ZIGBEE HOME AUTOMATION PUBLIC APPLICATION PROFILE

Home Automation
Public Application Profile

ZigBee Profile: 0x0104

Revision 29
Version 1.2

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Abstract This document defines the home automation profile.

Keywords ZigBee, Profile, Home Automation, Application Framework.

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Energy@home is a no-profit association registered under the Italian law with the mission of promoting technologies and services for energy efficiency at home http://www.energy-home.it.

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DOCUMENT HISTORY

Table 1.1 shows the change history for this specification.

Table 1.1 Document Revision Change History

Revision	Version	Description
0	0.1	Original version.
1	0.1	Store scene command added to general cluster.
2	0.1	Group Identifier and Vendor Identifier fields added into the general frame format to harmonize with CBA. ThermostatControl cluster and Thermostat device description added. Many editorial fixes.
3	0.3	Added clusters for ThermostatUnit, TempSensor, BinaryInput, BinaryOutput, PumpControl. Many editorial changes.
4	0.4	Moved all the cluster specifications to library files. Streamlined the rest of the document accordingly.
5, 6	0.4	Added space heating / cooling devices.
7	0.4	Added remote control and range extender. Many minor editorial changes.
8	0.4	Added mains power outlet.
9	0.4	Added constants, generic device, generic switchable device, generic level controllable device, configuration device and scene selection device. Streamlined cluster descriptions. Many editorial improvements.
10, 11, 12	0.5	Made changes to resolve comments from LB9.
13	0.5	Final changes to resolve comments from LB9. Specifically, text was added for polling rates, reporting, commissioning and modifications due to changes in the ZCL.
14	0.5	A couple more final adjustments.
15	0.6	Changes made due to initial comment resolution for LB13.

Table 1.1 Document Revision Change History (Continued)

Revision	Version	Description
16	0.6	Final changes due to comment resolution. Profile is ready for testing.
17	0.7	Added text to specify mandatory start up settings and commissioning behaviors.
18	0.7	Added text to specify mandatory and optional features and functions per device type.
19-24	0.7-0.9	Added text reflecting changes from Paris 2007 meeting to ensure inter operability between HA profile devices.
25	1.0	Editorial changes for release.
26	1.0	Added CCB resolutions
27	1.1	Added changes for 1.1 revision of 053520
28	1.1.1	Added changes from 1.1.1 revision doc 115340r03ZB_HA_PTG-Profile_1_1_1_revision_for_053520r28.doc
29	1.2	Added changes from 1.2 revision doc115474rXXZB_HA_PTG-Profile_1_2_revision_for_053520r29.doc

CHAPTER 1

INTRODUCTION

1.1 Scope

This profile defines device descriptions and standard practices for applications commonly found in a residential or light commercial environment. Installation scenarios range from a single room to an entire home. The key applications included in this profile are lighting, HVAC, window shades, security, door locks, electricity measurement and smart appliances.

1.2 Purpose

This profile provides standard interfaces and device definitions to allow interoperability among ZigBee Home Automation devices produced by various manufacturers.

1.3 Provisional Features

Some of the features in this version of this specification are provisional and non-certifiable. The text regarding these features may change before reaching certifiable status. The features consist of the following items:

- On/OFF Switch Configuration Cluster
- Poll Control - Multiple devices
- Door Lock cluster - Door State
- Door Lock cluster - Holiday Schedule
- Thermostat cluster - Schedule
- Thermostat cluster - Separate Temperature Sensor and HVAC Unit

- Thermostat User interface configuration cluster
- Electrical measurement cluster - Get Profile Info, Get Measurement Profile commands

CHAPTER 2

REFERENCES

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

2.1 ZigBee Alliance Documents

[B1] ZigBee document 08006r03, ZigBee PICS and Stack Profiles.

[B2] ZigBee document 075123r03, ZigBee Cluster Library Specification.

[B3] ZigBee document 075356r15ZB, ZigBee Smart Energy Profile Specification.

[B4] ZigBee document 115734r11, Electrical Measurement Cluster Specification.

[B5] ZigBee document 120177r05, EZ-Mode Commissioning Specification.

[B6] ZigBee Application Framework Working Group, ZigBee document 075123, *"ZigBee Cluster Library Specification"*, October 19, 2007.

[B7] ZigBee Standards Organization, *"ZigBee Home Automation Public Application Profile-Version 1.1"*, February 8, 2010.

[B8] ZigBee Technical Steering Committee (TSC), ZigBee Document 053474r17, *"The ZigBee Specification"*.

[B9] ZigBee Standards Organization, ZigBee document 075356r14, *"ZigBee Smart Energy Profile Specification"*, May 29, 2008.

[B10] ZigBee Standards Organization, ZigBee document 075356r15*“ZigBee Smart Energy Profile specification”*, Rev. 15 December 1, 2008.

[B11] *075366r00ZB_AFG-ZigBee_Cluster_Library_Public_download_version.pdf* – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

[B12] *105684r00ZB_MWG-Energy@Home_Use_cases.pdf* – This document describes the use cases requiring the use of this cluster.

[B13] *105714r00ZB_MWG-Energy@Home.ppt* – This document describes the marketing requirements for this new feature of HA.

[B14] *106085r00ZB_HA_PTG-Energy@Home_and_HA.ppt* – This document describes the functional requirement of this cluster.

[B15] *106086r00ZB_HA_PTG-E@H_specification_ver0.7.pdf* – This document describes the baseline for the definition of this cluster.

[B16] *106123r00ZB_MWG-Energy@Home_MRD.doc* – This document describes the marketing requirements for this new feature of HA.

[B17] *12-0208-03* ZigBee Home Automation Profile: Protocol Implementation Conformance (PICS) Proforma.

2.2 European Standards Documents

[B18] EN 50131 European Standards Series for Intruder Alarm Systems

[B19] Energy@Home project, *“Energy@Home Use Cases”,* Rev. 1.2, April 23, 2010.

[B20] BSI British Standards, document BS EN 50523-1:2009, *“Household appliances interworking - Part 1: Functional specification”*, July 2009.

[B21] BSI British Standards, document BS EN 50523-2:2009, *“Household appliances interworking - Part 2: Data structures”*, July 2009.

[B22] Indesit Co, *“UseCases: Smart Appliances Requirements and Data Structures”*, Rev. 1.0, March 22, 2010.

[B23] Indesit Co, Telecom Italia, *“Energy@Home, ZigBee and EN50523”,* Rev. 1.0, March 22, 2010.

[B24] ISO 4217 – This document describes currency designators and country codes.

CHAPTER 3

DEFINITIONS

3.1 Conformance Levels

Expected: A key word used to describe the behavior of the hardware or software in the design models assumed by this Draft. Other hardware and software design models may also be implemented.

May: A key word indicating a course of action permissible within the limits of the standard (“may” equals “is permitted”).

Shall: A key word indicating mandatory requirements to be strictly followed in order to conform to the standard; deviations from shall are prohibited (“shall” equals “is required to”).

Should: 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 (“should” equals “is recommended that”).

3.2 ZigBee Definitions

Attribute: A data entity which represents a physical quantity or state. This data is communicated to other devices using commands.

Cluster: A container for one or more attributes and/or messages in a command structure.

Cluster Identifier: A reference to the unique enumeration of clusters within a specific application profile. The cluster identifier is a 16-bit number unique within the scope of the application profile and identifies a specific cluster. Cluster identifiers are designated as inputs or outputs in the simple descriptor for use in creating a binding table.

Device: A description of a specific device within a profile. For example, the light sensor device description is a member of the ZigBee Home Automation public application profile. The device description also has a unique identifier that is exchanged as part of the discovery process.

Node: Same as a unit.

Product: A product is a unit that is intended to be marketed. It implements a public application profile.

Service Discovery: The ability of a device to locate services of interest.

Unit: A unit consists of one or more physical objects (for example: switch, controller, etc.) and their corresponding application profile(s) that share a single 802.15.4 radio. Each unit has a unique 64-bit IEEE address.

ZigBee Coordinator: An IEEE 802.15.4-2003 PAN coordinator.

ZigBee End Device: An IEEE 802.15.4-2003 RFD or FFD participating in a ZigBee network, which is neither the ZigBee coordinator nor a ZigBee router.

ZigBee Router: An IEEE 802.15.4-2003 FFD participating in a ZigBee network, which is not the ZigBee coordinator but may act as an IEEE 802.15.4-2003 coordinator within its personal operating space, that is capable of routing messages between devices and supporting associations.

CHAPTER 4

ACRONYMS AND ABBREVIATIONS

ACE	Ancillary Control Equipment
APS	Application Support Sub-layer
CIE	Control and Indicating Equipment
HA	Home Automation
IAS	Intruder Alarm Systems
WD	Warning Device
ZCL	ZigBee Cluster Library
HAN	Home Area Network
PAN	Personal Area Network
HA	ZigBee Home Automation

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CHAPTER 5

PROFILE DESCRIPTION

5.1 A ZigBee Home Automation Network

Home Automation (HA) networks are easily installed by either homeowners or home automation professionals. Installation concepts are simple and uniform across multiple OEM vendors.

ZigBee Home Automation is primarily focused on sporadic real time control of devices, that is, the network is normally quiet, but when a user presses a button on a device, he expects to see the result of that button press across the network quickly.

HA Networks could include nodes which are based on the ZigBee Feature Set and ZigBee PRO Feature Set.

Consumers are expected to buy a home automation system based on a single manufacturer's certified ZigBee Home Automation product suite and then expand the system with certified ZigBee Home Automation products from other vendors. It can occur that not all products in a home automation system are ZigBee Home Automation devices. In this case ZigBee Home Automation certified bridge devices are recommended that can bridge with the non-ZigBee home automation network. For instance, you can connect your ZigBee Home Automation certified devices to a computer equipped with a ZigBee Home Automation certified dongle.

Any ZigBee devices connecting to a ZigBee Home Automation network must be ZigBee certified.

All HA certified devices interoperate with any other HA certified devices. HA may interoperate with other ZigBee public application profile devices (ZigBee Health Care, ZigBee Smart Energy, etc.) if a device is in the HA network that is certified for both or multiple ZigBee public application profiles.

ZigBee Home Automation makes possible networks such as the following:

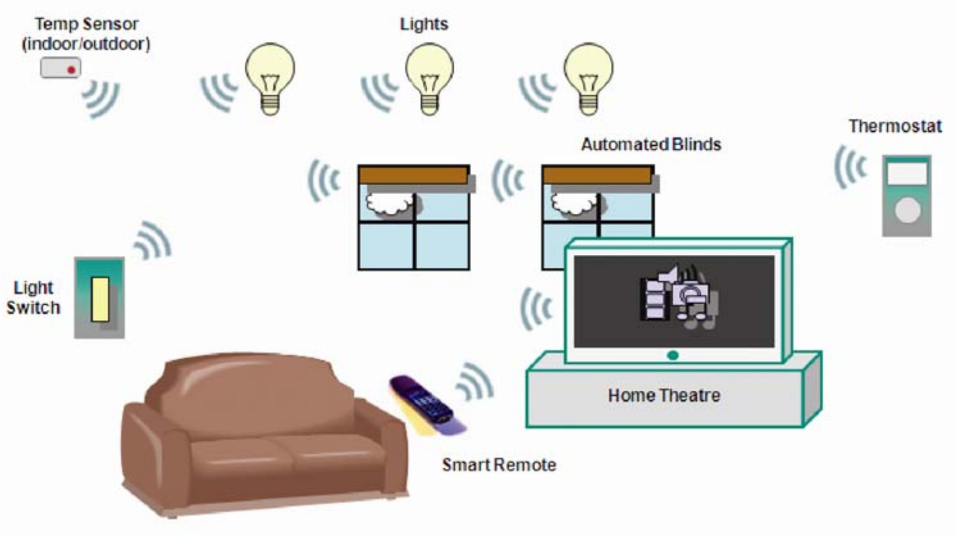

Figure 5.1 Home Network Enabled by ZigBee HA

In the above figure, the lights and switches can be controlled wirelessly, as well as blinds, the thermostat and other devices. Using the scene mechanism, a single press of a button on the remote control could dim the lights, lower the blinds, in preparation to watch a movie. Another button press, either on the remote or a specific switch within the home could place the home in the "At work" mode, lowering the air conditioner or heating in all rooms except the home office, and turning off all lights in the home once motion is no longer detected. The television or PC might provide easy configuration and access to the ZigBee network, and a WiFi router might provide internet access to ZigBee networks as well.

5.2 ZigBee Stack Profile

Products that conform to this specification shall use a ZigBee Pro stack revision as specified by the ZigBee Alliance [B1]. In addition to the requirements specified in [B1], the following requirements are mandatory for this application profile:

- Support for Application link keys is required.
- Source binding and groups/scenes shall be implemented on a device type basis, see device descriptions for applicability.
- In their normal operating state, ZigBee end devices shall poll no more frequently than once every 7.5 seconds except where this specification indicates. For a particular device description (for example, the IAS WD), or under certain conditions, ZigBee end devices may operate with a higher polling rate. These conditions include: commissioning, network maintenance, alarm

states, and short periods after transmitting a message to allow for acknowledgements and or responses to be received quickly. They shall return to the standard rate indicated previously during normal operation. It is recommended that ZigBee end devices poll much less frequently than once per 7.5 seconds, especially when the device normally only communicates due to user interaction (for example, the On/Off Light Switch).

- When they first join a network, ZigBee end devices should operate with a higher polling rate for approximately 1 minute in order to allow time for the coordinator to commission the device properly.
- Devices shall support the mandatory stack profile interoperability as described in section 7.2 and 7.3 of the document [B1], ZigBee PICS and Stack Profiles.
- Message fragmentation is not mandatory in HA. It is therefore recommended that a device not ask for a larger response than what can fit in a non-fragmented packet, especially during read or write of multiple attributes.
- If fragmentation is enabled, the device shall first query the Node descriptor of the device it will communicate with to determine the maximum incoming transfer size unless manufacturer-specific packets are sent. The sending device must use a message size during fragmentation that is smaller than this value. If Fragmentation is supported by the device is it recommend to have apsInterFrameDelay set to 50 and apsMaxWindowSize set to 1 in order to ensure maximum interoperability.
- The application should accept commands that may be arbitrarily longer than expected in terms of their application payload. This is necessary for forward compatibility so that command payloads may be extended in the future. This means that a node may throw out an application command for being too short but it should not throw one out for being too long. It should simply parse the command arguments that it understands and ignore the rest.
- Due to the fact that fragmentation is not provided for ZDO messages, a device should implement no more than 25 clusters per endpoint. This is so that devices may retrieve all of the clusters implemented on an endpoint in a single ZDO request. If a device implements more than 25 clusters per endpoint, that device shall also support the ZDO Extended Simple Descriptor Request command.

5.2.1 ZigBee Routing Table Size Recommendations

If a HA device is intended to be primarily deployed in a network that does not support many-to-one routing, its routing table size should be increased as much as possible to account for the typically dense topology of a ZigBee HA deployment. Alternatively, it is recommended that devices that will primarily be installed into many-to-one deployments also increase their own routing tables if possible, in case the devices are deployed in networks that use ad hoc On-Demand Distance

Vector (AODV) routing for the majority of their messaging, though this may be of secondary concern.

5.2.2 ZigBee HA Coordinator Recommendations

The coordinator should indicate to the installer when a new device joins the network. This could be via PC client, LCD screen, or other simple LED indication.

It is highly recommended that all network coordinators support the Time Cluster Server and update the three time attributes (*UTCTime*, *TimeStatus&LocalTime*) accordingly.

UTCTime&LocalTime attributes should be updated regularly to reflect the accurate time.

The *TimeStatus* attribute should have either the Master or Synchronized bitmap enabled to indicate the status of the Time Server.

If the coordinator supports the Door Lock Cluster Client and/or Thermostat Cluster Client and would like to utilize the scheduling features on the server devices, the coordinator shall follow this recommendation closely.

5.2.3 No Network Level Multicasts[1]

Devices in an HA network SHALL NOT use Network Level multicast, instead they SHALL use APS level multicast for all multicast functions. Furthermore all devices in the HA network SHALL set the stack primitive Network use Multicast, nwkUseMulticast=FALSE

5.3 Startup Attribute (SAS)

In order to ensure interoperability, all ZigBee HA devices should implement compatible Startup Attribute Sets (SAS). This does not mean that set must be modifiable through a commissioning cluster, but that the device must internally implement these stack settings to ensure compatibility and consistent user experience. The start up set parameters described by the Commissioning cluster provide a good basis to specify a HA startup set.

[1] CCB 1773

5.3.1 Start Up Parameters

Short Address: 0xFFFF
E PANiD: 0x0000000000000000
PAN ID: 0xFFFF

Channel Mask
All channels in frequency band. If needed, the power transmitted by the device on channel 26 can be lowered to comply with FCC regulations.

Protocol Version
0x02 (ZigBee Specification revision 17 (2007) and later).

Stack Profile
2 (ZigBee PRO Feature Set).

Startup Control
3 (three) if un-commissioned, so it will join network by association when join command is indicated by button press sequence.

0 (Zero) if commissioned. Indicates that the device should consider itself a part of the network indicated by the *ExtendedPANId* attribute. In this case it will not perform any explicit join or rejoin operation.

Trust Center Address
0x0000000000000000

Master Key
NULL

Network Key
NULL.

Default Trust Center Link Key
0x5A 0x69 0x67 0x42 0x65 0x65 0x41 0x6C 0x6C 0x69 0x61 0x6E 0x63 0x65 0x30 0x39

Note: *The Link Key is listed in little-endian format.*

Use Default Link Key Join
0x01 (True). This flag enables the use of default link key join as a fallback case at startup time.

5.3.2 Join Parameters

ScanAttempts
At boot time or when instructed to join a network, the device should make up to three (3) scan attempts to find a ZigBee Coordinator or Router to associate with. If it has not been commissioned, this means that when the user presses a button or

uses another methodology to get it to join a network, it will scan through all of the channels up to three times to find a network that allows joining. If it has already been commissioned, it should scan up to three times to find its old network to join.

TimeBetweenScans
(1 second) Determines the number of seconds between each unsuccessful scan attempt

Network Rejoin
A device may attempt to rejoin for a period of maximum 15 minutes, and should back off for minimum 15 minutes before attempting to rejoin again, unless prompted to rejoin by user interaction. The rejoin attempts in the rejoin period can be secure, unsecure or a combination.

Devices shall set either the ZigBee stack rejoin settings Config_Rejoin_Interval/RejoinInterval and Config_Max_Rejoin_Interval/MaxRejoinInterval, or the application shall put into effect the appropriate rejoin back off behavior through implementation-specific means.

Examples:

1. An “On/Off Switch” end device loses network connection and attempts to rejoin for 1 minutes and then backs off forever. When user presses the switch the device will attempt another rejoin.
2. An “On/Off Light” end device loses network connection and attempts to rejoin for 15 minutes and then backs off for 15 minutes before attempting to rejoin again.

5.3.3 Security Parameters

SecurityTimeoutPeriod
Determined by the stack profile.

TrustCenterNetworkKey
The Trust Center will pick the network key. ZigBee HA devices shall not depend on pre-configured network keys to be commissioned or to interoperate.

Trust Center Link Key
0x5A 0x69 0x67 0x42 0x65 0x65 0x41 0x6C 0x6C 0x69 0x61 0x6E 0x63 0x65 0x30 0x39

Note: *The Link Key is listed in little-endian format.*

The current network key shall be transported using the default TC link key in the case where the joining device is unknown or has no specific authorization associated with it. This allows for the case where alternative pre-configured link keys specifically associated with a device can be used as well.

It is not required to use Link keys for communication when a device has joined the network unless explicitly specified by the individual device which clusters require link keys. Only network level security is required when not specified.

5.3.4 End Device Parameters

IndirectPollRate
Set by stack profile. This is how often a device will poll its parent for new data. It is recommended that an end device designed to receive data should poll its parent every 60 seconds.

5.3.5 Link Status Parameters

LinkStatusPeriod
Set by the stack profile.

RouterAgeLimit
Set by the stack profile.

RepairThreshold
Set by the stack profile.

UpdatedDevice
Set by the stack profile.

UpdatedDeviceAlarmMask
Set by the stack profile.

5.3.6 Concentrator Parameters

ConcentratorFlag
Configures the device to be a concentrator. This would be typically part of an OEM “system controller” and not required to be on a HA certified device or configurable by 3rd party tool. If an OEM does make a device that can be a concentrator, it does not have to be configurable in any standardized way.

ConcentratorRadius
5 (five). OEMs that make a concentrator product will set the max concentrator radius to this value.

ConcentratorDiscoveryTime
Set by the stack profile. Indicates how soon nodes should reply to a concentrator after hearing a route request command.

5.3.7 APS Transport Parameters

MaxFrameRetries
Set by stack profile. This determines the maximum number of retries allowed after a transmission failure.

AckWaitDuration
Set by stack profile. This is the maximum number of seconds to wait for acknowledgement of an APS frame.

5.4 ZDO Config for HA Devices

ZDO messages relating to binding are either mandatory or optional based on a device-by-device basis. Also, reportable attributes require one or more bindings. See the device description sections for details on each device and which ZDO messages that each must support.

5.5 Device Discovery

When a central device wishes to discover all of the devices on a PAN, the recommended method is to use Network Management Mgmt_Lqi_req/ Mgmt_Lqi_rsp commands. This allows a central device (i.e. a diagnostic tool) to query the neighbor table information from every device in the network.Information included in this query provides the device type, IEEE address, network address, LQI,and other useful information for each neighboring device in a network.

Typically when a device is retrieving this information, there will be a fair amount of overlap within the provided responses. For instance, in a dense network, multiple devices may respond with the same neighbors in their neighbor table responses. It is also likely multiple Mgmt_Lqi_req/Mgmt_Lqi_rsp transactions will be required to retrieve an entire neighbor table per device due to the size of each table list entry. To optimize network traffic, it is recommend that each discovered device will be compared to any previously discovered devices and duplicate device discovery messages will not be sent.

5.6 Other HA Requirements and Best Practices

Preferred Channels (11, 14, 15, 19, 20, 24, 25)
When forming a new network, or scanning to join a network, HA devices should do channel scans using the above channel mask before scanning the rest of the channels in order to avoid the most commonly used WiFi channels. This is to

improve the user experience during installation (quicker joining) and possibly improve bandwidth (on average).

Broadcast Policy
Broadcasts are to be discouraged for HA devices, except for during discovery, when controlling groups, or invoking scenes.

Devices are limited to a maximum broadcast frequency of 9 broadcasts in 9 seconds but strongly encouraged to exercise broadcasts much less frequently. As an example, a latency sensitive application that normally has very low frequency of transmission may transmit two or three broadcasts consecutively within one second.

Frequency Agility
Frequency Agility would only make sense for an OEM system controller, or higher functioning device (system remote etc.).

- Devices must support frequency agility must also contain hooks so that they can be commanded to “go to channel X”.

Key Updates
It is recommended that upon join the Trust Center updates the joining device with a new network or device-specific Trust Center link key.

Return to Factory Defaults
In support of a return to factory default capability, HA devices shall implement the ZDO Management Leave server service. When invoked with a unicast address and the DeviceAddress set to NULL=0x00000000, the device shall implement a NWK Leave. When invoked with a broadcast address and the DeviceAddress set to NULL=0x00000000, the device shall wait the broadcast timeout period to allow the message to propagate through network, then the device shall implement a NWK Leave. Prior to execution of the NWK Leave in either case, processing in the device shall ensure all operating parameters are reset to allow a reset to factory defaults.

Wildcard Profile Id
When accessing cluster functionality across endpoints with different profile ids, devices should use the wildcard profile id. The wildcard profile id is 0xffff. Applications SHALL also allow messages addressed to the wildcard profile id through to access cluster functionality as they would if they included the HA profile id.

5.7 Device Descriptions

Device descriptions specified in this profile are summarized in Table 5.1. The devices are organized according the end application areas they address. A product that conforms to this specification shall implement at least one of these device descriptions and shall also include the device descriptions corresponding to all applications implemented on the product where a standard device description is specified in this profile. For example, if a product implements both a light dimmer and a light sensor application, then the Dimmable Light and Light Sensor device descriptions must both be supported.

This list will be added to in future versions of the profile as new clusters are developed to meet the needs of manufacturers. The reserved values shall not be used until the profile defines them. Manufacturer-specific device descriptions shall reside on a separate endpoint and use a private profile ID.

Table 5.1 Devices Specified in the HA Profile

	Device	Device ID
Generic	On/Off Switch	0x0000
	Level Control Switch	0x0001
	On/Off Output	0x0002
	Level Controllable Output	0x0003
	Scene Selector	0x0004
	Configuration Tool	0x0005
	Remote Control	0x0006
	Combined Interface	0x0007
	Range Extender	0x0008
	Mains Power Outlet	0x0009
	Door Lock	0x000A
	Door Lock Controller	0x000B
	Simple Sensor	0x000C
	Consumption Awareness Device	0x000D
	Home Gateway	0x0050
	Smart plug	0x0051
	White Goods	0x0052
	Meter Interface	0x0053
	Reserved	0x0060– 0x00FF

Table 5.1 Devices Specified in the HA Profile (Continued)

	Device	Device ID
Lighting	On/Off Light	0x0100
	Dimmable Light	0x0101
	Color Dimmable Light	0x0102
	On/Off Light Switch	0x0103
	Dimmer Switch	0x0104
	Color Dimmer Switch	0x0105
	Light Sensor	0x0106
	Occupancy Sensor	0x0107
	Reserved	0x0108 – 0x1FF
Closures	Shade	0x0200
	Shade Controller	0x0201
	Window Covering Device	0x0202
	Window Covering Controller	0x0203
	Reserved	0x0204 – 0x2FF
HVAC	Heating/Cooling Unit	0x0300
	Thermostat	0x0301
	Temperature Sensor	0x0302
	Pump	0x0303
	Pump Controller	0x0304
	Pressure Sensor	0x0305
	Flow Sensor	0x0306
	Mini Split AC	0x0307
	Reserved	0x0308 - 0x3FF
Intruder Alarm Systems	IAS Control and Indicating Equipment	0x0400
	IAS Ancillary Control Equipment	0x0401
	IAS Zone	0x0402
	IAS Warning Device	0x0403
	Reserved	0x0404-0xFFFF

5.8 ZigBee Cluster Library (ZCL)

This profile utilizes the clusters specified in the ZigBee Cluster Library. The implementation details for each cluster are given in the ZCL specifications. Further specification and clarification are given in this profile where necessary.

