



# **ZigBee Remote Control™ Public Application Profile Specification Version 1.1.0**

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Abstract                         This specification defines the protocol infrastructures and services available to applications operating on the ZigBee RF4CE platform using the ZigBee Remote Control profile.

Keywords                        RF4CE, application, ZRC, profile.

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# 1 Introduction

This specification specifies the ZigBee RF4CE profile 0x01: ZigBee Remote Control (ZRC) which interfaces to the ZigBee RF4CE network layer (see [R1] ). The ZRC profile defines commands and procedures to enable CE RC applications and utilizes the HDMI CEC command set.

## 1.1 Definitions

<b>Controller</b>	A PAN participant that has ZigBee RF4CE functionality.
<b>Device</b>	An object that has IEEE 802.15.4 functionality.
<b>Node</b>	A device that has ZigBee RF4CE functionality.
<b>Originator</b>	The device from which a ZigBee RF4CE transmission is sent.
<b>Pair</b>	A logical association between two nodes.
<b>PAN</b>	A personal area network as defined in IEEE 802.15.4.
<b>PAN coordinator</b>	A device that can create its own PAN.
<b>PAN participant</b>	A device that can join a PAN.
<b>RC network</b>	Multiple, interoperating, RC PANs.
<b>RC PAN</b>	A PAN consisting exclusively of ZigBee RF4CE nodes.
<b>Recipient</b>	The device to which a ZigBee RF4CE transmission is directed.
<b>Target</b>	A PAN coordinator that has ZigBee RF4CE functionality.

## 1.2 Conformance levels

The following words, used throughout this document, have specific meanings:

<b>May</b>	A key word indicating a course of action permissible within the limits of the standard ( <i>may equals is permitted</i> ).
<b>Shall</b>	A key word indicating mandatory requirements to be strictly followed in order to conform to the standard; deviations from shall are prohibited ( <i>shall equals is required to</i> ).
<b>Should</b>	A key word indicating that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; that a certain course of action is preferred but not necessarily required; or, that (in the negative form) a certain course of action is deprecated but not prohibited ( <i>should equals is recommended that</i> ).

## 1.3 Abbreviations

CE	Consumer electronics
CEC	Consumer electronics control
HDMI	High-definition multimedia interface
ID	Identifier
IEEE	Institute of electrical and electronic engineers

LQI	Link quality indication
MAC	Medium access control
NIB	Network information base
NLDE	Network layer data entity
NLME	Network layer management entity
NWK	Network
ORG	Originator
PAN	Personal area network
PHY	Physical
POS	Personal operating space
RC	Remote control
REC	Recipient
RF	Radio frequency
RF4CE	Radio frequency for consumer electronics
SAP	Service access point

1

## 2 **1.4 Conventions**

### 3 **1.4.1 Number formats**

4 In this specification hexadecimal numbers are prefixed with the designation “0x” and binary numbers are  
5 prefixed with the designation “0b”. All other numbers are assumed to be decimal.

### 6 **1.4.2 Transmission order**

7 The frames in this specification are described as a sequence of fields in a specific order. All frame formats  
8 are depicted in the order in which they are transmitted by the PHY, from left to right, where the leftmost bit  
9 is transmitted first in time. Bits within each field are numbered from 0 (leftmost and least significant) to k-1  
10 (rightmost and most significant), where the length of the field is k bits. Fields that are longer than a single  
11 octet are sent to the MAC in the order from the octet containing the lowest numbered bits to the octet  
12 containing the highest numbered bits.

### 13 **1.4.3 Timing values**

14 All timing values within this specification are specified in terms of MAC symbols. One MAC symbol is  
15 equal to 16µs. Where appropriate, absolute time values are presented in both MAC symbols and actual  
16 time in parenthesis.

### 17 **1.4.4 Message sequence charts**

18 During this specification, message sequence charts are used to illustrate the flow of various operations.  
19 Instances are labeled with the layer (APL for the application or NWK for the network) followed by the  
20 node type (ORG for the originator or REC for the recipient). Primitives are shown in normal style but, for  
21 simplicity, without the entity prefix (i.e. NLDE or NLME), e.g. “NLME-PAIR.response” becomes  
22 “PAIR.response”. Over the air command frames are labeled in italic text.

