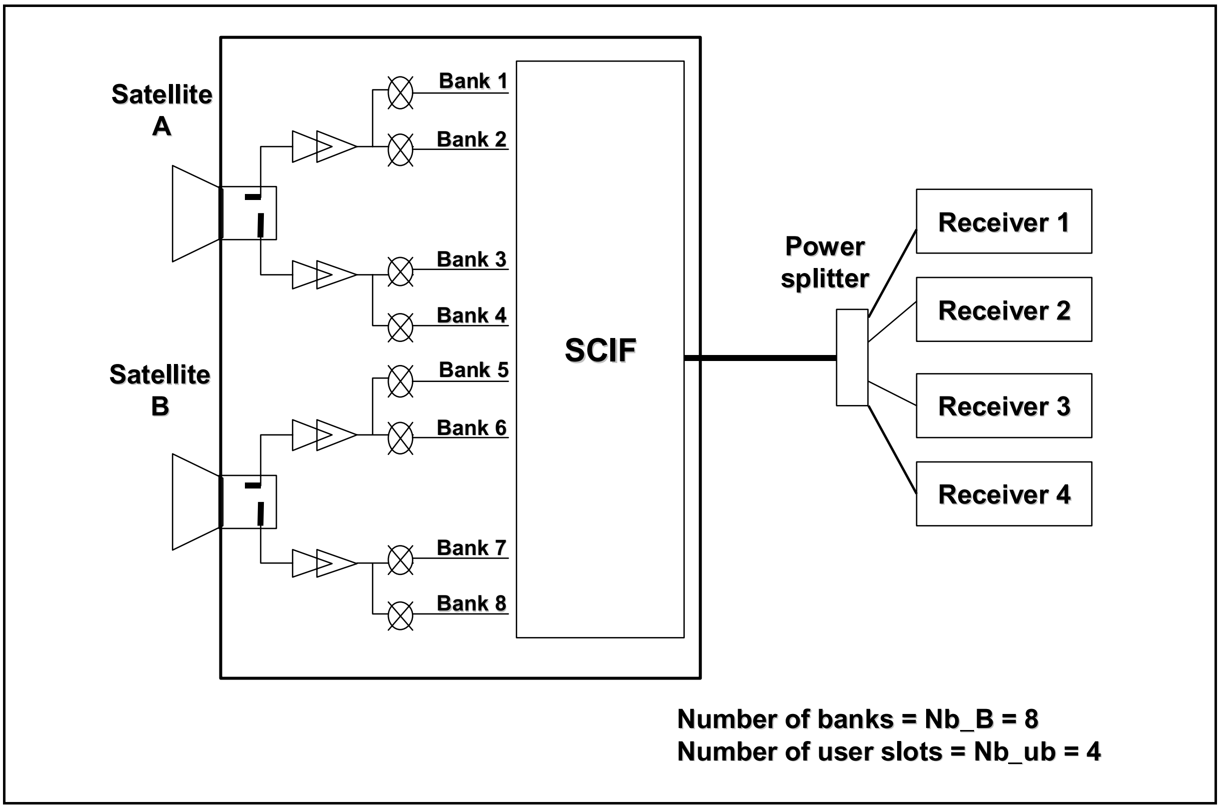

Figure 4 – Installation example implementing a monobloc LNB with four UB slots

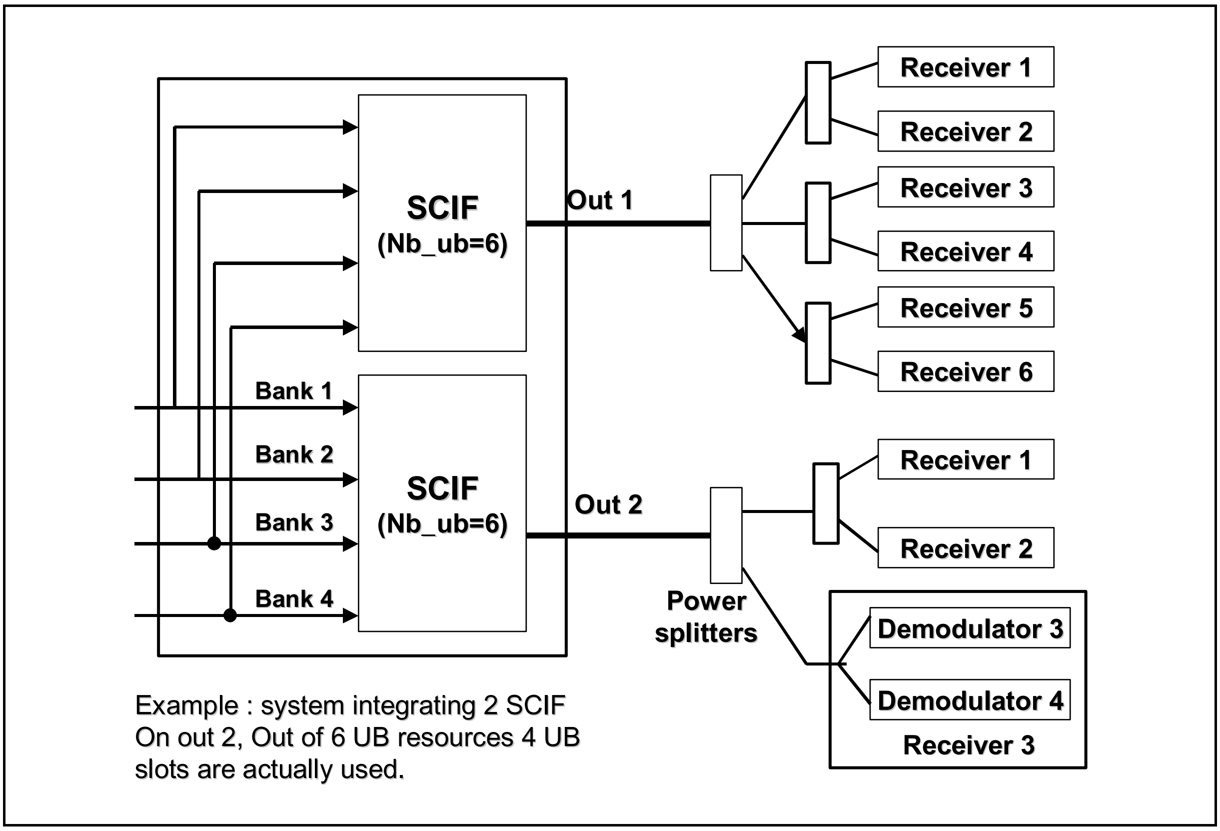

Figure 5 – Example of a switcher with two outputs serving six UB slots each

5 SCIF control signals

5.1 DC levels

In a single coaxial cable distribution system, all controls issued by the receivers (demodulators) are done according to the DiSEqC format.

The single coaxial cable distribution system is not backwards compatible with the former 13/18 V control associated with a continuous 22 kHz tone. The single coaxial cable distribution system is also not backwards compatible with the tone burst signalling.