5.9 Cluster List

The clusters used in this profile are listed in Table 5.2. The clusters are listed according the functional domain they belong to in the ZCL. The corresponding cluster identifiers can be found in the ZigBee Cluster Library specification [B2].

The functionality made available by all supported clusters shall be that given in their ZCL specifications except where a device description in this profile includes further specification, clarification or restriction as needed for that particular device.

Most clusters include optional attributes. The application designer must be aware that optional attributes may not be implemented on a particular device. It is the responsibility of a device's application to discover and deal with unsupported attributes on other devices.

It is expected that clusters will continue to be developed in the ZCL that will be useful in this profile. In many cases, new clusters will be organized into new device descriptions that are separate from those currently defined. There may also be situations where it makes sense to add clusters as optional or possibly even mandatory elements of existing device descriptions. Creating new device descriptions is the preferred method of adding new clusters to this specification, because new functionality can be mandated in a new device description without causing compatibility issues with previously-defined devices.

Manufacturer-specific clusters may be added to any device description in this profile as long as they follow the specifications given in the ZigBee Cluster Library [B2].

Table 5.2 Clusters Used in the HA Profile

Functional Domain	Cluster Name	Cluster ID	Certifiable
General	Basic	0x0000	
General	Power Configuration	0x0001	
General	Device Temperature Configuration	0x0002	
General	Identify	0x0003	
General	Groups	0x0004	

Table 5.2 Clusters Used in the HA Profile (Continued)

Functional Domain	Cluster Name	Cluster ID	Certifiable
General	Scenes	0x0005	
General	On/Off	0x0006	
General	On/Off Switch Configuration	0x0007	
General	Level Control	0x0008	
General	Alarms	0x0009	
General	Time	0x000A	
General	Binary Input (Basic)	0x000F	
General	Partition	0x0016	
General	Power Profile	0x001a	
General	EN50523Appliance Control	0x001b	
General	Poll Control	0x0020	
Closures	Shade Configuration	0x0100	
Closures	Door Lock	0x0101	
Closures	Window Covering	0x0102	
HVAC	Pump Configuration and Control	0x0200	
HVAC	Thermostat	0x0201	
HVAC	Fan Control	0x0202	
HVAC	Thermostat User Interface Configuration	0x0204	
Lighting	Color Control	0x0300	
Measurement & Sensing	Illuminance Measurement	0x0400	
Measurement & Sensing	Illuminance Level Sensing	0x0401	
Measurement & Sensing	Temperature Measurement	0x0402	
Measurement & Sensing	Pressure Measurement	0x0403	
Measurement & Sensing	Flow Measurement	0x0404	
Measurement & Sensing	Relative Humidity Measurement	0x0405	
Measurement & Sensing	Occupancy Sensing	0x0406	
Security and Safety	IAS Zone	0x0500	
Security and Safety	IAS ACE	0x0501	
Security and Safety	IAS WD	0x0502	
Smart Energy	Metering	0x0702	
Home Automation	EN50523 Appliance Identification	0x0b00	

Table 5.2 Clusters Used in the HA Profile (Continued)

Functional Domain	Cluster Name	Cluster ID	Certifiable
Home Automation	Meter Identification	0x0b01	
Home Automation	EN50523 Appliance events and Alert	0x0b02	
Home Automation	Appliance statistics	0x0b03	
Home Automation	Electricity Measurement	0x0b04	
Home Automation	Diagnostics	0x0b05	

CHAPTER

6

CONSTANTS, ERROR CODES AND GENERAL ALARMS

Profile-specific constants are shown in Table 6.1.

Table 6.1 Constants Specific to the HA Profile

Constant	**Description**	**Value**
minHAGroups	Minimum number of groups that shall be supported per node, across all endpoints on that node.	8
minHAScenes	Minimum number of scenes that shall be supported per node, across all groups on all endpoints on that node. This only applies to nodes that implement the server-side of the Scenes cluster on at least one endpoint.	16
Values of the *PhysicalEnvironment* attribute of the Basic cluster for use with this profile.	Atrium	0x01
	Bar	0x02
	Courtyard	0x03
	Bathroom	0x04
	Bedroom	0x05
	Billiard Room	0x06
	Utility Room	0x07
	Cellar	0x08
	Closet	0x09
	Theater	0x0A
	Office	0x0B

Table 6.1 Constants Specific to the HA Profile (Continued)

Constant	Description	Value
Values of the *PhysicalEnvironment* attribute of the Basic cluster for use with this profile.	Deck	0x0C
	Den	0x0D
	Dining Room	0x0E
	Electrical Room	0x0F
	Elevator	0x10
	Entry	0x11
	Family Room	0x12
	Main Floor	0x13
	Upstairs	0x14
	Downstairs	0x15
	Basement/Lower Level	0x16
	Gallery	0x17
	Game Room	0x18
	Garage	0x19
	Gym	0x1A
	Hallway	0x1B
	House	0x1C
	Kitchen	0x1D
	Laundry Room	0x1E
	Library	0x1F
	Master Bedroom	0x20
	Mud Room (small room for coats and boots)	0x21
	Nursery	0x22
	Pantry	0x23
	Office	0x24
	Outside	0x25
	Pool	0x26
	Porch	0x27
	Sewing Room	0x28
	Sitting Room	0x29
	Stairway	0x2A

Table 6.1 Constants Specific to the HA Profile (Continued)

Constant	Description	Value
	Yard	0x2B
Values of the *PhysicalEnvironment* attribute of the Basic cluster for use with this profile.	Attic	0x2C
	Hot Tub	0x2D
	Living Room	0x2E
	Sauna	0x2F
	Shop/Workshop	0x30
	Guest Bedroom	0x31
	Guest Bath	0x32
	Powder Room (1/2 bath)	0x33
	Back Yard	0x34
	Front Yard	0x35
	Patio	0x36
	Driveway	0x37
	Sun Room	0x38
	Living Room	0x39
	Spa	0x3A
	Whirlpool	0x3B
	Shed	0x3C
	Equipment Storage	0x3D
	Hobby/Craft Room	0x3E
	Fountain	0x3F
	Pond	0x40
	Reception Room	0x41
	Breakfast Room	0x42
	Nook	0x43
	Garden	0x44
	Balcony	0x45
	Panic Room	0x46
	Terrace	0x47
	Roof	0x48

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CHAPTER 7

DEVICE SPECIFICATIONS

7.1 Common Clusters

Support for certain clusters is common to all the devices in this profile. The clusters shown in Table 7.1 shall be supported by all devices in this profile as mandatory or optional according the designation given here. Individual device descriptions may place further restrictions on support of the optional clusters shown here.

Table 7.1 Clusters Common to All Devices

Server Side	**Client Side (see 7.1.4)**
Mandatory	
Basic	*None*
Identify	
Optional	
Clusters with reporting capability (see sub-clause 7.1.1 for details)	Clusters with reporting capability (see sub-clause 7.1.1 for details)
Power Configuration	Time
Device Temperature Configuration	OTA Bootload
Alarms	
Electrical Measurement	
Poll Control	
Partition	Partition
Manufacturer-specific (see sub-clause 7.1.6 for details)	Manufacturer-specific (see sub-clause 7.1.6 for details)

7.1.1 Optional Support for Clusters with Reporting Capability

Some clusters support the ability to report changes to the value of particular attributes. These reports are typically received by the client side of the cluster. All devices in this profile may support any cluster that receives attribute reports.

7.1.2 Groups and Scene Cluster Clarification

7.1.2.1 Groups Clarification

As Groupcasts are made on a broadcast to all devices for which macRxOnWhenIdle = TRUE, Sleeping end devices will not be able to benefit from the features of the Groups and Scenes server Cluster. For example, a door lock which would typically be a sleeping end device would not be able to receive the datagrams required to commission a scene or change for example, to a night scene. It is therefore not Mandatory but only optional to support the Groups and Scenes Server cluster if the device is a Sleeping end device (even when listed as Mandatory).

7.1.2.2 Scenes Clarification

Certain devices have several extension field sets. An example is the Dimmable Light that has an On/Off cluster and a level control cluster. It is required that a scene commissioned shall contain all extension field sets. For example, an Add Scene command sent to a Dimmable light shall contain an On/Off and CurrentLevel. A View Scene response would also contain all extension field sets.

7.1.3 Level Control Cluster Clarification

Table 7.2 shows how the level control cluster shall be implemented. This table shows how a light responds to the same command given a set of attribute settings. For instance if the physical light is off it responds differently than if the physical light is on. However regardless of the light’s on/off state, the internal light level can change as shown in Table 7.2.

Table 7.2 Move Commands without On/Off

State Before Command				State After Command			
Current Level Attribute	**On/Off Attribute**	**Physical Light**	**Command**	**Current Level Attribute**	**On/Off Attribute**	**Physical Light**	
0	0	Off	Move to level 128 over 2 sec	128	0	Off	Light stays off, level is changed
128	0	Off	Move to level 128 over 2 sec	128	0	Off	Light stays off
255	0	Off	Move to level 128 over 2 sec	128	0	Off	Light stays off, level is changed
0	1	Off (on at 0%)	Move to level 128 over 2 sec	128	1	On 50%	Light is on, so physical level adjusts up to half on
128	1	On 50%	Move to level 128 over 2 sec	128	1	On 50%	Same level so no changes
255	1	On full	Move to level 128 over 2 sec	128	1	On 50%	Light is on, so physical level adjusts down to half on
0	0	Off	Move rate = up 64 per second	255	0	Off	Light stays off, level is changed
128	0	Off	Move rate = up 64 per second	255	0	Off	Light stays off
255	0	Off	Move rate = up 64 per second	255	0	Off	Light stays off, level is changed
0	1	Off (on at 0%)	Move rate = up 64 per second	255	1	On full	Light is on, so physical level adjusts up to full on
128	1	On 50%	Move rate = up 64 per second	255	1	On full	Light is on, so physical level adjusts up to full on

Table 7.2 Move Commands without On/Off (Continued)

State Before Command				State After Command			
Current Level Attribute	**On/Off Attribute**	**Physical Light**	**Command**	**Current Level Attribute**	**On/Off Attribute**	**Physical Light**	
255	1	On full	Move rate = up 64 per second	255	1	On full	Light is on already at full, so no changes
0	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off
128	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off, level is changed
255	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off, level is changed
0	1	Off (on at 0%)	Move rate = down 64 per second	0	1	Off (on at 0%)	Level is already at 0 - - no changes to level or physical light
128	1	On 50%	Move rate = down 64 per second	0	1	Off (on at 0%)	Level moves down to zero, leaving the physical light off (0% on) and on/off attribute at 1
255	1	On full	Move rate = down 64 per second	0	1	Off (on at 0%)	Level moves down to zero, leaving the physical light off (0% on) and on/off attribute at 1

Table 7.3 Move Commands with On/Off

State Before Command				State After Command			
Current Level Attribute	**On/Off Attribute**	**Physical Light**	**Command**	**Level Attribute**	**On/Off Attribute**	**Physical Light**	
0	0	Off	Move to level 128 over 2 sec	128	1	On 50%	Physical light changes to ON, on/off attr is also adjusted
128	0	Off	Move to level 128 over 2 sec	128	1	On 50%	Physical light changes to ON, on/off attribute is also adjusted
255	0	Off	Move to level 128 over 2 sec	128	1	On 50%	Physical light changes to ON, on/off attr is also adjusted
0	1	off (on at 0%)	Move to level 128 over 2 sec	128	1	On 50%	Physical light goes from off to half on
128	1	On 50%	Move to level 128 over 2 sec	128	1	On 50%	Light is already half on, no change
255	1	On full	Move to level 128 over 2 sec	128	1	On 50%	Physical light goes from full on to half on
0	0	Off	Move rate = up 64 per second	255	1	On full	Physical light changes to ON, on/off attr is also adjusted
128	0	Off	Move rate = up 64 per second	255	1	On full	Physical light changes to ON, on/off attr is also adjusted
255	0	Off	Move rate = up 64 per second	255	1	On full	Physical light changes to ON, on/off attr is also adjusted

Table 7.3 Move Commands with On/Off (Continued)

State Before Command				State After Command			
Current Level Attribute	**On/Off Attribute**	**Physical Light**	**Command**	**Level Attribute**	**On/Off Attribute**	**Physical Light**	
0	1	Off (on at 0%)	Move rate = up 64 per second	255	1	On full	Physical level adjusts from off to full on
128	1	On 50%	Move rate = up 64 per second	255	1	On full	Physical level adjusts from half on to full on
255	1	On full	Move rate = up 64 per second	255	1	On full	Light is already on at full level, no changes
0	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off, level is also at 0
128	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off, level is also at 0
255	0	Off	Move rate = down 64 per second	0	0	Off	Light stays off, level is also at 0
0	1	Off (on at 0%)	Move rate = down 64 per second	0	0	Off	Physical light is already off, on/off attr is also adjusted
128	1	On 50%	Move rate = down 64 per second	0	0	Off	Light physically turns off, on/off attr is also adjusted
255	1	On full	Move rate = down 64 per second	0	0	Off	Light physically turns off, on/off attr is also adjusted

7.1.4 Client Cluster Mandatory Commands Clarification

The client generates the cluster-specific commands detailed in the "Commands Received" section of the server cluster as required by the application. This means that even though all commands are listed as mandatory it is only required to implement the client side required for the application.

For example, an On/Off switch might only implement the Toggle command and not the On and Off commands.

7.1.5 Attribute Reporting Clarification

This section clarifies how the Attribute reporting should be configured. All reportable attributes shall have a default configuration that is readable with the Read Reporting Configuration command.

The ZCL provides a mechanism for clusters to report changes to the value of various attributes. It also provides commands to configure the reporting parameters. The attributes that a particular cluster is capable of reporting are listed in the ZCL specification for each cluster. Devices shall support the reporting configuration mechanisms for all reportable attributes. The minimum reporting interval specified in [B2] shall be set to a value greater than or equal to 0x0001. The maximum reporting interval should be set to 0x0000 by default, and if it is set to a non-zero value it shall be set to a value greater than or equal to 0x003C and greater than the value of the minimum reporting interval. These settings will restrict the attributes from being reported more often than once every second if the attribute is changing quickly and at least once every minute if the attribute does not change for a long time. It is recommended that the minimum reporting interval be set to a higher value whenever the application can tolerate it. It is recommended that the maximum reporting interval be set to a much greater value to avoid unnecessary traffic.

Sections 2.2.1 and 2.4.11 in the ZigBee Cluster Library specification [B2] specify that a binding shall be created prior to setting up a report and that the reports are sent through the bindings created.

The specification is intended to mandate that, if one or more bindings are set up from the device, any attribute reports for a specific cluster are always sent over all bindings setup for that cluster.

Reporting uses bindings to determine the destination of a report. Reportable attributes shall have a default configuration. The device may also create its own source binding to address a report to a destination.

This specification also mandates that all reporting configuration tables and binding tables should be stored in non-volatile memory on the device so that in the event that the device loses power or resets for some other reason, reporting configuration information will not be lost.

In the event that a device is reset-to-factory-defaults, all bindings and reporting configurations will be reset to their default values (see clause 8.4).

7.1.6 Manufacturer-Specific Clusters

The ZCL provides a range of cluster IDs that are reserved for manufacturer-specific clusters. Manufacturer-specific clusters that conform to the requirements given in the ZCL may be added to any device description specified in this profile.

7.1.7 Cluster Usage Restrictions

It is possible to add any cluster defined in the ZigBee Cluster Specification as an optional cluster for any device in this profile and the Smart Energy Application Profile specification Annex D.

Any additional clusters added shall be declared on the device PICS and shall be tested in accordance with the base network and security configurations in this document and the messaging and behavior from that specific cluster test plan.

7.2 Certifiable HA Devices and Features

Not all features or devices listed in this document have been tested and certified. Therefore not all features in this document are certifiable. Only the features and devices listed in the Home Automation Test specification can be certified. The non-certifiable features cannot be certified until the appropriate test cases have been created, golden units from multiple manufacturers have completed testing with them, and the Home Automation Profile task group has approved them for certification.

Refer to Table 5.2 to determine which cluster is certifiable.

7.3 Feature and Function Description

Each device must support a certain set of features and functions. Table 7.4 specifies the mandatory and optional features and functions of each device. This chapter contains a description of what must be supported if the feature or function is supported by the device. The mandatory or optional configuration for each device is described in the following sections.

Table 7.4 Example Features and Functions Configuration for an HA Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M

Join (End Devices and Routers)

The device must provide a way of joining the network (see clause 8.4).

Form Network (Coordinator)

The device must provide a way of forming a network (see clause 8.4).

Allow Others to Join Network (Router and Coordinator Only)

The device must provide a way of allowing other devices to join the network (see clause 8.4).

Restore to Factory Fresh Settings

The device must provide a way of allowing a user to restore the device to its factory new settings (see clause 8.4).

Enable Identify Mode

The device must provide a way for the user to enable Identify for 60 seconds.

Group Nodes (Add Group If Identify)

If this feature is supported the device must provide a way for the user to send an “Add Group if Identifying Request”.

Create Scene (Store Scene)

The device must provide a way for the user to send a Store Scene request.

Service Discovery (Match Descriptor Request)

The device must provide a way to send Match Descriptor request, receive Match Descriptor responses and utilize them for commissioning the device.

ZDP Bind Response
The device must be able to receive a ZDP Bind Request and respond correctly with a ZDP Bind Response.

ZDP Unbind Response
The device must be able to receive a ZDP Unbind Request and respond correctly with an ZDP Unbind Response.

End Device Annce/Device Annce
The device must Send Device Annce upon joining and re-joining a network.

Service Discovery Response
The Device must be able to receive a Match Descriptor request, and respond with a Match Descriptor response correctly.

7.4 Generic Devices

7.4.1 On/Off Switch

The On/Off Switch is capable of sending on, off and toggle commands to devices to switch them on or off. This device should only be used when a more specific device specification (for example, an On/Off Light Switch) is not available.

7.4.1.1 Supported Clusters

In addition to those specified in Table 7.1, the On/Off Switch device shall support the clusters listed in Table 7.5.

Table 7.5 Clusters Supported by the On/Off Switch Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	On/Off (subject to binding)
	Identify
Optional	
	Scenes
	Groups
On/Off Switch Configuration	

7.4.1.2 Supported Features and Functions

The On/Off Switch device shall support the features and functions listed in Table 7.6.

Table 7.6 Example Features and Functions Supported by the On/Off Switch Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M

7.4.2 Level Control Switch

The Level Control Switch device is capable of sending on, off and toggle commands to a wide range of devices to switch them on or off, and can also control the level of a characteristic of such devices (for example, brightness of a light or height of a shade). This device should only be used when a more specific device specification (for example, an On/Off Light Switch) is not available.

7.4.2.1 Supported Clusters

In addition to those specified in Table 7.1, the Level Control Switch device shall support the clusters listed in Table 7.7.

Table 7.7 Clusters Supported by the Level Control Switch Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	
	Identify
	On/Off (subject to binding)
	Level Control (subject to binding)
Optional	
On/Off Switch Configuration	Scenes
	Groups

7.4.2.2 Supported Features and Functions

The Level Control Switch device shall support the features and functions listed in Table 7.8.

Table 7.8 Example Features and Functions Supported by the Level Control Switch Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M

7.4.3 On/Off Output

The On/Off Output device is capable of being switched on and off. This device should only be used when a more specific device specification (for example, a Basic Light) is not available.

7.4.3.1 Supported Clusters

In addition to those specified in Table 7.1, the On/Off Output device shall support the clusters listed in Table 7.9.

Table 7.9 Clusters Supported by the On/Off Output Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Scenes	
Groups	
Optional	
None	*None*

7.4.3.2 Supported Features and Functions

The On/Off Output device shall support the features and functions listed in Table 7.10.

Table 7.10 Example Features and Functions Supported by the On/Off Output Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M (applies to On/Off cluster only)
Service discovery (Match Descriptor Request)	O

Table 7.10 Example Features and Functions Supported by the On/Off Output Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.4 Level Controllable Output

The Level Controllable Output device can be switched on and off, and its output level adjusted. This device should only be used when a more specific device specification (for example, a Dimmer Switch) is not available.

7.4.4.1 Supported Clusters

In addition to those specified in Table 7.1, the Level Controllable Output device shall support the clusters listed in Table 7.11.

Table 7.11 Clusters Supported by the Level Controllable Output Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Level Control	
Scenes	
Groups	
Optional	
None	*None*

7.4.4.2 Supported Features and Functions

The Level Controllable Output device shall support the features and functions listed in Table 7.12.

Table 7.12 Example Features and Functions Supported by the Level Controllable Output Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M (applies to On/Off and Level Control cluster only)
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.5 Scene Selector

The Scene Selector device is capable of setting up and selecting scenes on other devices (including groups of devices).

7.4.5.1 Supported Clusters

In addition to those specified in Table 7.1, the Scene Selector device shall support the clusters listed in Table 7.13.

Table 7.13 Clusters Supported by the Scene Selector Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Scenes
	Groups
Optional	
None	Identify

7.4.5.2 Supported Features and Functions

The Scene Selector device shall support the features and functions listed in Table 7.14.

Table 7.14 Example Features and Functions Supported by the Scene Selector Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	M
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.6 Configuration Tool

The Configuration Tool device is capable of configuring other devices. This device is intended for configuring newly installed devices and may be used for performance optimization thereafter.

The intention of this specification is to define a generic configuration device type. In future versions of the profile, new configuration devices may be specified by explicitly specifying the supported clusters.

7.4.6.1 Supported Clusters

In addition to those specified in Table 7.1, the Configuration Tool device shall support all of the mandatory and at least one of the optional clusters listed in Table 7.15.

Both client and server forms of the Basic cluster are mandatory, so that the device can interrogate what other devices are present on the network, and so that other devices can also interrogate it if required. The Identify client cluster is mandatory so that the device can ask other devices to identify themselves.

Table 7.15 Clusters Supported by the Configuration Tool Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Minimum one optional cluster
Optional	
None	Basic
	Identify
	Groups
	Scenes
	Illluminance Level Sensing
	Temperature Measurement
	Pressure Measurement
	Flow Measurement
	Occupancy Sensing
	Pump Configuration and Control
	Shade Configuration
	Thermostat User Interface Configuration

7.4.6.2 Supported Features and Functions

The Configuration Tool device shall support the features and functions listed in Table 7.16.

Table 7.16 Example Features and Functions Supported by the Configuration Tool Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	M
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.7 Remote Control

The Remote Control device is capable of controlling and monitoring other devices.

Typically the Remote Control device is a handheld, battery powered device, that can control devices (for example, turn a light on/off), monitor devices (for example, read the status of a temperature sensor) or do some user configuration (for example, change the setpoint of a thermostat or a light sensor).

7.4.7.1 Supported Clusters

In addition to those specified in Table 7.1, the Remote Control device shall support all mandatory and any of the optional clusters listed in Table 7.17.

The intention of this specification is to define a generic remote control device type. New, explicit remote control devices may be specified in future versions by (more) explicitly specifying the supported clusters. Minimum one optional cluster shall be implemented. It is not permissible to have a Device with no actual functionality.

Table 7.17 Clusters Supported by the Remote Control Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Minimum one optional cluster
Optional	
	Basic
	Identify
None	On/Off
	Level Control
	Groups
	Scenes
	Color Control
	Pump Configuration and Control
	Shade Configuration
	On/Off Switch Configuration
	Temperature Measurement
	Illuminance Level Sensing
	Illuminance Measurements
	Window Covering
	Door Lock
	Thermostat

7.4.7.2 Supported Features and Functions

The Remote Control device shall support the features and functions listed in Table 7.18.

Table 7.18 Example Features and Functions Supported by the Remote Control Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M

Table 7.18 Example Features and Functions Supported by the Remote Control Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.7.3 Notes on Operation

To ensure interoperability, a remote controller shall allow the presence of other control devices in the network. In particular, this device should take measures to avoid “fighting” for control.

7.4.8 Combined Interface

The Combined Interface device is capable of controlling and monitoring other devices. It is typically a mains-powered device like a personal computer.

7.4.8.1 Supported Clusters

In addition to those specified in Table 7.1, the Combined Interface device shall support all mandatory and any of the optional clusters listed in Table 7.19.

Table 7.19 Clusters Supported by the Combined Interface Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Minimum one optional Cluster
Optional	
None	Basic
	Identify

Table 7.19 Clusters Supported by the Combined Interface Device (Continued)

Server Side	Client Side (see 7.1.4)
	Color Control
	Pump Configuration and Control
	Shade Configuration
	On/Off Switch Configuration
	Temperature Measurement
	Illluminance Level Sensing
	Illluminance Measurement
	Thermostat User Interface Configuration
	Level Control
	Groups
	Scenes
	Window Covering
	Door Lock
	Thermostat
	On/Off

7.4.8.2 Supported Features and Functions

The Combined Interface device shall support the features and functions listed in Table 7.20.

Table 7.20 Example Features and Functions Supported by the Combined Interface Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O

Table 7.20 Example Features and Functions Supported by the Combined Interface Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.8.3 Notes on Operation

To ensure interoperability, a Combined Interface device shall allow the presence of other control devices in the network. In particular, this device should take measures to avoid “fighting” for control.

7.4.9 Range Extender

The Range Extender is a simple device that acts as a router for other devices. The Range Extender device shall not be a ZigBee end device. A product that implements the Range Extender devices shall not implement any other devices defined in this profile. This device shall only be used if the product is not intended to have any other application, or if a private application is implemented that has not been addressed by this profile.

7.4.9.1 Supported Clusters

The Range Extender device shall only support the mandatory common clusters listed in Table 7.1.

7.4.9.2 Supported Features and Functions

The Range Extender device shall support the features and functions listed in Table 7.21.

Table 7.21 Example Features and Functions Supported by the Range Extender Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M

Table 7.21 Example Features and Functions Supported by the Range Extender Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.10 Mains Power Outlet

The Mains Power Outlet device is capable of being switched on and off. This device shall control a mains power outlet.

7.4.10.1 Supported Clusters

In addition to those specified in Table 7.1, the Mains Power Outlet device shall support the clusters listed in Table 7.22.

Table 7.22 Clusters Supported by the Mains Power Outlet Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Scenes	
Groups	
Optional	
None	*None*

7.4.10.2 Supported Features and Functions

The Mains Power Outlet device shall support the features and functions listed in Table 7.23.

Table 7.23 Example Features and Functions Supported by the Mains Power Outlet Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.11 Door Lock

The Door Lock is capable of receiving Door Lock cluster commands

7.4.11.1 Supported Clusters

In addition to those specified in Table 7.1, the Door Lock device shall support the clusters listed in Table 7.24.

Note: for sleeping end devices, see sub-clause 7.1.2, “Groups and Scene Cluster Clarification”.