#### 1.4.5 Reserved values

Unless otherwise specified, all reserved fields appearing in a frame structure (c.f. Figure 2) shall be set to zero on transmission and ignored upon reception. Reserved values appearing in multi-value fields (c.f. Table 1) shall not be used.

#### 1.5 References<sup>1</sup>

- [R1] ZigBee RF4CE Specification, ZigBee Alliance document 094945, Version 1.0.1, November, 2010.
- [R2] High-Definition Multimedia Interface Specification, HDMI Licensing, LLC, Version 1.3a, November 10, 2006.

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<sup>1</sup> The version and date information in these references was correct at the time this document was released.

## 2 General ZRC command frame format

The general ZRC command frame shall be formatted as illustrated in Figure 1.

Bits: 8	Variable
Frame control	Command payload
ZRC header	ZRC payload

**Figure 1 – General ZRC command frame format**

### 2.1 Frame control field

The frame control field is 8 bits in length and contains information defining the ZRC command code. The frame control field shall be formatted as illustrated in Figure 2.

Bits: 0-4	5-7
ZRC command code	Reserved

**Figure 2 – Format of the ZRC frame control field**

#### 2.1.1 ZRC command code sub-field

The ZRC command code sub-field is 5-bits in length and shall be set to one of the non reserved values listed in Table 1. Each of these commands is described in the following sub-clauses.

**Table 1 – Values of the ZRC command code field**

ZRC command code	Description
0x00	Reserved
0x01	User control pressed
0x02	User control repeated
0x03	User control released
0x04	Command discovery request
0x05	Command discovery response
0x06 – 0x1f	Reserved

### 2.2 Command payload field

The command payload field has a variable length and contains information specific to individual ZRC commands.

### 3 ZRC command frames

#### 3.1 User control pressed command frame

The user control pressed command frame allows a node to request a remote node performs the specified RC (HDMI CEC) command.

This command shall be directed either to a specific node that is already in the pairing table or broadcast.

The user control pressed command frame shall be formatted as illustrated in Figure 3.

Bits: 8	8	Variable
Frame control	RC command code	RC command payload
ZRC header	ZRC payload	

**Figure 3 – Format of the user control pressed command frame**

##### 3.1.1 RC command code field

The RC command code field is 8-bits in length and shall contain the HDMI CEC operand “[UI Command]” (see [R2] for details).

##### 3.1.2 RC command payload field

The RC command payload field has a variable length and shall contain the additional operands, if any, required by the HDMI CEC command specified in the RC command code field (see [R2] for details). If the HDMI CEC command specified in the RC command code field does not specify any additional operands, the RC command payload field shall not be included.

#### 3.2 User control repeated command frame

The user control repeated command frame allows a node to request a remote node performs the last RC command requested through a user control pressed command frame (e.g. when an RC button is held down).

This command frame shall only be sent following a user control pressed command frame.

The user control repeated command frame shall be formatted as illustrated in Figure 4.

Bits: 8	8	Variable
Frame control	RC command code	RC command payload
ZRC header	ZRC payload	

**Figure 4 – Format of the user control repeated command frame**

##### 3.2.1 RC command code field

The RC command code field is 8-bits in length and shall contain the HDMI CEC operand “[UI Command]” (see [R2] for details) that corresponds to the user control being repeated.

##### 3.2.2 RC command payload field

The RC command payload field has a variable length and shall contain the additional operands, if any, required by the HDMI CEC command specified in the RC command code field (see [R2] for details). If the

HDMI CEC command specified in the RC command code field does not specify any additional operands, the RC command payload field shall not be included.

### 3.3 User control released command frame

The user control released command frame allows a node to notify a remote node that an RC command should be terminated following a user control repeated command frame (e.g. when an RC button is released).

This command frame shall be sent following a user control repeated command frame to indicate the termination of the operation. This command frame may also be sent following a user control pressed command frame if a user control repeated command frame is not sent.

The user control released command frame shall be formatted as illustrated in Figure 5.

Bits: 8	8
Frame control	RC command code
ZRC header	ZRC payload

**Figure 5 – Format of the user control released command frame**

#### 3.3.1 RC command code field

The RC command code field is 8-bits in length and shall contain the HDMI CEC operand “[UI Command]” (see [R2] for details) that corresponds to the user control being released.

