EUTELSAT

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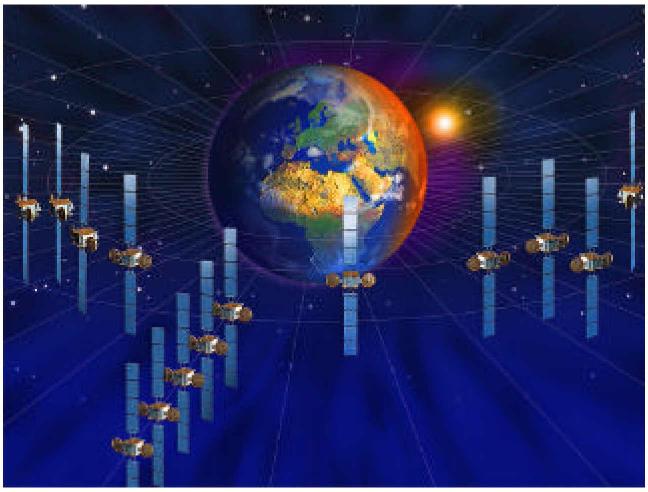
DiSEqC 1.0 DiSEqC 2.0

Digital Satellite Equipment Control (DiSEqC™)



UPDATE AND RECOMMENDATIONS FOR IMPLEMENTATION

VERSION 2.1

February 25, 1998

Reference Documents that define the DiSEqC System:

DiSEqC™ Bus Specification Version 4.2 (February 25, 1998)

DiSEqC™ Slave Microcontroller Specification Version 1.0 (February 25, 1998)

DiSEqC™ Logos and Their Conditions of Use (February 25, 1998)

Associated Documents:

Update and Recommendations for Implementation Version 2.1 (February 25, 1998)

Application Information for using a "PIC" Microcontroller in DiSEqC™ LNB and simple switcher Applications Version 1.0 (June 7, 1999)

Application Information for Tuner-Receiver/IRDs (April 12, 1996)

Application Information for LNBs and Switchers Version 2 (February 25, 1998)

Reset Circuits for the Slave Microcontroller (August 12, 1996)

Simple Tone Burst Detection Circuit (August 12, 1996)

Positioner Application Note Version 1.0 (March 15, 1998)

CONTENTS

1. Introduction

This document describes the recommended implementation of the DiSEqC™ Bus Specification in certain defined configurations and applications. It does NOT replace the Bus Specification, and in case of inconsistencies between the two documents, the Bus Specification takes priority and is always the reference document. These recommendations are only intended to serve as a guide to manufacturers and should not be considered as restricting the application of DiSEqC™ in any way. This document, version 2.1, concentrates on "Enhanced" one-way DiSEqC™ (Level 1.1) which extends the range of applications that can be supported with one-way communication. In particular the need to repeat DiSEqC™ messages where switches are "cascaded", to offer more switching states as well as supporting remote frequency tuning. The equivalent level in two-way DiSEqC™ is also defined. One-way positioner commands are also introduced and a new level 1.2 defined.

At this time with the first generation of DiSEqC™ products already in the market it is also necessary to plan the move to full DiSEqC™ and to drop the old switching protocols (namely the 13/17V) to fully realise the potential cost savings at a system level. It is likely, therefore that DiSEqC™ only products will emerge by the end of this year. This will mean that the need for repeated messages is increasingly important to support non-backwards compatible DiSEqC™ devices, LNBs for example.

2. Simple Tone Burst DiSEqC™ Commands

The DiSEqC™ specification includes some extra commands that have been designed to be detected by a cheaper analogue circuit in the case of a simple two-state switch. In this type of application *(see Figure 11: "DiSEqC‰ Compatible" switch, page 22),* where the slave IC would not be used to provide any additional functionality (such as 13/17V detection, continuous 22 kHz detection etc.) it is reasonable to find the lowest possible cost solution. To allow for these applications tone burst commands are defined as alternatives to the DiSEqC™ commands for the Satellite Position switch.

These simple commands should be viewed as an extension to the DiSEqC™ command set to allow for cost-reduced, simple two-state analogue switches and to avoid the unnecessary proliferation of other simple propriety protocols which could be incompatible in a future DiSEqC™ environment. Receiver manufacturers should always implement BOTH the simple tone burst commands and the standard DiSEqC™ commands in order to qualify for the use of the DiSEqC™ logo *"Logos and Conditions of Use"* *"February 25, 1998"*).

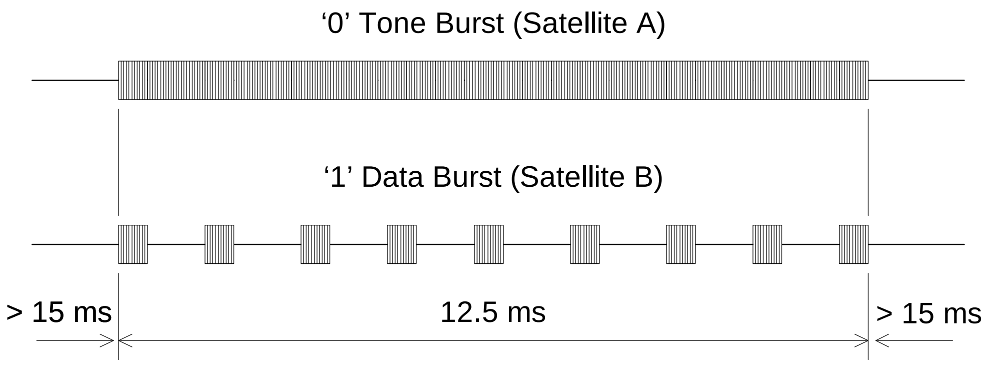


Figure 1: Timing Diagram for Tone Burst Control Signal

3. Definitions of DiSEqC™ Levels of Implementation

The full DiSEqC™ specification allows for many different levels of implementation and in order to clearly distinguish between these levels and the consequent functionality it is intended to indicate the implementation level in the branding of DiSEqC™ products, in the same way there are different versions of software packages or Dolby™ B or C etc.

The broad levels are defined as follows:

LEVEL	CONTROL	PRODUCT TYPE
“DiSEqC™ Compatible”	Tone Burst Command	Simple two-state switches only
DiSEqC™ 1.0	One-way DiSEqC™ Commands	Receivers only
DiSEqC™ 2.0	Two-way DiSEqC™ Commands	Receivers and Accessories
DiSEqC™ 3.0	Two-way Commands and external Bus Control	Receivers (which can be controlled/ programmed via the bus)

Table 1: Definition of the DiSEqC™ Levels

A more detailed description of the different levels of implementation is given below from either a receiver or accessory point of view:

3.1. Proposed Levels of Implementation for Receivers

The table below gives a more detailed definition of the different DiSEqC™ levels currently employed and proposed for receivers:

LEVEL	DIRECTIONALITY	COMMANDS
DiSEqC™ 1.0*	One-way signals	At least the control of the 4 “committed” switches, plus the capability of one repeat and the Tone Burst command
DiSEqC™ 1.1	One-way signals	As level 1.0 above plus the capability of the 4 “Uncommitted” switches,and transmission of up to 2 repeats and remote (head end) tuning mode
DiSEqC™ 1.2	One-way signals	As level 1.1 above plus the capability of one-way positioner commands
DiSEqC™ 2.0	Two-way signals	At least the control of the 4 “committed” switches, plus the capability of one repeat and the Tone Burst command, plus LNB L.O. frequency reading, one repeat.
DiSEqC™ 2.1	Two-way signals	As level 2.0 above plus control of the 4 uncommitted switches, 2nd repeat, remote tuning mode
DiSEqC™ 2.2	Two-way signals	As level 2.1 above plus positioner commands
etc.		
DiSEqC™ 3.0	Two-way signals	All level 2.n plus external bus control of master

Table 2: DiSEqC™Levels - Receivers

Note: * The exact definition of DiSEqC™ level 1.0 is now being standardised through CENELEC as an amendment to EN61319-1 *(see Annex B.)*.

3.2. Proposed Levels of Implementation for Accessories

The table below gives a more detailed definition of the different DiSEqC™ levels currently employed and proposed for accessories (switches, LNBs etc.):

LEVEL	DIRECTIONALITY	DETECTION METHOD
Tone Burst ("DiSEqC™ Compatible")	One-way signals	Simple Analogue circuit
DiSEqC™ 1.0	One-way signals	NOT RECOMMENDED (*see section 5.2.*)
DiSEqC™ 1.1	One-way signals	NOT RECOMMENDED for switchers (*see section 5.2.*), Proprietary Microcontroller for remote controlled SMATV components
DiSEqC™ I.2	One-way signals	Proprietary Microcontroller for positioner commands
DiSEqC™ 2.0	Two-way signals	Slave IC
DiSEqC™ 2.1	Two-way signals	Proprietary Microcontroller
DiSEqC™ 2.2	Two-way signals	Proprietary Microcontroller
DiSEqC™ 3.0	Two-way signals	Proprietary Microcontroller

Table 3: DiSEqC™ Levels - Accessories

4. Recommended Implementation for Receivers

4.1. One-way DiSEqC™

This is implemented by simply NOT requesting a reply in the framing byte of the DiSEqC™ message:

E0 = Command from Master, No reply required, First transmission

E1 = Command from Master, No reply required, Repeated transmission

In a one-way system there are obvious limitations compared with a full two-way system, the main problem being that the automatic identification of the actual installation configuration is impossible. Therefore as the installation configurations become more complex (e.g. three or four LNB/IF inputs) the necessary "links" within the receiver software become more complicated and yet still require a reasonable level of understanding from the installer or user during installation. In a two-way system, with self-interrogation of the bus, it is possible to tailor the menus according to the devices found on the bus and even allow, automatically, for differences in local oscillators (assuming DiSEqC™ LNBs are used).

Therefore, in one-way applications, to ensure compatibility between different manufacturers' equipment and to limit the complexity of the receiver software we suggest that only a limited number of "common" installation configurations are to be supported *(see Annex A.)* in terms of pre-programmed software in the receiver. Of course even one-way DiSEqC™ allows for many other types of installations but these other configurations will require a higher level of understanding from the installer and possibly re-programming of the receiver as required. To accommodate the "Enhanced" one-way DiSEqC™ it would be advisable to have a DiSEqC™ installation menu where the different features can be selected by the user/installer (see later).

The simplest method to implement one-way DiSEqC™ 1.0 is to send all types of signals every time the receiver changes channels. The DiSEqC™ commands must be sent first (so that if a Slave IC is present it will then react in DiSEqC™ mode), the Tone Burst commands should be sent next followed by the continuous signalling, see diagram below:

4.1.1. Recommended sequence of commands for one-way DiSEqC™ 1.0

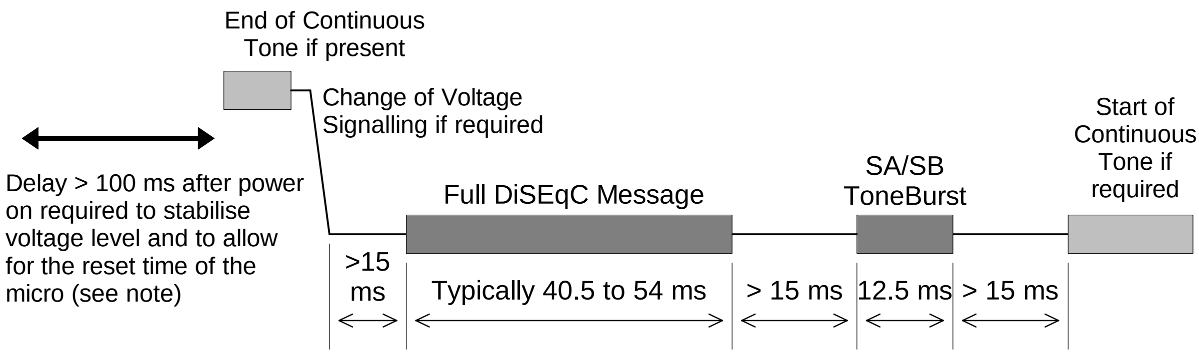


Figure 2: Timing Diagram for DiSEqC™ 1.0

Note: It is important that the power rail has stabilised and the voltage is above 12 V BEFORE the messages are transmitted, if for example the receiver is coming out of stand-by (e.g. power-on or for a timer event) and the messages are sent too quickly then the detection circuits may not operate correctly. A delay is also required depending on the reset time of the Slave IC. Therefore, a minimum delay of 100 ms is recommended in these cases.

4.1.2. Command Structure DiSEqC™Level 1.0

DiSEqC™ level 1.0 is restricted to the "committed" switches which can all be addressed with only one command: "Write Port N0" = 38h.

Name	Continuous commands	Tone Burst	DiSEqC™ commands bytes	
Band (low/high)	0/22 kHz	-	" Write N0" 38 Fx	20/24
Polarity (ver/hor)	13/17 V	-		21/25
Sat Position (A/B)	(0/22 kHz)	No mod/mod		22/26
Option (A/B)	-	-		23/27

Table 4: DiSEqC™ Level 1.0 commands

Note: More details regarding the definition of DiSEqC™ level 1.0 are given later *(see Annex B.).*

4.2. Enhanced one-way DiSEqC™

Various manufacturers have requested three further applications that should be supported by one-way DiSEqC™, these can be summarised as:

1. More switching options

2. Cascaded devices which require several repeated DiSEqC™ messages

3. Remote tuning for subscriber controlled SMATV headends for single cable IF distribution systems

Note: EUTELSAT strongly recommends that receiver manufacturers not intending to implement two-way DiSEqC™ in the medium term should at least move to enhanced one-way DiSEqC™ level 1.1 as quickly as possible.