In single coaxial cable distribution systems, the signal-sending receiver generates a high DC level upon which the DiSEqC control signals are added. After sending the DiSEqC control signal the receiver returns to an idle mode in which it generates a low DC level onto the single cable distribution system (refer to Figure 6). With reference to EN 61319-1, the low and high DC level shall have the following limits on the signal-sending- receiver side:

– LOW _DC value: 12,5 V to 14 V

– HIGH_ DC value: 17 V to 19 V

The delays (td & ta) shall have the following limits:

– td_{min} > 4 ms and td_{max} < 22 ms

– ta_{min} > 2 ms and ta_{max} < 60 ms

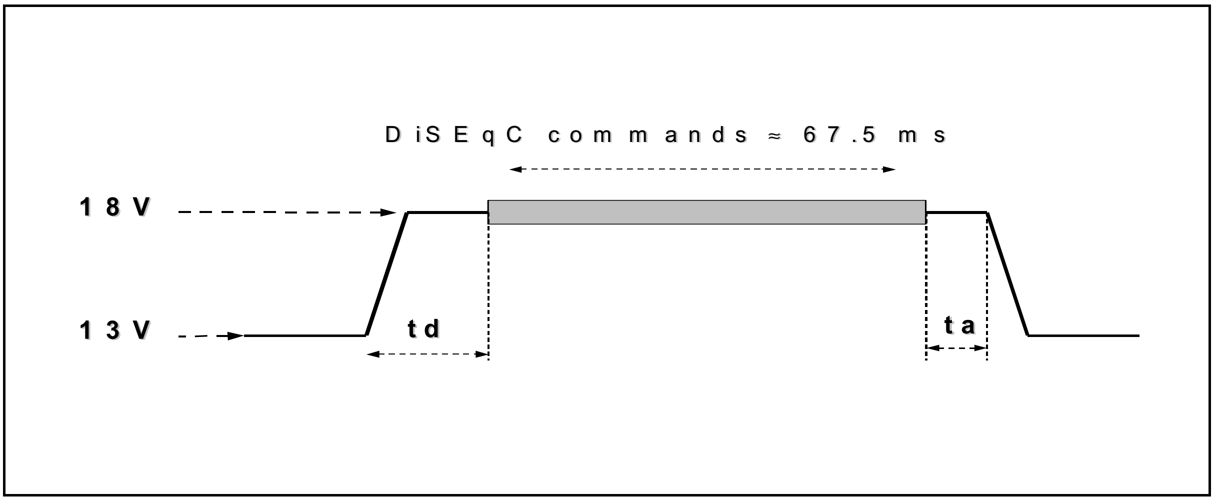

Figure 6 – Outlines of the signal sent by the receiver

The hardware of the communication bus has to be realized according to the DiSEqC bus functional specification. Some additional care shall be taken to ensure an appropriate impedance of the installation during the DiSEqC sequences. In Annex A implementations are suggested.

5.2 Method of the data bit signalling

DiSEqC uses base-band timings of 500 µs (+/- 100 µs) for a one-third-bit PWK coded signal on a nominal 22 kHz (+/- 4 kHz) carrier. See DiSEqC bus functional specification and EN 61319/1996/A11:1999.

Figure 7 shows the 22 KHz time envelop for each bit transmitted, with nominally 22 cycles for a bit “0” and 11 cycles for a bit “1”.

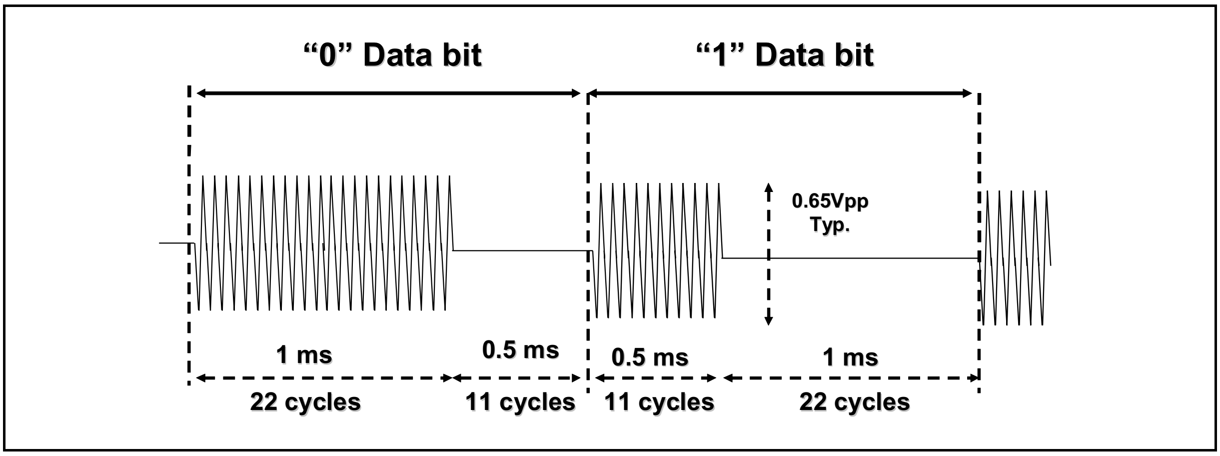

Figure 7 – Bit signalling according to DiSEqC format

5.3 Structure of the DiSEqC message in the single coaxial cable system

The structure of the message sent by the receiver to the SCIF is described in Figure 8.

Each message contains 5 bytes of 8 data bits each, an odd parity bit is added to each byte. A byte has a typical duration of 13,5 ms; the 5 bytes message lasts 67,5 ms.

The length of the DiSEqC control sequence is limited to 5 bytes for minimizing the traffic and consequently the risk of collisions.

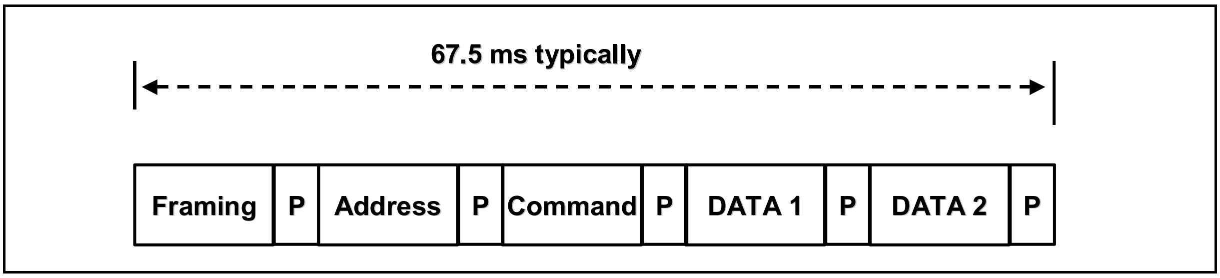

Figure 8 – DiSEqC command structure

IMPORTANT NOTE 1: For compatibility reasons concerning MDU extension (see Clause 9), SCIF devices without MDU option are not required to detect but have to tolerate other command structures (concerning command length and sequence of different bytes).

IMPORTANT NOTE 2: The SCIF devices are not required to detect but have to tolerate other command structures (e.g.: tone burst control) that would follow the 5 bytes command structure described in this section; in this case a minimum duration higher than the above specified “ta“ shall be respected between the SCIF control command and these added commands.

6 Structure and format of the DiSEqC messages

6.1 DiSEqC addressesl

FRAMING

In order to minimize the overall DiSEqC signal traffic, the single coaxial cable distribution commands only use the framing word **E0h** (command from master (receiver), no reply required, first transmission).

ADDRESS: the following addresses are recognized by the SCIF: 00h, 10h, and 11h.

COMMAND: the following command values are implemented: 5Ah and 5Bh.

All DiSEqC sequences used in the single coaxial cable distribution include two data bytes: Data 1 and Data 2.

6.2 Normal operation

This subclause defines the DiSEqC control sequences used during normal operation of the system; the control signals of this subclause implement the command value: 5Ah.

Two control sequences are defined during normal operation:

– ODU_Channel_change;

– ODU_PowerOFF.

The support of the two above commands is mandatory for all SCIF compatible equipment.

6.2.1 ODU_Channel_change

ODU_Channel_change: the receiver sends this command when tuning to a (new) channel is required.