### 3.4 Command discovery request command frame

The command discovery request command frame allows a node to query which user control commands are supported on a remote node, i.e. those specified in the user control pressed command frame. The remote node responds with a command discovery response command frame which contains a bitmap indicating the user control commands supported for the requested command bank.

This command shall be directed to a specific node that is already in the pairing table.

The command discovery request command frame shall be formatted as illustrated in Figure 6.

Bits: 8	8
Frame control	Reserved
ZRC header	ZRC payload

**Figure 6 – Format of the command discovery request command frame**

### 3.5 Command discovery response command frame

The command discovery response command frame allows a node to respond to a command discovery request from a remote node, indicating which user control commands, i.e. those specified in the user control pressed command frame, it supports.

This command shall be directed to a specific node that is already in the pairing table.

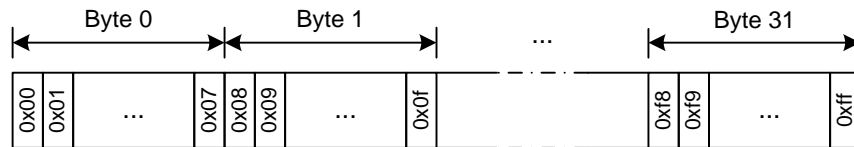
The command discovery response command frame shall be formatted as illustrated in Figure 7.

<b>Bits: 8</b>	<b>8</b>	<b>256</b>
Frame control	Reserved	Commands supported
ZRC header	ZRC payload	

**Figure 7 – Format of the command discovery response command frame**

### 3.5.1 Commands supported field

The commands supported field is 256 bits in length and contains an indication of which user control commands are supported. The least significant bit of this field corresponds to the command with ID 0x00 and the most significant bit of this field corresponds to the command with ID 0xff, as illustrated in Figure 8.



**Figure 8 – Format of the commands supported field**

For each bit, if the corresponding command is supported the bit shall be set to one. Otherwise, the bit shall be set to zero. For example, a TV device supporting the mandatory command set (see Annex A) would return its commands supported field as illustrated in Figure 9.

Byte 00	Byte 01	Byte 02	Byte 03	Byte 04	Byte 05	Byte 06	Byte 07
1f	22	00	00	00	00	03	00
Byte 08	Byte 09	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15
06	00	00	00	00	38	00	00
Byte 16	Byte 17	Byte 18	Byte 19	Byte 20	Byte 21	Byte 22	Byte 23
00	00	00	00	00	00	00	00
Byte 24	Byte 25	Byte 26	Byte 27	Byte 28	Byte 29	Byte 30	Byte 31
00	00	00	00	00	00	00	00

**Figure 9 – Example use of the commands supported field for mandatory TV commands**

## 4 ZRC profile constants and attributes

### 4.1 ZRC profile constants

The constants that define the characteristics of the ZRC profile are presented in Table 2.

**Table 2 – ZRC profile constants**

Constant	Description	Value
<i>aplcMaxCmdDiscRxOnDuration</i>	The maximum duration that the receiver is enabled on a controller after pairing to receive any command discovery request command frames.	200ms
<i>aplcMaxKeyRepeatInterval</i>	The maximum time between consecutive user control repeated command frame transmissions.	100ms
<i>aplcMaxPairIndicationWaitTime</i>	The maximum amount of time a device waits after receiving a successful NLME-AUTO-DISCOVERY.confirm primitive for a pair indication to arrive from the pairing initiator.	1s
<i>aplcMaxResponseWaitTime</i>	The maximum time a device shall wait for a response command frame following a request command frame.	200ms
<i>aplcMinKeyExchangeTransferCount</i>	The minimum value of the KeyExTransferCount parameter passed to the pair request primitive during the push button pairing procedure.	3
<i>aplcMinTargetBlackoutPeriod</i>	The minimum amount of time a device must wait after a successful pairing attempt with a target before attempting command discovery.	500ms



## 4.2 ZRC profile attributes

The ZRC profile defines attributes required to manage the way the ZRC profile operates. These attributes are presented in Table 3.