Table 7.24 Clusters Supported by the Door Lock Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Door Lock	*None*
Scenes	
Groups	

Table 7.24 Clusters Supported by the Door Lock Device (Continued)

Server Side	Client Side (see 7.1.4)
Optional	
Alarms	Time
Power Configuration	OTA Bootload
Poll Control	

7.4.11.2 Supported Features and Functions

The Door Lock device shall support the features and functions listed in Table 7.25.

Table 7.25 Example Features and Functions Supported by the Door Lock Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.12 Door Lock Controller

The Door Lock Controller is capable of sending Door Lock cluster commands.

7.4.12.1 Supported Clusters

In addition to those specified in Table 7.1, the Door Lock Controller shall support the clusters listed in Table 7.26.

Table 7.26 Clusters Supported by the Door Lock Controller

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Door Lock
	Scenes
	Groups
	Identify
Optional	
None	*None*

7.4.12.2 Supported Features and Functions

The Door Lock Controller shall support the features and functions listed in Table 7.27.

Table 7.27 Example Features and Functions Supported by the Door Lock Controller

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.13 Simple Sensor

The Simple Sensor is a Simple Sensor only supporting a binary input. Examples of usage are window magnet contacts and other simple on/off devices that have no "active" function but only can report their status.

7.4.13.1 Supported Clusters

In addition to those specified in Table 7.1, the Simple Sensor device shall support the clusters listed in Table 7.28.

Table 7.28 Clusters Supported by the Simple Sensor

Server Side	Client Side (see 7.1.4)
Mandatory	
Binary Input (Basic)	Identify
Optional	
None	*None*

7.4.13.2 Supported Features and Functions

The Simple Sensor Device shall support the features and functions listed in Table 7.29.

Table 7.29 Example Features and Functions Supported by the Simple Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M

Table 7.29 Example Features and Functions Supported by the Simple Sensor Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.14 Consumption Awareness Device

The Consumption Awareness Device is a device aware of its energy consumption and has the capability to report it.

In addition to those specified in Table 7.1, the Consumption Awareness Device shall support the clusters listed in Table 7.30.

Table 7.30 Clusters Supported by the Consumption Awareness Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Meter	Identify
Optional	
None	*None*

7.4.14.1 Supported Features and Functions

The Consumption Awareness Device shall support the features and functions listed in Table 7.31.

Table 7.31 Example Features and Functions Supported by the Consumption Awareness Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O

Table 7.31 Example Features and Functions Supported by the Consumption Awareness Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.15 Home Gateway/Energy Management System

The Home Gateway/Energy Management System device performs home control and monitoring activities. It is executed on a Home gateway that is able to collect energy data, from the Meter interface and from the user’s appliances, and to publish them in the home network through broadband LAN technologies (e.g., WiFi and/or Ethernet) and the wide area network (WAN).

7.4.15.1 Supported Clusters

In addition to those specified in Table 7.1, the Home Gateway/Energy Management System shall support the clusters listed in Table 7.32:

Table 7.32 Clusters Supported by the Home Gateway/EnergyManagementSystem

Server Side	Client Side (see 7.1.4)
Mandatory	
Time	
	Metering
	Meter Identification
	Power Profile
	Appliance Statistics
Optional	
Metering	
	Basic
	Identify

Table 7.32 Clusters Supported by the Home Gateway/EnergyManagementSystem

Server Side	Client Side (see 7.1.4)
	EN50523 Appliance Control
	EN50523 Appliance Identification
	EN50523 Appliance Events & Alerts
	Price

7.4.15.2 Supported Features and Functions

The Home Gateway/Energy Management System Device shall support the features and functions listed in Table 7.33.

Table 7.33 Example Features and Functions Supported by the Home Gateway/Energy Management System

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	M
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.16 Smart Plug

Smart Plugs can participate in home monitoring and control activities. Smart Plugs may provide information about instantaneous power using the Metering cluster for the power and energy information and may optionally support the Electrical Measurement Cluster. Smart Plugs may also be controlled by using the On/Off cluster.

7.4.16.1 Supported Clusters

In addition to those specified in Table 7.1, the Smart Plug shall support the clusters listed in Table 7.34:

Table 7.34 Clusters Supported by the Smart Plug

Server Side	Client Side (see 7.1.4)
Mandatory	
	Identify
Metering	
On/Off	
Optional	
Electrical Measurement	
	Time
	Demand Response/Load Control
	Price

7.4.16.2 Supported Features and Functions

The Smart Plug Device shall support the features and functions listed in Table 7.35.

Table 7.35 Example Features and Functions Supported by the Smart Plugs

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M

Table 7.35 Example Features and Functions Supported by the Smart Plugs

Device Type/Feature or Function	Mandatory/ Optional
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.17 White Goods

White Goods devices can actively participate in home control and monitoring activities. Moreover, White Goods could provide data related to device usage (statistics) and participate in in-home energy management activities.

7.4.17.1 Supported Clusters

In addition to those specified in Table 7.1, the White Goods shall support the clusters listed in Table 7.36:

Table 7.36 Clusters Supported by the White Goods

Server Side	Client Side (see 7.1.4)
Mandatory	
	Identify
Power Profile	
EN50523 Appliance Control	
EN50523 Appliance Identification	
EN50523 Appliance Events & Alerts	
Optional	
Metering	
Appliance Statistics[a]	
	Time
	Meter Identification
	Price

[a] CCB 1771

7.4.17.2 Supported Features and Functions

The White Goods Device shall support the features and functions listed in Table 7.37.

Table 7.37 Example Features and Functions Supported by the White Goods

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.4.18 Meter Interface

The Meter Interface device represents an interface to a metering device (e.g.,electricity, gas, water, heat, etc.) that is able to send meter information to the home automation network. Depending on what is being measured, the device may be capable of immediate (requested via polling) readings or of autonomous periodic readings (sent via push mechanism). A Metering Interface device may also be capable of communicating certain status indicators (e.g., battery low, tamper detected).In the event that the Meter Interface cannot provide price information, the use of Price Cluster as defined in the Smart Energy specification could be limited to the provision of time-of-use (TOU) intervals by using the Get Scheduled Prices without specifying the actual price. In the case of the Publish Price Command Payload the Price field will be always 0xff..ff, and the Price Tier field shall specify the current tier name.

7.4.18.1 Supported Clusters

In addition to those specified in Table 7.1, the Meter Interface shall support the clusters listed in Table 7.38:

Table 7.38 Clusters Supported by the Meter Interface

Server Side	Client Side (see 7.1.4)
Mandatory	
	Identify
Metering	
Meter Identification	
Optional	
Price	Price
	Time
	PrePayment
	Message

7.4.18.2 Supported Features and Functions

The Meter Interface shall support the features and functions listed in Table 7.39.

Table 7.39 Example Features and Functions Supported by the White Goods

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M

Table 7.39 Example Features and Functions Supported by the White Goods

Device Type/Feature or Function	Mandatory/ Optional
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5 Lighting Devices

7.5.1 On/Off Light

The On/Off Light device is a light that can be switched on and off.

7.5.1.1 Supported Clusters

In addition to those specified in Table 7.1, the On/Off Light Device shall support the clusters listed in Table 7.40.

Table 7.40 Clusters Supported by the On/Off Light Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Scenes	
Groups	
Optional	
None	Occupancy Sensing

7.5.1.2 Occupancy Sensing Cluster Support

If an On/Off Light device supports the Occupancy Sensing cluster, the action taken upon receipt of a report (indicating a change in state of the *Occupancy* attribute) is left up to the manufacturer. The ability to configure this behavior may be included in a future version of this application profile.

7.5.1.3 Supported Features and Functions

The On/Off Light Device shall support the features and functions listed in Table 7.41.

Table 7.41 Example Features and Functions Supported by the On/Off Light Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.2 Dimmable Light

The Dimmable Light device is a light that can be switched on and off, and whose luminance level may be controlled.

7.5.2.1 Supported Clusters

In addition to those specified in Table 7.1, the Dimmable Light device shall support the clusters listed in Table 7.42.

Table 7.42 Clusters Supported by the Dimmable Light Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Level Control	
Scenes	

Table 7.42 Clusters Supported by the Dimmable Light Device (Continued)

Server Side	Client Side (see 7.1.4)
Groups	
Optional	
None	Occupancy Sensing

7.5.2.2 Level Control Cluster (Server) Clarification

The Level Control cluster shall allow control over the luminance level of the light. The functionality made available by this cluster shall be that given in specification [B2].

When the level is set to 0, the light shall be turned fully off. When the level is set to 254, the light shall be turned on to the maximum level possible for the device.

It is recommended that the luminance is interpreted as a logarithmic scale, according to what is given in specification [B4].

7.5.2.3 Occupancy Sensing Cluster Support

If a Dimmable Light supports the Occupancy Sensing cluster, the action taken upon receipt of a report indicating a change in state of the *Occupancy* attribute is left up to the manufacturer. The ability to configure this behavior may be included in a future version of this application profile.

7.5.2.4 Supported Features and Functions

The Dimmable Light Device shall support the features and functions listed in Table 7.43.

Table 7.43 Example Features and Functions Supported by the Dimmable Light Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M

Table 7.43 Example Features and Functions Supported by the Dimmable Light Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.3 Color Dimmable Light

The Color Dimmable Light device can be switched on and off, and its luminance, hue, and saturation levels may be controlled.

7.5.3.1 Supported Clusters

In addition to those specified in Table 7.1, the Color Dimmable Light device shall support the clusters listed in Table 7.44.

Table 7.44 Clusters Supported by the Color Dimmable Light Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	*None*
Level Control	
Color Control	
Scenes	
Groups	
Optional	
None	Occupancy Sensing

7.5.3.2 Occupancy Sensing Cluster Support

If a Color Dimmable Light Device supports the Occupancy Sensing cluster, the action taken upon receipt of a report indicating a change in state of the *Occupancy* attribute is left up to the manufacturer. The ability to configure this behavior may be included in a future version of this application profile.

7.5.3.3 Supported Features and Functions

The Color Dimmable Light Device shall support the features and functions listed in Table 7.45.

Table 7.45 Example Features and Functions Supported by the Color Dimmable Light Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.4 On/Off Light Switch

The On/Off Light Switch device can send on, off and toggle commands to devices (typically lights) to switch them on or off.

The On/Off Light Switch device is identical in functionality to the On/Off Switch (see sub-clause 7.4.1), and supports the same clusters.

It has a different Device ID (see Table 5.1) to enable more detailed matching if required, and a more specific icon to be drawn where needed.

7.5.4.1 Supported Clusters

In addition to those specified in Table 7.1, the On/Off Light Switch shall support the clusters listed in Table 7.46.

Table 7.46 Clusters Supported by the On/Off Light Switch

Server Side	Client Side (see 7.1.4)
Mandatory	
	On/Off
	Identify
Optional	
	Scenes
	Groups
On/Off Switch Configuration	

7.5.4.2 Supported Features and Functions

The On/Off Light Switch device shall support the features and functions listed in Table 7.47.

Table 7.47 Example Features and Functions Supported by the On/Off Light Switch

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.5 Dimmer Switch

The Dimmer Switch device can send on, off and toggle commands to devices (typically lights) to switch them on or off, and can also control the level of a characteristic of such devices (typically the brightness of lights).

The Dimmer Switch device is identical in functionality to the Level Control Switch (see sub-clause 7.4.2), and supports the same clusters.

It has a different Device ID (see Table 5.1) to enable more detailed matching if required, and a more specific icon to be drawn where needed.

7.5.5.1 Supported Clusters

In addition to those specified in Table 7.1, the Dimmer Switch shall support the clusters listed in Table 7.48.

Table 7.48 Clusters Supported by the Dimmer Switch Device

Server Side	Client Side (see 7.1.4)
Mandatory	
	On/Off
	Level Control
	Identify
Optional	
On/Off Switch Configuration	Scenes
	Groups

7.5.5.2 Supported Features and Functions

The Dimmer Switch Device shall support the features and functions listed in Table 7.49.

Table 7.49 Example Features and Functions Supported by the Dimmer Switch Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M

Table 7.49 Example Features and Functions Supported by the Dimmer Switch Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.6 Color Dimmer Switch

The Color Dimmer Switch device can turn a light on and off, and control the luminance, hue and saturation levels of a multi-color light.

7.5.6.1 Supported Clusters

In addition to those specified in Table 7.1, the Color Dimmer Switch shall support the clusters listed in Table 7.50.

Table 7.50 Clusters Supported by the Color Dimmer Switch Device

Server Side	Client Side (see 7.1.4)
Mandatory	
	On/Off
	Level Control
	Color Control
	Identify
Optional	
On/Off Switch Configuration	Scenes
	Groups

7.5.6.2 Supported Features and Functions

The Color Dimmer Switch device shall support the features and functions listed in Table 7.51.

Table 7.51 Example Features and Functions Supported by the Color Dimmer Switch Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.7 Light Sensor

The Light Sensor device reports the illuminance of an area.

7.5.7.1 Supported Clusters

In addition to those specified in Table 7.1, the Light Sensor device shall support the clusters listed in Table 7.52.

Table 7.52 Clusters Supported by the Light Sensor Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Illuminance Measurement	Identify
Optional	
None	Groups

7.5.7.2 Supported Features and Functions

The Light Sensor device shall support the features and functions listed in Table 7.53.

Table 7.53 Example Features and Functions Supported by the Light Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.5.8 Occupancy Sensor

The Occupancy Sensor device reports the occupancy state of an area.

7.5.8.1 Supported Clusters

In addition to those specified in Table 7.1, the Occupancy Sensor device shall support the clusters listed in Table 7.54.

Table 7.54 Clusters Supported by the Occupancy Sensor Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Occupancy Sensing	Identify
Optional	
None	Groups

7.5.8.2 Supported Features and Functions

The Occupancy Sensor device shall support the features and functions listed in Table 7.55.

Table 7.55 Example Features and Functions Supported by the Occupancy Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.6 Closure Devices

7.6.1 Shade

The Shade device provides the ability to open or close window coverings, including setting partially open or partially closed states. This device type includes roller shades, drapes, and tilt-only blinds.

7.6.1.1 Supported Clusters

In addition to those specified in Table 7.1, the Shade device shall support the clusters listed in Table 7.56.

Table 7.56 Clusters Supported by the Shade Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Shade Configuration	*None*
On/Off	
Level Control	
Scenes	
Groups	
Optional	
None	*None*

7.6.1.2 On/Off Cluster (Server) Clarification

The functionality of the supported On/Off cluster follows the specifications in the dependencies section of the Level Control cluster specification [B2]. For this device, “On” shall mean that the shade is open and “Off” shall mean that the shade is closed (i.e. at the level corresponding to the *ClosedLimit* attribute of the Shade Configuration cluster).

7.6.1.3 Level Control Cluster (Server) Clarification

The Level Control cluster shall allow control over the position of the shade. The functionality made available shall be that given in its specification [B2].

The position of the shade shall correspond to the level by the following relationship:

Shade position = *ClosedLimit* x (255 – *Level*) /255

When Level is 0 the shade is at the *ClosedLimit* and is closed. When *Level* is 255 the shade is at position 0 and is fully open.

7.6.1.4 Supported Features and Functions

The Shade device shall support the features and functions listed in Table 7.57.

Table 7.57 Example Features and Functions Supported by the Shade Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.6.2 Shade Controller

The Shade Controller device can control the level of a shade, and put it into configuration mode so that the user may adjust its limits.

7.6.2.1 Supported Clusters

In addition to those specified in Table 7.1, the Shade Controller device shall support the clusters listed in Table 7.58.

Table 7.58 Clusters Supported by the Shade Controller Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	On/Off
	Level Control
	Identify
Optional	
None	Shade Configuration
	Scenes
	Groups

7.6.2.2 Supported Features and Functions

The Shade Controller device shall support the features and functions listed in Table 7.59.

Table 7.59 Example Features and Functions Supported by the Shade Controller Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.6.3 Window Covering Device

The Window Covering device represents an automatic window covering.

7.6.3.1 Supported Clusters

In addition to those specified in Table 7.1, the Window Covering device shall support the clusters listed in Table 7.60.

Table 7.60 Clusters Supported by the Window Covering Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Window Covering	*None*
Scenes	
Groups	
Optional	
None	*None*

7.6.3.2 Supported Features and Functions

The Window Covering device shall support the features and functions listed in Table 7.61.

Table 7.61 Example Features and Functions Supported by the Window Covering Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M

Table 7.61 Example Features and Functions Supported by the Window Covering Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.6.4 Window Covering Controller

The Window Covering controller is a device that controls an automatic window covering.

7.6.4.1 Supported Clusters

In addition to those specified in Table 7.1, the Window Covering Controller device shall support the clusters listed in Table 7.62.

Table 7.62 Clusters Supported by the Window Covering Controller Device

Server Side	Client Side (see 7.1.4)
Mandatory	
None	Window Covering
	Identify
Optional	
None	Scenes
	Groups
	Identify

7.6.4.2 Supported Features and Functions

The Window Covering Controller device shall support the features and functions listed in Table 7.63.

Table 7.63 Example Features and Functions Supported by the Window Covering Controller Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7 HVAC Devices

7.7.1 Heating/Cooling Unit

The Heating/Cooling Unit device can heat or cool a space in a house. It is not mandatory to provide both functionalities (for example, the device may just heat but not cool). It may be an indoor air handler.

7.7.1.1 Supported Clusters

In addition to those specified in Table 7.1, the Heating/Cooling Unit device shall support the clusters listed in Table 7.64.

Table 7.64 Clusters Supported by the Heating/Cooling Unit Device

Server Side	Client Side (see 7.1.4)
Mandatory	
On/Off	
Thermostat	

Table 7.64 Clusters Supported by the Heating/Cooling Unit Device (Continued)

Server Side	Client Side (see 7.1.4)
Optional	
Fan Control	*None*
Level Control	
Groups	

7.7.1.2 Thermostat Cluster (Server)

The Thermostat client cluster shall support a subset of the functionality specified in [B2], i.e., the ability to receive notifications of heating and/or cooling demand.

7.7.1.3 Supported Features and Functions

The Heating/Cooling Unit device shall support the features and functions listed in Table 7.65.

Table 7.65 Example Features and Functions Supported by the Heating/Cooling Unit Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	M
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.2 Thermostat

The Thermostat device can have either built-in or separate sensors for temperature, humidity or occupancy. It allows the desired temperature to be set either remotely or locally. The thermostat may send heating and/or cooling requirement notifications to a heating/cooling unit (for example, an indoor air handler) or may include a mechanism to control a heating or cooling unit directly.

7.7.2.1 Supported Clusters

In addition to those specified in Table 7.1, the Thermostat device shall support the clusters listed in Table 7.66.

Table 7.66 Clusters Supported by the Thermostat Device

Server Side	**Client Side (see 7.1.4)**
Mandatory	
Thermostat	*None*
Optional	
Scenes	
Groups	
Thermostat User Interface Configuration	
Fan Control	Fan Control
Temperature Measurement	Temperature Measurement
Occupancy Sensing	Occupancy Sensing
Relative Humidity Measurement	Relative Humidity Measurement
Alarms	Time
Power Configuration	OTA Bootload
Poll Control	

7.7.2.2 Temperature Measurement Cluster (Client)

The functionality made available by the Temperature Measurement client cluster shall be that given in its specification [B2]. It is used to receive temperature measurements when either the local or outdoor temperature for the thermostat cluster is designated to be sensed remotely.

7.7.2.3 Occupancy Sensing Cluster (Client)

The functionality made available by the Occupancy Sensing client cluster shall be that given in its specification [B2]. It is used to receive occupancy notifications when occupancy for the thermostat cluster is designated to be sensed remotely.

7.7.2.4 Relative Humidity Measurement Cluster (Client)

The functionality made available by the Relative Humidity Measurement client cluster shall be that given in its specification [B2]. It is used to receive humidity measurements when humidity for the Thermostat cluster is designated to be sensed remotely.

7.7.2.5 Scene Table Extensions

The following extension fields shall be added to the Scene table for the Thermostat cluster:

OccupiedCoolingSetpoint

OccupiedHeatingSetpoint

SystemMode

7.7.2.6 Supported Features and Functions

The Thermostat device shall support the features and functions listed in Table 7.67.

Table 7.67 Example Features and Functions Supported by the Thermostat Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M

Table 7.67 Example Features and Functions Supported by the Thermostat Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.3 Temperature Sensor

The Temperature Sensor device reports measurements of temperature.

7.7.3.1 Supported Clusters

In addition to those specified in Table 7.1, the Temperature Sensor device shall support the clusters listed in Table 7.68.

Table 7.68 Clusters Supported by the Temperature Sensor Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Temperature Measurement	Identify
Optional	
None	Groups

7.7.3.2 Supported Features and Functions

The Temperature Sensor device shall support the features and functions listed in Table 7.69.

Table 7.69 Example Features and Functions Supported by the Temperature Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O

Table 7.69 Example Features and Functions Supported by the Temperature Sensor Device (Continued)

Device Type/Feature or Function	Mandatory/ Optional
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	O
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.4 Pump

The Pump device is a pump that may have variable speed. It may have optional built-in sensors and a regulation mechanism. It is typically used for pumping water.

7.7.4.1 Supported Clusters

In addition to those specified in Table 7.1, the Pump device shall support the clusters listed in Table 7.70.

Table 7.70 Clusters Supported by the Pump Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Pump Configuration and Control	Identify
On/Off	
Scenes	
Groups	
Optional	
Level Control	
Alarms	

Table 7.70 Clusters Supported by the Pump Device (Continued)

Server Side	Client Side (see 7.1.4)
Pressure Measurement	Pressure Measurement
Temperature Measurement	Temperature Measurement
Flow Measurement	Flow Measurement

7.7.4.2 On/Off Cluster (Server) Clarifications

The actions carried out by the pump on receipt of commands are shown in Table 7.71.

Table 7.71 Pump Actions on Receipt for On/Off Commands

Command	Action on Receipt
Off	If the pump is powered on, store the current level then immediately power it off.
On	If the pump is powered off, power it on and move immediately to the level stored by a previous Off command. If no such level has been stored, move immediately to the maximum level allowed for the pump.
Toggle	If the pump is powered on, proceed as for the Off command. If the device is powered off, proceed as for the On command.

7.7.4.3 Level Control Cluster (Server) Clarifications

The Level Control cluster shall allow controlling the pump setpoints as specified in [B2], however the transition time is always ignored.

The Setpoint of the pump is a percentage related to the Level according to Table 7.72.

Table 7.72 Relationship Between Level and Setpoint

Level	Setpoint	Meaning
0	N/A	Pump is stopped
1 - 200	Level / 2 (0.5 - 100.0%)	Pump setpoint in percent
201 - 255	100.0%	Pump setpoint is 100.0%

7.7.4.4 Pressure Measurement Notification (Server)

This cluster allows serving of internal pressure measurement if available. This is independent of the Pressure Measurement client cluster, which connects to an external networked pressure sensor.

7.7.4.5 Temperature Measurement Notification (Server)

This cluster allows serving of internal temperature measurement if available. This is independent of the Temperature Measurement client cluster, which connects to an external networked temperature sensor.

7.7.4.6 Flow Measurement Notification (Server)

This cluster allows serving of internal flow measurement if available. This is independent of the Flow Measurement client cluster, which connects to an external networked flow sensor.

7.7.4.7 Supported Features and Functions

The Pump device shall support the features and functions listed in Table 7.73.

Table 7.73 Example Features and Functions Supported by the Pump Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	M
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.5 Pump Controller

The Pump Controller device can configure and control a Pump device.

7.7.5.1 Supported Clusters

In addition to those specified in Table 7.1, the Temperature Sensor device shall support the clusters listed in Table 7.74.

Table 7.74 Clusters Supported by the Pump Controller Device

Server Side	**Client Side (see 7.1.4)**
Mandatory	
None	Pump Configuration and Control
	On/Off
	Identify
Optional	
None	Scenes
	Groups
	Pressure Measurement
	Temperature Measurement
	Flow Measurement
	Level Control

7.7.5.2 Pressure Measurement (Client)

This cluster allows configuration and monitoring of the Pressure Sensor internal to a Pump device.

7.7.5.3 Temperature Measurement Notification (Client)

This cluster allows configuration and monitoring of the Temperature Sensor internal to a Pump device.

7.7.5.4 Flow Measurement Notification (Client)

This cluster allows configuration and monitoring of the Flow Sensor internal to a Pump device.

7.7.5.5 Supported Features and Functions

The Pump Controller device shall support the features and functions listed in Table 7.75.

Table 7.75 Example Features and Functions Supported by the Pump Controller Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.6 Pressure Sensor

The Pressure Sensor device measures and periodically reports the pressure of a liquid (typically water).

7.7.6.1 Supported Clusters

In addition to those specified in Table 7.1, the Temperature Sensor device shall support the clusters listed in Table 7.76.

Table 7.76 Clusters Supported by the Pressure Sensor Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Pressure Measurement	Identify
Optional	
None	Groups

7.7.6.2 Supported Features and Functions

The Pressure Sensor device shall support the features and functions listed in Table 7.77.

Table 7.77 Example Features and Functions Supported by the Pressure Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.7.7 Flow Sensor

The Flow Sensor device measures and periodically reports the flow rate of a liquid (typically water).

7.7.7.1 Supported Clusters

In addition to those specified in Table 7.1, the Flow Sensor device shall support the clusters listed in Table 7.78.

Table 7.78 Clusters Supported by the Flow Sensor Device

Server Side	Client Side (see 7.1.4)
Mandatory	
Flow Measurement	Identify
Optional	
None	Groups

7.7.7.2 Supported Features and Functions

The Flow Sensor device shall support the features and functions listed in Table 7.79.

Table 7.79 Example Features and Functions Supported by the Flow Sensor Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.8 Intruder Alarm System Devices

7.8.1 IAS Control and Indicating Equipment (CIE)

The IAS CIE device is the central Control and Indicating Equipment for an Intruder Alarm System. It receives inputs from sensors (Zones) and control equipment (ACE), and sends output to a warning device (WD).

7.8.1.1 Supported Clusters

In addition to those specified in Table 7.1, the IAS CIE device shall support the clusters listed in Table 7.80.

Table 7.80 Clusters Supported by the IAS CIE Device

Server Side	**Client Side (see 7.1.4)**
Mandatory	
IAS ACE	IAS WD
	Identify
	IAS Zones
Optional	
None	Scenes
	Groups

7.8.1.2 Basic Cluster (Server) Restrictions

The ability to disable the device shall not be provided. That is, the *DeviceEnable* attribute shall be read-only and set to 1.

7.8.1.3 Supported Features and Functions

The IAS CIE device shall support the features and functions listed in Table 7.81.