ODU_Channel_change format:

E0h	00h or 10h or 11h	5Ah	Data 1	Data 2

Data 1 format

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
UB [2:0]			Bank [2:0]			T [9:8]	

Data 2 format

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
T [7:0]							

– UB [2:0] bits select the slot on which the desired signal is expected (Table 2)

– Bank [2:0] bits select the signal bank which carries the desired channel (Table 3)

– The T[..] word is the tuning word calculated by the receiver.

$$T = round\ \left(\left(abs(F_T - F_O) + F_{UB} \right) / S \right) - 350$$

where

- T = decimal value of the tuning word T[..]
- F_T = transponder frequency in MHz (e.g. 12 515,25).
- F_O = Oscillator frequency of the 1st conversion stage of the LNB (in switch application, F_O is also the oscillator frequency of the 1st conversion stage of the LNB which generates the signal of the desired bank).
- F_{UB} = desired UB slot centre frequency in MHz (e.g. 1 632).
- S = coding step size. Actual value 4 MHz (high step size is needed for minimizing the length of the T[..] word).
- 350 = constant value used to further compress the T[..] word.

IMPORTANT NOTE: Since the tuning word is entirely calculated by the demodulator, the rounding effects induced by the coding step size can be fully predicted and then fully compensated. During the channel acquisition the frequency search range remains unchanged compared with conventional solutions. In A.4, some explanation and suggestions are given to better exploit the calculated tuning word.

6.2.2 ODU_PowerOFF

ODU_PowerOFF: the receiver sends this command as soon as the corresponding demodulator is turned-OFF, in doing so both power is saved and an UB resource can be released.

E0h	00h or 10h or 11h	5Ah	Data 1	Data 2 =**00**

Data 1

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
UB [2:0]			0	0	0	0	0

The UB [2:0] bits select the UB slot that shall be turned OFF.

6.3 Special modes

This subclause defines the DiSEqC control sequence used during special modes of the system; the control signals of this subclause use the command value: 5Bh.

A wide variety of special operation modes can be foreseen:

– installation mode;

– operation mode compatible with professional installation equipment;

– dynamic allocation of the UB slots, etc.

This document only deals with the installation mode; further extension could integrate functions required by other special modes.

6.3.1 Installation, SCIF parameters recognition

To operate in a single coaxial cable operation, the receivers need to identify several parameters of the SCIF to calculate the tuning word and to position the tuner at the right frequency.

The parameters absolutely needed by the receiver to select desired channels are:

F_O	Local oscillator frequency of the LNB or of the LNB generating a bank.
F_{UB}	The centre frequency of the UB slot allocated to the receiver.
S	Coding step size of the channel, value actually frozen at 4 MHz

6.3.1.1 Automatic installation with the RF tone signalling method

This subclause describes the procedure and the DiSEqC control sequences required for implementing an automatic recognition of the parameters of the SCIF.

Principle:

By means of specific DiSEqC commands each receiver can interrogate the database of the SCIF device. The “interrogation” messages carry three pieces of information:

– the UB slot on which the answer is expected (UB [2:0]);

– the type of information that is checked (Sub-function [4:0]);

– a number that is compared with a value stored in the database of the SCIF: LUT [7:0].

The SCIF device answers to the request by generating a RF tone (CW).

– The answer is "YES" when the information in Data 2 matches with the similar data stored in the database of the SCIF. In case of "YES" answer, the frequency of the RF tone matches with the centre frequency of the UB slot.

– The answer is NO as long as the Data 2 value does not match with the value stored in the SCIF database. In case of "NO" answer, the frequency of the RF tone is 20 MHz above the UB centre frequency. As long as the answer is NO, the receiver increments its pointer in the look-up table of interest.

In this European Standard three such system parameter recognition commands are defined:

– ODU_UBxSignal_ON;

– ODU_Config;

– ODU_LoFreq.

These commands respect the following format:

E0h	00h or 10h or 11h	**5Bh**	Data 1	Data 2

Data 1

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
UB [2:0]			Sub function [4:0]				

Data 2

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
LUT [7:0]							

The list of the commands required in the automatic installation with the RF tone signalling method is given in Table 1.

Table 1 – Automatic installation sub-functions

System function	**DATA 1**		**DATA 2**	**SCIF action**
	UB [2:0]	Sub-function [4:0]	LUT [7:0]	
ODU_UbxSignal_ON	= 00h	= 00h	= 00h	Generates a tone at each UB slot centre frequency
ODU_Config	UB	= 01h	Config_Nb	Generates a RF tone answer in the slot defined by UB [2:0]
ODU_LoFreq	UB	= 02h	LoFreq	Generates a RF tone answer in the slot defined by UB [2:0]
Not yet defined	UB	03h → 1Fh	Not yet defined	Not yet defined

ODU_UBxSignal_ON: On the receiver side the implementation of the function is processed differently, no look-up table is checked.

6.3.1.2 Installation with manual entry of the system parameters

All receivers compatible with the single coaxial cable distribution shall also feature an installation mode in which the end-user can manually enter the system parameters:

– UB number and corresponding centre frequency in MHz. All the local oscillator frequencies of the installation (e.g. 9 750 MHz and 10 600 MHz).

To be able to implement this manual entry, the system parameters shall be made available to the end-user by the SCIF makers (e.g. label on the SCIF case).

6.3.2 ODU_UBxSignal_ON

Upon this command, the SCIF device generates a RF tone at the centre frequency of all the UB slots available on the cable served by the SCIF (Figure 9).

With a proper RF power detection routine (RF scanning) using the receiver tuner, the receiver can identify the centre frequency of each UB slots, and also identify the number of UB slots served on the cable. After processing the ODU_UBxSignal_ON function, the receiver can use one of the identified UB slots as feedback channel for the other functions such as ODU_Config or ODU_LoFreq.

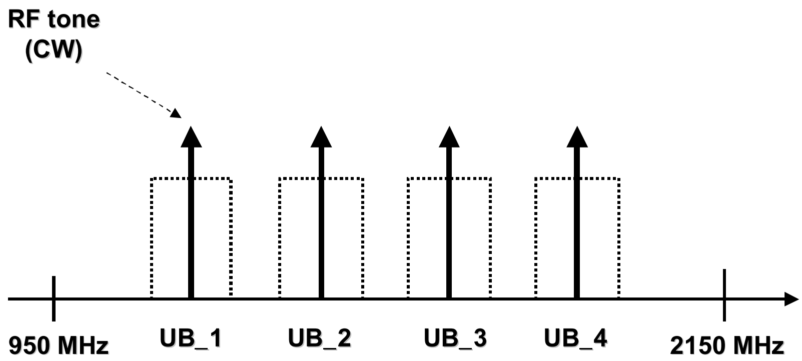

Figure 9 – Example of signal structure delivered by the SCIF featuring four UB slots after an ODU_UBxSignal_ON

IMPORTANT NOTE: The reliability of the RF tone signalling method directly depends on a proper recognition of the UB slot number (see Table 2). For ensuring a certain level of reliability it is required to implement the following check in the automatic installation software procedure of the receiver:

In order to check if the detected tone is not of parasitic nature, every signal detected by the RF scanning procedure shall be tentatively turned OFF with an ODU_Power_OFF command. For safe operation, the check routine shall test all possible values of the UB [2:0] field of the ODU_Power_OFF command (per default 8 tests per signal detected by the RF scanning procedure). In A.5, some implementation guidelines are provided.

6.3.3 ODU_Config

The purpose of the ODU_Config command is to identify useful parameters of the installation and of the SCIF device.

The identification is done in the following way: the receiver scrolls down an ODU_Config command (Table 4), if the Config_Nb value sent in data 2 matches with the SCIF configuration, the SCIF device responds with a RF tone at the centre frequency of the UB slot defined in the ODU_Config request, in the opposite case the RF tone is 20 MHz above the UB slot centre frequency. The process is stopped when the SCIF device responds with a “positive” answer.

EXAMPLE ***E0h 10h 5Bh 41h 13h***; the receiver checks if the installation configuration number is 13, the RF answer of the SCIF device is expected on UB slot 2.

The system is based on look-up tables, so that Config_Nb define many parameters. Table 4 gives the defined configurations.

The Config_Nb values from 00h to 0Fh are reserved. Config_Nb value = FFh will never match with an actual configuration of the SCIF, and thus can be used by the receiver to force a NO answer.