**Table 3 – ZRC profile attributes**

Attribute	Identifier	Type	Range	Description	Default
<i>aplKeyRepeatInterval</i>	0x80	Integer	$0 - aplcMaxKeyRepeatInterval$	The interval in ms at which user command repeat frames will be transmitted.	$0.5 * aplcMaxKeyRepeatInterval$
<i>aplKeyRepeatWaitTime</i>	0x81	Integer	$\geq (2 * aplcMaxKeyRepeatInterval)$	The duration that a recipient of a user control repeated command frame waits before terminating a repeated operation.	$(2 * aplcMaxKeyRepeatInterval)$
<i>aplKeyExchange-TransferCount</i>	0x82	Integer	$aplMinKeyExchange-TransferCount - 0xff$	The value of the KeyExTransfer-Count parameter passed to the pair request primitive during the push button pairing procedure.	0x24

## 5 Functional description

All nodes operating according to the ZRC profile shall support security and shall ensure that the security capable sub-field of *nwkNodeCapabilities* is set to one.

### 5.1 Initialization

A node operating according to the ZRC profile shall configure the NIB attributes listed in Table 4. All other NIB attributes shall be set to their default values.

**Table 4 – ZRC profile initial NIB attribute settings**

NIB attribute	Identifier	Initial value
<i>nwkActivePeriod</i>	0x60	Implementation specific
<i>nwkDiscoveryLQIThreshold</i>	0x62	Implementation specific
<i>nwkDiscoveryRepetitionInterval</i>	0x63	0x00f424 (1s)
<i>nwkDutyCycle</i>	0x64	Implementation specific
<i>nwkMaxDiscoveryRepetitions</i>	0x69	0x1e
<i>nwkMaxReportedNodeDescriptors</i>	0x6c	1

### 5.2 Discovery/pairing procedure

Devices implementing the ZRC profile shall support the push-button pairing protocol illustrated in Figure 10.

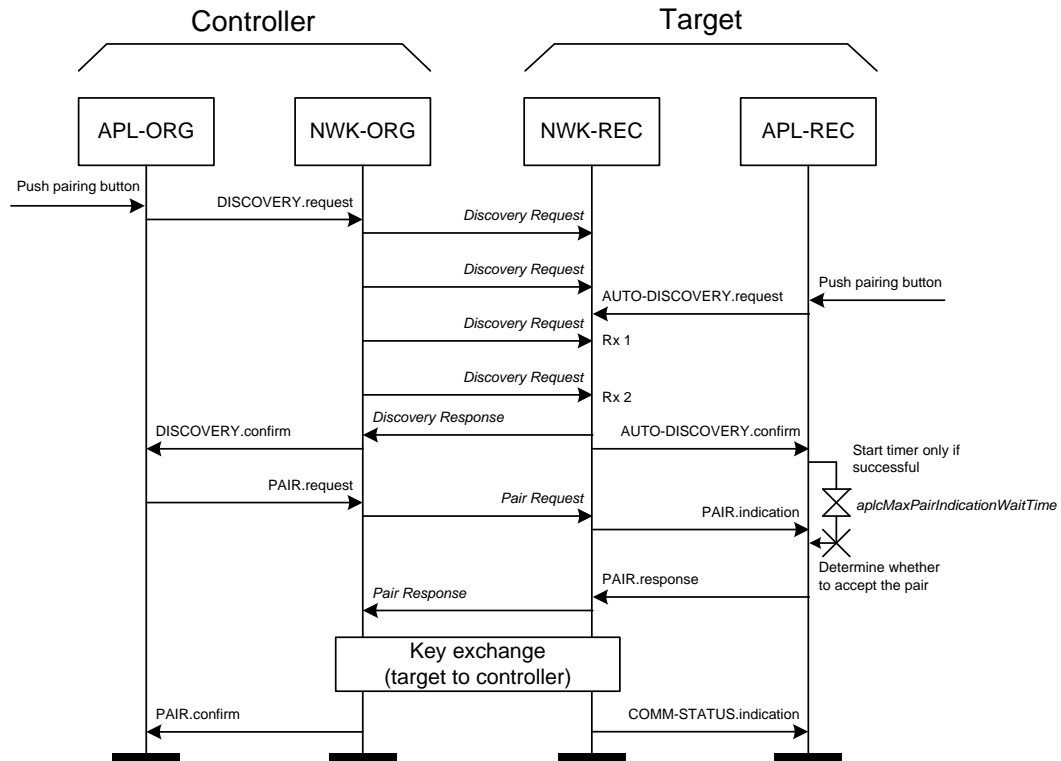


Figure 10 – ZRC profile push button pairing protocol

On receipt of a push button stimulus from the user, the application shall instigate the discovery/pairing procedure according to the type of the node. The procedure for each type of node is described in the following sub-clauses.