Table 7.81 Example Features and Functions Supported by the IAS CIE Device

Device Type/Feature or Function	**Mandatory/ Optional**
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M

Table 7.81 Example Features and Functions Supported by the IAS CIE Device

Device Type/Feature or Function	Mandatory/ Optional
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.8.2 IAS Ancillary Control Equipment (ACE)

The IAS ACE device is a remote control for an Intruder Alarm System. A ZigBee enabled ACE device can access an IAS CIE device and manipulate the IAS system, on behalf of a level-2 user (see [B4]). The device can also act as a Zone sensor.

7.8.2.1 Supported Clusters

In addition to those specified in Table 7.76, the IAS ACE device shall support the clusters listed in Table 7.82.

Table 7.82 Clusters Supported by the IAS ACE Device

Server Side	Client Side (see 7.1.4)
Mandatory	
IAS Zones	IAS ACE
	Identify
Optional	
None	*None*

7.8.2.2 Supported Features and Functions

The IAS ACE device shall support the features and functions listed in Table 7.82.

Table 7.83 Example Features and Functions Supported by the IAS ACE Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.8.3 IAS Zone

An IAS Zone device detects alarm conditions (for example, intrusion, fire) and signals them to the Control and Indicating Equipment (CIE) of an IAS system. An IAS Zone device supports up to two alarm types, low battery reports, and supervision of the IAS network.

7.8.3.1 Supported Clusters

In addition to those specified in Table 7.1, the IAS Zone device shall support the clusters listed in Table 7.84.

Table 7.84 Clusters Supported by the IAS Zone Device

Server Side	Client Side (see 7.1.4)
Mandatory	
IAS Zones	*None*
Optional	
None	*None*

7.8.3.2 Supported Features and Functions

The IAS Zone device shall support the features and functions listed in Table 7.85.

Table 7.85 Example Features and Functions Supported by the IAS Zone Device

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	M
ZDP Unbind Response	M
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

7.8.4 IAS Warning Device (WD)

An IAS WD device can produce audible and visible warning indications (siren, strobe lighting, etc.) when instructed to by an IAS Central Indicating Equipment (CIE) on detection of a system alarm condition. The IAS WD can also act as a sensor (Zone).

7.8.4.1 Supported Clusters

In addition to those specified in Table 7.1, the IAS WD shall support the clusters listed in Table 7.86.

Table 7.86 Clusters Supported by the IAS WD Device

Server Side	Client Side (see 7.1.4)
Mandatory	
IAS WD	*None*
IAS Zone	
Optional	
Scenes	*None*
Groups	

7.8.4.2 Polling Rate Exception

The IAS WD may poll at a maximum rate of once per second when it is implemented as a battery-powered ZigBee end device that sleeps. It is recommended that this exception be used cautiously, and that the number of devices installed in a network that make use of this be kept to a minimum.

7.8.4.3 Supported Features and Functions

The IAS WD shall support the features and functions listed in Table 7.87.

Table 7.87 Example Features and Functions Supported by the IAS WD

Device Type/Feature or Function	Mandatory/ Optional
Join (end devices and routers only)	M
Form Network (Coordinator only)	M
Allow Others to Join Network (routers and Coordinators only)	M
Restore to Factory Fresh Settings	M
Enable Identify Mode	O
Group Nodes (send out an Add Group If Identify)	O
Create Scene (Store Scene)	O
Service discovery (Match Descriptor Request)	O
ZDP Bind Response	O
ZDP Unbind Response	O
End Device Annce/Device Annce	M
Service Discovery Response (Match Descriptor Response)	M
EZ-Mode Commissioning	M

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CHAPTER

8

HOME AUTOMATION COMMISSIONING

8.1 Network Steering

8.1.1 Form

HA devices must form their own network or join an existing network.

It is intended that an HA network use simple methods to form a network and to commission devices into it. The primary means of commissioning a network will use EZ-mode methods (button presses or similar user actions) to get nodes to join a network.

This specification has no mandates to the start-up sequence of devices or the network. Here are some recommended practices for user feedback on a device:

- A device should be able to indicate to the user that it has decided to become the coordinator of a network.
- A device should be able to indicate to the user, that it has successfully joined a network.
- A device should be able to indicate to the user, that it is in the process of searching for or joining a network.

These indications can be implemented in a number of ways including blinking indicator lights, colored indicator lights, arrays of indicator lights, text displays, graphic displays, audible indicators such as buzzers and speakers, etc. Blinking a green indicator light is the recommended method.

8.1.2 Join

For devices joining an established network, the device may change between router and end device behavior. This decision must be made, however, prior joining a network. The mode of operation is not allowed to change while the device is actively joined, but the behavior can subsequently change if the device first leaves, changes behavior, and then joins the network again using the different mode of operation.

8.2 Commissioning

All of the devices described in this document will require some form of commissioning, even if the user or installer doesn't see it. This is because, for example, an actuating device needs to be bound to some sort of target in order to do useful work, and even if the required initializations are done at the factory before the device is sold, the required operations are virtually the same as is the outcome.

8.2.1 Support for Commissioning Modes

There are two main commissioning modes supported in HA:

1. EZ-Mode commissioning (push button commissioning)
2. Centralized commissioning (aka tool / gateway / S-mode)

All HA devices can be controlled by a Commissioning Director specified in Centralized commissioning.

EZ-Mode and Centralized commissioning are complementary and fully compatible.

8.3 EZ-Mode Commissioning

8.3.1 References

[B25] ZigBee Document 07-5123 ZigBee Cluster Library Specification

8.3.2 Terms

Term	**Description**
Commission	*Verb*: to put a device in an operational state
Bind or Binding	*Verb:* create a binding or the act of creating a binding
Binding	*Noun:* a ZigBee source binding table entry in a device which determines where data is sent from a cluster on and endpoint

Term	Description
Invoke EZ-Mode Method	A method, requiring human interaction, to initiate or end EZ-Mode commissioning
Node	A physical unit with a single MAC address and ZigBee stack
EZ-Mode Network Steering or Network Steering	Joining the proper network as identified by the user, or forming a network when desired by the user
EZ-Mode Finding and Binding	Discovering and creating source bindings between clusters that direct data flow for operational transactions
User	A person performing network steering and/or commissioning
Operational State	Participating in operational transactions
Operational Transaction	Transactions that are used to perform device functions, such attribute reporting or actuation commands (e.g., On, Off, Toggle, etc.) and are not one-time transactions or commissioning transactions.
Initiator	An endpoint that has at least 1 cluster that is an initiator of operational transactions
Target	An endpoint that has at least 1 cluster that is a target of operational transactions

8.3.3 EZ-Mode Invocation

1 EZ-Mode operations shall be invoked by some interactive means on a device.

2 A Factory Reset operation, that clears bindings and groups, shall be invoked by some interactive means on a device.

NOTE: *EZ-Mode invocation may be overloaded to include both Network Steering and Finding and Binding.*

8.3.4 EZ-Mode Network Steering

1 When EZ-Mode Network Steering is invoked on a node that is not joined to a network, it shall attempt to join an existing network. If no networks are found, it may form a network.

2 If a ZigBee Router or Coordinator joins or forms a network, it shall set its own PermitJoin value to at least EZModeTime.

3 If the node is a ZigBee Router and joins a network, it shall broadcast a PermitJoin time of at least EZModeTime.

4 When EZ-Mode Network Steering is invoked on a ZigBee Router or Coordinator, and the node is already joined to a network, the node shall broadcast a minimum PermitJoin time of EZModeTime and shall set its own PermitJoin time to this value.

8.3.5 EZ-Mode Finding and Binding

1 When EZ-Mode Finding and Binding is invoked on a Target endpoint, it shall set its Identify cluster attribute IdentifyTime to a minimum of EZModeTime. Optionally PermitJoin may also be broadcast with the same time value to synchronize IdentifyTime in the network.

2 When EZ-Mode Finding and Binding is invoked on a Target endpoint, it may synchronize all other identifying endpoints in the network to at least EZModeTime.

3 When EZ-Mode Finding and Binding is invoked on an Initiator endpoint, it shall broadcast to all nodes (including sleepy ZEDs) the Identify Query command one or more times.

4 If an Initiator endpoint performing EZ-Mode Finding and Binding receives an Identify Query re-sponse from an endpoint, then it should attempt to discover clusters on the responding end-point that match clusters on the Initiator endpoint (such as sending a Simple Descriptor request). If a cluster matches on the responding endpoint, this responding endpoint is the Target. For each matching cluster on the Target, the Initiator shall create or use an existing source binding. The binding source shall be the Initiator's matching cluster. The binding's destination shall address (unicast or group) the Target's matching cluster.

5 Once the Initiator is done binding, it may set the IdentifyTime of its Targets to zero.

6 An attribute that supports reporting shall have a default report configuration.

8.3.6 EZ-Mode Network Steering

The flowchart in Figure 8.1 is included to clarify the process. If there is a conflict between the flowchart and the normative text, the text takes precedence.

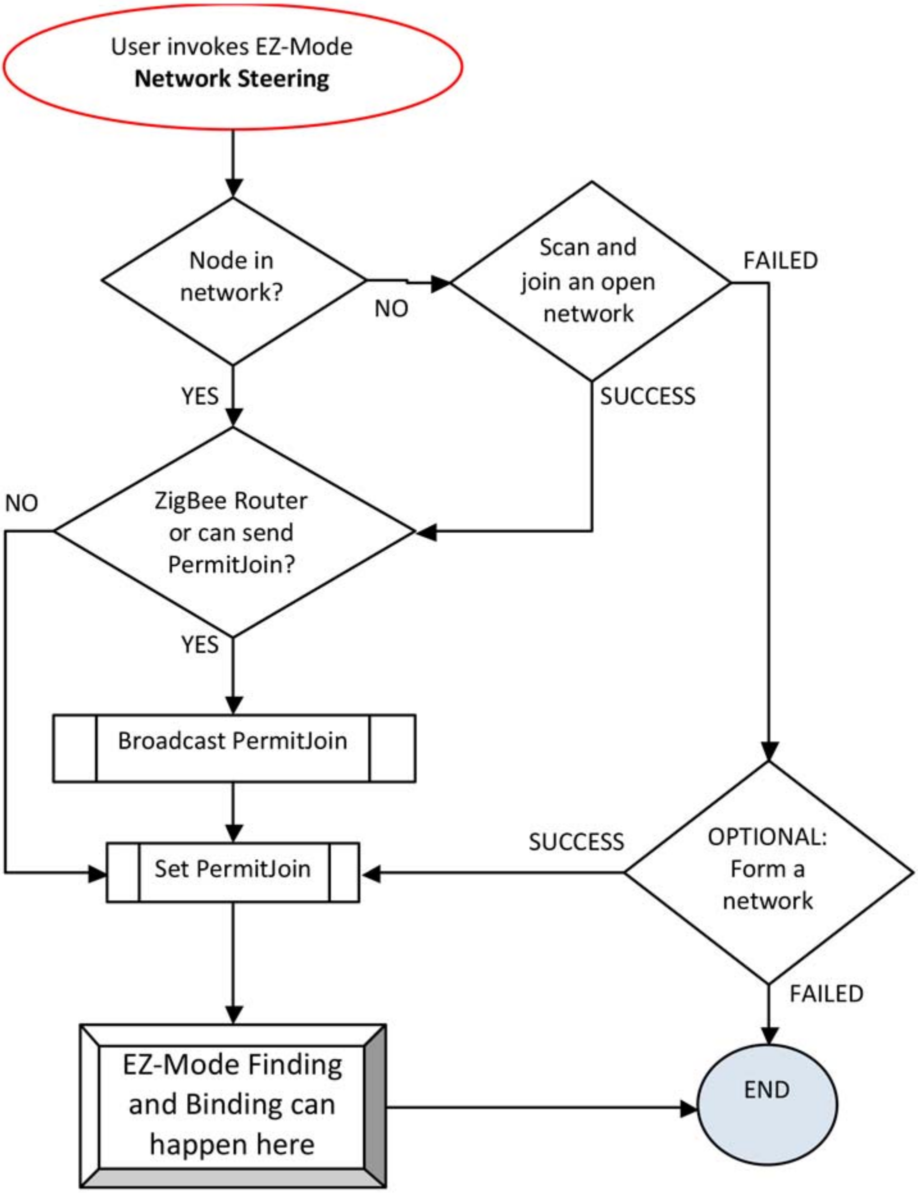

Figure 8.1 EZ-Mode Network Steering Flowchart

8.3.7 EZ-Mode Initiator: Finding and Binding

The flowchart in Figure 8.2 is included to clarify the process. If there is a conflict between the flowchart and the normative text, the text takes precedence.

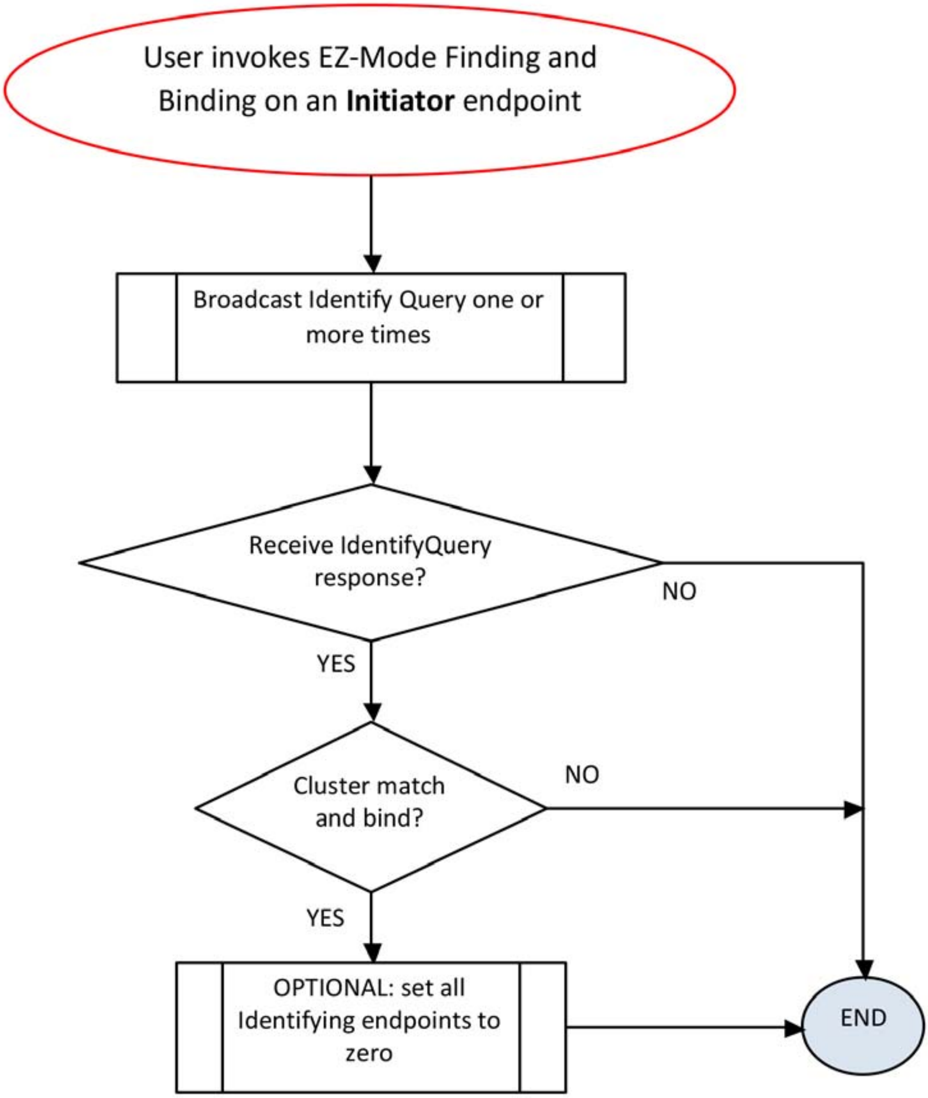
User invokes EZ-Mode Finding and Binding on an **Initiator** endpoint
Broadcast Identify Query one or more times
Receive IdentifyQuery response?
NO
YES
Cluster match and bind?
NO
YES
OPTIONAL: set all Identifying endpoints to zero
END

Figure 8.2 EZ-Mode Initiator Finding and Binding Flowchart

8.3.8 EZ-Mode Target: Finding and Binding

The flowchart in Figure 8.3 is included to clarify the process. If there is a conflict between the flowchart and the normative text, the text takes precedence.

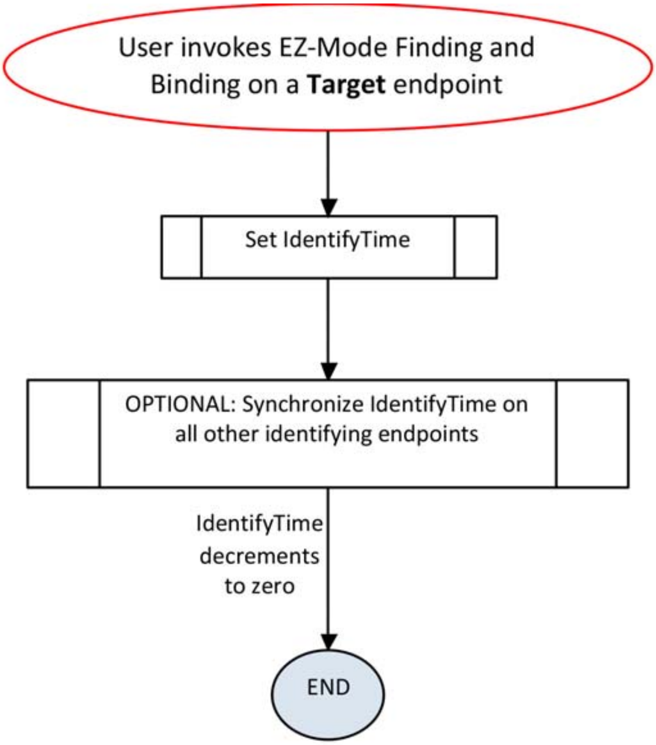
User invokes EZ-Mode Finding and Binding on a Target endpoint
Set IdentifyTime
OPTIONAL: Synchronize IdentifyTime on all other identifying endpoints
IdentifyTime decrements to zero
END

Figure 8.3 EZ-Mode Target Finding and Binding Flowchart

8.3.9 EZ-Mode Default Constants

Table 8.1 EZ-Mode Default Constants

Name	Value	Description
EZModeTime	3 Minutes	Minimum and recommended PermitJoin time broadcast for EZ-Mode Network Steering and minimum IdentifyTime set for EZ-Mode Finding and Binding.

8.3.10 EZ-Mode Device Types

Table 8.2 defines the minimal requirement for each device to be certified as compatible with EZ-Mode.

Table 8.2 Minimum Requirements for EZ-Mode Compatibility

Device	Network Part	Initiator	Target
0x0000 (On/Off Switch)	M	M	
0x0001 (Level Control Switch)	M	M	
0x0002 (On/Off Output)	M		M
0x0003 (Level Controllable Output)	M		M
0x0004 (Scene Selector)	M		
0x0005 (Configuration Tool)	M		
0x0006 (Remote Control)	M		
0x0007 (Combined Interface)	M		
0x0008 (Range Extender)	M		
0x0009 (Mains Power Outlet)	M		M
0x000A (Door Lock)	M		
0x000B (Door Lock Controller)	M		
0x000C (Simple Sensor)	M	M	
0x000D (Consumption Awareness Device)	M	M	
0x0050 (Home Gateway)	M		
0x0051 (Smart Plug)	M	M	
0x0052 (White Goods)	M	M	
0x0053 (Meter Interface)	M	M	
0x0100 (On/Off Light)	M		M
0x0101 (Dimmable Light)	M		M
0x0102 (Color Dimmable Light)	M		M
0x0103 (On/Off Light Switch)	M	M	
0x0104 (Dimmer Switch)	M	M	
0x0105 (Color Dimmer Switch)	M	M	
0x0106 (Light Sensor)	M	M	
0x0107 (Occupancy Sensor)	M	M	
0x0200 (Shade)	M		M
0x0201 (Shade Controller)	M	M	
0x0202 (Window Covering Device)	M		M
0x0203 (Window Covering Controller)	M	M	
0x0300 (Heating/Cooling Unit)	M		M

Table 8.2 Minimum Requirements for EZ-Mode Compatibility (Continued)

Device	Network Part	Initiator	Target
0x0301 (Thermostat)	M		M
0x0302 (Temperature Sensor)	M	M	
0x0303 (Pump)	M	M	M
0x0304 (Pump Controller)	M	M	M
0x0305 (Pressure Sensor)	M	M	
0x0306 (Flow Sensor)	M	M	
0x0307 (Mini Split AC)	M		
0x0400 (IAS Control and Indicating Equipment)	M		
0x0401 (IAS Ancillary Control Equipment)	M		
0x0402 (IAS Zone)	M		
0x0403 (IAS Warning Device)	M		

8.3.11 Identify Cluster Attribute

Add a *CommissionState* attribute and explanation text:

Table 8.1 Attributes of the Identify Server Cluster

Identifier	Name	Type	Range	Access	Default	M/O
0x0001	CommissionState	8-bit bitmap	-	Read	0x00	O

8.3.11.1 CommissionState Attribute

The *CommissionState* attribute is in this form:

Table 8.2 Values of the CommissionState Attribute

Bit Field Name	Bit(s)	Description
Network State	0	1=Device is on the proper network. Must be set to 1 if Operational State is set to 1 0=device is not on a network, a temporary network, or it is unknown if the device is on the proper network
Operational State	1	1=Device is commissioned for operation. The Network State shall be set to 1. 0=Device is not commissioned for operation.
Reserved	2-7	Reserved bits

This attribute shall be a persistent attribute across power cycles. The device may update these states at any time.

Devices may choose to leave a network and reset to factory fresh settings at some point in time if they consider themselves un-commissioned, or if commissioning was interrupted by power loss. If power loss is not the cause, it is recommended that devices choosing to implement this feature do so upon expiry of their PermitJoin or Identify time.

The commissioned or un-commissioned decision is application specific, but may consider data such as the *CommisisonState* attribute, binding table entries, group memberships and/or reception of operational commands.

Devices implementing this feature are recommended to support the *CommisisonState* attribute and Update Commission State command (see below) to allow remote devices to understand and influence this decision.

It is recommended as a best practice that upon commissioning themselves to a Target, EZMode initiators send an Update Commission State command, with Action field equal to "Set" and the CommissionStateMask field having an Operational State bit set, in order to notify the Target that it has been commissioned.

8.3.12 Identify Cluster Commands

Add a EZ-Mode Invoke command in 3.5.3.3 with explanation text in new clause 3.5.2.3.3:

Table 8.3 Received Command IDs for the Identify Cluster

Table 8.3

Command Identifier Field Value	Description	M/O
0x02	EZ-Mode Invoke	O
0x03	Update Commission State	M[a]O

[a] Mandatory if *CommissonState* attribute supported

8.3.12.1 EZ-Mode Invoke Command

This command invokes EZ-Mode over the air.

8.3.12.1.1 Payload Format

The command payload shall be formatted as illustrated in Figure 8.4:

Octets	1
Data Type	8-bit bitmap
Field Name	Action

Figure 8.4 Format of the EZ-Mode Invoke Command Payload

8.3.12.1.2 Effect on Receipt

On receipt of this command, the device (endpoint) shall perform the following actions for each bit field of the Action field, if the bit field is non-zero:

Bit Field Name	Bit(s)	Process Order	Description of Action, If Non-zero
Factory Fresh	0	1	Clear all bindings, group table entries and the ComissionState attribute and revert to Factory Fresh settings
Network Steering	1	2	Invoke the EZ-Mode Network Steering process
Finding and Binding	2	3	Invoke the EZ-Mode Finding and Binding process if Network Steering is successful
Reserved	3-7	-	Reserved bits

Figure 8.5 Format of the Action field

8.3.12.2 Update Commission State Command

This command updates the *CommissionState* attribute over the air.

8.3.12.2.1 Payload Format

The command payload shall be formatted as illustrated in Figure 8.4:

Octets	1	1
Data Type	8-bit enum	8-bit bitmap
Field Name	Action	CommissionStateMask

Figure 8.6 Format of Update Commission State Command Payload

8.3.12.2.2 Effect on Receipt

On receipt of this command, the device (endpoint) shall perform the following actions on the *CommisionState* attribute based on the Action field:

Action Field	**Action Enumerated Value**	**Description of Effect**
Null	0	Do nothing
Set	1	For each bit set in the CommissionStateMask, set the same bit in the *CommissionState* attribute
Clear	2	For each bit set in the CommissionStateMask, clear the same bit in the *CommissionState* attribute
Reserved	3-255	Do nothing

Figure 8.7 Values of the Action field

8.4 Centralized Commissioning

8.4.1 Central Commissioning Overview

Central commissioning is a method that allows a fixed or mobile device to commission other devices on the same network. This may also be referred to as Gateway, Tool, or S-Mode commissioning.

This can be a central device such as a gateway, a home controller or a commissioning tool that is typically connected to a graphical user interface. This device is able to configure bindings and reporting on other devices in the network. It may also be a device that automatically commissions other devices on the network from a fixed pre-loaded configuration.

Any device in the HA network with this functionality is defined as a Commissioning Director, Director, or CD.

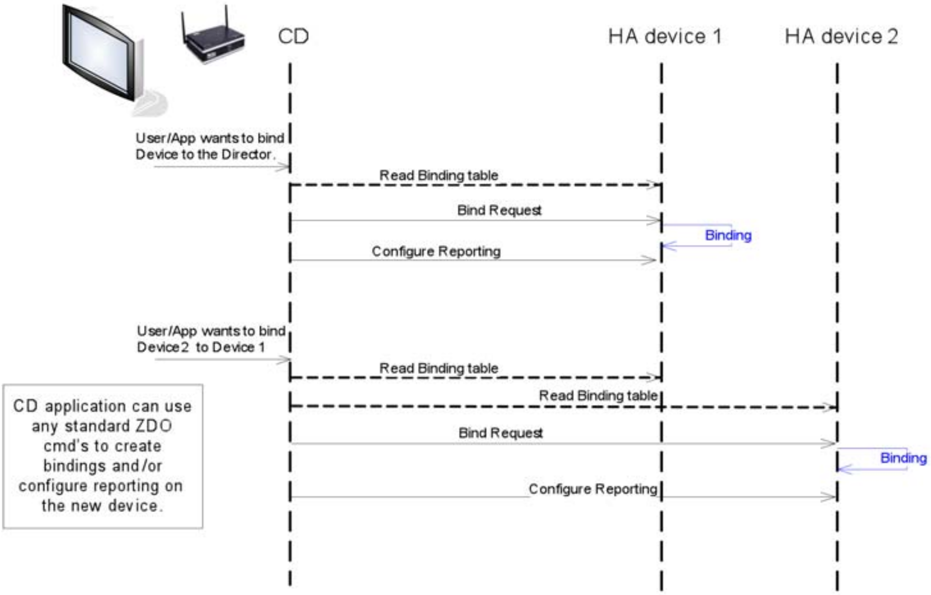
CD
HA device 1
HA device 2
User/App wants to bind Device to the Director.
Read Binding table
Bind Request
Binding
Configure Reporting
User/App wants to bind Device2 to Device 1
Read Binding table
Read Binding table
Bind Request
Binding
Configure Reporting
CD application can use any standard ZDO cmd's to create bindings and/or configure reporting on the new device.