6.3.4 ODU_LoFreq

The purpose of the ODU_LoFreq command is to identify the value of the local oscillator frequency used in the LNB of the installation; in practice the number of local oscillators is reduced to one or two values per installation.

The ODU_LoFreq command is processed in a similar way as ODU_Config. Tables 5 and 6 are the relevant look-up tables.

By combining an ODU_LoFreq and an ODU_Config function the receiver can identify all necessary parameters of the SCIF.

By combining an ODU_UBxSignal_ON and an ODU_LoFreq command, the receiver can identify the parameter at least required to operate a channel change operation.

NOTE The SCIF devices embedded in switches are also required to answer to the ODU_LoFreq command.

7 Look-up tables and conventions

7.1 UB slots numbering

Table 2 describes the numbering order of the UB slots.

Table 2 – UB slot numbering

UB slot	UB[2:0]
UB_1	00h
UB_2	01h
UB_3	02h
UB_4	03h
UB_5	04h
UB_6	05h
UB_7	06h
UB_8	07h

Definition: UB_1 features always the lowest centre frequency among the slots available in the system, UB_2 the second lowest and so forth.

The centre frequency of the UB slots shall respect the following limits: 950 MHz F_{UB} 2 150 MHz.

7.2 Input banks numbering

Table 3 – Input bank numbering

Bank [2:0]	Satellite	LNB
00h	Position A	Low band / vertical polarization
01h		High band / vertical polarization
02h		Low band /horizontal polarization
03h		High band / horizontal polarization
04h	Position B	Low band / vertical polarization
05h		High band / vertical polarization
06h		Low band /horizontal polarization
07h		High band / horizontal polarization

NOTE In wide band applications, the low and high bands are merged into a single wide band, the SCIF equally decodes the values Bank[2:0] = 2n and Bank[2:0] = 2n+1 (e.g. Bank[2:0]=02h and Bank[2:0]=03h, both values mean: satellite position A, horizontal polarization).

In systems supporting a single satellite position, the SCIF equally decodes the values Bank[2:0]= m and Bank[2:0]= m+4 (e.g. Bank[2:0]= 02h and Bank[2:0] = 06h mean: Low band horizontal polarization).

7.3 Config_Nb table

Table 4 – Config_Nb table

Data 2 [7:0] Config_Nb	Number of satellite positions	Number of input banks	Standard (S) or wide band (WB) RF	Number of UB slots
00 → 0F	Reserved			
10h	1	4	S	2
11h				4
12h				6
13h				8
14h		2	WB	2
15h				4
16h				6
17h				8
18h	2	8	S	2
19h				4
1Ah				6
1Bh				8
1Ch		4	WB	2
1Dh				4
1Eh				6
1Fh				8

Config_Nb = FFh will never match with an actual configuration of the SCIF, and then it can be used by the receiver to force a NO answer.

7.4 LoFreq table

Table 5, which specifies the local oscillator frequency in standard RF, is compatible with the one given 9.6 of the DiSEqC bus functional specification.

Table 5 – Local oscillator frequency (LO) table in Standard RF (Conventional RF)

Local oscillator frequency	Data 2 [7:0]= LoFreq
None (switcher)	00h
Unknown	01h
9 750 MHz	02h
10 000 MHz	03h
10 600 MHz	04h
10 750 MHz	05h
11 000 MHz	06h
11 250 MHz	07h
11 475 MHz	08h
20 250 MHz	09h
5 150 MHz	0Ah
1 585 MHz	0Bh
13 850 MHz	0Ch
Not allocated	0Dh.. 0Fh
Wide band Look-up table (Table 6)	10h.. 1Fh
Not allocated	20h .. FFh

LoFreq value = FFh will never match with an actual configuration of the SCIF, and thus can be used by the receiver to force a NO answer.

Table 6 gives an extension of the local oscillator frequency in wide band applications.

Table 6 – Local oscillator frequency (LO) table in Wide band RF

Local oscillator frequency	Data 2 [7:0]= LoFreq
None (switcher)	10h
10 000 MHz	11h
10 200 MHz	12h
13 250 MHz	13h
13 450 MHz	14h
Not allocated	15h .. 1Fh

<u>Case of Ku band LNB using LO frequencies listed in Tables 5 & 6</u>

The Ku band LNB (SCIF) that use LO frequencies listed in either Tables 5 and 6 are allowed to operate according to two different modes: Direct mode or Universal LNB emulation mode. The operating mode is defined by the firmware of the SCIF.

– Direct mode: In this case the SCIF responds to an ODU_LoFreq command with an answer that ***directly*** matches with the LO frequency actually implemented in the SCIF (example: a wide band LNB with a 10,2 GHz LO and operating in ***direct mode*** responds YES only when Data2 = 12h).

– Universal LNB emulation mode: In this case the SCIF responds to an ODU_LoFreq command with answers that emulate an Universal LNB (example: a wide band LNB with a 10,2 GHz LO and operating ***Universal LNB emulation mode*** responds YES only when Data2 = 02h and 04h).

  - The firmware of this type of LNB shall retrieve the desired signal centre frequency according to the tuning word calculation method described on ODU_Channel_Change (6.2.1).

  - For software consistency reasons it is required that this type of LNB responds to the ODU_Config commands with values ranging either from 10h to 13h or 18h to 1Bh.

<u>Case of Ku band LNB using LO frequencies not listed in Tables 5 & 6</u>

Ku band LNB (SCIF) that uses LO frequencies not listed in Tables 5 & 6 shall operate in ***Universal LNB emulation mode***, independent to their actual LO frequencies. Very precisely this type of LNB shall answer “YES” to ODU_LoFreq commands with Data 2 = 02h and 04h.

The firmware of this type of LNB shall retrieve the desired signal centre frequency according to the tuning word calculation method described on ODU_Channel_Change (6.2.1).

For software consistency reasons it is required that this type of LNB responds to the ODU_Config commands with values ranging either from 10h to 13h or 18h to 1Bh.

8 Traffic collision management rules

The single coaxial cable installation actually implements a multi-master to one slave architecture, therefore collisions may happen between DiSEqC control sequences issued by different receiver units.

When a collision event happens, the SCIF cannot decode any of the conflicting DiSEqC control sequences; this means that the DiSEqC control sequences are not processed.

The following descriptions specify the operating mode in case of DiSEqC signals collision.

Each of the conflicting receivers detects the failure of its DiSEqC control sequence. The DiSEqC control sequence is repeated after a random delay. In case of subsequent collisions the DiSEqC control sequence is repeated up to 4 times (5 attempts including the initial sequence). In the very unlikely occurrence of 5 subsequent collisions, the mechanism is stopped and the repeat operation is left to the end-user (Figure 10). Timer controlled processes are allowed to repeat up to 7 times (including the initial sequence).