### 5.2.1 Controller side discovery/pairing procedure

On receipt of a push button stimulus from the user, the application of a controller node shall instigate the discovery/pairing procedure with the network layer by issuing the NLME-DISCOVERY.request primitive to the NLME.

For the discovery, the controller shall set the following parameters: the discovery duration shall be set to 0x00186a (100ms); the profile identifier list disclosed as supported by the node shall contain at least the value 0x01 (the ZRC profile identifier) and the list of profile identifiers by which incoming discovery response command frames are matched shall contain at least the value 0x01 (the ZRC profile identifier).

On receipt of an unsuccessful confirmation of discovery from the network layer, via the NLME-DISCOVERY.confirm primitive, the application shall terminate the procedure and perform no further processing.

On receipt of a successful confirmation of discovery from the network layer with more than one node descriptor, via the NLME-DISCOVERY.confirm primitive, the application shall discard the information and terminate the procedure, performing no further processing.

On receipt of a successful confirmation of discovery from the network layer, via the NLME-DISCOVERY.confirm primitive, containing exactly one node descriptor, the application shall instigate a pair request by issuing the NLME-PAIR.request primitive to the NLME.

For the pairing, the controller shall set the key exchange transfer count to *aplKeyExchange-TransferCount*.

On receipt of a successful confirmation of pairing from the network layer, via the NLME-PAIR.confirm primitive, the application shall be considered paired to the node with the indicated reference into the pairing table.

If command discovery is supported, the application shall then request that the receiver is enabled for a duration of *aplMaxCmdDiscRxOnDuration* by issuing the NLME-RX-ENABLE.request primitive to the NLME.

### 5.2.2 Target side discovery/pairing procedure

On receipt of a push button stimulus from the user, the application of a target node shall instigate the discovery/pairing procedure with the network layer by issuing the NLME-AUTO-DISCOVERY.request primitive to the NLME. The automatic discovery response mode duration shall be set to 0x1c9c38 (30s).

On receipt of a successful automatic discovery response mode notification from the NLME, via the NLME-AUTO-DISCOVERY.confirm primitive, the application shall request that the NWK layer enable its receiver and wait either for *aplMaxPairIndicationWaitTime* or until a corresponding pairing request notification is received from the NLME, via the NLME-PAIR.indication primitive. If the expected pairing request notification is not received within *aplMaxPairIndicationWaitTime*, the application shall terminate the procedure and perform no further processing. If the notification indicated that a provisional pairing table entry was created, the application shall decide whether to respond to the pair. The procedure for deciding whether to respond to a pair request is out of the scope of this specification. If the application chooses to respond to the pair request, it shall instigate it with the network layer by issuing the NLME-PAIR.response primitive to the NLME.

If the notification indicated a key exchange transfer count that was less than *aplMinKeyExchangeTransferCount*, the application shall respond indicating that the pair request was not permitted. If the notification indicated that there is no capacity for the new entry in the pairing table, the application shall respond indicating an identical (i.e. no capacity) status and perform no further processing. If the notification indicated that the pairing request corresponded to a duplicate entry, the application shall respond with a successful status and perform no further processing. The application shall instigate the response by issuing the NLME-PAIR.response primitive to the NLME.

If the transmission of the subsequent pair response command and subsequent link key exchange, as necessary, was successful, indicated through the NLME-COMM-STATUS.indication primitive from the NLME, the application shall be considered paired to the device with the indicated reference into the pairing table.

If required, the target may then generate and transmit a command discovery request command frame to the controller in order to determine its supported command set according to the procedure described in sub-clause 5.4.

## 5.3 User control procedure

User control commands are instigated from some originator node (such as an RC) to a recipient node (such as a TV). User commands instigated from a device such as an RC can be sent each time a key is pressed and released (e.g. changing a TV channel). However, if the RC key is held down, it may be desirable to instigate a command cycle until the key is released (e.g. incrementing the volume). The ZRC profile supports both use cases.