Figure 8.8 Principle of Central Commissioning with a Commissioning Director.

8.4.2 Minimum Requirements for All Devices

- A device shall process and respond to the ZDO discovery services: Active_EP_req, Simple_Desc_req, Match_Desc_req, IEEE_addr_req, NWK_addr_req.
- Routers and coordinators shall process and respond to the ZDO node manager service Mgmt_Bind_req and Mgmt_Lqi_req.
- A device shall process and respond to the ZDO binding table services Bind_req, Unbind_req, and.
- A device shall implement a binding table whose number of available entries is greater than or equal to the number of supported clusters that may initiate normal operational transactions[2].
- A device that supports a reportable attribute shall have a default report configuration.

[2] Operational transactions are not one time transactions or commissioning transactions. Operational transactions are those that are used to perform the device function, such attribute reporting or actuation commands (e.g. On, Off, Toggle, etc.).

- A device that supports a reportable attribute shall process and respond to ZCL commands to read and configure at least one report for that attribute.
- A device that supports a Group Table shall support a the Groups cluster on any endpoint that has a cluster that may be a target of an operational transaction.

8.4.3 Node Discovery

In order to commission devices, the Director needs to discover the nodes in the network. There are two ways nodes can be detected:

8.4.3.1 New Devices Joining

New devices that join the network are announced by a broadcast ZDO command Device_annce. A Director may then use ZDO discovery services (see sub-clause 8.4.2) to understand the nodes in the network, then binding table services (see sub-clause 8.4.2), to manage binding tables, and possibly Groups cluster commands to manage group tables.

8.4.3.2 Devices in Existing Network

When a Director joins an existing network, it needs to discover nodes already in the network.

It is recommended the Director to use the Mgmt_Lqi_req to discover nodes in the network. The benefit of using Mgmt_Lqi_req (instead of IEEE_addr_req or NWK_addr_req) are:

- Device type ZC, ZR, ZED information
- Rx_On_when_Idle information
- Information about parent-child relationships

The algorithms used for managing the incoming Mgmt_Lqi_rsp is not specified.

After this, the Director can perform any commission action as proposed in sub-clause 8.4.1.

8.5 Group Messaging vs. Unicast Messaging

It is important to consider that groups make use of broadcast transmissions. Group messaging should only be used when a device needs to communicate with a group of greater than 5. For groups of less than 5, standard binding and unicast messages should be employed unless simultaneous action is required by the command e.g., lighting. Also, there is no acknowledgement service for group messages, because they are broadcast. Unicast messaging shall be used if a device requires APS acknowledgments.

The commissioning procedures described in EZ-mode and Centralized commissioning can also be used to create one-to-one bindings for unicast messaging. When these procedures are utilized, the decision to create a group or not can be made by the application based on a local device policy. If a device is being bound to only 2 or 3 other devices, a unicast binding entry can be created for each target, and three unicasts will be sent instead of a group broadcast. When the destination is a large number of devices, a group binding entry should be created. This makes group vs. unicast messaging transparent to the user.

8.6 Bindings Required for Commissioning

A minimum number of binding table entries are required per device in order for the device to be able to be commissioned. Each device shall contain a minimum of one binding per endpoint times the number of clusters on that endpoint that support bindings. Thus if a device contains 5 endpoints each with two clusters which expect to be bound, that device must contain a minimum of 10 binding table entries. This rule ensures that properly formatted devices may be commissioned through the use of bindings in a network.

8.7 Network Sharing

8.7.0.1 HA Device Joining SE Network

An HA device that wishes to join an SE 1.x network must have the option to join with an installation code, as described in the SE 1.x specification. Such HA devices may have a user interface to select between using the HA default link key or the SE installation code. A simple HA device without the appropriate user interface may choose to try both the HA default link key and SE installation code when joining a network.

An HA device that joins an SE 1.x network is not required to initiate certificate-based key establishment. It will only have the authorization for messages with network layer encryption, but not APS layer encryption.

Depending on the security policy of the SE 1.x network, the trust center may remove devices that do not initiate key establishment from the network. So an SE 1.x trust center that wishes to accept an HA device must set its security policy to allow a device without key establishment support to remain on the network.

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CHAPTER 9

HOME AUTOMATION SPECIFIC CLUSTER DESCRIPTIONS

9.1 Electrical Measurement Cluster

9.1.1 Overview

9.1.1.1 General

This cluster (cluster ID: 0x0b04) provides a mechanism for querying data about the electrical properties as measured by the device. This cluster may be implemented on any device type and be implemented on a per-endpoint basis. For example, a power strip device could represent each outlet on a different endpoint and report electrical information for each individual outlet. The only caveat is that if you implement an attribute that has an associated multiplier and divisor, then you must implement the associated multiplier and divisor attributes. For example if you implement DCVoltage, you must also implement DCVoltageMultiplier and DCVoltageDivisor.

If you are interested in reading information about the power supply or battery level on the device, please see the Power Configuration cluster.

9.1.1.2 Formatting

Most measurement values have an associated multiplier and divisor attribute. Multiplier attributes provide a value to be multiplied against a raw or uncompensated measurement value. Divisor attributes provide a value to divide the results of applying a multiplier attribute against a raw or uncompensated measurement value. If a multiplier or divisor attribute is present, its corresponding divisor or multiplier attribute shall be implemented as well.

9.1.2 Server

9.1.2.1 Dependencies

For the alarm functionality in this cluster to be operational, any endpoint that implements the Electrical Measurement server cluster shall also implement the Alarms server cluster.

9.1.2.2 Attributes

The server side of this cluster contains certain attributes associated with the electrical properties and configuration.

Table 9.1 Attributes of the Electrical Measurement Cluster

Attribute Set Identifier	Description
0x00	Basic Information
0x01	DC Measurement
0x02	DC Formatting
0x03	AC (Non-phase Specific) Measurements
0x04	AC (Non-phase Specific) Formatting
0x05	AC (Single Phase or Phase A) Measurements
0x06	AC Formatting
0x07	DC Manufacturer Threshold Alarms
0x08	AC Manufacturer Threshold Alarms
0x09	AC Phase B Measurements
0x0A	AC Phase C Measurements
0x0B – FF	Reserved.

9.1.2.2.1 Basic Information

Table 9.2 Electrical Measurement Cluster Basic Information

Identifier	Name	Type	Range	Access	Default	Mandatory/ Optional
0x0000	MeasurementType	32-bit BitMap	0x00000000 – 0xFFFFFFFF	Read Only	0x00000000	M

9.1.2.2.1.1 MeasurementType

Indicates a device’s measurement capabilities. This will be indicated by setting the desire measurement bits to 1, as mentioned in Tables 9.3 and 9.4. This attribute will be used client devices to determine what all attribute is supported by the meter. Unused bits should be set to zero.

Table 9.3 MeasurementType Attribute

Bit	Flag Name / Description
0	Active measurement (AC)
1	Reactive measurement (AC)
2	Apparent measurement (AC)
3	Phase A measurement
4	Phase B measurement
5	Phase C measurement
6	DC measurement
7	Harmonics measurement
8	Power quality measurement
9 – 31	Reserved

9.1.2.2.2 DC Measurement

Table 9.4 DC Measurement Attributes

Identifier	Name	Type	Range	Access	Default	Mandatory/ Optional
0x0100	DCVoltage	Signed 16-bit integer	-32767 - 32767	Read only	0x8000	O
0x0101	DCVoltage Min	Signed 16-bit integer	-32767 - 32767	Read only	0x8000	O
0x0102	DCVoltage Max	Signed 16-bit integer	-32767 - 32767	Read only	0x8000	O
0x0103	DCCurrent	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O
0x0104	DCCurrent Min	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O
0x0105	DCCurrent Max	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O

Table 9.4 DC Measurement Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	Mandatory/ Optional
0x0106	DCPower	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O
0x0107	DCPowerMin	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O
0x0108	DCPowerMax	Signed 16-bit integer	-32767 – 32767	Read only	0x8000	O
0x0109 – 0x01FF	Reserved					

9.1.2.2.2.1 DCVoltage

The DCVoltage attribute represents the most recent DC voltage reading in Volts (V). If the voltage cannot be measured, a value of 0x8000 is returned.

9.1.2.2.2.2 DCVoltageMin

The DCVoltageMin attribute represents the lowest DC voltage value measured in Volts (V). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.2.3 DCVoltageMax

The DCVoltageMax attribute represents the highest DC voltage value measured in Volts (V). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.2.4 DCCurrent

The DCCurrent attribute represents the most recent DC current reading in Amps (A). If the current cannot be measured, a value of 0x8000 is returned.

9.1.2.2.2.5 DCCurrentMin

The DCCurrentMin attribute represents the lowest DC current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.2.6 DCCurrentMax

The DCCurrentMax attribute represents the highest DC current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.2.7 DCPower

The DCPower attribute represents the most recent DC power reading in Watts (W). If the power cannot be measured, a value of 0x8000 is returned.

9.1.2.2.2.8 DCPowerMin

The DCPowerMin attribute represents the lowest DC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.2.9 DCPowerMax

The DCPowerMax attribute represents the highest DC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.3 DC Formatting

Table 9.5 DC Formatting Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0200	*DCVoltageMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0201	*DCVoltageDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0202	*DCCurrentMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0203	*DCCurrentDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0204	*DCPowerMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0205	*DCPowerDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0206 – 0x02FF	Reserved					

9.1.2.2.3.1 DCVoltageMultiplier

The *DCVoltageMultiplier* provides a value to be multiplied against the *DCVoltage*, *DCVoltageMin*, and *DCVoltageMax* attributes. This attribute must be used in conjunction with the *DCVoltageDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.3.2 DCVoltageDivisor

The *DCVoltageDivisor* provides a value to be divided against the *DCVoltage*, *DCVoltageMin*, and *DCVoltageMax* attributes. This attribute must be used in conjunction with the *DCVoltageMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.3.3 DCCurrentMultiplier

The *DCCurrentMultiplier* provides a value to be multiplied against the *DCCurrent*, *DCCurrentMin*, and *DCCurrentMax* attributes. This attribute must be used in conjunction with the *DCCurrentDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.3.4 DCCurrentDivisor

The *DCCurrentDivisor* provides a value to be divided against the *DCCurrent*, *DCCurrentMin*, and *DCCurrentMax* attributes. This attribute must be used in conjunction with the *DCCurrentMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.3.5 DCPowerMultiplier

The *DCPowerMultiplier* provides a value to be multiplied against the *DCPower*, *DCPowerMin*, and *DCPowerMax* attributes. This attribute must be used in conjunction with the *DCPowerDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.3.6 DCPowerDivisor

The *DCPowerDivisor* provides a value to be divided against the *DCPower*, *DCPowerMin*, and *DCPowerMax* attributes. This attribute must be used in conjunction with the *DCPowerMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.4 AC (Non-phase Specific) Measurements

Table 9.6 AC (Non-phase Specific) Measurement Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0300	*ACFrequency*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0301	*ACFrequencyMin*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0302	*ACFrequencyMax*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0303	*NeutralCurrent*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read Only	0xFFFF	O
0x0304	*TotalActivePower*	Signed 32-bit integer	-8,388,607 to 8,388,607	Read Only	-	O
0x0305	*TotalReactivePower*	Signed 32-bit integer	-8,388,607 to 8,388,607	Read Only	-	O
0x0306	*TotalApparentPower*	Unsigned 32-bit integer	0x000000 – 0xFFFFFF	Read Only	0x000001	O
0x0307	*Measured1stHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x0308	*Measured3rdHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x0309	*Measured5thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x030A	*Measured7thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x030B	*Measured9thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x030C	*Measured11thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x030D	*MeasuredPhase1stHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x030E	*MeasuredPhase3rdHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x030F	*MeasuredPhase5thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x0310	*MeasuredPhase7thHarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O

Table 9.6 AC (Non-phase Specific) Measurement Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0311	*MeasuredPhase9th HarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x0312	*MeasuredPhase11th HarmonicCurrent*	Signed 16-bit integer	-32768 – 32767	Read only	0x8000	O
0x0313 – 0x03FF	Reserved					

9.1.2.2.4.1 ACFrequency

The *ACFrequency* attribute represents the most recent AC Frequency reading in Hertz (Hz). If the frequency cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.4.2 ACFrequencyMin

The *ACFrequencyMin* attribute represents the lowest AC Frequency value measured in Hertz (Hz). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.4.3 ACFrequencyMax

The *ACFrequencyMax* attribute represents the highest AC Frequency value measured in Hertz (Hz). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.4.4 Neutral Current

The *NeutralCurrent* attribute represents the AC neutral (Line-Out) current value at the moment in time the attribute is read, in Amps (A). If the instantaneous current cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.4.5 Total Active Power

Active power represents the current demand of active power delivered or received at the premises, in kW. Positive values indicate power delivered to the premises where negative values indicate power received from the premises. In case if device is capable of measuring multi elements or phases then this will be net active power value.

9.1.2.2.4.6 Total Reactive Power

Reactive power represents the current demand of reactive power delivered or received at the premises, in kVAr. Positive values indicate power delivered to the premises where negative values indicate power received from the premises. In case if device is capable of measuring multi elements or phases then this will be net reactive power value.

9.1.2.2.4.7 Total Apparent Power

Represents the current demand of apparent power, in kVA. In case if device is capable of measuring multi elements or phases then this will be net apparent power value.

9.1.2.2.4.8 Measured Nth Harmonic Current Attributes

The *Measured1stHarmonicCurrent* through *MeasuredNthHarmonicCurrent* attributes represent the most recent Nth harmonic current reading in an AC frequency. The unit for this measurement is 10 ^ *NthHarmonicCurrentMultiplier* amperes. If *NthHarmonicCurrentMultiplier* is not implemented the unit is in amperes. If the Nth harmonic current cannot be measured a value of 0x8000 is returned. A positive value indicates the measured Nth harmonic current is positive, and a negative value indicates that the measured Nth harmonic current is negative.

9.1.2.2.4.9 Measured Phase Nth Harmonic Current Attributes

The *MeasuredPhase1stHarmonicCurrent* through *MeasuredPhaseNthHarmonicCurrent* attributes represent the most recent phase of the Nth harmonic current reading in an AC frequency. The unit for this measurement is 10 ^ *PhaseNthHarmonicCurrentMultiplier* degree. If *PhaseNthHarmonicCurrentMultiplier* is not implemented the unit is in degree. If the phase of the Nth harmonic current cannot be measured a value of 0x8000 is returned. A positive value indicates the measured phase of the Nth harmonic current is prehurry, and a negative value indicates that the measured phase of the Nth harmonic current is lagging.

9.1.2.2.5 AC (Non-phase Specific) Formatting

Table 9.7 AC (Non-phase Specific) Formatting Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0400	*ACFrequencyMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0401	*ACFrequencyDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0402	*PowerMultiplier*	Unsigned 32-bit integer	0x000000 – 0xFFFFFF	Read Only	0x000001	O

Table 9.7 AC (Non-phase Specific) Formatting Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0403	*PowerDivisor*	Unsigned 32-bit integer	0x000000 – 0xFFFFFF	Read Only	0x000001	O
0x0404	*HarmonicCurrentMultiplier*	Signed 8-bit integer	-127 – 127	Read only	0x00	O
0x0405	*PhaseHarmonicCurrentMultiplier*	Signed 8-bit integer	-127 – 127	Read only	0x00	O
0x0406 – 0x04FF	Reserved					

9.1.2.2.5.1 ACFrequencyMultiplier

Provides a value to be multiplied against the *ACFrequency* attribute. This attribute must be used in conjunction with the *ACFrequencyDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.5.2 ACFrequencyDivisor

Provides a value to be divided against the *ACFrequency* attribute. This attribute must be used in conjunction with the *ACFrequencyMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.5.3 PowerMultiplier

Provides a value to be multiplied against a raw or uncompensated sensor count of power being measured by the metering device. If present, this attribute must be applied against all power/demand values to derive the delivered and received values expressed in the specified units. This attribute must be used in conjunction with the *PowerDivisor* attribute.

9.1.2.2.5.4 PowerDivisor

Provides a value to divide against the results of applying the *Multiplier* attribute against a raw or uncompensated sensor count of power being measured by the metering device. If present, this attribute must be applied against all demand/ power values to derive the delivered and received values expressed in the specified units. This attribute must be used in conjunction with the *PowerMultiplier* attribute.

9.1.2.2.5.5 HarmonicCurrentMultiplier

Represents the unit value for the *MeasuredNthHarmonicCurrent* attribute in the format *MeasuredNthHarmonicCurrent* * 10 ^ *HarmonicCurrentMultiplier* amperes.

9.1.2.2.5.6 PhaseHarmonicCurrentMultiplier

Represents the unit value for the *MeasuredPhaseNthHarmonicCurrent* attribute in the format *MeasuredPhaseNthHarmonicCurrent* * 10 ^ *PhaseHarmonicCurrentMultiplier* degrees.

9.1.2.2.6 AC (Single Phase or Phase A) Measurements

Table 9.8 AC (Single Phase or Phase A) Measurement Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0500	*Reserved*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0501	*LineCurrent*	Unsigned 16-bit integer	0x0000 – - 0xFFFF	Read only	0xFFFF	O
0x0502	*ActiveCurrent*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0503	*ReactiveCurrent*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0504	*Reserved*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0505	*RMSVoltage*	Unsigned 16-bit integer	0x0000– - 0xFFFF	Read only	0xFFFF	O
0x0506	*RMSVoltageMin*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0507	*RMSVoltageMax*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0508	*RMSCurrent*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0509	*RMSCurrentMin*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x050A	*RMSCurrentMax*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x050B	*ActivePower*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x050C	*ActivePowerMin*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x050D	*ActivePowerMax*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O

Table 9.8 AC (Single Phase or Phase A) Measurement Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x050E	*ReactivePower*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x050F	*ApparentPower*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read Only	0xFFFF	O
0x0510	*PowerFactor*	Signed 8-bit integer	-100 to +100	Read Only	0x00	O
0x0511	*AverageRMSVoltage MeasurementPeriod*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0512	*AverageRMSOverVoltageCounter*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0513	*AverageRMSUnderVoltageCounter*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0514	*RMSExtremeOverVoltagePeriod*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0515	*RMSExtremeUnderVoltagePeriod*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0516	*RMSVoltageSagPeriod*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0517	*RMSVoltageSwellPeriod*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0518 – 0x05FF	Reserved					

9.1.2.2.6.1 LineCurrent

Represents the single phase or Phase A, AC line current (Square root of active and reactive current) value at the moment in time the attribute is read, in Amps (A). If the instantaneous current cannot be measured, a value of 0x8000 is returned.

9.1.2.2.6.2 ActiveCurrent

Represents the single phase or Phase A, AC active/resistive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.6.3 ReactiveCurrent

Represents the single phase or Phase A, AC reactive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.6.4 RMSVoltage

Represents the most recent RMS voltage reading in Volts (V). If the RMS voltage cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.6.5 RMSVoltageMin

Represents the lowest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.6.6 RMSVoltageMax

Represents the highest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.6.7 RMSCurrent

Represents the most recent RMS current reading in Amps (A). If the power cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.6.8 RMSCurrentMin

Represents the lowest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.6.9 RMSCurrentMax

Represents the highest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.6.10 ActivePower

Represents the single phase or Phase A, current demand of active power delivered or received at the premises, in Watts (W). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.6.11 ActivePowerMin

Represents the lowest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.6.12 ActivePowerMax

Represents the highest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.6.13 ReactivePower

Represents the single phase or Phase A, current demand of reactive power delivered or received at the premises, in VAr. Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.6.14 ApparentPower

Represents the single phase or Phase A, current demand of apparent (Square root of active and reactive power) power, in VA.

9.1.2.2.6.15 PowerFactor

Contains the single phase or PhaseA, Power Factor ratio in 1/100ths.

9.1.2.2.6.16 AverageRMSVoltageMeasurementPeriod

The Period in seconds that the RMS voltage is averaged over

9.1.2.2.6.17 AverageRMSOverVoltageCounter

The number of times the average RMS voltage, has been above the *AverageRMS OverVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.6.18 AverageRMSUnderVoltageCounter

The number of times the average RMS voltage, has been below the *AverageRMS underVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.6.19 RMSExtremeOverVoltagePeriod

The duration in seconds used to measure an extreme over voltage condition.

9.1.2.2.6.20 RMSExtremeUnderVoltagePeriod

The duration in seconds used to measure an extreme under voltage condition.

9.1.2.2.6.21 RMSVoltageSagPeriod

The duration in seconds used to measure a voltage sag condition.

9.1.2.2.6.22 RMSVoltageSwellPeriod

The duration in seconds used to measure a voltage swell condition.

9.1.2.2.7 AC Formatting

Table 9.9 AC Formatting Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0600	*ACVoltageMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0601	*ACVoltageDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0602	*ACCurrentMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0603	*ACCurrentDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0604	*ACPowerMultiplier*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0605	*ACPowerDivisor*	Unsigned 16-bit integer	0x0001 – 0xFFFF	Read only	0x0001	O
0x0606 – 0x06FF	Reserved					

9.1.2.2.7.1 ACVoltageMultiplier

Provides a value to be multiplied against the *InstantaneousVoltage* and *RMSVoltage* attributes. This attribute must be used in conjunction with the *ACVoltageDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.7.2 ACVoltageDivisor

Provides a value to be divided against the *InstantaneousVoltage* and *RMSVoltage* attributes. This attribute must be used in conjunction with the *ACVoltageMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.7.3 ACCurrentMultiplier

Provides a value to be multiplied against the *InstantaneousCurrent* and *RMSCurrent* attributes. This attribute must be used in conjunction with the *ACCurrentDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.7.4 ACCurrentDivisor

Provides a value to be divided against the *ACCurrent*, *InstantaneousCurrent* and *RMSCurrent* attributes. This attribute must be used in conjunction with the *ACCurrentMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.7.5 ACPowerMultiplier

Provides a value to be multiplied against the *InstantaneousPower* and *ActivePower* attributes. This attribute must be used in conjunction with the *ACPowerDivisor* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.7.6 ACPowerDivisor

Provides a value to be divided against the *InstantaneousPower* and *ActivePower* attributes. This attribute must be used in conjunction with the *ACPowerMultiplier* attribute. 0x0000 is an invalid value for this attribute.

9.1.2.2.8 DC Manufacturer Threshold Alarms

Table 9.10 DC Manufacturer Threshold Alarms Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0700	*DCOverloadAlarmsMask*	Bitmap 8	0000 00xx	Read/write	0000 0000	O
0x0701	*DCVoltageOverload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0702	*DCCurrentOverload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0703 – 0x07FF	Reserved					

9.1.2.2.8.1 DC Overload Alarms Mask

Specifies which configurable alarms may be generated, as listed in Figure 9.1. A ‘1’ in each bit position enables the alarm.

Bit	Description
Bit0	Voltage Overload
Bit1	Current Overload
Bit2 – Bit7	Reserved

Figure 9.1 The DC Overload Alarm Mask

9.1.2.2.8.2 DC Voltage Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output voltage supported by device. The value is multiplied and divided by the *DCVoltageMultiplier* the *DCVoltageDivisor* respectively.

9.1.2.2.8.3 DC Current Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output current supported by device. The value is multiplied and divided by the *DCCurrentMultiplier* and *DCCurrentDivider* respectively.

9.1.2.2.9 AC Manufacturer Threshold Alarms

Table 9.11 DC Manufacturer Threshold Alarms Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0800	*ACAlarmsMask*	Bitmap 16	0000 xxxx	Read/write	0000 0000	O
0x0801	*ACVoltageOverload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0802	*ACCurrentOverload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0803	*ACActivePowerOverload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0804	*ACReactivePower Overload*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0805	*AverageRMSOverVoltage*	Signed 16-bit integer	-32768 – 32767	Read Only		O
0x0806	*AverageRMSUnder Voltage*	Signed 16-bit integer	-32768 – 32767	Read Only		O
0x0807	*RMSExtremeOverVoltage*	Signed 16-bit integer	-32768 – 32767	Read/Write		O
0x0808	*RMSExtremeUnder Voltage*	Signed 16-bit integer	-32768 – 32767	Read/Write		O
0x0809	*RMSVoltageSag*	Signed 16-bit integer	-32768 – 32767	Read/Write		O
0x080A	*RMSVoltageSwell*	Signed 16-bit integer	-32768 – 32767	Read/Write		O
0x080B – 0x08FF	Reserved					

9.1.2.2.9.1 AC Alarms Mask

Specifies which configurable alarms may be generated, as listed in Figure 9.2. A ‘1’ in each bit position enables the alarm.

Bit	Description
Bit0	Voltage Overload
Bit1	Current Overload
Bit2	Active Power Overload
Bit3	Reactive Power Overload
Bit4	Average RMS Over Voltage
Bit5	Average RMS Under Voltage
Bit6	RMS Extreme Over Voltage
Bit7	RMS Extreme Under Voltage
Bit8	RMS Voltage Sag
Bit9	RMS Voltage Swell
Bit10 – Bit15	Reserved

Figure 9.2 The AC Alarm Mask Attribute

9.1.2.2.9.2 AC Voltage Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output voltage supported by device. The value is multiplied and divided by the A*CVoltageMultiplier* the A*CVoltageDivisor,* respectively. The value is voltage RMS.

9.1.2.2.9.3 AC Current Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output current supported by device. The value is multiplied and divided by the A*CCurrentMultiplier* and *ACCurrentDivider,* respectively. The value is current RMS.

9.1.2.2.9.4 AC Active Power Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output active power supported by device. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor,* respectively.

9.1.2.2.9.5 AC Reactive Power Overload

Specifies the alarm threshold, set by the manufacturer, for the maximum output reactive power supported by device. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively.