4.2.1. Recommended sequence of commands for enhanced one-way DiSEqC™ 1.1

In order to support "cascaded" DiSEqC™ devices *(see Figure 15: Cascaded DiSEqC‰ switches, page 24)* it is necessary to repeat the DiSEqC™ commands for the "distant" devices which are beyond an IF switch. Otherwise, if the "nearby" switch is open there is no IF path connected until the first DiSEqC™ message causes the switch to close and connects the distant switch. The dc path is only connected at the same time and therefore, it is necessary to allow at least 100 ms for the distant DiSEqC™ slave IC to power-up BEFORE repeating the message to correctly control this new device. To make use of this "dead" time we recommend that an uncommitted switch message is sent in the 100 ms gap between the repeated committed switch messages. The reason for this is, that if both committed and uncommitted switches are employed, it is most likely to be inside the same device (typically a large SMATV node with up to 32 inputs) and there is no need allow a 100 ms gap between these messages (or to repeat the uncommitted message). This solution also provides the extra switching commands requested in a very time efficient manner.

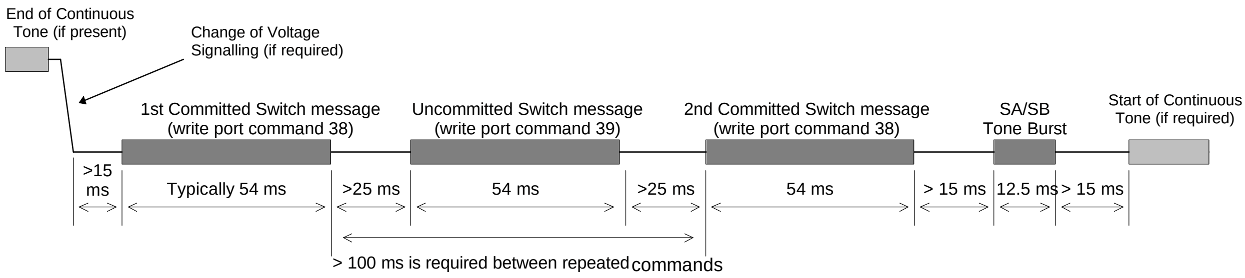


Figure 3: Timing Diagram for DiSEqC™ 1.1 (one repeat)

This is the recommended default setting for the Setup menu (see section 4.2.8).

Ideally, there should be independent control of both the committed and uncommitted switches. This means 4 additional programmable bits per channel in the memory of the IRD. To allow the rapid introduction of level 1.1 in existing designs, where memory may be restricted, the same "data" can be used for both the committed switches (command 38h and the uncommitted switches (command 39h) to qualify for level 1.1. Although this will mean that the IRD can only control four switch settings independently, it does at least mean the IRD can operate with either type of switcher (using either committed switches or uncommitted switches).

4.2.2. Repeated DiSEqC™ Messages

The number of times the same message will need to be repeated will depend on the number of levels of cascaded devices that are required to be supported. Obviously the more times the message is repeated the longer the delay in selecting the required channel. To avoid unnecessarily long delays in simple systems we recommend that the number of repeats be user selectable in the DiSEqC™ installation menu (*see section 4.2.8.*) It is unlikely that there are many applications requiring more than two repetitions (i.e. the same message is sent three times), this allows for two levels of switches plus a DiSEqC™ LNB.

Note: In a two-way system the receiver can interrogate the bus to establish the exact configuration and automatically select the required number of repeats.

Note: The Tone Burst signal must always be at the end of the message, AFTER the last repeated DiSEqC™ command. Therefore, if a Tone-Burst switch is used, it MUST be farthest from the receiver to operate correctly.

4.2.3. Recommended sequence of commands for double repeated messages

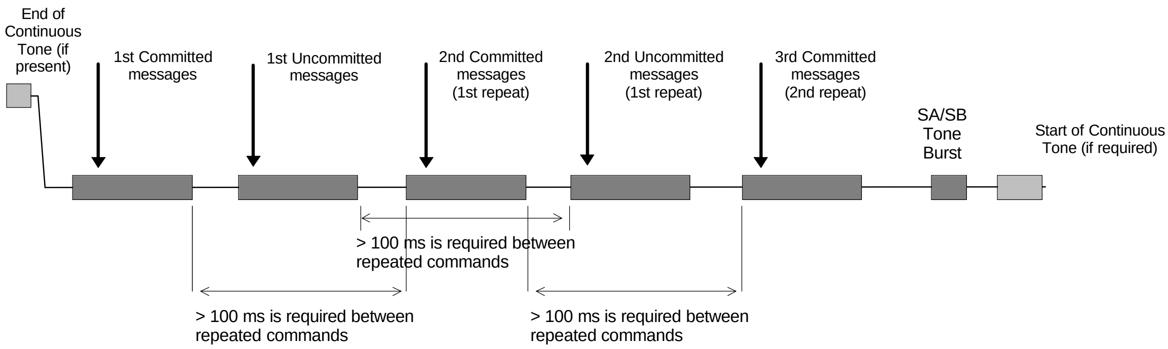


Figure 4: Timing Diagram for DiSEqC™ 1.1 (multiple repeats)

4.2.4. Remote Tuning

There has been a strong request from several manufacturers (namely the members of the ZVEI group in Germany) to include a special SMATV mode within one-way DiSEqC™ to allow for the interface with subscriber controlled SMATV headends.

In future there will be intelligent SMATV headends which only transmit the desired transponder to each user. The great advantage of this concept is that it is possible to use existing single cable “tree” distribution network installed in many buildings today.

The SMATV headend has one remote controllable frequency convertor for each user. This convertor must be controllable by the satellite receiver/IRD. In a special SMATV mode of the receiver this is achieved by transmitting, in addition to the DiSEqC™ 1.0 commands, the desired transponder frequency via the DiSEqC™ “write frequency” command (58h). This message is sent in the usual way at every programme change and at the initialisation procedure after power on.

It is important to understand that the DiSEqC™ signals are simply used as an "open interface" for the data transmission from the satellite receiver to a propriety modem located between the receiver and the wall outlet *(see Figure 19: Subscriber controlled SMATV Headend, page 26).* The modem converts the DiSEqC™ commands to a suitable propriety bus format (typically a faster multi-master bus) for the transmission to the headend.

In the remote tuning SMATV mode the tuner in the receiver stays fixed on the subscriber's individual transmission frequency of the SMATV headend. The selection of this SMATV mode and the fixed transmission frequency need only be entered one time during the installation procedure. In this mode the LNB voltage should remained fixed in the low setting (13 V) to minimise power consumption (the polarisation control is performed via the DiSEqC™ message).

4.2.5. Transmission of the desired transponder frequency

The desired transponder frequency can be written in a packed BCD string form, the message is structured as follows:

FRAMING	ADDRESS	COMMAND	DATA	DATA	DATA

where:

FRAMING BYTE: E0h
Command from Master. No reply required.
First transmission

ADDRESS BYTE: 71h
Intelligent slave interface for Multi-Master Bus

COMMAND BYTE: 58h
Write channel frequency (BCD string)

DATA BYTES: Max. 3 bytes for the transponder frequency (GHz)

The high nibble of the first data byte contains the tens of GHz digit and the low nibble contains the GHz digit in BCD form. Subsequent bytes contain BCD nibbles in descending order until only trailing zeros remain.

For example 12.650 GHz would be transmitted in two bytes:

1	2	6	5	0	0
0001	0010	0110	0101	0000	0000

4.2.6. Full sequence of commands in Remote Tuning SMATV mode

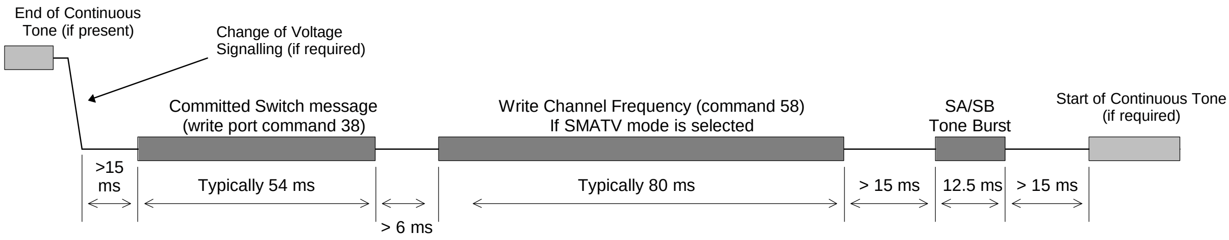


Figure 5: Timing Diagram for DiSEqC™ 1.1 (SMATV mode)

Note: It is still necessary to send the committed switch message in the SMATV mode to define the: polarity, band and satellite position, required at the input to the frequency convertor.

4.2.7. Command Structure for DiSEqC™ Level 1.1

The table below gives the list of DiSEqC™ functional commands required to implement enhanced one-way DiSEqC™ level 1.1:

Name	Continuous commands	Tone Burst	DiSEqC™ commands bytes	
Band (low/high)	0/22 kHz	-	" Write N0" 38 Fx	20/24
Polarity (ver/hor)	13/17 V	-		21/25
Sat Position (A/B)	(0/22 kHz)	No mod/mod		22/26
Option (A/B)	-	-		23/27
Switch 1 (A/B)	-	-	" Write N1" 39 Fx	28/2C
Switch 2 (A/B)	-	-		29/2D
Switch 3 (A/B)	-	-		2A/2E
Switch 4 (A/B)	-	-		2B/2F
Write channel frequency	-	-		58

Table 5: DiSEqC™ Level 1.1 commands

Note: The reason for the two separate groups of 4 switches is very important. Each group of switches can be addressed with one DiSEqC™ message (4 bytes), this means that even in the case where it is necessary to change ALL 4 states of one group it will never take more than 4 bytes (54 ms).

4.2.8. Setup Menu for DiSEqC™ level 1.1

To enable the features of enhanced one-way DiSEqC™ to be implemented it is necessary for the receiver to have a DiSEqC™ setup menu as part of the installation procedure. In this menu the first level is to select either "DTH" mode or "SMATV" mode, below which there are sub-menus as follows:

OPERATIONAL MODE	SELECTION POSSIBILITIES
DTH	No repeat
	One Repeat (Default)
	Two Repeats
SMATV (Multi-Switches)	Program Committed and/or Uncommitted switches and setup LNB L.O.s for each input
SMATV (Remote Tuning)	Enable Write channel frequency commands and enter fixed subscriber frequency

Table 6: DiSEqC™ Level 1.1 Setup Menu

4.2.9. DiSEqC™ Level 1.2 for Positioners

A new set of positioner commands have been defined to allow positioners to operate with only one-way DiSEqC™ signals. This limits the software overhead in the IRD, but requires more intelligence in the positioner controller. This is very attractive in terms of upgrades where even budget priced IRDs can offer future upgradability to motorised systems. In addition the single cable installation (using only the IF cable) means that the cost of installing the positioner at a later date is reduced. Below is the mandatory set of positioner commands required to qualify for level 1.2:

Status	Hex. Byte	Command Name	Command Function	Total Bytes	Reply Data
M	60	Halt	Stop Positioner Motor	3	-
M	63	Limits Off	Disable Limits	3	-
M	66	Limit E	Set East Limit (and enable limits)	3	-
M	67	Limit W	Set West Limit (and enable limits)	3	-
M	68	Go East	Drive Motor East (with optional timeout)	4	-
M	69	Go West	Drive Motor West (with optional timeout)	4	-
M	6A	Store nn	Store Satellite Position nn & Enable Limits	4	-
M	6B	Goto nn	Drive Motor to Satellite Position nn	4	-

Table 7: Mandatory Positioner Commands for DiSEqC™ Level 1.2

For the full set of positioner commands please refer to the *"Bus Functional Specification Version 4.2"*. For more information regarding the implementation of DiSEqC™ commands for positioners please refer to the forthcoming *"Positioner Application Note Version 1.0"* to be published soon.

4.3. Two-way DiSEqC™

All the above recommendations for one-way DiSEqC™ are applicable to full two-way DiSEqC™ in terms of the functional definition of levels 2.0, 2.1, 2.2, etc. However, it is of course possible to significantly simplify the user operation of the receiver by making use of the replies (remember all accessories using the slave IC should have reply capability). In fact the setup menu described above can be completely transparent to the user if the receiver interrogates the bus to find out exactly which configuration exists and to setup the DiSEqC™ implementation accordingly *(see "Application Information for Tuner-Receiver/IRDs", "April 12, 1996"*). The real benefits of two-way DiSEqC™ are only realised through intelligent software in the receiver.

The reply capability of DiSEqC™ LNBs to declare their actual local oscillator frequency is one of the most obvious examples of the benefit of two-way communications. In additions "hand-shaking" ensures the correct operation of the slave devices and any errors in communication can be automatically resolved.

Many more advanced features are already specified for two-way DiSEqC™, some of which are already implemented in the existing slave IC. For example, it is possible to "signal" to the master the special addresses 18h to 1Fh by configuring the slave IC to only support the uncommitted switches *(see "Slave microcontroller version 1.0", Table 4: SMATV addresses, page 10).*

In order to realise all these benefits of two-way communication it is only necessary to implement in hardware the required source impedance and a few Bus interface components (typically one transistor), everything else remains in software. As the industry gains experience in DiSEqC™ messaging the improved functionality of a two-way system will quickly out-weigh any software overhead.