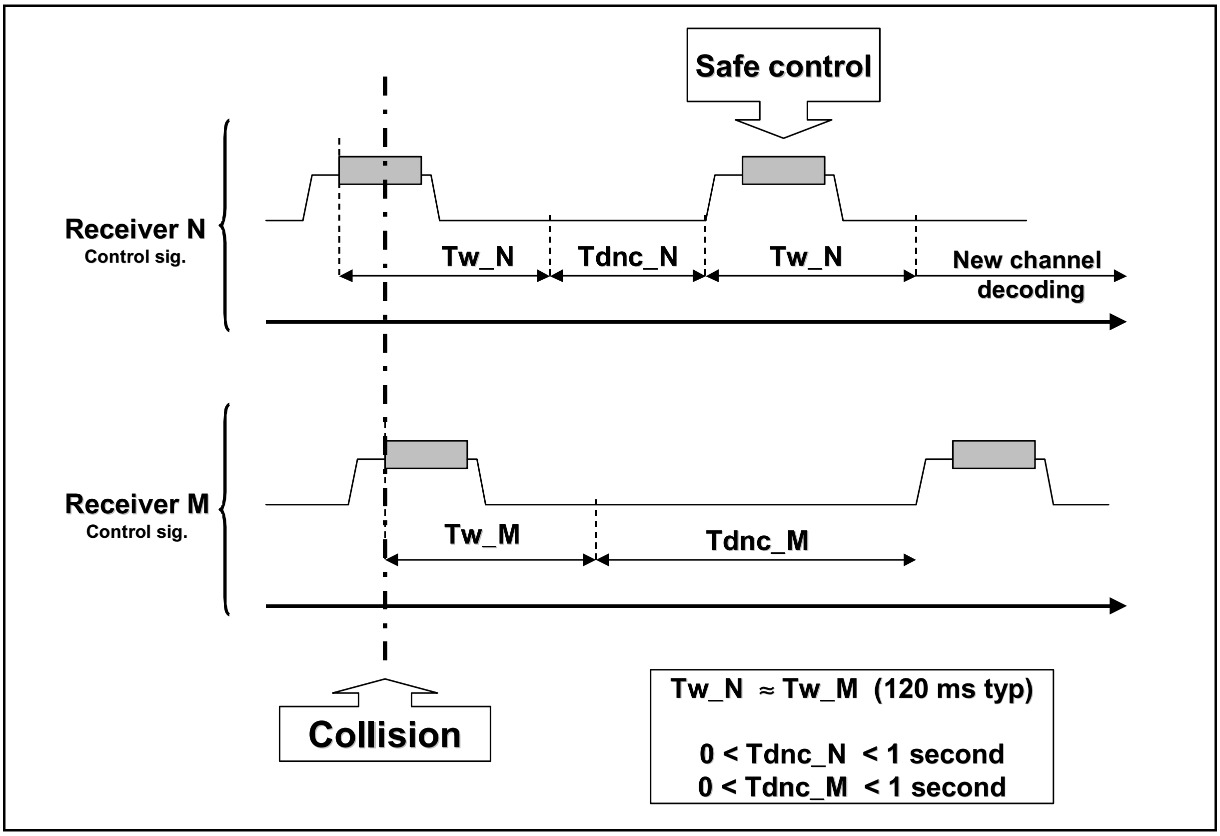

Figure 10 – DiSEqC command collision between two receivers and recovery system

Automatic detection of DiSEqC control sequence failure

In case of DiSEqC sequence failure, the transport stream being decoded remains unchanged; this situation can be detected after a delay Tw (Twait) by different methods.

1. The absence of corrupted packet after the DiSEqC control sequence; this detection is operated at the demodulator level. Tw_max= DiSEqC sequence duration +10 ms.

2. Continuity in the PCR counter; this detection is operated in the low-level software drivers of the demultiplexer. For details, see EN ISO/IEC 13818-1. Tw_max = DiSEqC sequence duration + 200 ms (PCR is refreshed every 100 ms).

3. Continuity in the transport_stream_id value. Tw_max = DiSEqC sequence duration + 1 000 ms (500 ms maximum duration between SI information carrying the transport_stream_id).

Each of the aforementioned method can be used alone or in combination with another for double check procedure.

Random delay generation law

After detection of the DiSEqC control sequence failure, the receiver waits for a random duration period of time Tdnc (T delay new control) before generating a new DiSEqC control sequence (Figure 11).

– Tdnc = $(P/ 2^{10})$, value in seconds.

– P: decimal value of the shift register generated by the polynomial generator $X^{10}+X^3+1$. The MSB of the P word is the left most bit of the shift register.

- At power ON, the shift register associated to the demodulator assigned to the user band UB is preset as following
  - P[7:10] = UB+1
  - P[2:5] = UB+1
- P is shifted by one step at each ODU_Channel_Change.
- In case of collision, the shift register associated to the demodulator is preset in the same way as at power ON, and then is shifted 3 times.

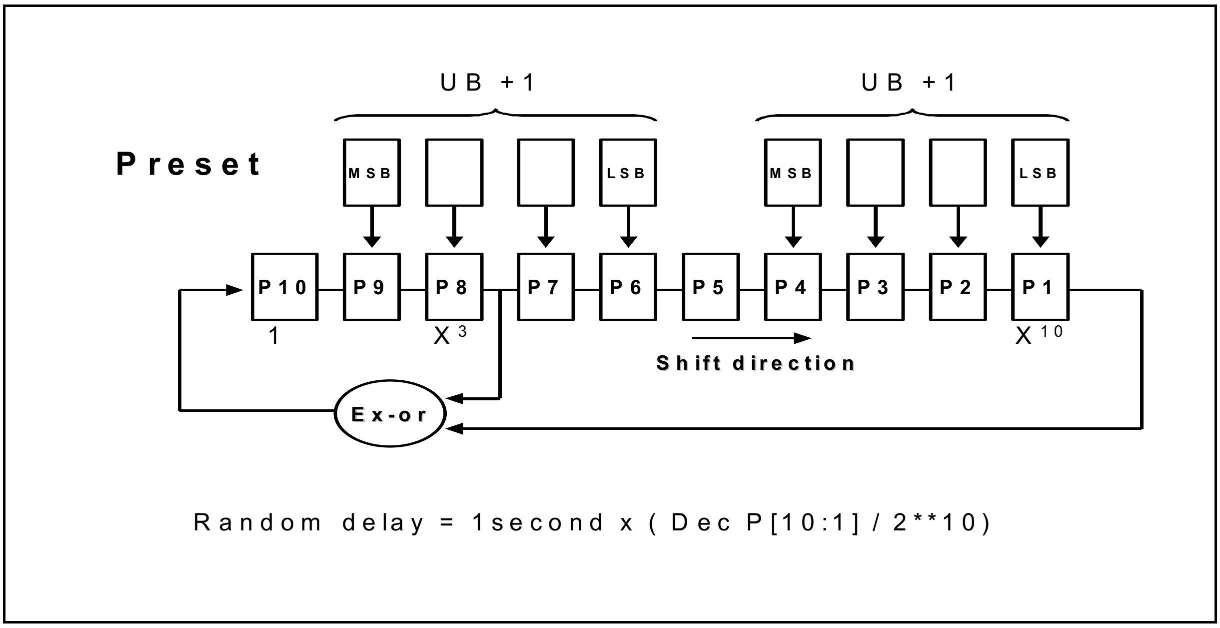

Figure 11 – Pseudo random delay generation for the repeat operation

9 Optional extension of the single cable distribution to the multi-dwelling installations

9.1 Extension for multi-dwelling installations

Single dwelling installations are individual subscriber installations like family systems where all Set-Top-Boxes are in the hand of one user or user group (family). Multiple dwelling installations are community installations of different user groups, which especially require additional measures to avoid disturbances among the users. This particularly relates to a fixed pairing of UB slot and user by a PIN code.

The extension for multi-dwelling installation is based on the same system as single dwelling installations. Therefore in this clause only the specific extensions for multi dwelling installations are described.

Also it is mandatory that SCIF´s and Set-Top-Boxes where the extensions for multi dwelling installations are implemented according to this clause shall completely remain backwards compatible for single dwelling installations as described in Clause 1 to Clause 8.

9.2 Extensions for structure and format of the DiSEqC messages

The command structure is extended by one byte end therefore is 6 bytes long. This extension is indicated by the command byte 5Ch (normal operation) and by the command byte 5Dh (specific sequences for installation).

Commands for normal operation:

– ODU_Channel_change_MDU

– ODU_PowerOFF_MDU

E0h	00h or 10h or 11h	5Ch	Data 1	Data 2	Data 3

Data 1 and Data 2 have the same content as described in 6.2.1 for ODU_Channel_Change and in 6.2.2 for ODU_PowerOFF.

Data 3 is foreseen for an additional PIN Code P[7:0]. The PIN code is intended for optional pairing of UB-Slot and Set-Top-Box which is necessary for more reliable operation in multi-dwelling installations.