9.1.2.2.9.6 Average RMS over Voltage

The average RMS voltage above which an over voltage condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.9.7 Average RMS Under Voltage

The average RMS voltage below which an under voltage condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.9.8 RMSExtremeOverVoltage

The RMS voltage above which an extreme under voltage condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.9.9 RMSExtremeUnderVoltage

The RMS voltage below which an extreme under voltage condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.9.10 RMSVoltageSag

The RMS voltage below which a sag condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.9.11 RMSVoltageSwell

The RMS voltage above which a swell condition is reported. The threshold shall be configurable within the specified operating range of the electricity meter. The value is multiplied and divided by the *ACPowerMultiplier* and *ACPowerDivisor*, respectively

9.1.2.2.10 AC Phase B Measurements

Table 9.12 AC Phase B Measurements Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0900	Reserved	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0901	*LineCurrentPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0902	*ActiveCurrentPhB*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0903	*ReactiveCurrentPhB*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0904	*Reserved*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0905	*RMSVoltagePhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0906	*RMSVoltageMinPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0907	*RMSVoltageMaxPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0908	*RMSCurrentPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0909	*RMSCurrentMinPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x090A	*RMSCurrentMaxPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x090B	*ActivePowerPhB*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x090C	*ActivePowerMinPhB*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x090D	*ActivePowerMaxPhB*	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x090E	*ReactivePowerPhB*	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x090F	*ApparentPowerPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read Only	0xFFFF	O
0x0910	*PowerFactorPhB*	Signed 8-bit integer	-100 to +100	Read Only	0x00	O

Table 9.12 AC Phase B Measurements Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0911	*AverageRMSVoltageMeasurementPeriodPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0912	*AverageRMSOverVoltageCounterPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0913	*AverageRMSUnderVoltageCounterPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0914	*RMSExtremeOverVoltagePeriodPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0915	*RMSExtremeUnderVoltagePeriodPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0916	*RMSVoltageSagPeriodPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0917	*RMSVoltageSwellPeriodPhB*	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0918 – 0x09FF	Reserved					

9.1.2.2.10.1 LineCurrentPhB

Represents the Phase B, AC line current (Square root sum of active and reactive currents) value at the moment in time the attribute is read, in Amps (A). If the instantaneous current cannot be measured, a value of 0x8000 is returned.

9.1.2.2.10.2 ActiveCurrentPhB

Represents the Phase B, AC active/resistive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.10.3 ReactiveCurrentPhB

Represents the Phase B, AC reactive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.10.4 RMSVoltagePhB

Represents the most recent RMS voltage reading in Volts (V). If the RMS voltage cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.10.5 RMSVoltageMinPhB

Represents the lowest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.10.6 RMSVoltageMaxPhB

Represents the highest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.10.7 RMSCurrentPhB

Represents the most recent RMS current reading in Amps (A). If the power cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.10.8 RMSCurrentMinPhB

Represents the lowest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.10.9 RMSCurrentMaxPhB

Represents the highest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.10.10 ActivePowerPhB

Represents the Phase B, current demand of active power delivered or received at the premises, in Watts (W). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.10.11 ActivePowerMinPhB

Represents the lowest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.10.12 ActivePowerMaxPhB

Represents the highest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.10.13 ReactivePowerPhB

Represents the Phase B, current demand of reactive power delivered or received at the premises, in VAr. Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.10.14 ApparentPowerPhB

Represents the Phase B, current demand of apparent (Square root of active and reactive power) power, in VA.

9.1.2.2.10.15 PowerFactorPhB

Contains the PhaseB, Power Factor ratio in 1/100ths.

9.1.2.2.10.16 AverageRMSVoltageMeasurementPeriodPhB

The Period in seconds that the RMS voltage is averaged over

9.1.2.2.10.17 AverageRMSOverVoltageCounterPhB

The number of times the average RMS voltage, has been above the *AverageRMS OverVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.10.18 AverageRMSUnderVoltageCounterPhB

The number of times the average RMS voltage, has been below the *AverageRMS underVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.10.19 RMSExtremeOverVoltagePeriodPhB

The duration in seconds used to measure an extreme over voltage condition.

9.1.2.2.10.20 RMSExtremeUnderVoltagePeriodPhB

The duration in seconds used to measure an extreme under voltage condition.

9.1.2.2.10.21 RMSVoltageSagPeriodPhB

The duration in seconds used to measure a voltage sag condition.

9.1.2.2.10.22 RMSVoltageSwellPeriodPhB

The duration in seconds used to measure a voltage swell condition.

9.1.2.2.11 AC Phase C Measurements

Table 9.13 AC Phase C Measurements Attributes

Identifier	Name	Type	Range	Access	Default	Mandatory/ Optional
0x0A00	Reserved	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0A01	LineCurrentPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0A02	ActiveCurrentPhC	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0A03	ReactiveCurrentPhC	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0A04	Reserved	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0A05	RMSVoltagePhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0A06	RMSVoltageMinPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0A07	RMSVoltageMaxPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0x8000	O
0x0A08	RMSCurrentPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0A09	RMSCurrentMinPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0A0A	RMSCurrentMaxPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read only	0xFFFF	O
0x0A0B	ActivePowerPhC	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0A0C	ActivePowerMinPhC	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0A0D	ActivePowerMaxPhC	Signed 16-bit integer	-32768 – 32767	Read only	0xFFFF	O
0x0A0E	ReactivePowerPhC	Signed 16-bit integer	-32768 – 32767	Read Only	0xFFFF	O
0x0A0F	ApparentPowerPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read Only	0xFFFF	O
0x0A10	PowerFactorPhC	Signed 8-bit integer	-100 to +100	Read Only	0x00	O
0x0A11	AverageRMSVoltageMeasurementPeriodPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O

Table 9.13 AC Phase C Measurements Attributes (Continued)

Identifier	Name	Type	Range	Access	Default	Mandatory/ Optional
0x0A12	AverageRMSOverVoltageCounterPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A13	AverageRMSUnderVoltageCounterPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A14	RMSExtremeOverVoltagePeriodPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A15	RMSExtremeUnderVoltagePeriodPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A16	RMSVoltageSagPeriodPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A17	RMSVoltageSwellPeriodPhC	Unsigned 16-bit integer	0x0000 – 0xFFFF	Read/ Write	0x0000	O
0x0A18 – 0x0AFF	Reserved					

9.1.2.2.11.1 LineCurrentPhC

Represents the Phase C, AC line current (Square root of active and reactive current) value at the moment in time the attribute is read, in Amps (A). If the instantaneous current cannot be measured, a value of 0x8000 is returned.

9.1.2.2.11.2 ActiveCurrentPhC

Represents the Phase C, AC active/resistive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.11.3 ReactiveCurrentPhC

Represents the Phase C, AC reactive current value at the moment in time the attribute is read, in Amps (A). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.11.4 RMSVoltagePhC

Represents the most recent RMS voltage reading in Volts (V). If the RMS voltage cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.11.5 RMSVoltageMinPhC

Represents the lowest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.11.6 RMSVoltageMaxPhC

Represents the highest RMS voltage value measured in Volts (V). After resetting, this attribute will return a value of 0xFFFF until a measurement is made.

9.1.2.2.11.7 RMSCurrentPhC

Represents the most recent RMS current reading in Amps (A). If the power cannot be measured, a value of 0xFFFF is returned.

9.1.2.2.11.8 RMSCurrentMinPhC

Represents the lowest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.11.9 RMSCurrentMaxPhC

Represents the highest RMS current value measured in Amps (A). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.11.10 ActivePowerPhC

Represents the Phase C, current demand of active power delivered or received at the premises, in Watts (W). Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.11.11 ActivePowerMinPhC

Represents the lowest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.11.12 ActivePowerMaxPhC

Represents the highest AC power value measured in Watts (W). After resetting, this attribute will return a value of 0x8000 until a measurement is made.

9.1.2.2.11.13 ReactivePowerPhC

Represents the Phase C, current demand of reactive power delivered or received at the premises, in VAr. Positive values indicate power delivered to the premises where negative values indicate power received from the premises.

9.1.2.2.11.14 ApparentPowerPhC

Represents the Phase C, current demand of apparent (Square root of active and reactive power) power, in VA.

9.1.2.2.11.15 PowerFactorPhC

Contains the Phase C, Power Factor ratio in 1/100ths.

9.1.2.2.11.16 AverageRMSVoltageMeasurementPeriodPhC

The Period in seconds that the RMS voltage is averaged over

9.1.2.2.11.17 AverageRMSOverVoltageCounterPhC

The number of times the average RMS voltage, has been above the *AverageRMS OverVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.11.18 AverageRMSUnderVoltageCounterPhC

The number of times the average RMS voltage, has been below the *AverageRMS underVoltage* threshold since last reset. This counter may be reset by writing zero to the attribute.

9.1.2.2.11.19 RMSExtremeOverVoltagePeriodPhC

The duration in seconds used to measure an extreme over voltage condition.

9.1.2.2.11.20 RMSExtremeUnderVoltagePeriodPhC

The duration in seconds used to measure an extreme under voltage condition.

9.1.2.2.11.21 RMSVoltageSagPeriodPhC

The duration in seconds used to measure a voltage sag condition.

9.1.2.2.11.22 RMSVoltageSwellPeriodPhC

The duration in seconds used to measure a voltage swell condition.

9.1.2.3 Server Commands

9.1.2.3.1 Commands Generated

The command IDs generated by the electrical measurement server cluster are listed in Table 9.14.

Table 9.14 Generated Command ID's for the Electrical Measurement Server

Command Identifier Field Value	Description	Mandatory/ Optional
0x00	Get Profile Info Response Command	O
0x01	Get Measurement Profile Response Command	O
0x02 – 0xFF	Reserved for future	

9.1.2.3.1.1 Get Profile Info Response Command

The Get Profile Info Response Command shall be formatted as illustrated below

Octets	1	1	1	Variable
Data Type	Unsigned 8-bit integer	8-bit enumeration	Unsigned 8-bit integer	Array of attribute IDs (two byte unsigned values)
Field Name	Profile Count	Profile Interval Period	MaxNumberOfI ntervals	ListOfAttributes

Figure 9.3 Format of the Get Profile Info Response Command

9.1.2.3.1.1.1 Payload Details

Profile Count: Total number of supported profile.

Profile Interval Period: Represents the interval or time frame used to capture parameter for profiling purposes. ProfileIntervalPeriod is an enumerated field representing the following timeframes listed below.

Enumerated Value	Time Frame
0	Daily
1	60 minutes
2	30 minutes
3	15 minutes
4	10 minutes
5	7.5 minutes
6	5 minutes
7	2.5 minutes
8 to 255	Reserved for future

Figure 9.4 ProfileIntervalPeriod

MaxNumberOfIntervals: Represents the maximum number of intervals the device is capable of returning in one Get Measurement Profile Response command. It is required MaxNumberofIntervals fit within the default Fragmentation ASDU size of 128 bytes, or an optionally agreed upon larger Fragmentation ASDU size supported by both devices as per the application profile supported by the devices.

ListOfAttributes: Represents the list of attributes being profiled.

9.1.2.3.1.2 When Generated

This command is generated when the Client command GetProfileInfo is received.

9.1.2.3.1.3 Get Measurement Profile Response Command

The Get Measurement Profile Response Command shall be formatted as illustrated below

Octets	4	1	1	1	1	Variable
Data Type	UTC Time	8-bit enumeration	8-bit enumeration	Unsigned 8-bit integer	Unsigned 16-bit integer	Array of Attribute values
Field Name	StartTime	Status	ProfileIntervalPeriod	NumberOfIntervalsDelivered	Attribute Id	Intervals

Figure 9.5 Format of the Get Measurement Profile Response Command

9.1.2.3.1.3.1 Payload Details

StartTime: 32-bit value (in UTC) representing the end time of the most chronologically recent interval being requested. Example: Data collected from 2:00 PM to 3:00 PM would be specified as a 3:00 PM interval (end time).

Status: Table status enumeration lists the valid values returned in the Status field.

Table 9.15 List of Status Valid Values

Status Value	**Description**
0x00	Success
0x01	Attribute Profile not supported
0x02	Invalid Start Time
0x03	More intervals requested than can be returned
0x04	No intervals available for the requested time
0x05 to 0xFF	Reserved for future use

ProfileIntervalPeriod: Represents the interval or time frame used to capture parameter for profiling purposes. Refer to table “ProfileIntervalPeriod”.

NumberofIntervalsDelivered: Represents the number of intervals the device is returning. Please note the number of intervals returned in the Get Measurement Profile Response command can be calculated when the packets are received and can replace the usage of this field. The intent is to provide this information as a convenience.

AttributeID: The attribute that has been profiled by the application.

Intervals: Series of interval data captured using the period specified by the ProfileIntervalPeriod field. The content of the interval data depend of the type of information requested using the **AttributeID** field in the Get Measurement Profile Command. Data is organized in a reverse chronological order, the oldest intervals are transmitted first and the newest interval is transmitted last. Invalid intervals should be marked as 0xFFFF. For scaling and data type use the respective attribute set as defined above in attribute sets.

9.1.2.3.1.3.2 When Generated

This command is generated when the Client command GetMeasurementProfile is received.

9.1.2.4 Client Commands

9.1.2.4.1 Commands Generated

The command ID’s generated by the electrical measurement client cluster are listed in Table 9.16.

Table 9.16 Generated Command ID’s for the Electrical Measurement Client

Command Identifier Field Value	Description	Mandatory/ Optional
0x00	Get Profile Info Command	O
0x01	Get Measurement Profile Command	O
0x02 – 0xFF	Reserved for future	

9.1.2.4.1.1 Get Profile Info Command

This command has no payload.

9.1.2.4.1.1.1 Effect on Receipt

On receipt of this command, the device shall send a Get Profile Info Response Command. A ZCL default response with status

UNSUP_CLUSTER_COMMAND shall be returned if command is not supported on the device.

9.1.2.4.1.2 Get Measurement Profile Command

The Get Measurement Profile Command shall be formatted as illustrated in Figure 9.6.

Octets	2	1	1
Data Type	Unsigned 2-bit integer	UTC Time	Unsigned 8-bit integer
Field Name	Attribute ID	Start Time	NumberOfIntervals

Figure 9.6 Format of the Get Measurement Profile Command

9.1.2.4.1.2.1 Payload Details

Attribute ID: The electricity measurement attribute being profiled.

StartTime: 32-bit value (in UTCTime) used to select an Intervals block from all the Intervals blocks available. The Intervals block returned is the most recent block with its StartTime equal or greater to the one provided.

NumberOfIntervals: Represents the number of intervals being requested. This value can’t exceed the size stipulated in the MaxNumberOfIntervals field of Get Profile Info Response Command. If more intervals are requested than can be delivered, the GetMeasurementProfileResponse will return the number of intervals equal to MaxNumberOfIntervals. If fewer intervals available for the time period then only those available are returned.

9.1.2.4.1.2.2 Effect on Receipt

On receipt of this command, the device shall send a Get Measurement Profile Response Command. A ZCL default response with status UNSUP_CLUSTER_COMMAND shall be returned if command is not supported on the device.

9.2 Diagnostics Cluster

9.2.1 Overview

9.2.1.1 General

The diagnostics cluster provides access to information regarding the operation of the ZigBee stack over time. This information is useful to installers and other network administrators who wish to know how a particular device is functioning on the network.

The Diagnostics Cluster needs to understand the performance of the network over time in order to isolate network routing issues.

The Diagnostics Cluster is contained in a standalone document due to the fact that this cluster will be used by multiple profiles. As a result the cluster should not be included in any single profile specification.

While it is not absolutely essential, it is recommended that server attributes be stored in persistent memory. This especially makes sense if for instance some stack behavior were causing a device to reset. Without storing the associated server attributes in persistent memory there would be no way to analyze what was causing the reset behavior.

9.2.2 Server

9.2.2.1 Dependencies

There are no server dependencies

9.2.2.2 Attributes

The server attributes in the diagnostics cluster are broken up into several attribute sets listed below.

Table 9.17 Server Attribute Sets of the Diagnostics Cluster

Attribute Set Identifier	Description
0x0000	Hardware Information
0x0100	Stack/Network Information

9.2.2.2.1 Hardware Information Attribute Set

Table 9.18 Hardware Information Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0000	*NumberOfResets*	Int16u	0x0000 – 0xffff	Read Only	0x00000 000	O
0x0001	*PersistentMemory Writes*	Int16u	0x0000 – 0xffff	Read Only	0x00000 000	O

9.2.2.2.1.1 Number of Resets

An attribute that is incremented each time the device resets. A reset is defined as any time the device restarts. This is not the same as a reset to factory defaults, which should clear this and all values.

9.2.2.2.1.2 PersistentMemoryWrites

This attribute keeps track of the number of writes to persistent memory. Each time that the device stores a token in persistent memory it will increment this value.

9.2.2.2.2 Stack / Network Information Attribute Set

It should be noted that many of the counters in this attribute set will wrap quickly. They should be read frequently during periods of network interrogation in order to avoid missing points where the counters roll over.

Table 9.19 Stack / Network Information Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0100	*MacRxBcast*	Int32u	0x0000 – 0xffff	Read Only	0x0000	O
0x0101	*MacTxBcast*	Int32u	0x0000 – 0xffff	Read Only	0x0000	O
0x0102	*MacRxUcast*	Int32u	0x0000 – 0xffff	Read Only	0x0000	O
0x0103	*MacTxUcast*	Int32u	0x0000 – 0xffff	Read Only	0x0000	O
0x0104	*MacTxUcastRetry*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0105	*MacTxUcastFail*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0106	*APSRxBcast*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0107	*APSTxBcast*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O

Table 9.19 Stack / Network Information Attribute Set (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0108	*APSRxUcast*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0109	*APSTxUcastSuccess*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010A	*APSTxUcastRetry*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010B	*APSTxUcastFail*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010C	*RouteDiscInitiated*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010D	*NeighborAdded*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010E	*NeighborRemoved*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x010F	*NeighborStale*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0110	*JoinIndication*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0111	*ChildMoved*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0112	*NWKFCFailure*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0113	*APSFCFailure*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0114	*APSUnauthorizedKey*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0115	*NWKDecryptFailures*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0116	*APSDecryptFailures*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0117	*PacketBufferAllocateFailures*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0118	*RelayedUcast*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x0119	*PhytoMACqueuelimitreached*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x011A	*PacketValidatedropcount*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O

Table 9.19 Stack / Network Information Attribute Set (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x011B	*AverageMACRetryPer APSMessageSent*	Int16u	0x0000 – 0xffff	Read Only	0x0000	O
0x011C	*LastMessageLQI*	Int8u	0x00 – 0xff	Read Only	0x00	O
0x011D	*LastMessageRSSI*	Int8s	0x00 – 0xff	Read Only	0x00	O

9.2.2.2.2.1 MacRxBcast

A counter that is incremented each time the MAC layer receives a broadcast.

9.2.2.2.2.2 MacTxBcast

A counter that is incremented each time the MAC layer transmits a broadcast.

9.2.2.2.2.3 MacRxUcast

A counter that is incremented each time the MAC layer receives a unicast.

9.2.2.2.2.4 MacTxUcast

A counter that is incremented each time the MAC layer transmits a unicast.

9.2.2.2.2.5 MacTxUcastRetry

A counter that is incremented each time the MAC layer retries a unicast.

9.2.2.2.2.6 MacTxUcastFail

A counter that is incremented each time the MAC layer fails to send a unicast.

9.2.2.2.2.7 APSRxBcast

A counter that is incremented each time the APS layer receives a broadcast.

9.2.2.2.2.8 APSTxBcast

A counter that is incremented each time the APS layer transmits a broadcast.

9.2.2.2.2.9 APSRxUcast

A counter that is incremented each time the APS layer receives a unicast.

9.2.2.2.2.10 APSTxUcastSuccess

A counter that is incremented each time the APS layer successfully transmits a unicast.

9.2.2.2.2.11 APSTxUcastRetry

A counter that is incremented each time the APS layer retries the sending of a unicast.

9.2.2.2.2.12 APSTxUcastFail

A counter that is incremented each time the APS layer fails to send a unicast.

9.2.2.2.2.13 RouteDiscInitiated

A counter that is incremented each time the network layer submits a route discovery message to the MAC.

9.2.2.2.2.14 NeighborAdded

A counter that is incremented each time an entry is added to the neighbor table.

9.2.2.2.2.15 NeighborRemoved

A counter that is incremented each time an entry is removed from the neighbor table.

9.2.2.2.2.16 NeighborStale

A counter that is incremented each time a neighbor table entry becomes stale because the neighbor has not been heard from.

9.2.2.2.2.17 JoinIndication

A counter that is incremented each time a node joins or rejoins the network via this node.

9.2.2.2.2.18 ChildMoved

A counter that is incremented each time an entry is removed from the child table.

9.2.2.2.2.19 NWKFCFailure

A counter that is incremented each time a message is dropped at the network layer because the APS frame counter was not higher than the last message seen from that source.

9.2.2.2.2.20 APSFCFailure

A counter that is incremented each time a message is dropped at the APS layer because the APS frame counter was not higher than the last message seen from that source.

9.2.2.2.2.21 APSUnauthorizedKey

A counter that is incremented each time a message is dropped at the APS layer because it had APS encryption but the key associated with the sender has not been authenticated, and thus the key is not authorized for use in APS data messages.

9.2.2.2.2.22 NWKDecryptFailures

A counter that is incremented each time a NWK encrypted message was received but dropped because decryption failed.

9.2.2.2.2.23 APSDecryptFailures

A counter that is incremented each time an APS encrypted message was received but dropped because decryption failed.

9.2.2.2.2.24 PacketBufferAllocateFailures

A counter that is incremented each time the stack failed to allocate a packet buffers. This doesn't necessarily mean that the packet buffer count was 0 at the time, but that the number requested was greater than the number free.

9.2.2.2.2.25 RelayedUcast

A counter that is incremented each time a unicast packet is relayed.

9.2.2.2.2.26 PacketValidateDropCount

A counter that is incremented each time a packet was dropped due to a packet validation error. This could be due to length or other formatting problems in the packet.

9.2.2.2.2.27 AverageMACRetryPerAPSMessageSent

A counter that is equal to the average number of MAC retries needed to send an APS message.

9.2.2.2.2.28 LastMessageLQI

This is the Link Quality Indicator for the last message received. There is no current agreed upon standard for calculating the LQI. For some implementations LQI is related directly to RSSI for others it is a function of the number of errors received over a fixed number of bytes in a given message. The one thing that has been agreed is that the Link Quality Indicator is a value between 0 and 255 where 0 indicates the worst possible link and 255 indicates the best possible link. It should be noted that for a device reading the Last Message LQI the returned value shall be the LQI for the read attribute message used to read the attribute itself.

9.2.2.2.2.29 LastMessageRSSI

This is the receive signal strength indication for the last message received. As with Last Message LQI, it should be noted that for a device reading the Last Message RSSI, the returned value shall be the RSSI of the read attribute message used to read the attribute itself.

9.2.2.3 Commands

There are no commands received by the server side of the diagnostics cluster.

9.2.3 Client

9.2.3.1 Dependencies

There are no server dependencies

9.2.3.2 Attributes

There are no attributes on the client side of the diagnostics cluster.

9.2.3.3 Commands

There are no commands received by the client side of the diagnostics cluster.

9.3 Window Covering Cluster

9.3.1 Overview

The window covering cluster provides an interface for controlling and adjusting automatic window coverings such as drapery motors, automatic shades, and blinds.

Note*: This Cluster is provisionary and not certifiable. This feature set may change before reaching certifiable status in a future revision of this specification.*

9.3.2 Server

9.3.2.1 Attributes

For convenience, the attributes defined in this cluster are arranged into sets of related attributes; each set can contain up to 16 attributes. Attribute identifiers are encoded such that the most significant three nibbles specify the attribute set and the least significant nibble specifies the attribute within the set. The currently defined attribute sets are listed in Table 9.20.

Table 9.20 Window Covering Attribute Set

Attribute Set Identifier	Description
0x0000	Window Covering Information
0x0010	Window Covering Settings
0x0020 - 0xFFF0	Reserved

9.3.2.1.1 Window Covering Information Attribute Set

The Window Covering Information attribute set contains the attributes summarized in Table 9.21.

Table 9.21 Window Covering Information Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0000	*WindowCoveringType*	8-bit enumeration	0x00 – 0x09	Read only	0x00	M
0x0001	*PhysicalClosedLimit* — *Lift* (cm)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O
0x0002	*PhysicalClosedLimit* — *Tilt* (tenth of a degree)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O
0x0003	*CurrentPosition* — *Lift* (cm)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O
0x0004	*CurrentPosition* — *Tilt* (tenth of a degree)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O
0x0005	*NumberofActuations* — *Lift*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O
0x0006	*NumberofActuations* — *Tilt*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	O

Table 9.21 Window Covering Information Attribute Set (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0007	*Config/Status*	8-bit-bitmap	0xxx xxxx	Read Only	0000 0011	M
0x0008	*CurrentPosition – Lift Percentage*	Unsigned 8-bit integer	0-0x64	Read Only	0x00	(O), (M) if device is running in an open loop.[a]
0x0009	*CurrentPosition – Tilt Percentage*	Unsigned 8-bit integer	0-0x64	Read Only	0x00	(O), (M) if device is running in an open loop.[b]

[a] CCB 1774

[b] CCB 1774

9.3.2.1.2 WindowCoveringType Attribute

The *WindowCoveringType* attribute identifies the type of window covering being controlled by this endpoint and shall be set to one of the non-reserved values in Table 9.22.

Table 9.22 *WindowCoveringType*

Value	WindowCoveringType
0x00	Rollershade
0x01	Rollershade - 2 Motor
0x02	Rollershade – Exterior
0x03	Rollershade - Exterior - 2 Motor
0x04	Drapery
0x05	Awning
0x06	Shutter
0x07	Tilt Blind - Tilt Only
0x08	Tilt Blind - Lift and Tilt
0x09	Projector Screen

9.3.2.1.2.1 PhysicalClosedLimit – Lift Attribute

The *PhysicalClosedLimit – Lift* attribute identifies the maximum possible encoder position possible (in centimeters) to position the height of the window covering – this is ignored if the device is running in Open Loop Control.

9.3.2.1.2.2 PhysicalClosedLimit - Tilt Attribute

The *PhysicalClosedLimit –Tilt* attribute identifies the maximum possible encoder position possible (tenth of a degree) to position the angle of the window covering – this is ignored if the device is running in Open Loop Control.

9.3.2.1.2.3 CurrentPosition - Lift Attribute

The *CurrentPosition – Lift* attribute identifies the actual position (in centimeters) of the window covering from the top of the shade if Closed Loop Control is enabled. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.2.4 Current Position - Tilt Attribute

The *CurrentPosition – Tilt* attribute identifies the actual tilt position (tenth of a degree) of the window covering from Open if Closed Loop Control is enabled. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.2.5 Number of Actuations - Lift Attribute

The *NumberOfActuations – Lift* attribute identifies the total number of lift actuations applied to the Window Covering since the device was installed.