A device that supports the ZRC profile shall support the processing of a minimum of one key press at a time. Support for multiple key presses is application specific.

### 5.3.1 Originator side user control procedure

On receipt of a key press from the user, the originator node shall generate and transmit a user control pressed command frame to the appropriate recipient. If the key is released within *aplKeyRepeatInterval*, the originator may generate and transmit a user control released command frame to the same recipient.

If the key is not released within *aplKeyRepeatInterval*, the originator shall generate and transmit a user control repeated command frame to the recipient of the original user control pressed command frame. This

procedure shall be repeated at a rate of *aplKeyRepeatInterval* until the key is released after which the originator shall generate and transmit a user control released command frame to the same recipient.

### 5.3.2 Recipient side user control procedure

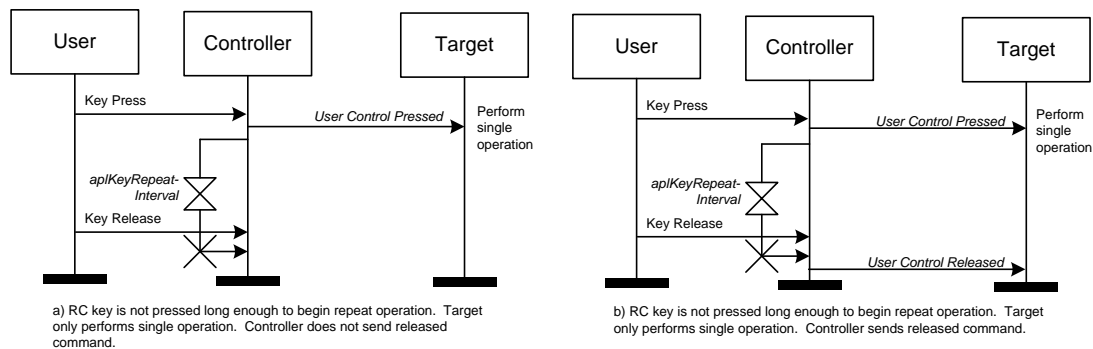
On receipt of a user control pressed command frame, the recipient node shall execute the requested operation once.

If a user control repeated command frame is received either following a user control pressed command frame or unsolicited (i.e., indicating that the original user control pressed command frame was lost), the recipient shall begin executing the command repeatedly at an application specific rate.

While a user control repeated command is received within a rate of *aplKeyRepeatWaitTime*, the recipient shall continue the operation. If a user control repeated command frame is not received within *aplKeyRepeatWaitTime* or a user control released command frame is received within *aplKeyRepeatWaitTime*, the recipient shall terminate the original requested operation.

If a user control released command frame is received without the prior reception of a user control pressed or a user control repeated command frame, as described above, the user control released command frame shall be discarded.

### 5.3.3 User control procedure message sequence charts

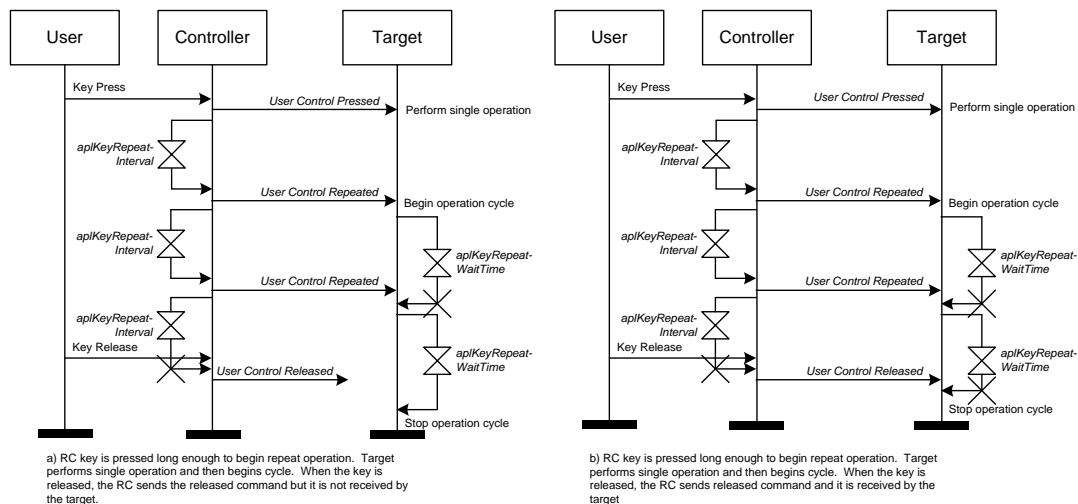


**Figure 11 – Basic user control procedure**

Figure 11 illustrates the basic control procedure in which the originator (a controller) transmits the user control pressed command frame to the recipient (a target).