When a UB slot is free, any receiver of the installation can access to it with or without PIN code. But once a UB slot has been accessed with its granted PIN code, the SCIF only gives access to this UB slot to commands carrying the proper PIN code, this operation mode remains so till the UB slot is turned-off with the proper ODU_PowerOFF_MDU command.

The receivers shall provide the end-user with an interface for entering the PIN code (e.g. feature in the installation menu).

9.3 Specific commands for installation (see 6.3.1 to 6.3.4)

Installation with manual entry of system parameters (see 9.4) is strongly recommended for multi dwelling units. So normally automatic installation is rather a specific feature for single dwelling units. But there may exist particular situations where installation commands would be also necessary for multi dwelling units. In this case installation commands are indicated with “5Dh” to make pairing of UB slot and user also available for this kind of installation procedures.

– ODU_UbxSignal_ON_MDU

– ODU_Config_MDU

– ODU_LoFreq_MDU

E0h	00h or 10h or 11h	5Dh	Data 1	Data 2	Data 3

Data 1 and Data 2 have the same content as described in 6.3.2 for ODU_UBxSignal_ON, in 6.3.3 for ODU_Config and in 6.3.4 for ODU_LoFreq.

Data 3 is used for an additional PIN code P[7:0].

IMPORTANT NOTE about SCIF device with MDU option: After an ODU_UBxSignal_ON or an ODU_Signal_ON_MDU the SCIF generates a RF tone at centre frequency for all UB slots which are not active at the time of the ODU_UbxSignal_ON (or ODU_UbxSignal_ON_MDU). The intention of this measure is that the signal reception of other Set-Top-Boxes will not be disturbed during the installation procedure of another receiver.

To cover this feature the proper recognition of the UB slot number is very important (see IMPORTANT NOTE in 6.3.2). Figure 12 shows an example in which for instance UB3 and UB4 are available.

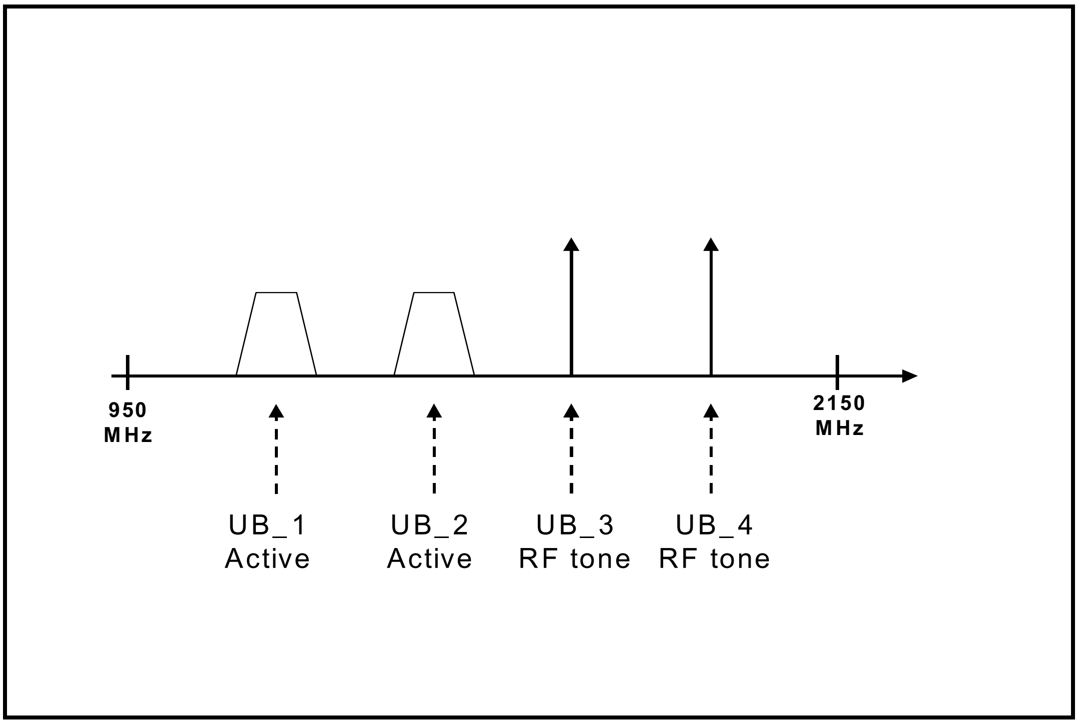

Figure 12 – Example of signal spectrum delivered by a SCIF (with MDU option) after an ODU_UbxSignal_ON (or an ODU_UbxSignal_ON_MDU) command

9.4 Installation with manual entry of the system parameters, PIN code handling

This subclause basically corresponds to 6.3.1.2.

But additionally to F_{UB} frequencies and – if necessary – F_O frequencies the PIN code shall be manually entered in the Set-Top-Box.

NOTE This specification only covers manual handling of PIN codes which also needs strong central administration by the installer, operator etc. Therefore PIN codes shall be stored in a non-volatile way in the SCIF. Additional commands like retrieving PIN codes from the SCIF etc. are not implemented in this specification to keep the implementation as simple as possible. It is required that the SCIF manufacturer makes the UB slot to PIN code pairing available to the end-users (e.g. printed label on the SCIF cover).

9.5 SDU and MDU compatibility rules

Table 7 summarizes the expected system behaviour.

Table 7 – Expected system behaviour

Receiver command			SCIF (SDU only)	SCIF (with MDU option)
Command Name	**Number**	**Length**		
ODU_Channel_change	5Ah	5	Decode	Decode
ODU_Channel_change_MDU	5Ch	6	No action	Decode
ODU_PowerOFF	5Ah	5	Decode	Decode
ODU_PowerOFF_MDU	5Ch	6	No action	Decode
ODU_UbxSignal_ON	5Bh	5	Decode	RF tone at UB slot not currently in use
ODU_UbxSignal_ON_MDU	5Dh	6	Decode	RF tone at UB slot not currently in use
ODU_Config	5Bh	5	Decode	Decode
ODU_Config_MDU	5Dh	6	No action	Decode
ODU_LoFreq	5Bh	5	Decode	Decode
ODU_LoFreq_MDU	5Dh	6	No action	Decode

NOTE The SCIF with MDU option generally decodes 5Ah or 5Bh commands only under certain conditions (no valid PIN code received for this UB slot since last ODU_PowerOFF / ODU_PowerOFF_MDU).

Annex A
(informative)

Implementation guidelines

A.1 Installation impedance

The hardware of the communication bus has to be realized according to the DiSEqC bus fucntional specification. Some additional care shall be taken to ensure an appropriate impedance of the installation during the DiSEqC sequences. Figure A.1 describes two installation cases:

– either all receivers of the installation integrate a diode in the DC current path of the LNB supply;

– or all power splitters of the installation feature the capability to mask the output impedance of the receivers that are not sending DiSEqC commands. Power splitters with diodes realize such a feature.