9.3.2.1.2.6 Number of Actuations - Tilt Attribute

The *NumberOfActuations – Tilt* attribute identifies the total number of tilt actuations applied to the Window Covering since the device was installed.

9.3.2.1.2.7 Config/Status Attribute

The *ConfigStatus* attribute makes configuration and status information available. To change settings, devices shall write to the *Mode* attribute of the Window Covering Settings Attribute Set. The behavior causing the setting or clearing of each bit is vendor-specific. See Table 9.23 for details on each bit.

Table 9.23 Bit Meanings for the Config/Status Attribute

Bit	Meaning	Description
bit0	0 = Not Operational 1 = Operational	Operational: This status bit defines if the Window Covering is operational.
bit1	0 = Not Online 1 = Online	Online: This status bit defines if the Window Covering is enabled for transmitting over the ZigBee network.
bit2	0 = Commands are normal 1 = Open/Up Commands have been reversed	Reversal – Lift commands: This status bit identifies if the direction of rotation for the Window Covering has been reversed in order for Open/Up commands to match the physical installation condition.

Table 9.23 Bit Meanings for the Config/Status Attribute (Continued)

Bit	Meaning	Description
bit3	0 = Lift control is Open Loop 1 = Lift control is Closed Loop	Control – Lift: This status bit identifies if the window covering supports Open Loop or Closed Loop Lift Control.
bit4	0 = Tilt control is Open Loop 1 = Tilt control is Closed Loop	Control – Tilt: This status bit identifies if the window covering supports Open Loop or Closed Loop Tilt Control.
bit5	0 = Timer Controlled 1 = Encoder Controlled This bit is Ignored if running Lift in Open Loop Control.	Encoder – Lift: This status bit identifies if a Closed Loop Controlled Window Covering is employing an encoder for positioning the height of the window covering.
bit6	0 = Timer Controlled 1 = Encoder Controlled This bit is Ignored if running Tilt in Open Loop Control.	Encoder – Tilt: This status bit identifies if a Closed Loop Controlled Window Covering is employing an encoder for tilting the window covering.
bit7	Reserved	Reserved

9.3.2.1.3 CurrentPositionLiftPercentage Attribute

The *CurrentPositionLiftPercentage* attribute identifies the actual position as a percentage between the *PhysicalOpenLimitLift* attribute and the *PhysicalClosedLimitLift* attribute of the window covering from the top of the shade if Closed Loop Control is enabled. If the device is running in Open Loop Control or the device only supports Tilt actions, this attribute is not required as an attribute but has a special interpretation when received as part of a scene command (see “Scene Table Extensions” below).

9.3.2.1.4 CurrentPositionTiltPercentage Attribute

The *CurrentPositionLiftPercentage* attribute identifies the actual position as a percentage between the *PhysicalOpenLimitTilt* attribute and the *PhysicalClosedLimitTilt* attribute of the window covering from the top of the shade if Closed Loop Control is enabled. If the device is running in Open Loop Control or the device only support Lift actions, this attribute is not required as an attribute but has a special interpretation when received as part of a scene command (see “Scene Table Extensions” below).

9.3.2.1.5 Window Covering Settings Attribute Set

The Window Covering Settings attribute set contains the attributes summarized in Table 9.24.

Table 9.24 Window Covering Settings Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0010	*InstalledOpenLimit* — *Lift* (cm)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	M
0x0011	*InstalledClosedLimit* — *Lift* (cm)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0xffff	M
0x0012	*InstalledOpenLimit* — *Tilt* (tenth of an degree)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0x0000	M
0x0013	*InstalledClosedLimit* — *Tilt* (tenth of an degree)	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	0xffff	M
0x0014	*Velocity* — *Lift* (cm/second)	Unsigned 16-bit integer	0x0000 – 0xffff	Read / Write	0x0000	O
0x0015	*AccelerationTime* — *Lift* (tenth of a second)	Unsigned 16-bit integer	0x0000 – 0xffff	Read / Write	0x0000	O
0x0016	*DecelerationTime* — *Lift* (tenth of a second)	Unsigned 16-bit integer	0x0000 – 0xffff	Read / Write	0x0000	O
0x0017	*Mode*	8-bit-bitmap	xxx0 0000	Read / Write	0001 0100	M
0x0018	Intermediate Setpoints – Lift	Octet string	N, 0x0000, 0x0000,… (N comma separated values)	Read / Write	"1,0x0000"	O
0x0019	Intermediate Setpoints – Tilt	Octet string	N, 0x0000, 0x0000,… (N comma separated values)	Read / Write	"1,0x0000"	O

9.3.2.1.5.1 InstalledOpenLimit – Lift

The *InstalledOpenLimit – Lift* attribute identifies the Open Limit for Lifting the Window Covering whether position (in centimeters) is encoded or timed. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.5.2 InstalledClosedLimit – Lift

The *InstalledClosedLimit – Lift* attribute identifies the Closed Limit for Lifting the Window Covering whether position (in centimeters) is encoded or timed. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.5.3 InstalledOpenLimit – Tilt

The *InstalledOpenLimit – Tilt* attribute identifies the Open Limit for Tilting the Window Covering whether position (in tenth of a degree) is encoded or timed. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.5.4 InstalledClosedLimit – Tilt

The *InstalledClosedLimit – Tilt* attribute identifies the Closed Limit for Tilting the Window Covering whether position (in tenth of a degree) is encoded or timed. This attribute is ignored if the device is running in Open Loop Control.

9.3.2.1.5.5 Velocity – Lift

The *Velocity – Lift* attribute identifies the velocity (in centimeters per second) associated with Lifting the Window Covering.

9.3.2.1.5.6 AccelerationTime – Lift

The *AccelerationTime – Lift* attribute identifies any ramp up times to reaching the velocity setting (in tenth of a second) for positioning the Window Covering.

9.3.2.1.5.7 DecelerationTime – Lift

The *DecelerationTime – Lift* attribute identifies any ramp down times associated with stopping the positioning (in tenth of a second) of the Window Covering.

9.3.2.1.5.7.1 Mode

The *Mode* attribute allows configuration of the Window Covering, such as: reversing the motor direction, placing the Window Covering into calibration mode, placing the motor into maintenance mode, disabling the ZigBee network, and disabling status LEDs. See Table 9.25 for details.

Table 9.25 Bit Meanings for the Mode Attribute

Bit	Meaning	Description
bit0	0 = motor direction is normal 1 = motor direction is reversed	Disables (0) or Enables (1) the reversal of the motor rotating direction associated with an UP/ OPEN command. Should be set so that an UP/ OPEN command matches moving the Window Covering physically in that direction.
bit1	0 = run in normal mode 1 = run in calibration mode	Disables (0) or Enables (1) placing the Window Covering into Calibration Mode where limits are either setup using physical tools or limits are learned by the controller based on physical setup of the Window Covering by an installer.
bit2	0 = motor is running normally 1 = motor is running in maintenance mode	Disables (0) or Enables (1) placing the motor into Maintenance Mode where the motor cannot be moved over the network or by a switch connected to a Local Switch Input.
bit3	0 = LEDs are off 1 = LEDs will display feedback	Disables (0) or Enables (1) the display of any feedback LEDs resident especially on the packaging of an endpoint where they may cause distraction to the occupant.
bit4 – bit7	Reserved	Reserved

9.3.2.1.5.8 Intermediate Setpoints – Lift

Identifies the number of Intermediate Setpoints supported by the Window Covering for Lift and then identifies the position settings for those Intermediate Setpoints if Closed Loop Control is supported.

9.3.2.1.5.9 Intermediate Setpoints – Tilt

Identifies the number of Intermediate Setpoints supported by the Window Covering for Tilt and then identifies the position settings for those Intermediate Setpoints if Closed Loop Control is supported.

9.3.2.2 Commands Received

Table 9.26 Commands Received by the Window Covering Server Cluster

Command ID	Description	Mandatory/ Optional
0x00	Up / Open	M
0x01	Down / Close	M
0x02	Stop	M
0x03	Reserved	
0x04	Go To Lift Value	O

Table 9.26 Commands Received by the Window Covering Server Cluster

Command ID	Description	Mandatory/ Optional
0x05	Go to Lift Percentage	O
0x06	Reserved	
0x07	Go to Tilt Value	O
0x08	Go to Tilt Percentage	O
0x09	Reserved	
0x0A	Reserved	

9.3.2.2.1 Up / Open Command

9.3.2.2.1.1 Payload Format

This command has no payload.

9.3.2.2.1.2 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical lift is at the *InstalledOpenLimit – Lift* and the tilt is at the *InstalledOpenLimit – Tilt*. This will happen as fast as possible.

9.3.2.2.2 Down / Close Command

9.3.2.2.2.1 Payload Format

This command has no payload.

9.3.2.2.2.2 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical lift is at the *InstalledClosedLimit – Lift* and the tilt is at the *InstalledClosedLimit – Tilt*. This will happen as fast as possible.

9.3.2.2.3 Stop Command

9.3.2.2.3.1 Payload Format

This command has no payload.

9.3.2.2.3.2 Effect on Receipt

Upon receipt of this command, the Window Covering will stop any adjusting to the physical tilt and lift that is currently occurring.

9.3.2.2.4 Go To Lift Value

9.3.2.2.4.1 Payload Format

The Go To Lift Value command payload shall be formatted as illustrated in Figure 9.7.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	Lift Value

Figure 9.7 Format of the Go To Lift Value Command

9.3.2.2.4.1.1 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical lift is at the lift value specified in the payload of this command as long as that value is not larger than *InstalledOpenLimit – Lift* and not smaller than *InstalledClosedLimit – Lift*. If the lift value is out of bounds a default response containing the status of INVALID_VALUE will be returned.

9.3.2.2.4.2 Go to Lift Percentage

9.3.2.2.4.2.1 Payload Format

The Go To Lift Percentage command payload shall be formatted as illustrated in Figure 9.8.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Percentage Lift Value

Figure 9.8 Format of the Go To Lift Percentage Command

9.3.2.2.4.2.2 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical lift is at the lift percentage specified in the payload of this command.The percentage value will be mapped to a 8-bit unsigned integer value between InstalledOpenLimit and InstalledClosedLimit. If the percentage lift value is larger than 100, no physical action will be taken and a default response containing the status of INVALID_VALUE will be returned. If the device only supports open loop lift action then a zero percentage should be treated as a down/ close command and a non-zero percentage should be treated as an up/open command. If the device is only a tilt control device, then the command should be ignored and a UNSUPPORTED_COMMAND status should be returned. The device must support either the Go To Lift Percentage or the Go To Tilt Percentage command.

9.3.2.2.4.3 Go to Tilt Value

9.3.2.2.4.3.1 Payload Format

The Go To Tilt Value command payload shall be formatted as illustrated in Figure 9.9.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	Tilt Value

Figure 9.9 Format of the Go To Tilt Value Command

9.3.2.2.4.3.2 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical tilt is at the tilt value specified in the payload of this command as long as that value is not larger than *InstalledOpenLimit – Tilt* and not smaller than *InstalledClosedLimit – Tilt*. If the tilt value is out of bounds a default response containing the status of INVALID_VALUE will be returned.

9.3.2.2.4.4 Go to Tilt Percentage

9.3.2.2.4.4.1 Payload Format

The Go To Tilt Percentage command payload shall be formatted as illustrated in Figure 9.10.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Percentage Tilt Value

Figure 9.10 Format of the Go To Lift Percentage Command

9.3.2.2.4.4.2 Effect on Receipt

Upon receipt of this command, the Window Covering will adjust the window so the physical tilt is at the tilt percentage specified in the payload of this command. The percentage value will be mapped to a 8-bit unsigned integer value between

InstalledOpenLimit – Tilt and *InstalledClosedLimit – Tilt*. If the percentage tilt value is larger than 100, no physical action will be taken and a default response containing the status of INVALID_VALUE will be returned. If the device only supports open loop tilt action then a zero percentage should be treated as a down/close command and a non-zero percentage should be treated as an up/open command. If the device is only a lift control device, then the command should be ignored and a UNSUPPORTED_COMMAND status should be returned. The device must support either the Go To Lift Percentage or the Go To Tilt Percentage command.

9.3.2.2.5 Commands Generated

This cluster uses the standard Default Response command defined in the ZCL specification for responding to received commands. Possible status values that can be returned are: SUCCESS, NOT_FOUND, NOT_AUTHORIZED, INSUFFICIENT_SPACE, UNSUP_CLUSTER_COMMAND, INVALID_FIELD, INVALID_VALUE, HARDWARE_FAILURE, FAILURE.

9.3.2.2.6 Scene Table Extensions

If the Window Covering server cluster is implemented, the following extension field is added to the Scene table:

- **CurrentPositionLiftPercentage**
  When the *CurrentPositionLiftPercentage* attribute is part of a Scene table, the attribute is treated as a writeable command, that is, setting the lift percentage of the covering device to the value specified in the Scene table extension over the specified transition time. The device may treat the command as a linear transition if appropriate or may accelerate and decelerate as it deems necessary. If the device is only a tilt controlling device this Scene table extension is ignored. If the device is an open loop controlled lift device, then a percentage of 0 is treated as a close command and a non zero percentage is treated as an open command and the device will ignore the transition time and transition as fast as appropriate for that device.

- **CurrentPositionTiltPercentage**
  When the *CurrentPositionTiltPercentage* attribute is part of a Scene table, the attribute is treated as a writeable command, that is, setting the tilt percentage of the covering device to the value specified in the Scene table extension over the specified transition time. The device may treat the command as a linear transition if appropriate or may accelerate and decelerate as it deems necessary. If the device is only a lift controlling device this Scene table extension is ignored. If the device is an open loop controlled tilt device, then a percentage of 0 is treated as a close command and a non zero percentage is treated as an open command and the device will ignore the transition time and transition as fast as appropriate for that device.

- **CurrentPositionLiftSetpoint**
  When the *CurrentPositionLiftSetpoint* attribute is part of a Scene table, the attribute is treated as is *CurrentPositionLiftPercentage* above.
- **CurrentPositionTiltSetpoint**
  When the *CurrentPositionTiltSetpoint* attribute is part of a Scene table, the attribute is treated as is *CurrentPositionTiltPercentage* above.

9.3.2.2.7 Attribute Reporting

This cluster shall support attribute reporting using the Report Attributes command and according to the minimum and maximum reporting interval settings described in the ZCL. The following attributes shall be reported:

CurrentPosition – Lift

CurrentPosition – Tilt

9.3.3 Client

9.3.3.1 Attributes

The client has no attributes.

9.3.3.2 Command Received

No cluster-specific commands are received by the client.

9.3.3.3 Commands Generated

The client generates the cluster-specific commands detailed in sub-clause 9.5.2.2.

9.4 Poll Control Cluster

9.4.1 Overview

This cluster provides a mechanism for the management of an end device's MAC Data Request rate. For the purposes of this cluster, the term "poll" always refers to the sending of a MAC Data Request from the end device to the end device's parent.

This cluster can be used for instance by a configuration device to make an end device responsive for a certain period of time so that the device can be managed by the controller.

This cluster is composed of a client and server. The end device implements the server side of this cluster. The server side contains several attributes related to the

MAC Data Request rate for the device. The client side implements commands used to manage the poll rate for the device.

The end device which implements the server side of this cluster sends a query to the client on a predetermined interval to see if the client would like to manage the poll period of the end device in question. When the client side of the cluster hears from the server it has the opportunity to respond with configuration data to either put the end device in a short poll mode or let the end device continue to function normally.

9.4.2 Terminology

MAC Data Request Rate: The MAC Data Request rate or simply “poll rate” is the frequency with which an end device sends a MAC Data Request to its parent. A parent device is only required to store a single message for its child for 7.68 seconds. Therefore if an end device wants to retrieve messages from its parent, it must send a MAC Data Request every 7.68 seconds.

Generally end devices have two different rates at which they send MAC Data Polls to their parents. A slower rate for when the device is not expecting data (Long Poll Interval) and a faster rate (Short Poll Interval) for when the device is expecting data.

End devices only know that they are expecting data when they have initiated some sort of transaction. This cluster provides a mechanism for forcing this state to make the end device responsive to asynchronous messaging.

Long Poll Interval: The amount of time between MAC Data Requests when the device is in its normal operating state and not expecting any messages.

Short Poll Interval: The amount of time between MAC Data Requests when the device is either expecting data or has been put into “Fast Poll Mode” by the controlling device.

Fast Poll Mode: When the device is polling frequently to retrieve data from its parent we say that the device is in “Fast Poll Mode”. The entire purpose of this cluster is to provide a means of managing when an end device goes into and out of Fast Poll Mode so that it can be made responsive for a controlling device.

9.4.3 Commissioning Process for the Poll Control Cluster

Poll Control Cluster Clients shall configure bindings on the device implementing the Poll Control Cluster Server so that they will receive the regular check-in command on the configured *Check-In Interval*. This can be done during the configuration period on the end device implementing the Poll Control Cluster

Server during which it is in fast poll mode. The device that implements the Poll Control Cluster Server shall check its bindings on the configured check-in Interval. If it has any bindings related to any endpoint and the Poll Control Cluster, it will send a check-in command out on that binding.

9.4.4 Server

9.4.4.1 Attributes

The server side of this cluster contains certain attributes associated with the poll period. *CheckInIntervalMin*, *LongPollIntervalMin*, *FastPollTimeoutMaximum* attributes are optional however if they are not supported you could end up with a lot of chatter on the network as clients and servers attempt to negotiate the poll period. It is therefore recommended that these attributes be supported.

Table 9.27 Server Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0000	*Check-inInterval*	Unsigned 32-bit integer	0x0 – 0x6E0000	Read/Write	0x3840 (1 hr.)	M
0x0001	*LongPollInterval*	Unsigned 32-bit integer	0x04 – 0x6E0000	Read	0x14 (5 sec)	M
0x0002	*ShortPollInterval*	Unsigned 16-bit integer	0x01 – 0xffff	Read	0x02 (2 qs)	M
0x0003	*FastPollTimeout*	Unsigned 16-bit integer	0x01 – 0xffff	Read/Write	0x28 (10 sec.)	M
0x0004	*Check-inIntervalMin*	Unsigned 32-bit integer	-	Read	0	O
0x0005	*LongPollIntervalMin*	Unsigned 32-bit integer	-	Read	0	O
0x0006	*FastPollTimeoutMax*	Unsigned 16-bit integer	-	Read	0	O

9.4.4.1.1 Check-inInterval Attribute

The Poll Control server is responsible for checking in with the poll control client periodically to see if the poll control client wants to modify the poll rate of the poll control server. This is due to the fact that the Poll Control server is implemented on an end device that may have an unpredictable sleep-wake cycle.

The *Check-inInterval* represents the default amount of time between check-ins by the poll control server with the poll control client. The *Check-inInterval* is measured in quarterseconds. A value of 0 indicates that the Poll Control Server is turned off and the poll control server will not check-in with the poll control client.

The Poll Control Server checks in with the Poll Control Client by sending a Check-in command to the Client. This value should be longer than the *LongPoll Interval* attribute. If the Client writes an invalid attribute value (Example: Out of Range as defined in Table 9.27 or a value smaller than the optional *Check-inIntervalMin* attribute value or a value smaller than the *LongPollInterval* attribute value), the Server should return Write Attributes Response with a error status not equal to ZCL_SUCCESS(0x00).

The Poll Control Client will hold onto the actions or messages for the Poll Control Server at the application level until the Poll Control Server checks in with the Poll Control Client.

9.4.4.1.2 LongPollInterval Attribute

An end device that implements the Poll Control server may optionally expose a *LongPollInterval* attribute. The Long Poll Interval represents the maximum amount of time in quarterseconds between MAC Data Requests from the end device to its parent.

The *LongPollInterval* defines the frequency of polling that an end device does when it is NOT in fast poll mode. The *LongPollInterval* should be longer than the *ShortPollInterval* attribute but shorter than the *Check-inInterval* attribute.

A value of 0xffffffff is reserved to indicate that the device does not have or does not know its long poll interval.

9.4.4.1.3 ShortPollInterval Attribute

An end device that implements the Poll Control server may optionally expose the *ShortPollInterval* attribute. The *ShortPollInterval* represents the number of quarterseconds that an end device waits between MAC Data Requests to its parent when it is expecting data (i.e. in fast poll mode).

9.4.4.1.4 FastPollTimeout Attribute

The *FastPollTimeout* attribute represents the number of quarterseconds that an end device will stay in fast poll mode by default. It is suggested that the *FastPollTimeout* attribute value be greater than 7.68 seconds.

The Poll Control Cluster Client may override this value by indicating a different value in the Fast Poll Duration argument in the Check-in Response command. If the Client writes a value out of range as defined in Table 9.27 or greater than the optional *FastPollTimeoutMax* attribute value if supported, the Server returns a Write Attributes Response of status Success (0x00) but the *FastPollTimeout* attribute value is automatically updated to an acceptable value. An end device that implements the Poll Control server can be put into a fast poll mode during which it will send MAC Data Requests to its parent at the frequency of its configured *ShortPollInterval* attribute. During this period of time, fast polling is considered active. When the device goes into fast poll mode, it is required to send MAC Data

Requests to its parent at an accelerated rate and is thus more responsive on the network and can receive data asynchronously from the device implementing the Poll Control Cluster Client.

9.4.4.1.5 Check-inIntervalMin

The Poll Control Server may optionally provide its own minimum value for the *Check-inInterval* to protect against the *Check-inInterval* being set too low and draining the battery on the end device implementing the Poll Control Server.

9.4.4.1.6 LongPollIntervalMin

The Poll Control Server may optionally provide its own minimum value for the *LongPollInterval* to protect against another device setting the value to too short a time resulting in an inadvertent power drain on the device.

9.4.4.1.7 FastPollTimeoutMax

The Poll Control Server may optionally provide its own maximum value for the *FastPollTimeout* to avoid it being set to too high a value resulting in an inadvertent power drain on the device.

9.4.4.2 Attribute Settings and Battery Life Considerations

The Poll Control Cluster is used on end devices that may be battery powered. In order to conserve battery life, it is important that the Poll Control Server maintain certain boundaries for the setting of the *Check-inInterval*, *LongPollInterval* and the *ShortPollInterval*. Therefore, while these attributes are all Read/Write, it is possible that a battery-powered device might maintain its own boundary for the min and max of each of these attributes. The end device implementing the Poll Control Cluster Server may define its own boundaries for these attributes in order to protect itself against a power drain due to improper configuration.

For instance a battery powered device may not allow another device to set its *Check-inInterval* to too short a value or its *FastPollTimeout* to too long an interval because it might cause the device to send too frequent check-in messages on the network and stay in fast poll mode for too long a time resulting in a drain on the battery.

The C*heck-inInterval*, *LongPollInterval* and *ShortPollInterval* should be set such that:

Check-in Interval >= Long Poll Interval >= Short Poll Interval

The default values chosen for this cluster are:

Check-in Interval = 1 hour = 0x3840 quarterseconds.

Long Poll Interval = 5 seconds = 0x14 quarterseconds.

Short Poll Interval = 2 quarterseconds = 0x02 quarterseconds.

Fast Poll Timeout = 10 seconds = 0x28 quarterseconds.

It should be noted that for the Check-in Interval, 0 is a special value and does not apply to this equation.

9.4.4.3 Commands

Table 9.28 Commands Generated by the Poll Control Server

Command ID	Description	Mandatory/ Optional
0x00	Check-in	M

9.4.4.4 Check-in

The Poll Control Cluster server sends out a Check-in command to the devices to which it is paired based on the server's *Check-inInterval* attribute. It does this to find out if any of the Poll Control Cluster Clients with which it is paired are interested in having it enter fast poll mode so that it can be managed. This request is sent out based on either the *Check-inInterval*, or the next Check-in value in the Fast Poll Stop Request generated by the Poll Control Cluster Client.

The Check-in command expects a Check-in Response command to be sent back from the Poll Control Client. If the Poll Control Server does not receive a Check-in response back from the Poll Control Client up to7.68 seconds it is free to return to polling according to the *LongPollInterval*.

9.4.4.4.1 Payload Format

There is no payload for this command.

9.4.4.4.2 Effect Upon Receipt

Upon receipt of the Check-in command, the Poll Control Cluster client will respond with a Check-in Response command indicating that the server should or should not begin fast poll mode.

9.4.5 Client

9.4.5.1 Attributes

There are no attributes on the client side of the Poll Control Cluster.

9.4.5.2 Commands

Table 9.29 Commands Generated by the Poll Control Client

Command ID	Description	Mandatory/ Optional
0x00	Check-in Response	M
0x01	Fast Poll Stop	M
0x02	Set Long Poll Interval	O
0x03	Set Short Poll Interval	O

9.4.5.3 Check-in Response

The Check-in Response is sent in response to the receipt of a Check-in command. The Check-in Response is used by the Poll Control Client to indicate whether it would like the device implementing the Poll Control Cluster Server to go into a fast poll mode and for how long. If the Poll Control Cluster Client indicates that it would like the device to go into a fast poll mode, it is responsible for telling the device to stop fast polling when it is done sending messages to the fast polling device.

9.4.5.3.1 Payload Format

Octets	1	2
Data Type	Boolean	Unsigned 16-bit integer
Field Name	Start Fast Polling	Fast Poll Timeout

Figure 9.11 Format of the Check-in Response Payload

9.4.5.3.1.1 Start Fast Polling

This Boolean value indicates whether or not the Poll Control Server device should begin fast polling or not. If the Start Fast Polling value is true, the server device is expected to begin fast polling until the Fast Poll Timeout has expired. If the Start Fast Polling argument is false, the Poll Control Server may continue in normal operation and is not required to go into fast poll mode.

9.4.5.3.1.2 Fast Poll Timeout

The Fast Poll Timeout value indicates the number of quarterseconds during which the device should continue fast polling. If the Fast Poll Timeout value is 0, the device is expected to continue fast polling until the amount of time indicated it the *FastPollTimeout* attribute has elapsed or it receives a Fast Poll Stop command. If the Start Fast Polling argument is false, the Poll Control Server may ignore the Fast Poll Timeout argument.

The Fast Poll Timeout argument temporarily overrides the *FastPollTimeout* attribute on the Poll Control Cluster Server for the fast poll mode induced by the Check-in Response command. This value is not expected to overwrite the stored value in the *FastPollTimeout* attribute.

If the FastPollTimeout parameter in the CheckInResponse command is greater than the *FastPollTimeoutMax* attribute value, the Server Device shall respond with a default response of error status not equal to ZCL_SUCCESS. It is suggested to use the Error Status of ZCL_INVALID_FIELD (0x85).