5. Implementation for Accessories

5.1. Detection of Tone Burst commands using an analogue circuit

The cost advantage of the analogue detection of the Tone Burst is only achieved in applications where the Slave IC cannot be used to add any additional functionality *(see Annex A. Common configurations for one-way DiSEqC‰, page 22)*. Please refer to the document *“Simple "ToneBurst" Detection Circuit”* for more details, but the exact design will depend on the manufacturer’s own preferred solution.

5.2. Detection using the Slave IC

The advantage of the Slave IC is that in one very cheap microcontroller a large amount of functionality is included:

1. DiSEqC™ detection

2. Tone Burst detection

3. 13/17 V and continuous 22 kHz tone detection

4. Reply capability

5. Decode mode

It is STRONGLY recommended that any accessory utilising the Slave IC should always implement the return path modem (only one transistor) since two-way capability significantly improves the user friendliness of the system and some receiver manufacturers will start with two-way communication. It has been estimated (by a manufacturer) that a typical detection circuit using a Slave IC with all the above functionality (but excluding voltage regulation and PCB space) is approximately 1.1 ECU (i.e. < £1), this replaces the cost for the existing analogue detection circuits.

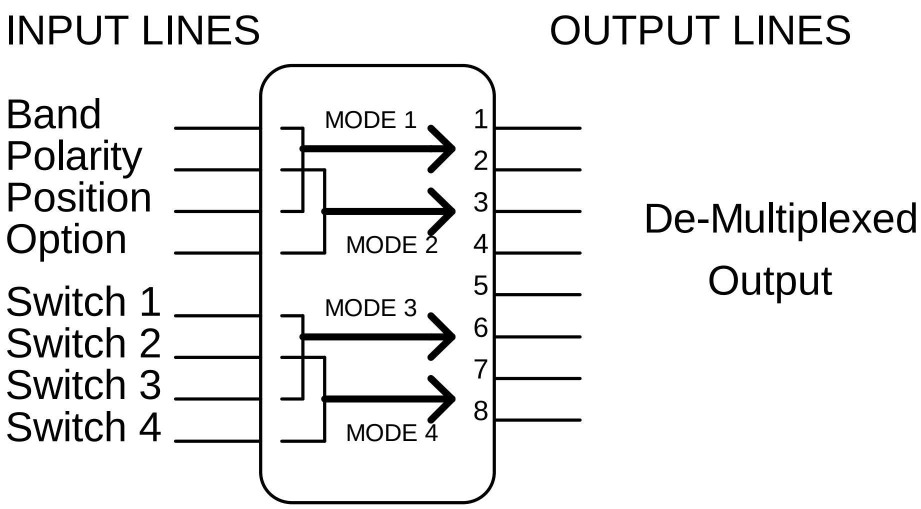
Note: Accessories using the Slave IC but NOT implementing the return path will NOT be eligible for DiSEqC™ branding.

5.2.1. Dual Functionality of continuous 22 kHz signal

In many existing installations (particularly in SMATV) the continuous 22 kHz tone is used for position switching rather than frequency band. When the Slave IC is used in backwards compatible mode it is therefore necessary to be able to select either mode of operation:

22 kHz = Frequency band (for receivers wanting low and high band)

or



22 kHz = Position (receivers wanting one band from two positions)

In the current software (versions 0.2 & 1.0) the mode of operation is determined by connecting a diode between pins Strobe E and S3 of the Slave IC *(see "Slave microcontroller version 1.0", section 7.1. Backwards Compatibility, on page 21*). This feature could be implemented in an eight input/output multi-switch by using an eight way dip switch which can switch the diode in or out for each Slave IC. This allows a "mixed" population of receivers to use the same type of multi-switch without any additional logic inside the switch.

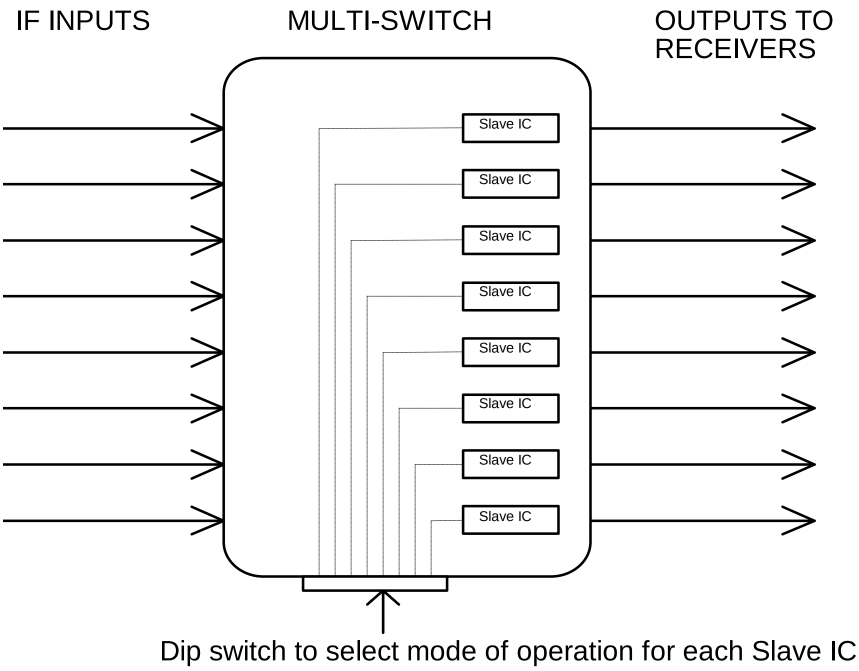


Figure 6: Possible configuration to support old and new receivers in 8-way distribution systems

5.2.2. Decode (de-multiplex) Mode

Given the current configuration of the Slave IC which has 8 output lines, several manufacturers have requested a decode (or de-multiplex) mode from three input lines (i.e. $2^3 = 8$ states) in order to avoid additional logic and to be able to drive switches directly. In the final version there are 4 groups of 3 inputs which can be configured to decode to the 8 output lines, and each mode can be inverted giving a total of 8 different decode configurations. *Figure 7:*, shows how the inputs are grouped, for a full description of the decode mode please refer to the updated DiSEqC™ Slave Microcontroller Specification (version 1.0) and the latest application documents.

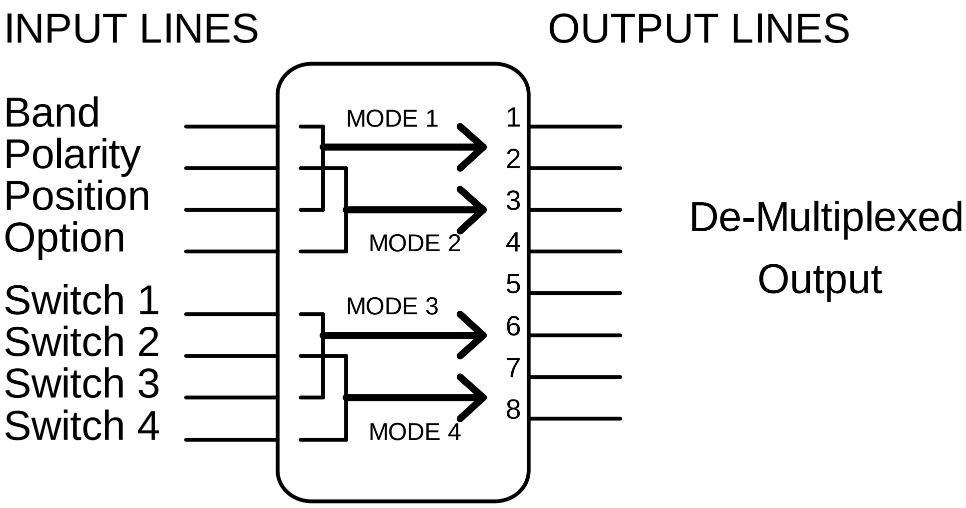


Figure 7: Decode (de-multiplex) Modes

6. Trade Mark and Self-Certification

6.1. DiSEqC™ Logo

The DiSEqC™ logo has been designed to be suitable for use on products as well as in printed format. The logo will clearly indicate the level of implementation employed to allow consumers to easily exercise choice in selecting the most appropriate system for their requirements and to ensure inter-compatibility between different manufacturer's products.

The use of the logo will be controlled in the following way:

1. Manufacturers will self-certify compliance to the bus specification by testing with the Test Tool.

2. Two samples (from mass production) must be submitted to the "product library" at EUTELSAT which will be accessible by all manufacturers.

3. Any incompatibilities between products are to be resolved between manufacturers.

Please refer to the document *"Logos and Conditions of Use"*, *"February 25, 1998"*

6.2. Test Tool

To allow fast development and self-certification, the idea a Test Tool has been developed (based on the original evaluation boards) which allows the precise performance of a device to be measured in terms of the bus specification. Revisions to the bus specification would be accompanied by the appropriate changes (if necessary) to the Test Tool. In order to self-certify compliance to the bus specification it will be mandatory that manufacturers procure a Test Tool for their own use. Owners of evaluation boards are entitled to receive one of the Test Tools free of charge. For new manufacturers the cost of the Test Tool will be a nominal sum simply to cover the hardware costs, please send enquiries directly to EUTELSAT at the address at the end of the document.

7. Reset Procedure

7.1. IF Loop-Through

> Receivers employing an IF Loop-Through (e.g. digital IRDs with a loop-through for an analogue receiver) **MUST** include a reset for the Slave IC each time the IF path is switched. This is to ensure backwards compatibility with old receivers.

Please refer to the following diagrams:

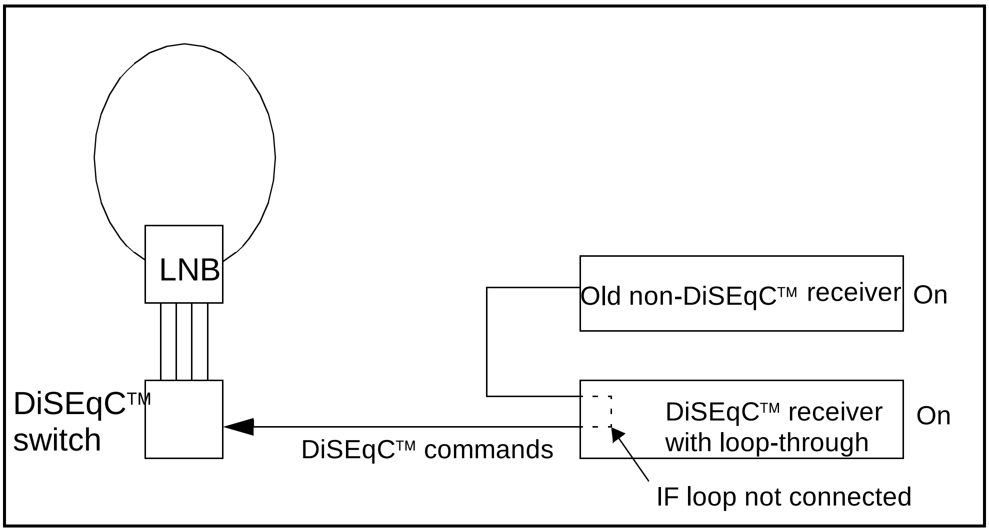


Figure 8: DiSEqC™ receiver with loop-through is controlling DiSEqC™ devices using DiSEqC™ commands

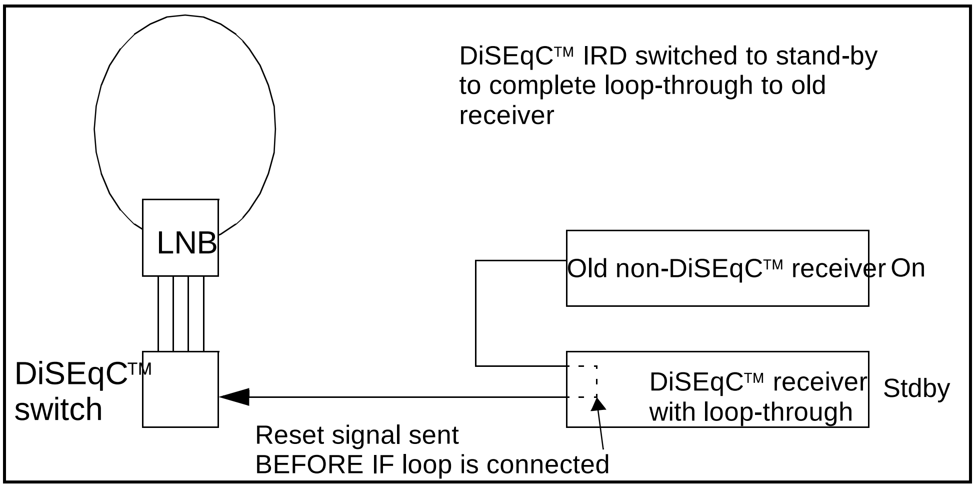


Figure 9: When DiSEqC™ receiver is switched to stand-by, a reset signal must be sent to the DiSEqC™ switch (and/or LNB)

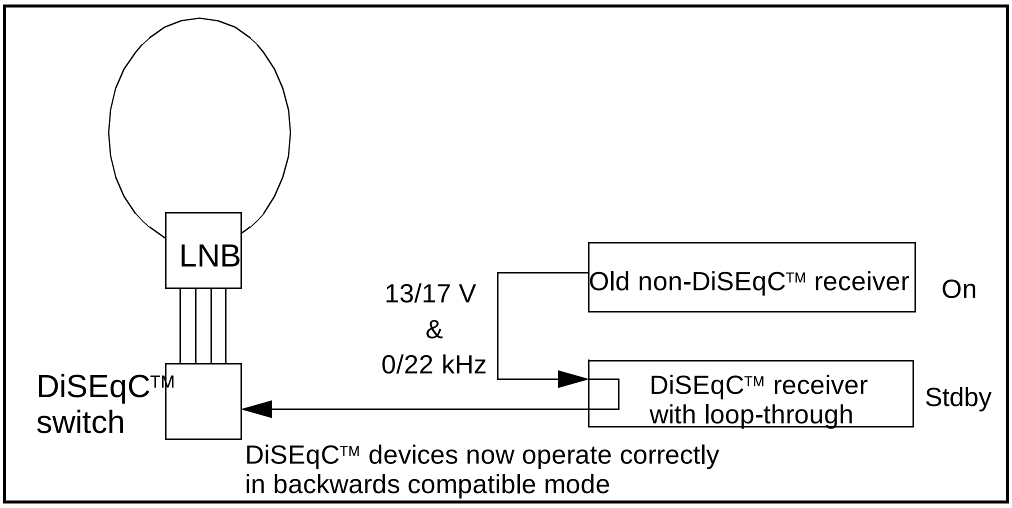


Figure 10: Slave ICs in the DiSEqC™ devices can now operate in backwards compatible mode

If NO reset signal is sent AND the analogue receiver is ALREADY switched on when the Digital IRD is powered down, then there is a strong possibility that power to the bus is maintained (particularly if the IF switching is very quick) and the Slave IC is then LOCKED into DiSEqC™ mode and would not respond to the conventional signals. In this case the user must switch-off the analogue receiver (i.e. remove the power from the bus) to force the Slave IC to reset. Therefore we STRONGLY RECOMMEND that all receivers with an IF Loop-Through implement a RESET command WHENEVER THE IF PATH IS SWITCHED. In general it is advisable that all receivers send a reset command when switching to stand-by.