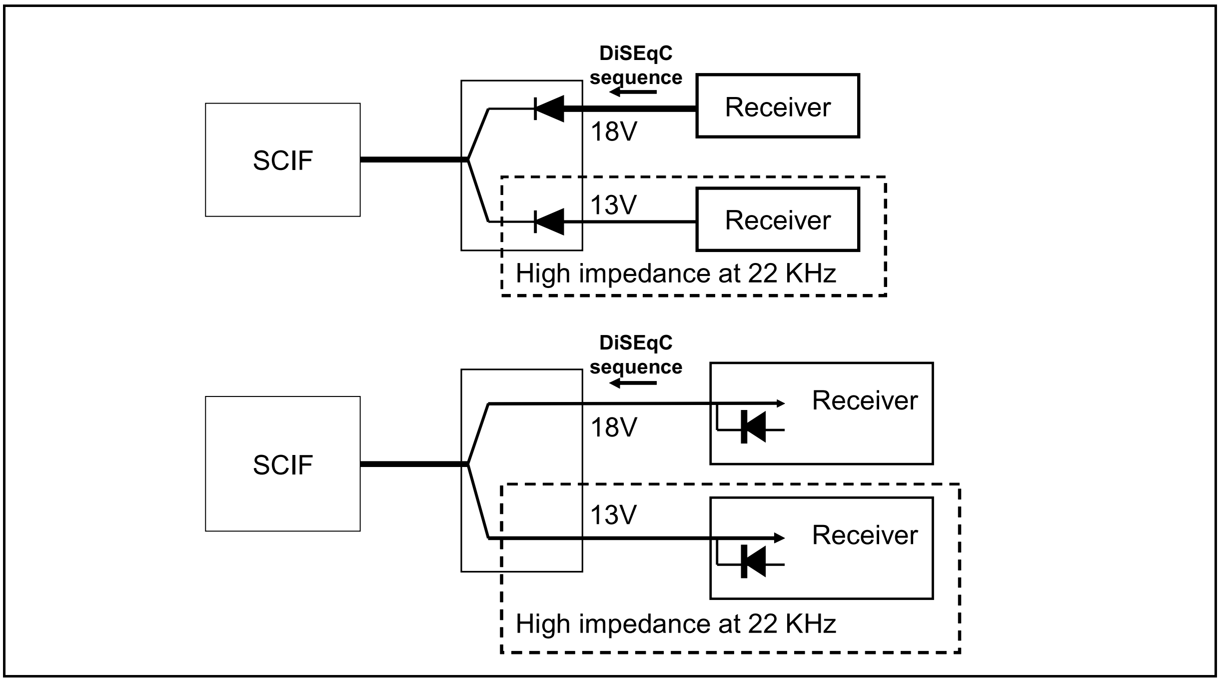

Figure A.1 – Solution for masking the impedance of the installation during the DiSEqC commands.

A.2 Installation: signal reflection and returned loss

In single cable installations, cares have to be taken about signal echoes generated by poorly terminated or by un-terminated cables. To avoid potential problems attention shall be paid to the isolation characteristics of the power splitters implemented in the installation. With reference to EN 50083-4, the splitters shall feature isolations figures better or equal to Category A.

A.3 Power supply of the SCIF

The power consumption of the SCIF increases with the number of UB slots.

In some cases the current consumption of the SCIF may exceed the maximum LNB supply current capability of a receiver (typically I_supply_max ≥ 350 mA); in such cases the SCIF device shall be supplied independently as shown in Figure A.2:

– either with a separate power supply cable (self-powered SCIF);
– or via a power “inserter”.

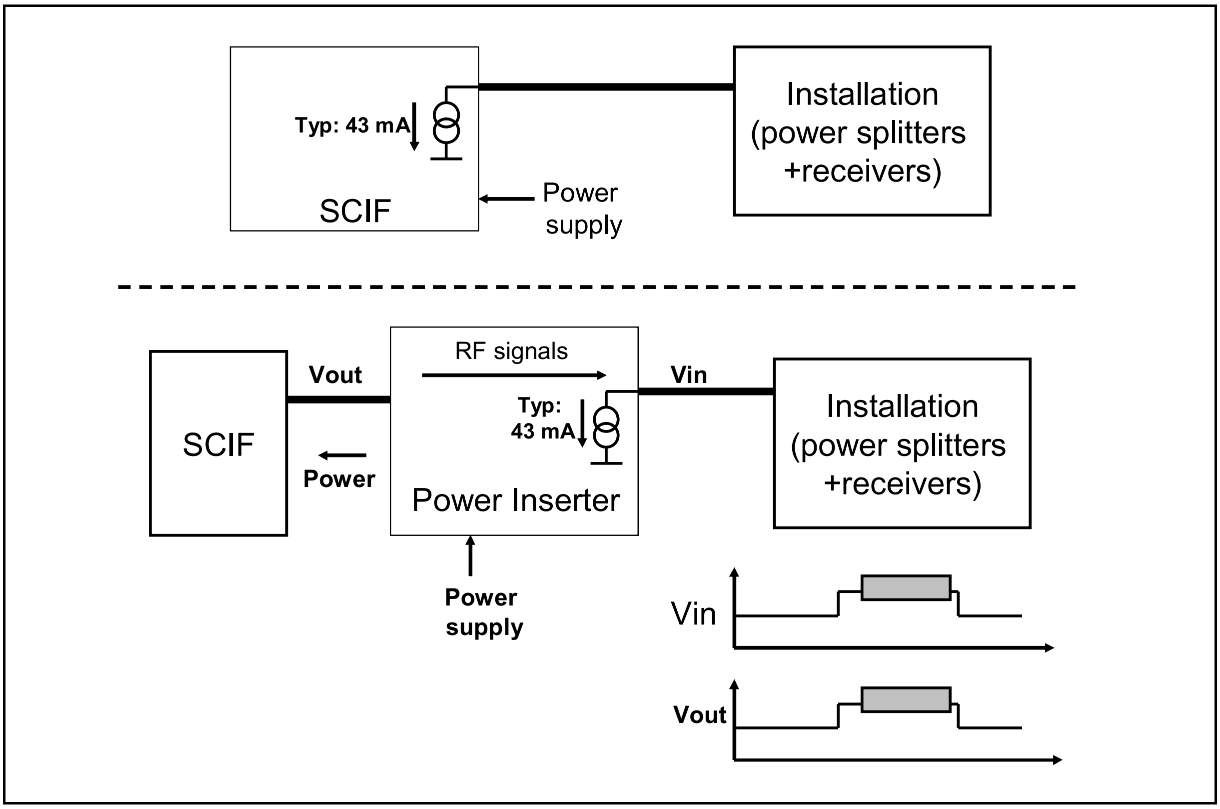

Figure A.2 – Implementation of an external power supply

The power inserter is required to transmit the DiSEqC commands and the DC levels to the SCIF. The load impedance of the power inserter on the installation side is not very critical; the following range is acceptable: 200 Ω < *Z* < 6 kΩ.

<u>IMPORTANT NOTE:</u>

– It may happen that UB slots are not turned off by their corresponding receivers (e.g. receiver turned off by the main switch button or by an accidental disconnection of the AC mains cordon); in this situation the SCIF does not receive the expected ODU_Power_OFF and eventually UB slots remain in operation and waste power. To solve this issue, the following is recommended: Self-powered SCIF turns off all UB slots when the DC voltage on the cable is lower than 5 V (all receivers of the installation are turned off))

– Power inserter does not deliver power to the SCIF when the DC voltage on the cable (Vin_DC) is lower than 5 V, this situation corresponds to: all receivers are turn-off.

A.4 Tuning word calculation, software recommendations

The selection of the desired signal to be shifted to the designated UB slots requires the calculation of a tuning word (ODU_Channel_change Data 1 [1:0] & Data 2). Several methods are theoretically possible; here the tuning word calculation method has been selected to realize the following compromise:

– to use the highest possible step size as possible (lower number of required bits);

– not to enlarge the frequency range in the signal acquisition sequence by unknown unpredictable rounding calculation effects.

To achieve this compromise, the following implementation is suggested at each channel change:

– First the receiver calculated the tuning word T to be carried by the ODU8Channel_change.

$$T = round\ \left(\left(abs(F_T - F_O) + F_{UB} \right) / S \right) - 350$$

– The SCIF operates very simple process of the tuning word carried by the ODU_Channel_change command.

  - In super-heterodyne SCIF implementation, the SCIF simply calculates the required frequency conversion frequency f_vco as:

    – f_vco = (T + 350) x S

    – No extra rounding effect in the SCIF

– The demodulator embedded in the receiver starts searching the signal at a frequency f_start that compensates all possible rounding in the tuning word calculation

    – f_start = F_{UB} - Correction.