The user does not hold down the key long enough for the controller to instigate a repeat control (i.e. it is released within *aplKeyRepeatInterval*) so the operation is atomic and the target executes the operation only once. As a user control repeated command frame is not received the target does not need to start a timer.

The controller can decide (a) to simply ignore the key release and not send a user control released command frame or (b) to send a user control released command frame when the key is released.



**Figure 12 – User control repeat procedure**

Figure 12 illustrates the repeat control procedure in which the originator (a controller) first transmits the user control pressed command frame to the recipient (a target). However, in this case, the user holds down the key long enough for the controller to instigate a repeat operation (i.e. it is not released within *aplKeyRepeatInterval*).

While the key is held down, the controller transmits a user control repeated command frame to the target at a rate equal to *aplKeyRepeatInterval* until the key is released. The target receives the first user control repeated command frame and begins repeating the original command at an application defined rate. While a user control repeated command frame is received within *aplKeyRepeatWaitTime*, it continues the operation until either this interval expires or the recipient receives a user control released command frame. At this point, the target terminates the operation.

After sending a user control released command frame, the controller always sends a user control released command frame. The target starts a timer and stops its repeated operation (a) if the user control released command frame is not received within *aplKeyRepeatWaitTime* or (b) on receipt of the user control released command frame.

## 5.4 Command discovery procedure

A device may request command discovery from a target once it has been successfully paired. However, the device shall wait at least *aplMinTargetBlackoutPeriod* after receiving a successful indication of pairing before requesting command discovery from the target. Command discovery can only be guaranteed from a controller immediately following a successful pairing operation, as described in sub-clause 5.2.2, since the controller will typically sleep most of the time. A controller can choose whether to respond to a command discovery request command frame.

A device requesting command discovery shall generate and transmit a command discovery request command frame to the intended recipient. If the transmission was successful, the device shall wait either for *aplMaxResponseWaitTime* or until a command discovery response command frame is received from the recipient. If a command discovery response command frame is not received within *aplMaxResponseWaitTime*, the device must assume that the recipient only supports the mandatory command set appropriate for its device type, as specified in Annex A. If a command discovery response command frame is received within *aplMaxResponseWaitTime*, the application may use the information in a manufacturer-specific way.

On receipt of a command discovery request command frame by a target, it shall generate and transmit a command discovery response command frame back to the originator.

- 1 On receipt of a command discovery request command frame by a controller, if command discovery is
- 2 supported, it shall generate and transmit a command discovery response command frame back to the
- 3 originator. If the recipient does not support command discovery, the frame shall be discarded.
- 4

## 6 Annex A: Mandatory command matrix

ID	User operation	Device									
		TV	Projector	Player	Recorder	Video Player/ Recorder	Audio Player/ Recorder	Audio Video Recorder	Set top box	Home Theater System	Media Center/PC
0x00	Select	M	M	M	M	M		M	M	M	M
0x01	Up	M	M	M	M	M		M	M	M	M
0x02	Down	M	M	M	M	M		M	M	M	M
0x03	Left	M	M	M	M	M		M	M	M	M
0x04	Right	M	M	M	M	M		M	M	M	M
0x05	Right-Up										
0x06	Right-Down										
0x07	Left-Up										
0x08	Left-Down										
0x09	Root Menu – see Note 2	M	M	M	M	M		M	M	M	M
0x0A	Setup Menu										
0x0B	Contents Menu										
0x0C	Favorite Menu										
0x0D	Exit	M	M	M	M	M		M	M	M	M
0x0E - 0x0F	Reserved										
0x10	See HDMI CEC v1.4										
0x11	See HDMI CEC v1.4										
0x12 – 0x1C	Reserved										