The reset signal can be generated in two ways:

1. DiSEqC™ reset command 00h

2. Power-down (at least 50 ms)

Note: In the case of the Power-down technique, it will be necessary to allow an additional 100 ms delay on the subsequent power-on to allow the slave IC to reset, this gives a total reset period of at least 150 ms before a new command can be detected. The DiSEqC™ reset command will only take 40 ms and no additional delay is required.

Annex A. Common configurations for one-way DiSEqC™

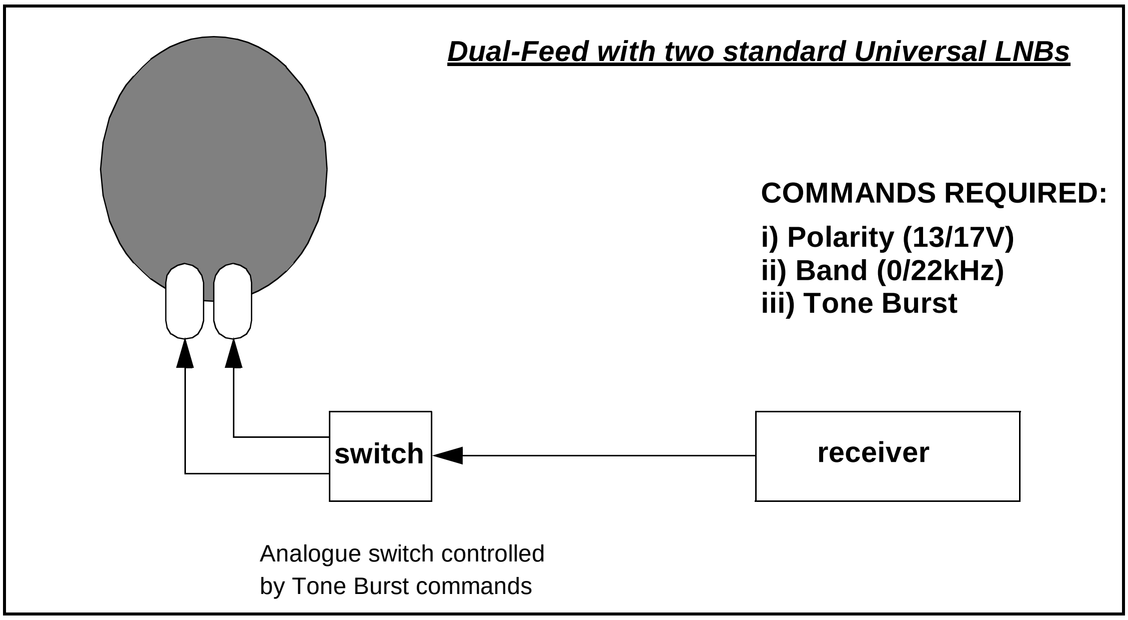


Figure 11: "DiSEqC™ Compatible" switch

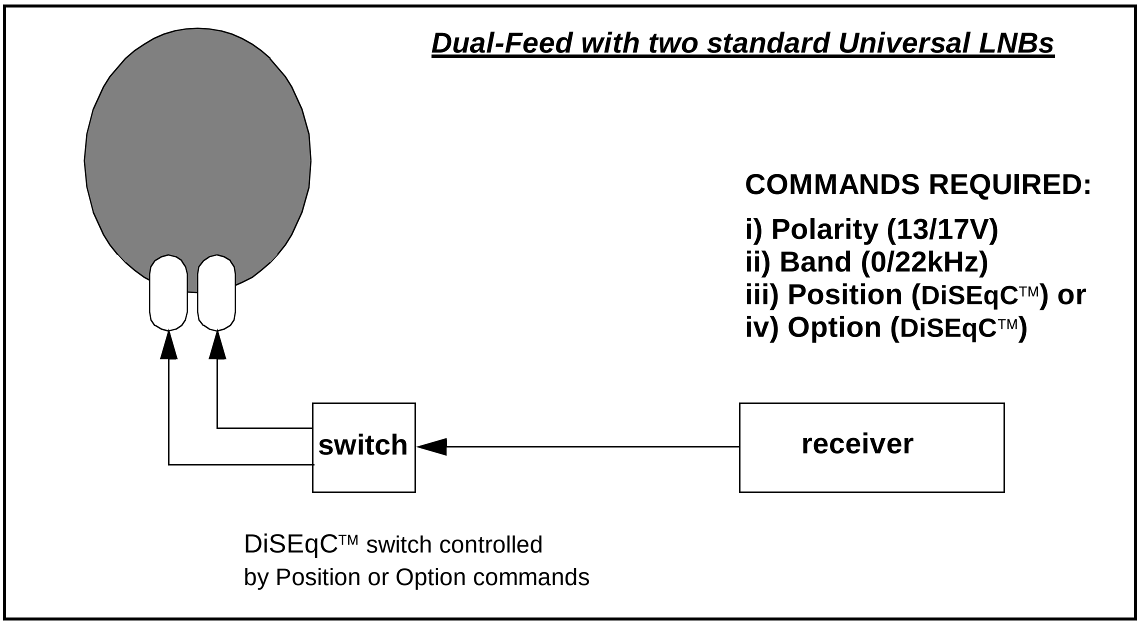


Figure 12: DiSEqC™ switch

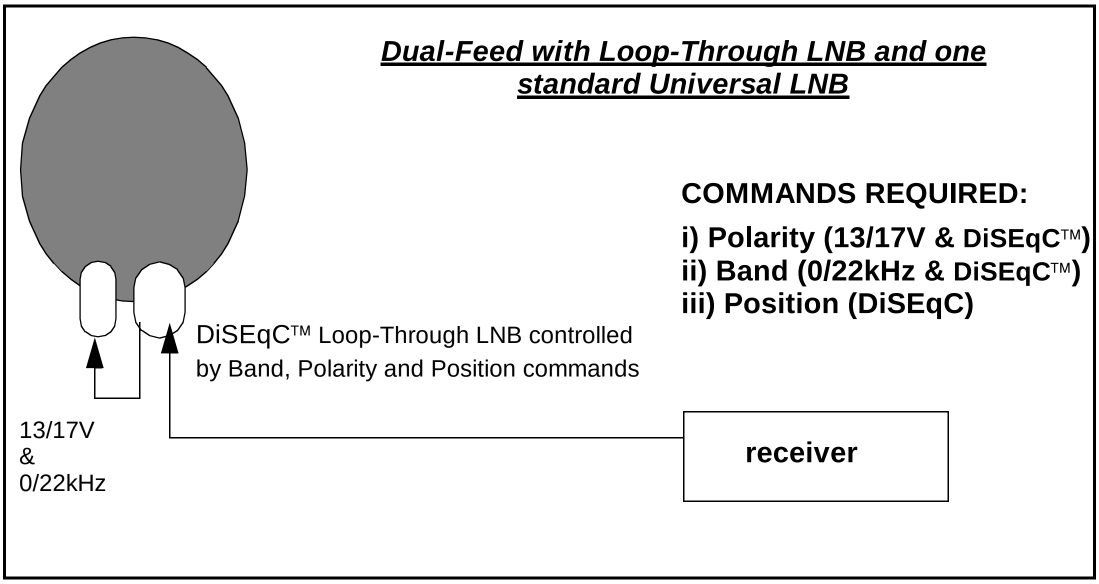


Figure 13: DiSEqC™ Loop-Through LNB

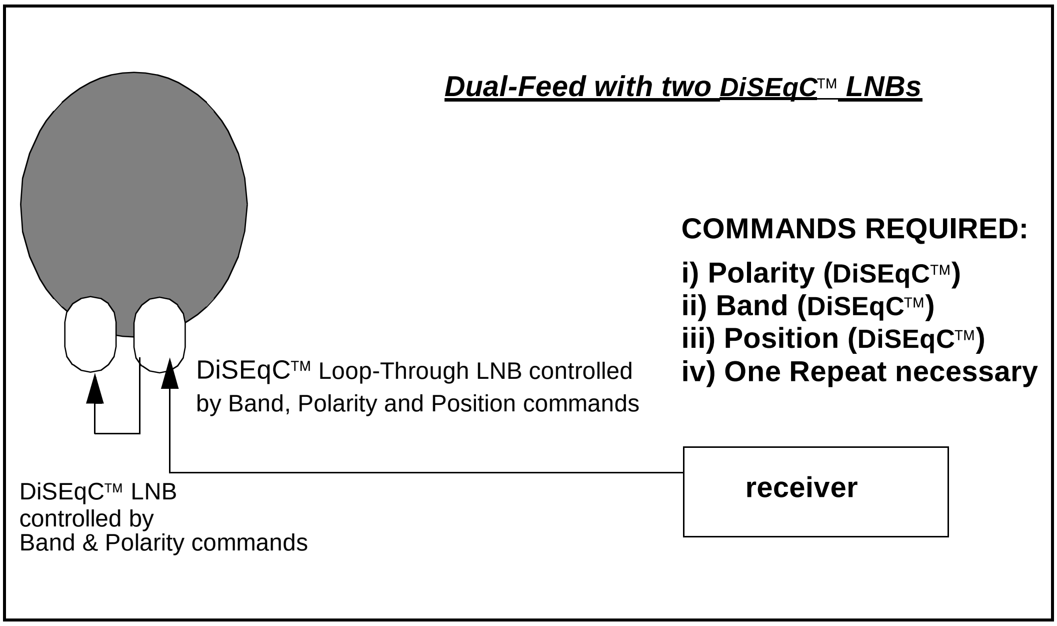


Figure 14: Two DiSEqC™ LNBs

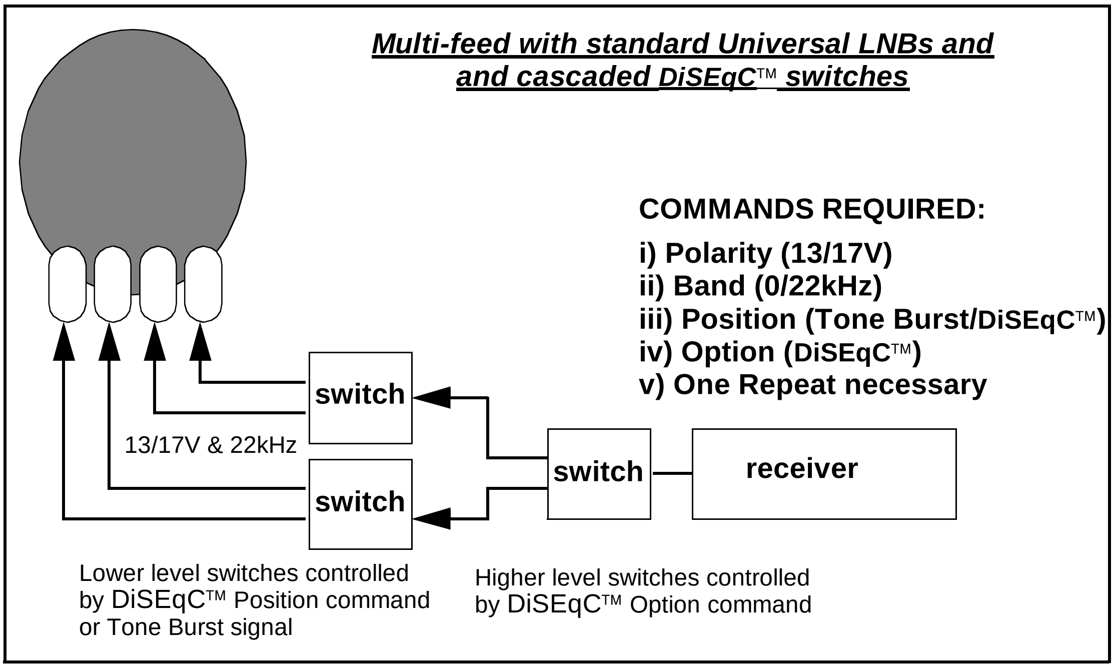


Figure 15: Cascaded DiSEqC™ switches

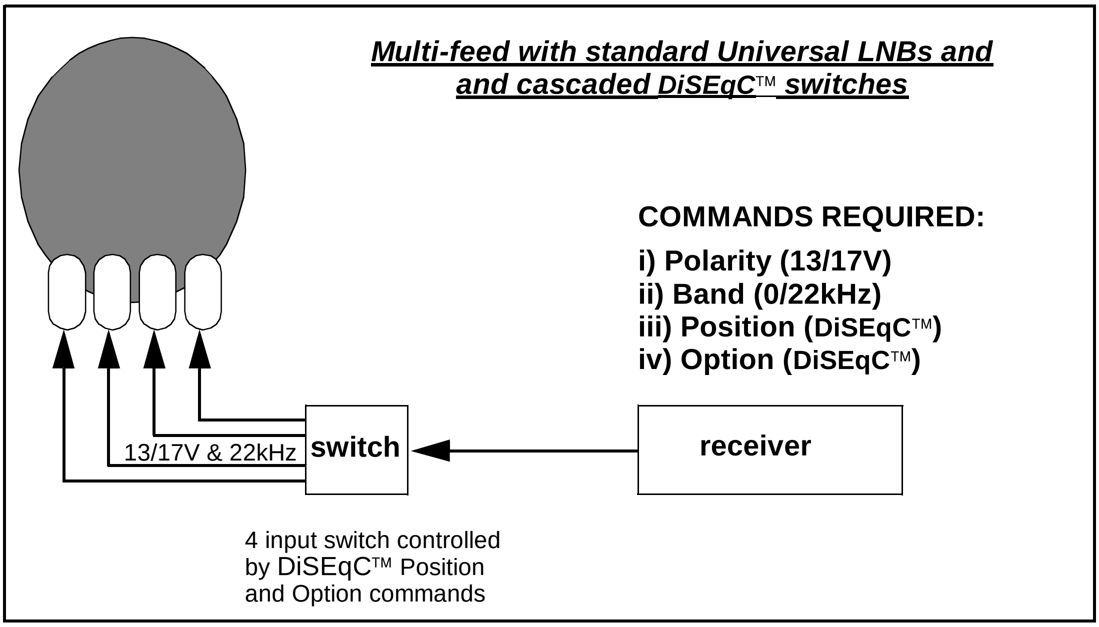


Figure 16: 4 Input DiSEqC™ switch

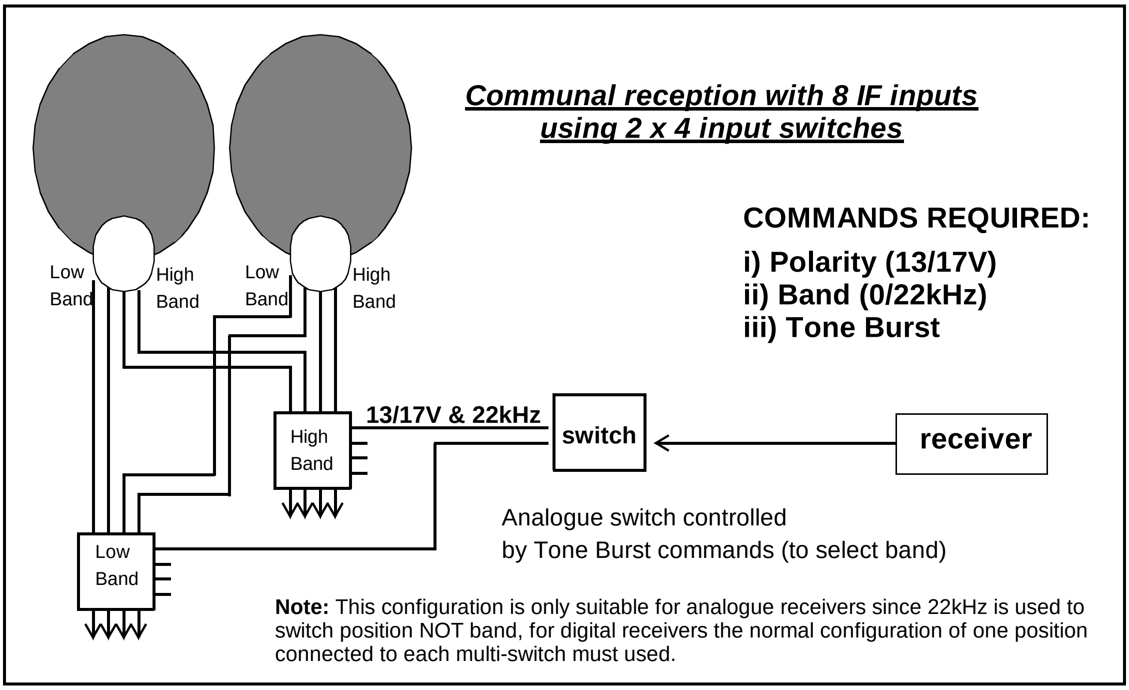


Figure 17: 8 cable switched IF distribution with Tone Burst control

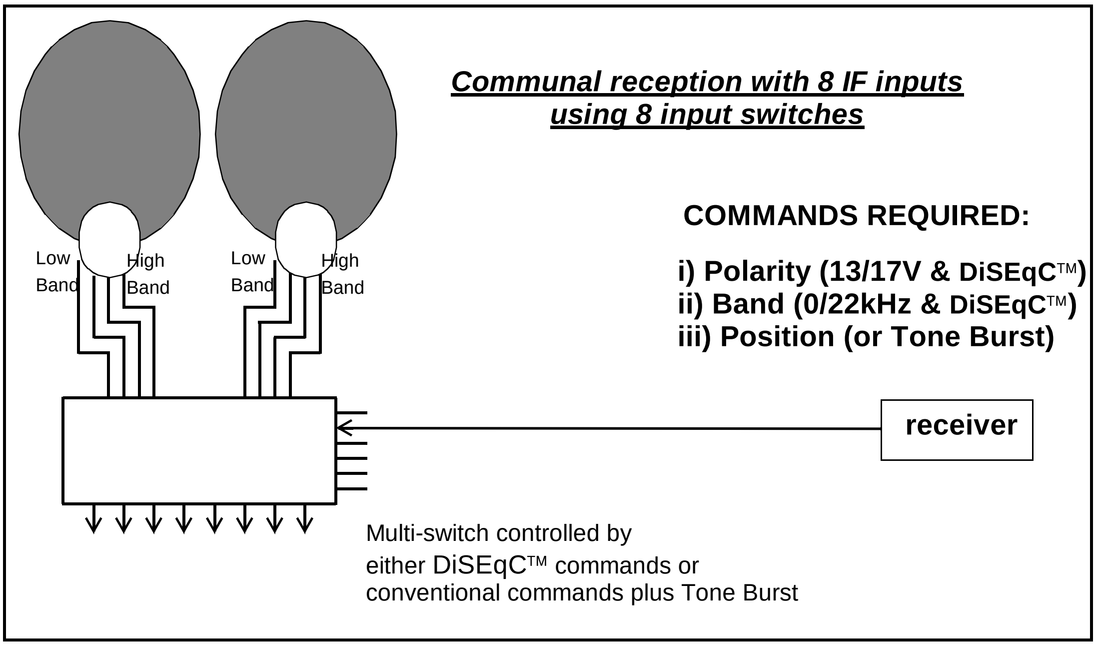


Figure 18: DiSEqC™ Multi-switch

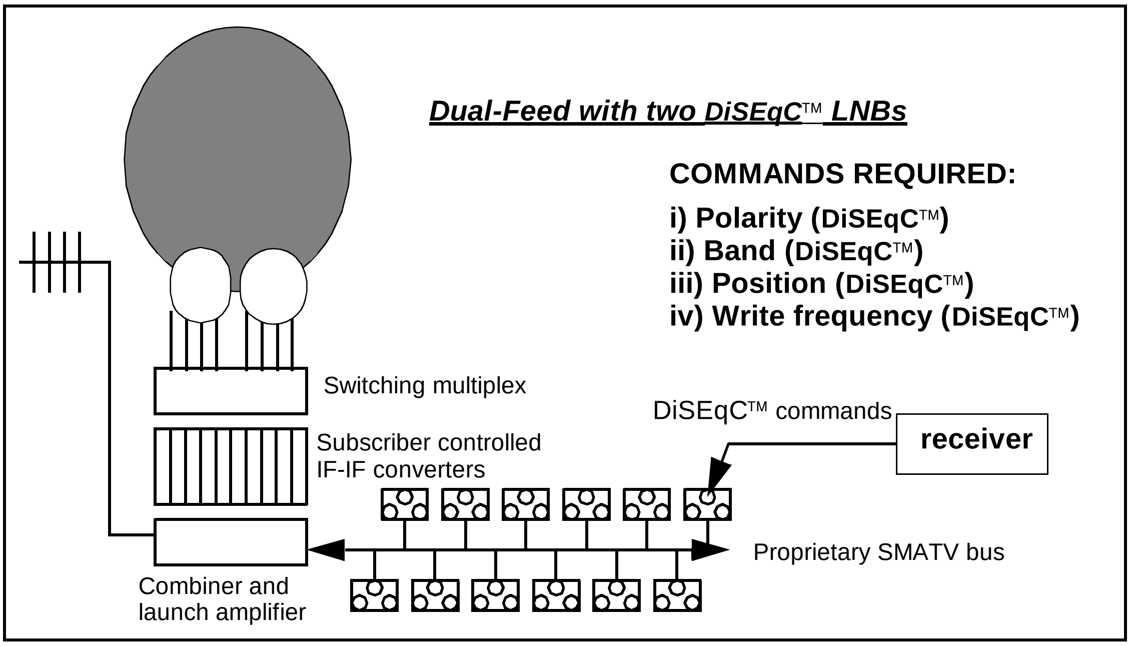


Figure 19: Subscriber controlled SMATV Headend

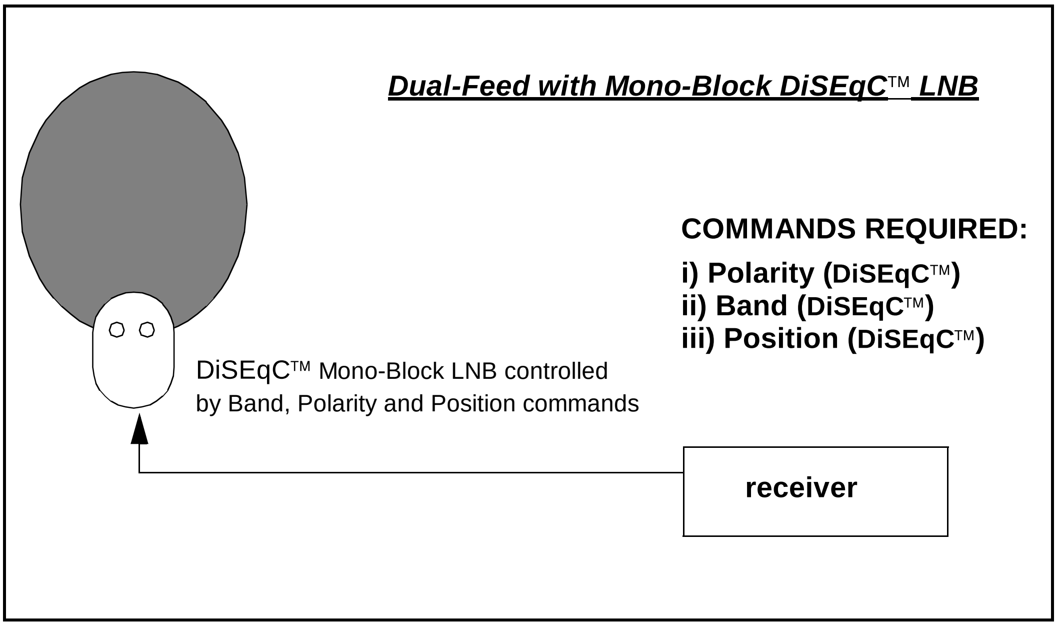


Figure 20: DiSEqC™ Mono-Block LNB

Annex B. Progress of CENELEC Standardisation

B.1. Current status

DiSEqC™ level 1.0 is planned to be incorporated as part of the existing European Norm EN 61319-1 "Interconnection of Satellite Receiving Equipment".

To this entent, the draft amendment prA11 of EN 61319-1 has been formally accepted by the TC 206 committee and has been approved for the Unique Acceptance Procedure (UAP).

This procedure takes 6 months to complete and is planned to start shortly.

B.2. Summary of prA11 of EN 61319-1

INTRODUCTION

In the first edition of the CLC publication EN 61319-1, the interfaces for the control and command of the devices associated with the satellite receivers are described in the following clauses:

cl 4:Interface requirements for polarizers and polar switchers

cl 5:Interface requirements for low noise block converters (LNB)

cl 6:Interface requirements for switching between different antenna sources or antenna positions.

In these clauses, analogue techniques are described and in particular the so called “13/18 DC. voltage and 22 kHz tone” which are extensively used in EUROPE today.

The purpose of this amendment is to introduce a single method of communication, between the satellite receiver and the peripheral equipment, using only the existing coaxial cable. The method is based on the specifications of the “Digital Satellite Equipment Control Bus” called DiSEqC™. It can replace all conventional analogue switching and all other control wiring.