    – Correction = S x { {(|F_T - F_O| + F_{UB}) / S} - { round { (|F_T - F_O| + F_{UB}) / S } }

    – With a signal search initiated at f_start, the search range is only required to compensate the usual drift of the first conversion stage of the LNB (typically +/- 5 MHz).

– EXAMPLE:

  - F_T : 12 515,25 MHz; F_O : 10 600 MHz; F_{UB} : 1 632 MHz

    – Decimal value of T[9:0] = 537.

    – Theoretical tuning value = 536,812 (without rounding)

    – Correction = 4 MHz x (536,812 5 – 537) = - 0,75 MHz

    – f_start = F_{UB} - Correction = 1 632 MHz + 0,75 MHz = 1 632,75 MHz

    – f_vco = {Decimal value of T[9:0] +350} x 4 MHz = 3 548 MHz

    – f_signal = f_vco - (F_T - F_O); f_signal : actual frequency of the desired signal transported by the single cable connection.

    – f_signal = 3548 – (12 515,25 – 10 600) = 1 632,75 MHz

    – f_signal = f_start → full compensation of the rounding errors

NOTE Although the suggested method allows a full compensation of the rounding errors, it is recommended to widen the frequency search range of the receivers to typically +/- 8 MHz.

A.5 RF scanning, RF tone recognition, SCIF parameter recognition

The automatic recognition of the SCIF characteristics implements a RF tone feedback signalling method. The reliability of this solution widely depends on a proper identification of the centre frequencies of the UB slot and on the proper identification of the UB slot number.

The auto recognition of the SCIF parameters is a process managed by the receiver and which requires several steps:

1. to send an ODU_UBx_Signal_ON;
2. RF scanning;
3. careful identification of UB slots numbers;
4. polling of the SCIF database with the ODU_Config and the ODU_LoFreq commands.

On the basis of an example illustrated in Figure A.3, some recommendations are given about the SCIF parameters recognition software. In this example the SCIF features four UB slots (UB_1, UB_2, UB_3, UB_4).

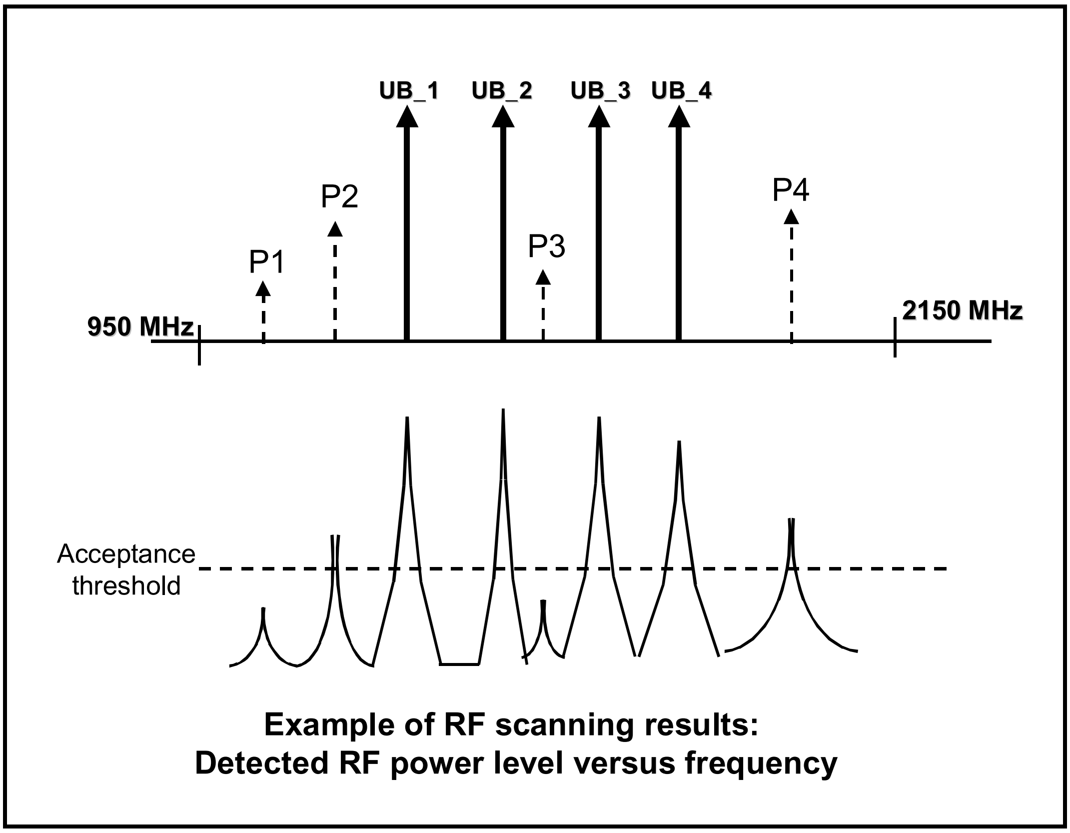

Figure A.3 – Example of a RF spectrum found after an ODU_UBxSignal_ON

1) After an ODU_UBxSignal_ON command, the SCIF generates a RF tone signal at the centre frequency of all available UB slots (in single dwelling installation all slots are considered as available). For information, the typical power of the RF tone at the output of the SCIF: -27 dBm.

2) During the RF scanning step, the receiver may also detect parasitic signals such as P1, P2, P3, P4 (these parasitic signal have various origins : inter-modulation, interferences issued by mobile phone systems: DECT, GSM, …). With a first level of screening, the software only considers all the detected signals that have a level higher than a given acceptance threshold (for information: typical acceptance threshold: -55 dBm). On the basis of the given example (Figure A.3), after the first level of screening, the list of potential UB slots centre frequency indicators is: P2, UB_1, UB_2, UB_3, UB_4, P4.

3) Careful identification of the slots. With reference to 6.2.1.2, the receiver shall implement a check routine, which applies to all the detected signals screened by the power acceptance threshold.

   Check routine:

   – One after the other, each detected signal is tentatively turned-off. During this operation the receiver monitors the RF power in a frequency range close to the considered detected during the RF scanning (remark: with zero-IF tuner RF tone signal might not be detected if the tuner frequency perfectly matches with the actual RF tone frequency, typically a small offset of 1 MHz is recommended). The turn-off operation implements a loop in which the UB [2:0] field of the ODU_PowerOFF takes all possible values from 0 to 7. A detected signal is a true UB slot RF tone when it can be turned-OFF by a single iteration of the ODU_PowerOFF command (i.e. a single UB [2:0] value). More precisely:

   – Detected signals that cannot be turned-off by any of the ODU_PowerOFF command (0 < dec(UB [2;0]) < 7) can be safely considered as a spurious signal or eventually as an UB slot which actually is active (see 6.3.2).

   – Detected signals that can be turned-off by several ODU_PowerOFF (0 < dec(UB[2:0]) < 7) are potentially inter-modulation products of several UB RF tones.

4) Polling the SCIF database: this operation can be implemented only once a feedback channel has been safely identified (a UB number safely identified). On the receiver side, the polling of the SCIF database requires the capability to clearly detect the defined 20 MHz frequency shift of the RF tone.

   – Several identification strategies are possible: to first check LoFreq table (Tables 5 and 6) or to first check the Config_Nb tables; no guidelines are given in this document. However the following remarks and suggestion are reminded:

   – Under specific conditions of multiple dwelling installations, it may occur that not all the UB slots are made available (i.e. their corresponding RF tone is not turned-ON after an ODU_UBxSignal_ON command and cannot be turned-off by any of ODU_PowerOFF command). In this case, the number of truly identified UB slots may not match with the value stored in the SCIF Config_Nb table. Then while checking the Config_Nb table, the check routine should test all the configurations that feature a number of UB slots equal or higher to the number of UB slots truly identified during the UB numbering check session (third step above described).

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