ID	User operation	Device									
		TV	Projector	Player	Recorder	Video Player/Recorder	Audio Player/Recorder	Audio Video Recorder	Set top box	Home Theater System	Media Center/PC
0x1D	See HDMI CEC v1.4										
0x1E	See HDMI CEC v1.4										
0x1F	See HDMI CEC v1.4										
0x20	<b>Number 0 or Number 10</b>										
0x21 - 0x29	<b>Numbers 1-9</b>										
0x2A	Dot										
0x2B	Enter										
0x2C	Clear										
0x2D - 0x2E	Reserved										
0x2F	Next Favorite										
0x30	Channel Up	<b>M</b>							<b>M</b>		
0x31	Channel Down	<b>M</b>							<b>M</b>		
0x32	Previous Channel										
0x33	Sound Select										
0x34	Input Select		<b>M</b>								
0x35	Display Information										
0x36	Help										
0x37	Page Up										
0x38	Page Down										
0x39 - 0x3F	Reserved										

ID	User operation	Device									
		TV	Projector	Player	Recorder	Video Player/Recorder	Audio Player/Recorder	Audio Video Recorder	Set top box	Home Theater System	Media Center/PC
0x40	Power										
0x41	Volume Up	M								M	M
0x42	Volume Down	M								M	M
0x43	Mute										
0x44	Play			M	M	M	M	M			M
0x45	Stop			M	M	M	M	M			M
0x46	Pause			M	M	M	M	M			M
0x47	Record				M	M	M	M			
0x48	Rewind			M	M	M		M			M
0x49	Fast forward			M	M	M		M			M
0x4A	Eject										
0x4B	Forward										
0x4C	Backward										
0x4D	See HDMI CEC v1.4										
0x4E	See HDMI CEC v1.4										
0x4F	Reserved										
0x50	Angle										
0x51	Sub picture										
0x52	See HDMI CEC v1.4										
0x53	See HDMI CEC v1.4										

ID	User operation	Device									
		TV	Projector	Player	Recorder	Video Player/Recorder	Audio Player/Recorder	Audio Video Recorder	Set top box	Home Theater System	Media Center/PC
0x54	See HDMI CEC v1.4										
0x55	See HDMI CEC v1.4										
0x56	See HDMI CEC v1.4										
0x57	See HDMI CEC v1.4										
0x58 – 0x5F	Reserved										
0x60	Play Function										
0x61	Pause-Play Function										
0x62	Record Function										
0x63	Pause-Record Function										
0x64	Stop Function										
0x65	Mute Function										
0x66	Restore Volume Function										
0x67	Tune Function										
0x68	Select Media Function										
0x69	Select A/V Input Function										
0x6A	Select Audio Input Function										
0x6B	See HDMI CEC v1.4	M	M	M	M	M	M	M	M	M	M
0x6C	See HDMI CEC v1.4	M	M	M	M	M	M	M	M	M	M
0x6D	See HDMI CEC v1.4	M	M	M	M	M	M	M	M	M	M
0x6E – 0x70	Reserved										

ID	User operation	Device									
		TV	Projector	Player	Recorder	Video Player/Recorder	Audio Player/Recorder	Audio Video Recorder	Set top box	Home Theater System	Media Center/PC
0x71	<b>F1 (Blue)</b>										
0x72	<b>F2 (Red)</b>										
0x73	<b>F3 (Green)</b>										
0x74	<b>F4 (Yellow)</b>										
0x75	<b>F5</b>										
0x76	See HDMI CEC v1.4										
0x77 – 0xFF	Reserved										

1

2 Note 1: The elements identified in **bold** are the only ones which are forwarded as part of the device Menu Control feature, see section .CEC 13.12.

3 Note 2: This triggers the initial display that a device shows. It is device-dependent and can be, for example, a contents menu, setup menu, favorite menu or other  
4 menu. The actual menu displayed may also depend on the device's current state.

5 Note 3: Codes indicating "See HDMI CEC v1.4" are declared *reserved* in HDMI CEC 1.3a and are defined only in later versions of HDMI CEC.

6 Note 4: Mandatory command codes for the device types *game console*, *satellite radio receiver*, *IR extender* and *monitor* are still to be determined.