It is backwards compatible with 13/18 volt and 22 kHz tone switching.

Interconnection of satellite receiving equipment

Part 1: Europe

Amendment prA11

SCOPE

This amendment deals with a subset of the DiSEqC™ Bus used for communications of control and command messages from the Satellite receiver/IRD to the peripheral equipment. It describes the principle of the communication method and gives the major requirements for:

-the system structure,

-the message structure and the table of commands,

-the signal characteristics,

-the signal transport conditions.

The following picture gives informative examples of typical configurations in order to show which interface is covered by the clauses of EN 61319-1 : 1995 and by those of this amendment.

Figure 1 is a reproduction of the figure 1 of the 1995 publication: it illustrates the "Conventional configuration"

Figure 2 shows how DiSEqC™ is used in the system.

(Existing diagram from CLC EN 61319-1 : 1995)

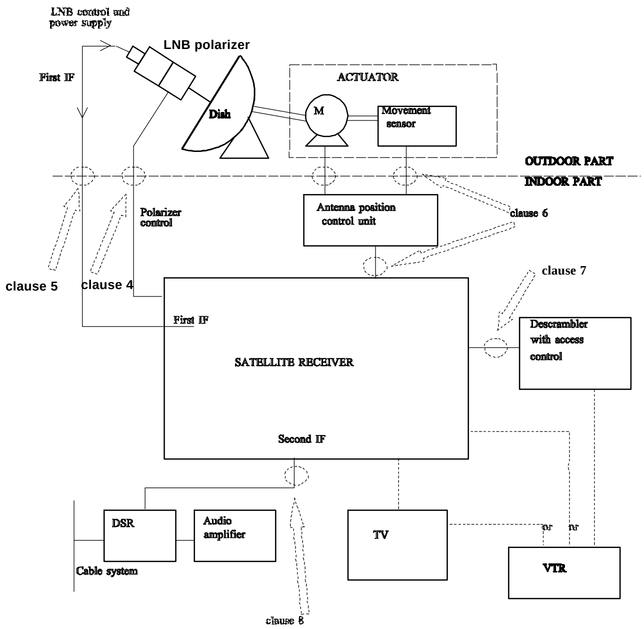


Figure 1 Diagram of a typical system

O D U = Outdoor Unit

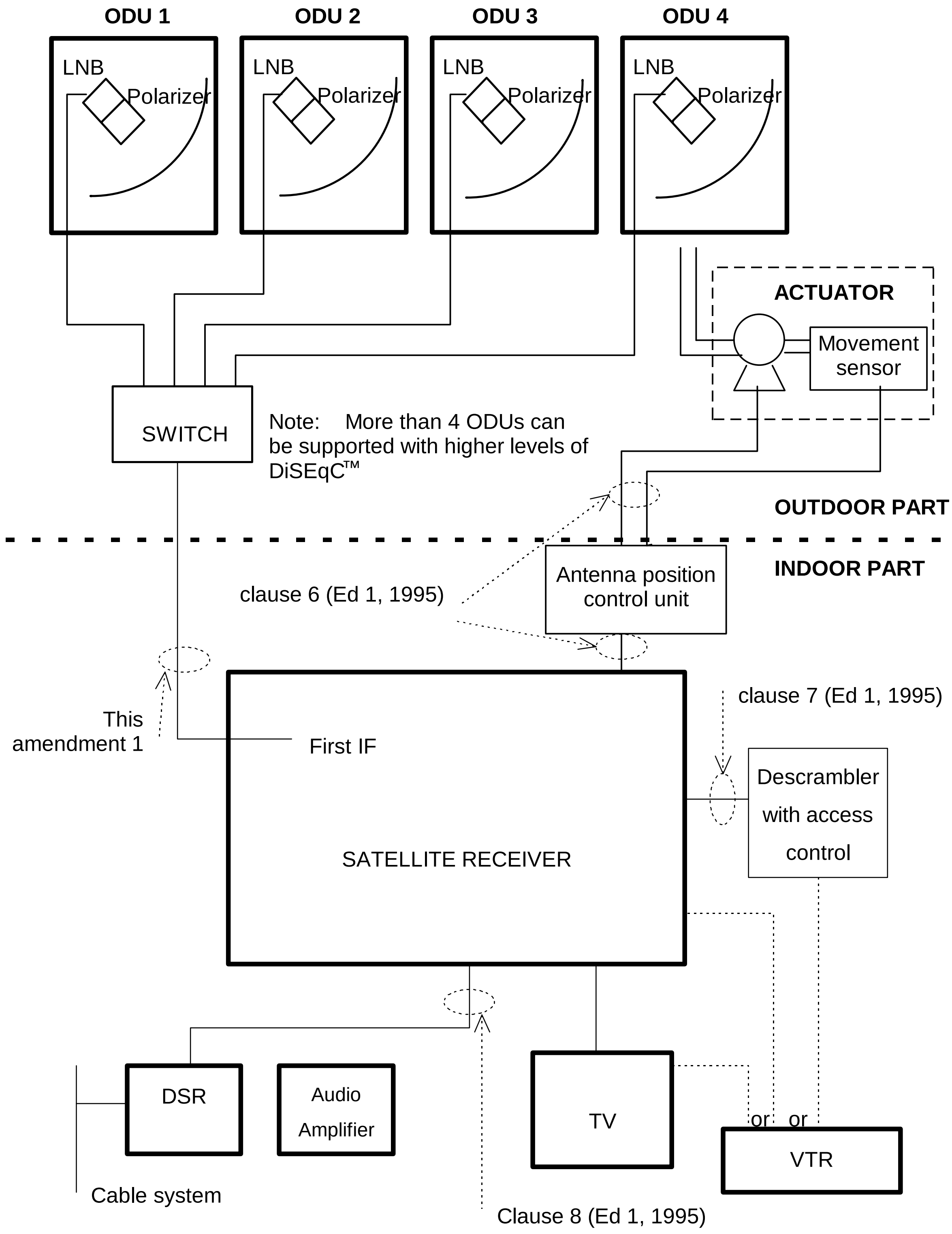


Figure 2: Diagram of a typical system using DiSEqC™

NORMATIVE REFERENCES

[1]EN 61319-1: 1995, “The interconnections of satellite receiving equipment, part 1

Europe.

[2]"DiSEqC™ Bus Functional Specifications Version 4.1", April 18th, 1997.

BASIC PRINCIPLE OF THE EXTENDED SIGNALLING METHOD

A complete description of the DiSEqC™ Bus is found in reference [2].

This standard deals with a subset of the DiSEqC™ Bus. Only ONE WAY SIGNALS from the satellite receiver/ IRD to the peripheral equipment are considered. Only the so called "DiSEqC™ level 1.0 are used (which includes the "Tone Burst signalling").

A significant difference between the content of this standard and the full DiSEqC™ specification is that automatic identification of the configuration (at the initialisation stage) by a dialogue between Master/Slave is impossible.

Appropriate procedures are therefore required at the installation of the systems.

The system is backwards compatible with the existing protocols, and to encourage the migration to full two-way DiSEqC™, it is recommended that the peripheral equipment always implement the reply capability (slave to master message).

TYPICAL APPLICATIONS

For the purpose of illustration, please refer to the typical applications as described in the informative annex A.

COMBINATION OF CONVENTIONAL AND NEW SIGNALLING MESSAGES

The conventional situation (reference [1]) is described by Figure 3:

13/18 V DC voltage

22 kHz continuous tone

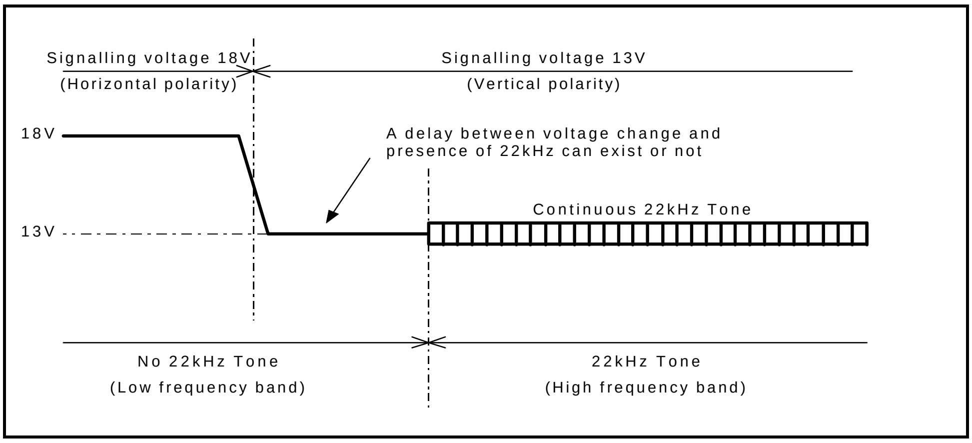


Figure 3: Conventional Signalling method

The new situation is described by Figure 4: DiSEqC™ level 1.0 which consists of two types of specific messages:

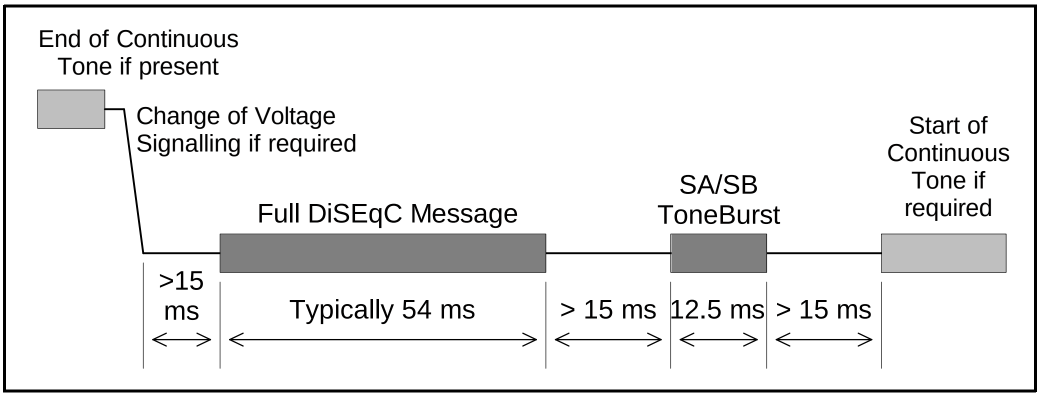


Figure 4: DiSEqC™ Level 1.0 Signalling

These messages are combined with the conventional 13/18V DC voltage and 22 kHz messages.

SIMPLE TONE BURST CONTROL SIGNAL

This command is intended just to control a simple two state switch.

The message can be recognised either by a simple analogue circuit or by a complete DiSEqC™ slave microcontroller.

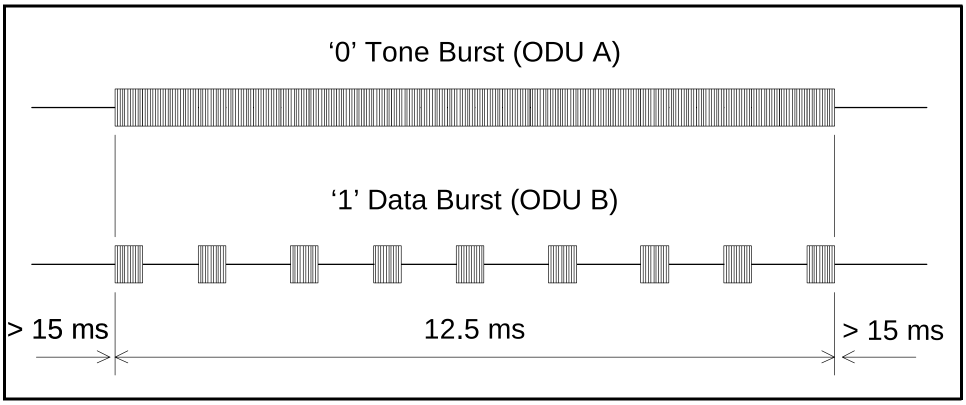


Figure 5 Modulation scheme for Tone Burst signal

Modulation mark period=500 µs ± 100 µs

Modulation space period=1 ms ± 200 µs

METHOD OF DATA BIT SIGNALLING

DiSEqC™ uses base-band timings of 500 ms (±100 ms) for a one-third bit PWK (Pulse Width Keying) coded signal period on a nominal 22 kHz (±4 kHz) carrier. In order to allow the detection of the end of a DiSEqC™ message a minimum period of 6 ms silence is required. The following diagram show the 22 kHz time envelope for each bit transmitted, with nominally 22 cycles for a Bit ‘0’ and 11 cycles for a Bit ‘1’. The 22 kHz tone is free running and can be chopped at random:

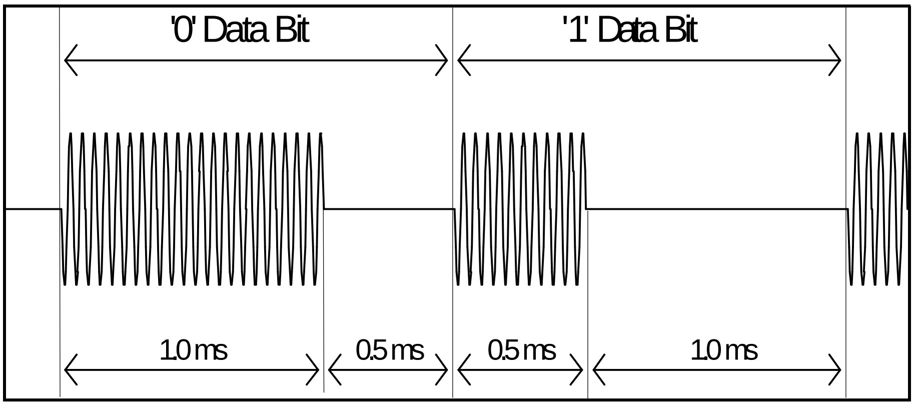


Figure 6 Modulation scheme for DiSEqC™ Bits

STRUCTURE OF A DISEQC MESSAGE

This structure is shown in figure 7.

As usual, eight elementary bits are associated to form a significant byte. In addition, odd parity bit is added to each byte.

Thus a byte has a typical duration of 13.5 ms and a DiSEqC™ message of 4 bytes has a duration of about 54 ms.

Master command to slaves:

FRAMING	P	ADDRESS	P	COMMAND	P	DATA	P

Figure 7: DiSEqC™ message structure

In the case of this standard, and with reference to Figure 5:

-The framing byte is E0h

("From Master, No reply, 1st transmissions")

-The address byte is 10h

("Any LNB switcher or SMATV")

-The command byte is 38h

(" Write to port group 0 (Committed switches)")

-The Data byte is according to the following table:

Voltage & Polarity (V/H)	Band (Low/High)	ODU inputs	Data	Data (Binary)	Tone Burst	SMATV Input
13 (V)	0	A	F0	1111.0000	A	1
18 (H)	0	A	F2	1111.0010	A	2
13 (V)	22K	A	F1	1111.0001	A	3
18 (H)	22K	A	F3	1111.0011	A	4
13 (V)	0	B	F4	1111.0100	B	5
18 (H)	0	B	F6	1111.0110	B	6
13 (V)	22K	B	F5	1111.0101	B	7
18 (H)	22K	B	F7	1111.0111	B	8
13 (V)	0	C	F8	1111.1000	A	9
18 (H)	0	C	FA	1111.1010	A	10
13 (V)	22K	C	F9	1111.1001	A	11
18 (H)	22K	C	FB	1111.1011	A	12
13 (V)	0	D	FC	1111.1100	B	13
18 (H)	0	D	FE	1111.1110	B	14
13 (V)	22K	D	FD	1111.1101	B	15
18 (H)	22K	D	FF	1111.1111	B	16

The relevant DiSEqC™ command must always correspond to the equivalent conventional control state.

In the same way, the DiSEqC™ "Position" bit always corresponds to the equivalent Tone Burst state.

CASCADED DiSEqC™ DEVICES

The case of cascaded DiSEqC™ devices is not considered in this standard. In the future this will be defined by additions to this standard, however at this time two possible techniques have already been identified:

1) Repeat commands (see reference [2])

2) Bus monitoring

POWER MANAGEMENT

To avoid overloading the satellite receiver's power supply, only one DC path between the receiver and the final LNB is allowed in the case of individual reception.

i.e. the DC path is always switched with the IF path.

In the case of SMATV installation with independent LNB power supply, this power management is not required if the DC load is high enough.

RESET AT POWER SET-UP.

In general, the Slave microcontroller shall be reset either by a power set-up or by a DiSEqC™ reset command 00h (full message is E0/00/00).

In the case of a power set-up reset there shall be at least 100 ms delay before the first DiSEqC™ message is sent.

Note:It is assumed that power set-up means that there has been no power present on the bus for at least 50 ms before the power is applied (or re-applied).

RESET WHEN USING LOOP THROUGH TUNERS

For receivers employing an IF Loop-Through (e.g. digital IRDs with a loop-through for an analogue receiver) must include a reset for the Slave IC each time the IF path is switched, to ensure backwards compatibility with non-DiSEqC™ receivers. Please refer to the following figures:

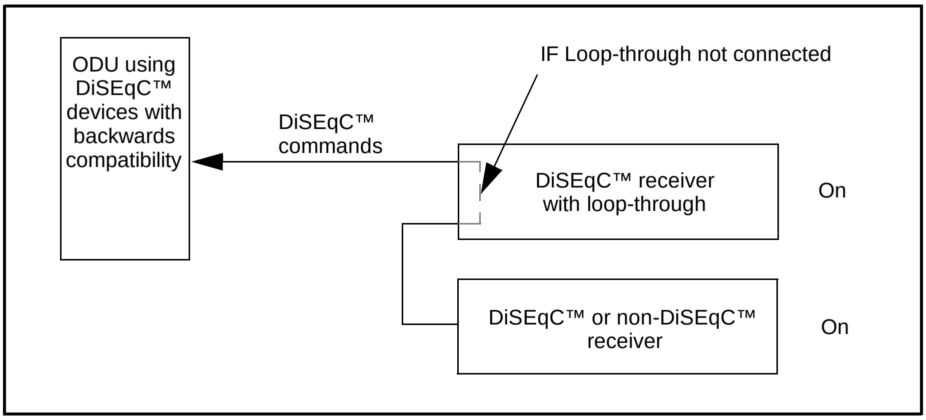


Figure 8a:DiSEqC™ receiver with loop-through is controlling DiSEqC™ devices using DiSEqC™ commands

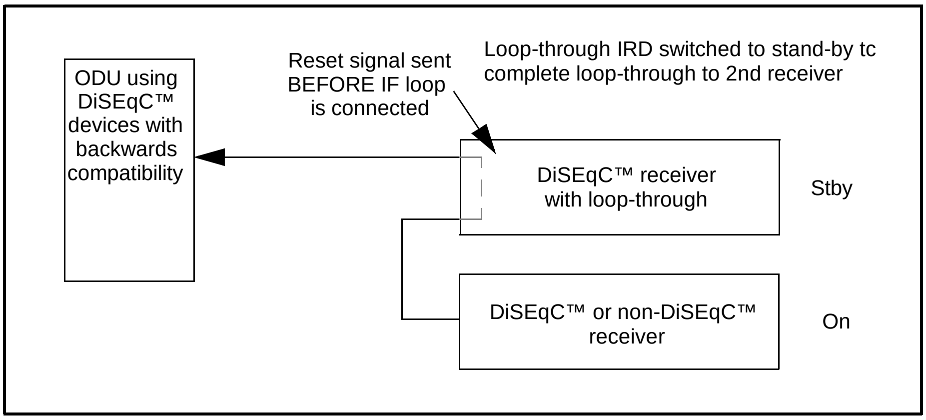


Figure 8b:When loop-through receiver is switched to stand-by a reset signal must be sent to the DiSEqC™ devices

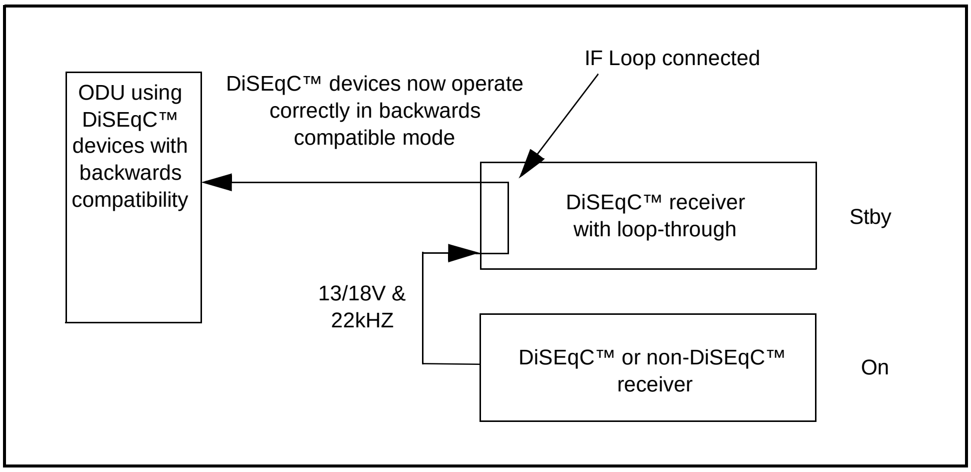


Figure 8c:Slave IC in DiSEqC™ devices can now operate in backwards compatible mode

If no reset signal is sent and the non-DiSEqC™ receiver is already switched on when the loop-through IRD is powered down, then there is a strong possibility that power to the bus is maintained (particularly if the IF switching is very quick) and the Slave IC is then locked into DiSEqC™ mode and would not respond to the conventional signals. In this case the user must switch-off the non-DiSEqC™ receiver (i.e. remove the power from the bus) to force the Slave IC to reset. Therefore all receivers with an IF Loop-Through shall send a reset signal whenever the IF path is switched

The reset signal can be generated in two ways:

1. DiSEqC™ reset command (E0/00/00h)

2. Power-down (at least 50 ms)

Note:In the case of the power-down technique, it is necessary to allow an additional 100 ms delay before a new DiSEqC™ command can be detected.

The reset signal shall be followed by the '0' Tone Burst (ODU A) to ensure the correct setting of a Tone Burst operated switch. This position 'A', shall be related to the satellite sources for the non-DiSEqC™ receiver, since this setting remains unaffected by subsequent 22 kHz switching from the non-DiSEqC™ receiver.

DC VOLTAGE RISE AND SETTLING TIME

In any case, the settling time, at power set up or when there is a change in voltage level, shall be less than 10 ms.

Note:It should be kept in mind that the connecting cable used between the satellite receiver/IRD and the accessories degrades the performances in terms of voltage level and rise time. The interface between the IRD and the accessories, as regard to the power supply aspect, must be carefully, specified (cable choice, cable length, maximum degradation for loop through LNBs and RF switch, capacitive load, etc.)

TIME SEQUENCES FOR DISEQC MESSAGES

There are requirements on the sequence of messages sent by the receiver/IRD to the LNBs.

Three cases are considered:

a)One input IRDs at power on:

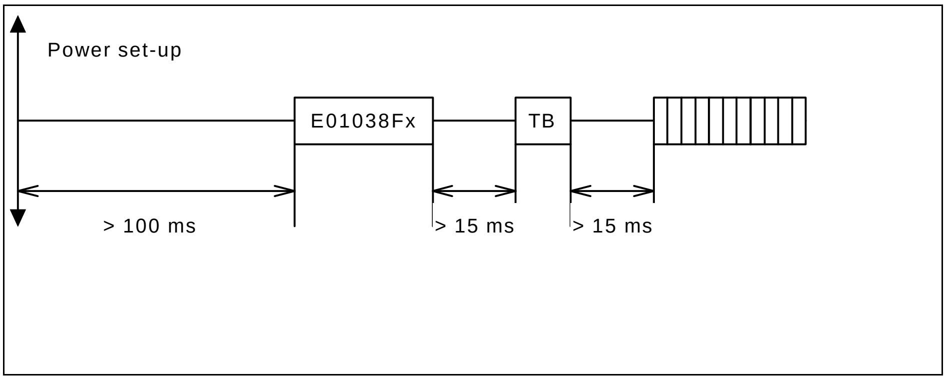


Figure 9: Timing sequence at power-on

b)Two input IRDs at power on or after each change of the input during operation:

The above sequence (figure 10) must be used

c)Change of the channel or change in the menu (no power interruption)

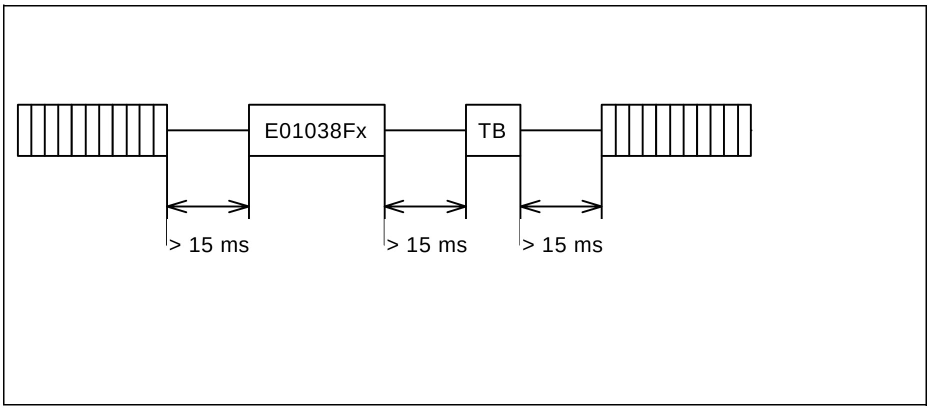


Figure 10: Timing sequence on channel/menu change (no power interruption)

FREQUENCY ALLOCATION OF THE LOCAL OSCILLATORS

In an SMATV situation, the combination of band, polarity, position and option commands allows selection of up to 16 IF inputs. Therefore, in principle, 16 different local oscillator frequencies could be used. As an example, in the simplest case where only two local oscillator frequencies (9.75 GHz and 10.6 GHz) are supported, these should be in close relation with the command of band selection (Low/High).

For SMATV, if there is no particular user's provisions, it is recommended to programme the local oscillators for the individual inputs by using only 9.75 and 10.6 GHz in the following way:

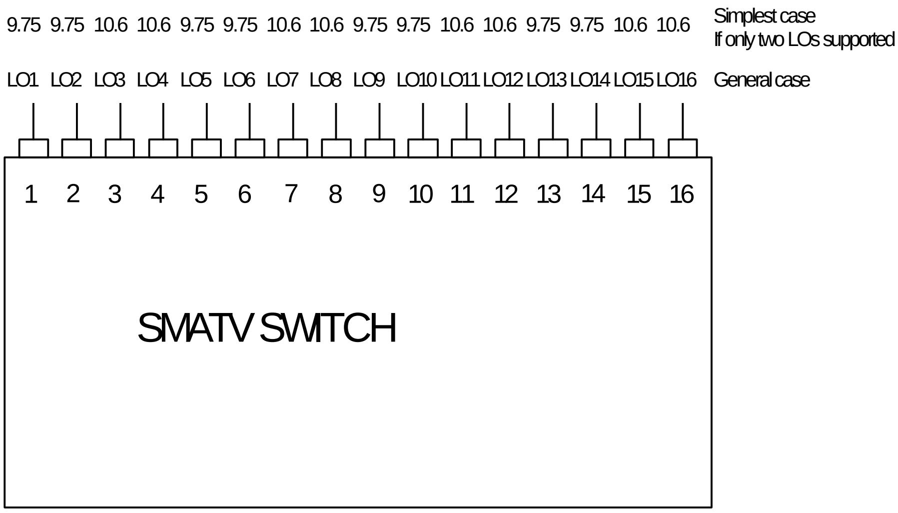


Figure 11: Allocation of LNB Local Oscillator frequencies in SMATV case

CHARACTERISTICS OF THE SIGNALLING DC VOLTAGE

This signalling voltage ("13/18 V") is used for polarization control in polar switchers ("13 V" for Vertical/ Right Hand circular and "18 V" for Horizontal/Left Hand circular).

The specifications of the publication CLC EN 61319-1:1995 (clause 4.3, 5.2.2 and 5.2.3) are used without any alterations.

CHARACTERISTICS OF THE 22 KHZ SIGNALLING TONE

In the conventional command method, this tone is used when a dual band block converter is combined with a polar switcher (see ref. [1]).

The presence of the tone corresponds to the selection of the higher microwave band. In the DiSEqC method, the previous disposition remains valid (backwards compatibility) but the 22 kHz tone is chopped to create a "Tone Burst" (See this amendment clause, page 9) used for selection of ODU A or ODU B.

The characteristics and tolerances of the 22 kHz tone are indicated in CLC EN 61319-1 : 1995 clause 5.2.3 and are used here without any alterations.

The 22 kHz tone, superimposed on the supply voltage, should be in the future centered on this continuous voltage in order to maintain the same mean value with or without the 22 kHz tone. In the future, this centering should be better than ± 20% of the amplitude of the 22 kHz tone.

TRANSPORT OF THE 22 KHZ TONE

To permit transport of the 22 kHz tone, it is recommended that the total load capacitance at the far end of the bus (cable) should not exceed 250 nF (0.25 µF). This value is chosen to tolerate one LNB of existing design for a cable length of up to 50 meters. True DiSEqC™ peripherals should not load the bus by typically more than 100 nF, and for certain classes of device such as SMATV nodes and Installer Aids, a much lower value is preferred.

To permit back-channel signalling in the future, the Master transmitter (in the Tuner-receiver/IRD) should present a nominal source impedance of 15Ω to the bus, at 22 kHz. This termination will typically consist of a resistor, a parallel inductor to support the DC power supply current, and a capacitor (to ground) to shape the 22 kHz tone when the cable length and termination capacitance are both small.

IPR, TRADEMARK AND LOGO

DiSEqC™ is an open standard, no license is required or royalty is to be paid to the rightholder EUTELSAT.

DiSEqC™ is a trademark of EUTELSAT.

Conditions for use of the trademark and the DiSEqC™ logo can be obtained from EUTELSAT.

Informative Annex A - typical applications

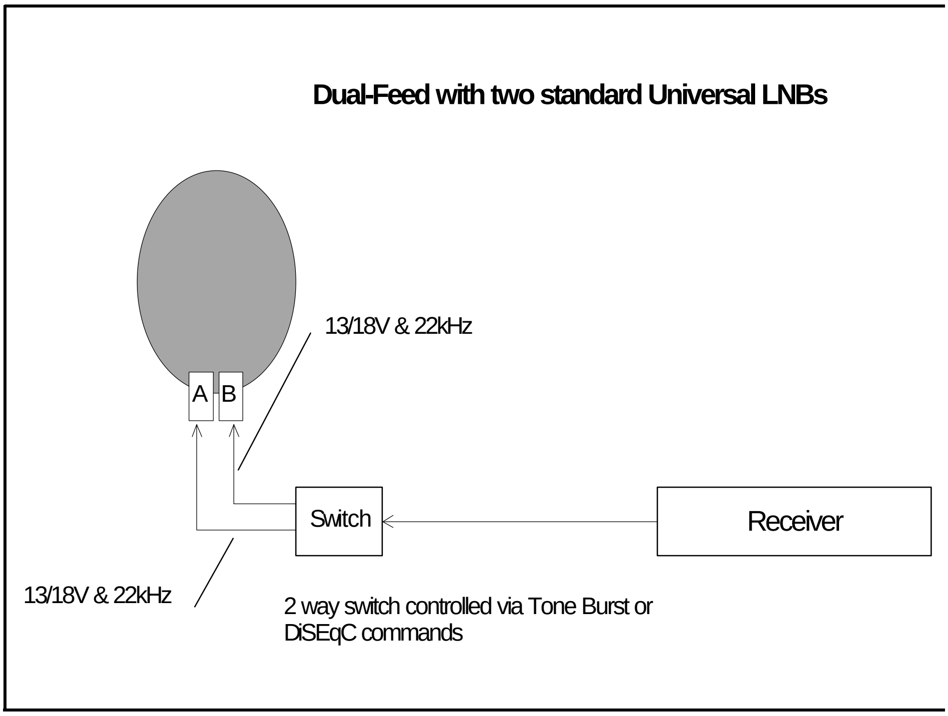


Figure A1:Two state switch controlled via DiSEqC™ level 1.0

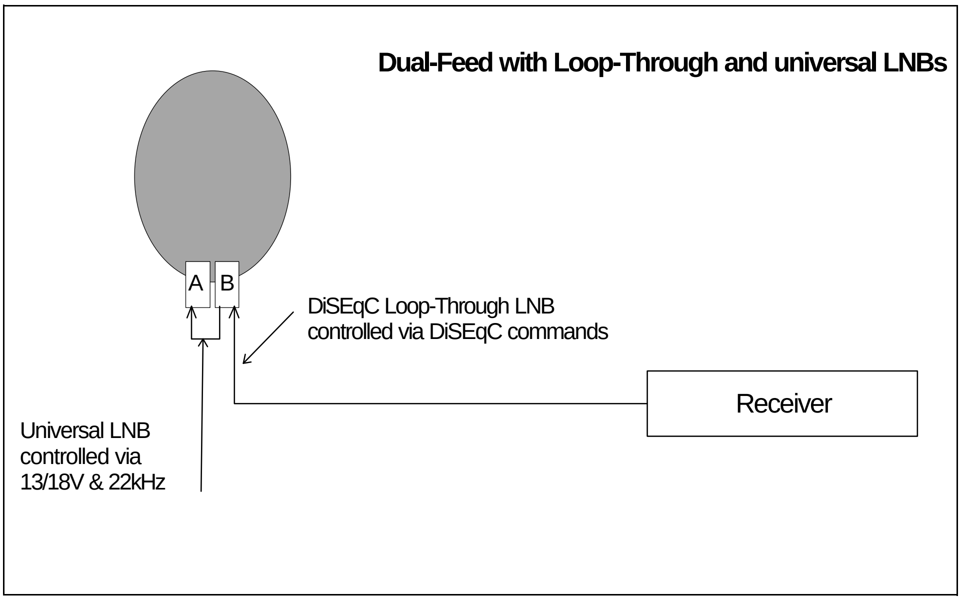


Figure A2:Dual Feed with Loop Through and an universal LNB using DiSEqC™ level 1.0

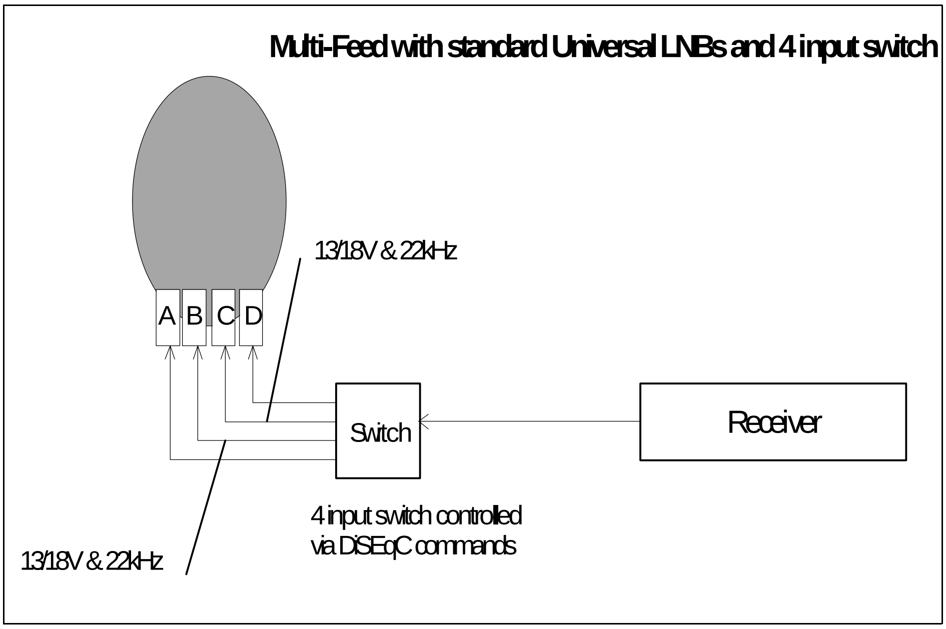


Figure A3:Multi-Feed with several universal LNBs and external switch using DiSEqC™ level 1.0

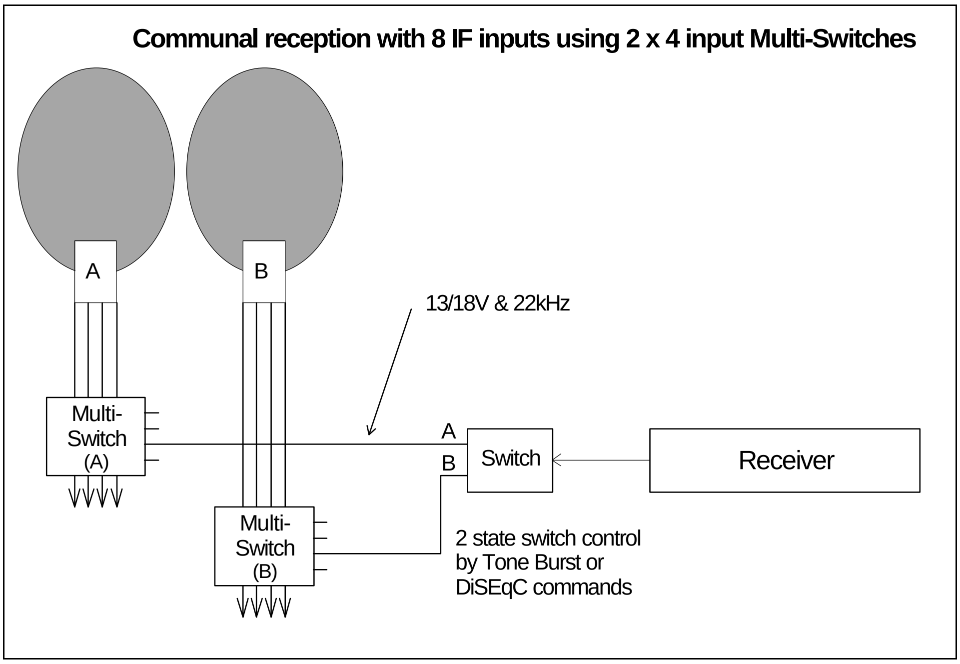


Figure A4:Communal reception with 8 IF inputs using 2 x 4 input conventional multi-switches using DiSEqC™ level 1.0

Communal reception with 8 IF inputs using 8 input Multi-Switch

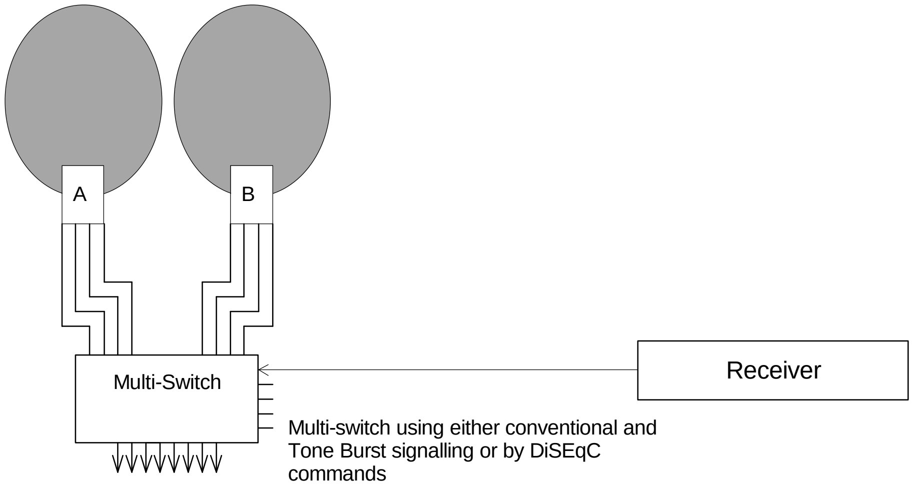


Figure A5:Communal reception with 8 IF inputs using DiSEqC™ level 1.0