9.4.5.4 Fast Poll Stop

The Fast Poll Stop command is used to stop the fast poll mode initiated by the Check-in response. The Fast Poll Stop command has no payload.

9.4.5.5 Set Long Poll Interval

The Set Long Poll Interval command is used to set the read only *LongPollInterval* attribute.

When the Poll Control Server receives the Set Long Poll Interval Command, it should check its internal minimal limit and the attributes relationship defined in 9.6.4.2 if the new Long Poll Interval is acceptable. If the new value is acceptable, the new value shall be saved to the *LongPollInterval* attribute.If the new value is not acceptable, the Poll Control Server shall send a default response of INVALID_VALUE (0x87) and the *LongPollInterval* attribute value is not updated.

9.4.5.5.1 Payload Format

Octets	4
Data Type	Unsigned 32-bit integer
Field Name	NewLongPollInterval

Figure 9.12 Format of the Set Long Poll Interval Command Payload

9.4.5.6 Set Short Poll Interval

The Set Short Poll Interval command is used to set the read only *ShortPollInterval* attribute.

When the Poll Control Server receives the Set Short Poll Interval Command, it should check its internal minimal limit and the attributes relationship defined in 9.6.4.2 if the new Short Poll Interval is acceptable. If the new value is acceptable, the new value shall be saved to the *ShortPollInterval* attribute. If the new value is not acceptable, the Poll Control Server shall send a default response of INVALID_VALUE (0x87) and the *ShortPollInterval* attribute value is not updated.

9.4.5.6.1 Payload Format

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	New Short Poll Interval

Figure 9.13 Format of the Set Short Poll Interval Command Payload

9.4.6 Poll Control Cluster Sequence Diagram

What follows is a typical sequence interaction between the client and server sides of the Poll Control Cluster.

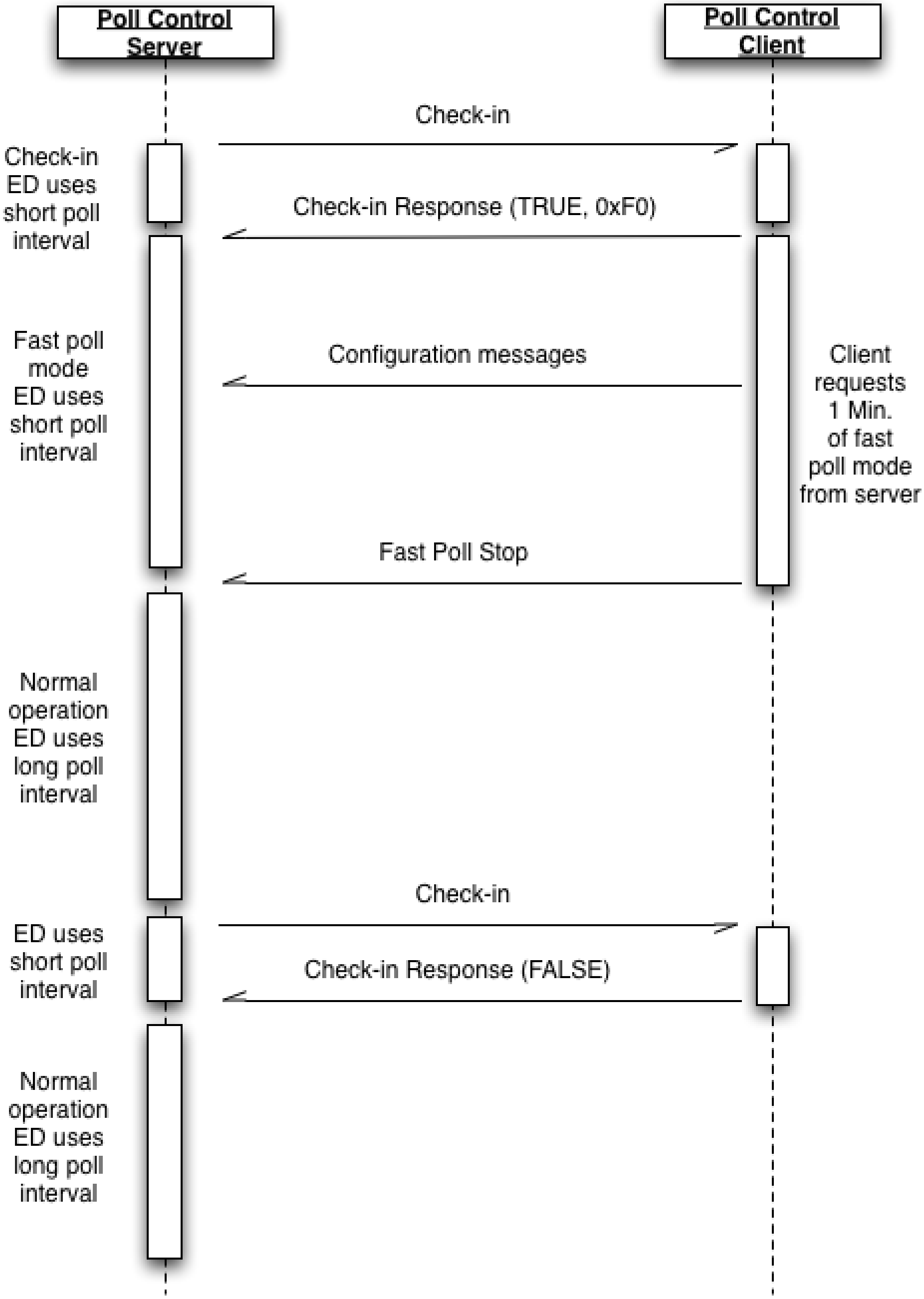

Poll Control Server
Poll Control Client
Check-in
Check-in ED uses short poll interval
Check-in Response (TRUE, 0xF0)
Fast poll mode ED uses short poll interval
Configuration messages
Client requests 1 Min. of fast poll mode from server
Fast Poll Stop
Normal operation ED uses long poll interval
Check-in
ED uses short poll interval
Check-in Response (FALSE)
Normal operation ED uses long poll interval

Figure 9.14 Poll Control Cluster Sequence Diagram

9.4.6.1 Guaranteed Consistent Check In Interval

Provided that the *Check-inInterval* attribute value stays constant, the interval between two Check In commands is guaranteed. The *Check-inInterval* should be kept independent regardless of when the Check-In Response or Fast Poll Stop command is received.

9.4.6.2 Multiple Poll Control Client

When the *Check-inInterval* expires, the Server should send parallel Check-In commands to all paired client devices.

The server should then enter a temporary Fast Poll Mode, with a fixed manufacturer-specific predefined check in timeout duration (t1), to wait for the Check-In Response Messages from all paired device.

Once the server received all the Check-In Response or if the temporary Fast Poll Mode timeout (t1), the server should then gather the information from all Check-In Response messages and determine the longest Fast Poll Timeout (t2) duration.

The Server device shall stay in the Fast Poll Mode for the longest Fast Poll Timeout (t2) duration. The server device may end fast poll mode before the longest fast poll timeout if it is able to determine that every start request from the paired device has been stopped explicitly by the Fast Poll Stop command or implicitly by a timeout.

For example:

Device A implements a poll control server, devices B and C implement poll control clients. Device A sends a check-in command to both B and C. Both B and C respond with check-in response command requesting a fast poll start. Assume B requests fast polling for 5 minutes and C requests fast polling for 10 minutes. If C sends a fast poll stop command after 7 minutes, device A may immediately end fast polling upon receipt of this command since the fast poll period requested by B would have expired after only 5 minutes (before the command from C was received).

When the *Check-inInterval* attribute is changed (provided that the new value is valid and within acceptable range), the device should reset the internal check-in interval timer and send a check-in command according to the new *Check-inInterval* value.[1]

9.5 Power Profile Cluster

This section describes the Power Profile cluster.

[1] CCB 1782

9.5.1 Overview

This cluster provides an interface for transferring power profile information from a device (e.g., White Goods) to a controller (e.g., the Home Gateway). The Power Profile can be solicited by client side (request command) or can be notified directly from the device (server side). The Power Profile represents a forecast of the energy that a device, that is able to predict its consumption, can share with an energy management system. It is split in multiple energy phases with a specific set of parameters representing the estimated "energy footprint" of an appliance. The data carried in the Power Profile can be updated during the different states of a Power Profile; since it represents a forecast of energy, duration and peak power of energy phases, it shall be considered as an estimation and not derived by measurements.

The Power Profile may also be used by an energy management system, together with other specific interfaces supported by the device, in order to schedule and control the device operation and to perform energy management within a home network. Informative examples on how the power Profile cluster might be used are reported in the sequence diagrams at the end of this chapter in sub-clause 9.5.10.

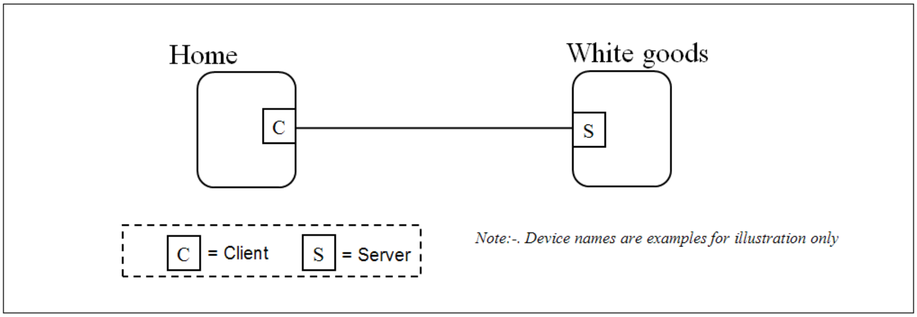


Figure 9.15 Typical Usage of the Power Profile Cluster

9.5.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

9.5.3 General Description

9.5.3.1 Dependencies

The PowerProfileCluster is dependent upon theAppliance Control Cluster for the parts regarding the status notification and power management commands. Other specific clusters for actuation for devices different than Smart Appliances. Due to the possible length of the Power Profile commands, the devices supporting the Power Profile clustermay leverage on Partitioning if required by the application.

9.5.4 Server Attributes

The currently defined attributes for this cluster are listed in Table 9.30. The following attributes represent the parameters for each Power profile's phases.

Table 9.30 Attributes of this Cluster

Identifier	Name	Type	Range	Access	Unit	Default	M/O	Reportable
0x0000	*TotalProfileNum*	Unsigned 8-bit integer	0x01 – 0xfe	Read Only	-	1	M	No
0x0001	*MultipleScheduling*	Boolean	0x00-0x01	Read Only	-	FALSE (0x00)	M	No
0x0002	*EnergyFormatting*	8-bit Bitmap	0x00-0xff	Read Only	-	0x01 (1/10 of Watt Hours represented)	M	No
0x0003	*EnergyRemote*	Boolean	TRUE or FALSE	Read Only	-	FALSE	M	Yes
0x0004	*ScheduleMode*	8-bit Bitmap	0x00-0xff	Read/Write	-	0x00	M	Yes

9.5.4.1 TotalProfileNum Attribute

The *TotalProfileNum* attribute represents the total number of profiles supported by the device.The minimum value for this attribute shall be 1.

9.5.4.2 MultipleScheduling Attribute

The *MultipleScheduling* attribute specifies if the server side of the Power Profile cluster supports the scheduling of multiple Energy Phases or it does support the scheduling of a single energy phase of the Power Profile at a time. If more than a single energy phases may be scheduled simultaneously the *MultipleScheduling* attribute shall be set to TRUE. In this case the device supporting the Power Profile server shall be able to process and manage scheduling commands carrying the schedule of more than one energy phase.

If the *MultipleScheduling* attribute is FALSE the device supporting the Power Profile client (e.g. EMS) shall be allowed to schedule just a single energy phase.

9.5.4.3 EnergyFormatting Attribute

The *EnergyFormatting* attribute provides a method to properly decipher the number of digits and the decimal location of the values found in the Energy Fields carried by the Power Profile Notification and Power Profile Response commands. This attribute is to be decoded as follows:

- Bits 0 to 2: Number of Digits to the right of the Decimal Point.
- Bits 3 to 6: Number of Digits to the left of the Decimal Point.
- Bit 7: If set, suppress leading zeros.

This attribute shall be used against the Energy fields.

9.5.4.4 EnergyRemote Attribute

The *EnergyRemote* attribute indicates whether the power profile server (e.g., appliance) is configured for remote control (e.g., by an energy management system).This refers to the selection chosen by the user on the remote control feature of the device. If the value is FALSE, the remote energy management is disabled, otherwise it is enabled. If the EnergyRemote is equal to FALSE all the supported PowerProfile shall set the Power Profile Remote Control field in the PowerProfile record equal to FALSE.

If the *EnergyRemote* attribute value is equal to TRUE at least one PowerProfile shall be remotely controllablesetting the Power Profile Remote Control field in the PowerProfile record to TRUE.

Table 9.31 *EnergyRemote* Attribute

Energy Remote Value	Description
0x00	FALSE = Remote Energy Management disabled
0x01	TRUE = Remote Energy Management enabled

9.5.4.5 ScheduleMode Attribute

The *ScheduleMode* attribute describes the criteria that should be used by the Power Profile cluster client side (e.g., energy management system) to schedule the power profiles.

Schedule Mode Field BitMap

Table 9.32 *ScheduleMode* Attribute

Bit	Description
bit0	bit0=1 : Schedule Mode Cheapest
bit1	bit1 =1: Schedule Mode Greenest
bit2 to bit7	Reserved

If the *ScheduleMode* attribute is set to the value 0x00, the scheduling criteria is demanded to the Power Profile cluster client side, which means that no specific preferences on the schedule mode are requested by the device supporting the server side of the power Profile cluster.

If “Schedule Mode Cheapest” is selected then the energy management system shall try to schedule the Power Profile to minimize the user’s energy bill.

If “Schedule Mode Greenest” is selected then the energy management system shall try to schedule the Power Profile to provide the highest availability of renewable energy sources.

Please note that how the energy management system may obtain “cheapest” or “greenest” information and estimate scheduling times is out of scope of this specification.

If more than a single bit is selected in the *ScheduleMode* bitmask, the Power Profile client shall try to calculate the schedule following all the selected criteria.

If all the bits are set to zero not specific optimization metrics preferences are requested by the device supporting the Power Profile server.

9.5.5 Server Commands Received

The command IDs for the commands received by the server side of the Power Profile Cluster are listed in Table 9.33.

Table 9.33 Cluster-specific Commands Received by the Server

Command Identifier Field Value	Description	Mandatory / Optional
0x00	PowerProfileRequest	M
0x01	PowerProfileStateRequest	M
0x02	GetPowerProfilePriceResponse	M
0x03	GetOverallSchedulePriceResponse	M
0x04	EnergyPhasesScheduleNotification	M
0x05	EnergyPhasesScheduleResponse	M

Table 9.33 Cluster-specific Commands Received by the Server (Continued)

Command Identifier Field Value	Description	Mandatory / Optional
0x06	PowerProfileScheduleConstraintsRequest	M
0x07	EnergyPhasesScheduleStateRequest	M
0x08	GetPowerProfilePriceExtendedResponse	M

9.5.5.1 Power Profile Request Command

The Power Profile Request Command is generated by a device supporting the client side of the Power Profile cluster in order to request the Power Profile of a server device. It is possible to request all profiles (without knowing how many Power Profiles the server has) or to request a specific PowerProfileID.

In the case of multiple profiles the server should send multiple messages, one for each Power Profile.

Although the profile is in a Power Profile running state (see *PowerProfileState*), the Power Profile Response transmitted as a reply to a Power Profile Request command shall carry all the energy phases of the estimated Power Profile, including the previous energy phases and the current energy phase which is running. The parameters of the Power Profile (e.g the ExpectedDuration or the Energy fields of all the energy phases) may be updated for the same Power Profile due to a tuning in the forecast.

9.5.5.1.1 Payload Format

The Power Profile Request Command payload shall be formatted as illustrated in Figure 9.16.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	PowerProfileID

Figure 9.16 Format of the Power Profile Request Command Payload

9.5.5.1.1.1 Payload Details

The payload of the Power Profile Request command carries the fields defined in Figure 9.16.

The PowerProfileID field specifies which profile (in the range 1 to *TotalProfileNum*) is requested. The special value 0x00 of this field does not refer to a particular profile; if 0x00 value is received the device should send details related to all the available profiles.

The PowerProfileID field shall not be greater than *TotalProfileNum.*

9.5.5.1.2 When Generated

This command is generated when the client side of the Power Profile cluster (e.g., a Home gateway device), needs to request the power profile to a device supporting the Power Profile cluster server side (e.g., White Good).

9.5.5.1.3 Effect on Receipt

The device that receives the Power Profile Request command shall reply with a *PowerProfileResponse* if supported. If the command is not supported the device shall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification).

If the requested profile data are not available, the device shall reply with a standard ZCL response NOT_FOUND 0x8b (according to ZCL specification).

9.5.5.2 Power Profile State Request Command

The Power Profile State Request command is generated in order to retrieve the identifiers of current Power Profiles. This command does not have a payload.

9.5.5.2.1 Effect on Receipt

On receipt of this command, the device shall generate a Power Profile State Response command.

9.5.5.3 Get Power Profile Price Response Command

The Get Power Profile Price Response command allows a device (client) to communicate the cost associated with a defined Power Profile to another device (server) requesting it. If the Price information requested related to the Power Profile is not available yet the response shall be a ZCL default response with "NOT FOUND" Status.

9.5.5.3.1 Payload Format

The Get Power Profile Price Response command payload shall be formatted as illustrated in Figure 9.17.

Octets	1	2	4	1
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 32-bit integer	Unsigned 8-bit integer
Field Name	Power Profile ID	Currency	Price	Price trailing Digit

Figure 9.17 Format of the Get Power Profile Price Response Command

9.5.5.3.1.1 Payload Details

PowerProfileID

The PowerProfileID field represents the identifier of the specific profile described by the Power Profile.

This is typically a sequential and contiguous number ranging from 1 to *TotalProfileNum*.

Currency

The Currency field identifies the local unit of currency used in the price field. This field is thought to be useful for displaying the appropriate symbol for a currency (i.e.: $, €). The value of the currency field should match the values defined by ISO 4217.

Price

The Price field contains the price of the energy of a specific Power Profile measured in base unit of Currency per Unit of Measure (as described in the Metering Cluster, see SE specification) with the decimal point located as indicated by the PriceTrailingDigit field when the energy is delivered to the premise.

Price Trailing Digit

The PriceTrailingDigit field determines where the decimal point is located in the price field. The PriceTrailingDigit indicates the number of digits to the right of the decimal point.

9.5.5.3.2 When Generated

This command is generated when the command Get Power Profile Price is received. Please refer to Get Power Profile Price command description.

9.5.5.3.3 Effect on Receipt

On receipt of this command, the originator (server) is notified of the associated cost of the requested Power Profile, calculated by the Power Profile clientside (see 9.7.10.1 for sequence diagrams and examples).

9.5.5.4 Get Overall Schedule Price Response Command

The Get Overall Schedule Price Response command allows a client to communicate the overall cost associated to all Power Profiles scheduled to a server requesting it. If the Price information requested is not available the response shall be a ZCL default response with “NOT FOUND” Status. The overall cost provided by the Power Profile Client side (e.g. energy management system) is intended as the cost of all the scheduled power profiles. This information may be helpful to assess the overall benefit provided by the scheduler, since a change in the scheduling of a specific device might -in some cases-increase its associated Power Profile cost. In fact in that case the schedule shall provide a global optimization by reducing the overall cost of all the scheduled power profiles, then reducing the energy bill for the user.

9.5.5.4.1 Payload Format

The Get Overall Schedule Price Response command payload shall be formatted as illustrated in Figure 9.18.

Octets	2	4	1
Data Type	Unsigned 16-bit integer	Unsigned 32-bit integer	Unsigned 8-bit integer
Field Name	Currency	Price	Price trailing Digit

Figure 9.18 Format of the Get Overall Schedule Price Response Command

9.5.5.4.2 Payload Details

See Get Power Profile Price Response command payload details.

9.5.5.4.3 When Generated

This command is generated when the command Get Overall Schedule Price Request is received.

9.5.5.4.4 Effect on Receipt

On receipt of this command, the originator is notified of the overall cost of the scheduled Power Profiles, calculated by the Power Profile cluster clientside. This information may be used to assess the overall benefit provided by the scheduler, which might be dependent on the schedule constraints. (see 9.7.10.1 for sequence diagrams and examples).

9.5.5.5 Energy Phases Schedule Notification Command

The Energy Phases Schedule Notification command is generated by a device supporting the client side of the Power Profile cluster in order to schedule the start of a Power Profile and its energy phases (they may be more than one in case of *MultipleScheduling* attribute equal to TRUE) on a the device supporting the server side of the Power Profile cluster, which did not solicit the schedule (“un-solicited” schedule). That happens when the Power Profile State carries a PowerProfileRemoteControl field equal to TRUE and the Energy Phase has a *MaxActivationDelay* different than 0x0000 (please note that changes on an already scheduled energy phase or power profile are possible but should be applied just in case of sensible advantages). The mechanisms designed to find the proper schedule are not part of the description of this command.

Please consider that, in case the *MultipleScheduling* attribute is FALSE (which means that the server side of the Power Profile cluster shall support the schedule of only a single energy phase at once), the Energy Phases Schedule Notification command should also be used to set a pause between two energy phases (energy pause behavior). In this case the Power Profile State may have any values but the command shall be issued only if the *PowerProfileRemoteControl* is set to TRUE and the Energy Phase has a *MaxActivationDelay* different than 0x0000.

9.5.5.5.1 Payload Format

The Energy Phases Schedule Notification command payload shall be formatted as illustrated in Figure 9.19.

Octets	1	1	1	2	…	1	2
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	…	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	PowerProfile ID	Num of Scheduled Phases	Energy PhaseID$_n$	Scheduled Time$_n$	…	Energy PhaseID$_n$	Scheduled Time$_n$

Figure 9.19 Format of the Energy Phases Schedule Notification Command Payload

9.5.5.5.1.1 Payload Details

The payload of the Energy Phases Schedule Notification command carries the fields defined in Figure 9.19. Each Energy Phases Schedule Notification message shall include only one Power Profile and the energy phases of that Power Profile that needs to be scheduled. In case this command needs to be sent to a device supporting the server side of the power Profile Cluster with the *MultipleScheduling* attribute set to false, the payload of Energy Phases Schedule Notification command shall carry just one phase and the Scheduled Time field shall indicate the time scheduled for the whole Power Profile to start (in case the Power Profile is not started yet). If the Power Profile is in ENERGY_PHASE_RUNNING state and the server side of the cluster has the *MultipleScheduling* attribute set to false, the Energy Phases Schedule Notification command shall carry the scheduled time of the next energy phase.

Power Profile ID

See definition in Power Profile Notification command.

Num of Scheduled Phases

The Num of Scheduled Phases field represents the total number of the energy phases of the Power Profile that need to be scheduled by this command.

The Energy phases that are not required to be scheduled shall not be counted in Num of Scheduled Phases field. The Num of Scheduled Phases shall be equal to 1 in case the *MultipleScheduling* attribute set to FALSE (only one energy phase shall be scheduled at a time).The *Num of Scheduled Phases* may be greater than 1in case the *MultipleScheduling* attribute set to TRUE (scheduling o multiple energy phases at the same time).

Energy Phase ID

See definition in Power Profile Notification command.

Scheduled Time

The Scheduled Time field represents the relative time scheduled in respect to the end of the previous energy phase. The unit is the minute. The Scheduled Time for the first Energy phase represents the scheduled time (expressed in relative encoding in respect to the current time) for the start of the Power Profile. The Scheduled Time fields for the subsequent Energy phases represent the relative time in minutes in respect to the previous scheduled Energy phase. The Energy phases that are not required to be scheduled will not be included in the commands and not be counted in Num of Scheduled Phases field. Only the Power Profile carrying a Power Profile Remote Control field equal to TRUE (as indicated in Power Profile State Notification command) and the Energy Phases supporting *MaxActivationDelay* different than 0x0000 shall be schedulable (as indicated in Power Profile Notification command).

9.5.5.5.2 When Generated

This command is generated when the client side of the Power Profile cluster (e.g., a Home gateway device), has calculated a specific schedule for a Power Profile and needs to send the schedule (i.e., “unsolicited” schedule) to a device supporting the Power Profile cluster server side (e.g., White Goods). This command shall be generated only if the recipient devices support schedulable Power Profiles (i.e. only if the Power Profile carries the first Energy Phase with a *MaxActivationDelay* different than 0x0000).

9.5.5.5.3 Effect on Receipt

The device that receives the Energy Phases Schedule Notification command shall reply with a standard Default response only if requested in the ZCL header of the Energy Phases Schedule Notification command or there is an error (as from ZCL specification).

If the device that receives the Energy Phases Schedule Notification command cannot schedule the energy phases because the activation delay of any of carried phases is equal to zero, it shall reply with a standard Default response with the error code NOT_AUTHORIZED (0x7e).

In case the scheduling state of the recipient entity changes after the reception of this command, the recipient will issue an Energy Phases Schedule State Notification.

9.5.5.6 Energy Phases Schedule Response Command

This command is generated by the client side of Power Profile cluster as a reply to the Energy Phases Schedule Request command.

9.5.5.6.1 Payload Format

The Energy Phases Schedule Response command payload shall have the same payload as Energy Phases Schedule Notification command as described in 9.7.5.5 (Energy Phases Schedule Notification command, but “solicited” schedule because it is triggered by the Energy Phases Schedule Request command).

9.5.5.6.1.1 Payload Details

The payload of the Energy Phases Schedule Response command carries the fields defined in 9.7.5.5 (the same as Energy Phases Schedule Notification command).

9.5.5.6.2 When Generated

This command is generated when the server side of the Power Profile cluster (e.g., a White Goods device), has requested, using the Energy Phases Schedule Request, the schedule of a specific power profile to a device supporting the Power Profile cluster client side (e.g., Home gateway) which shall calculate the schedules (“solicited” schedule) and reply with the Energy Phases Schedule Response.

9.5.5.6.3 Effect on Receipt

The device that receives the Energy Phases Schedule Response command shall reply with a standard Default response only if requested in the ZCL header of the Energy Phases Schedule Response command. If the reception of Energy Phases Schedule Response command is not supported the device shall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification).

In case the scheduling state of the recipient entity changes after the reception of this command, the recipient will issue an Energy Phases Schedule State Notification.

9.5.5.7 Power Profile Schedule Constraints Request Command

The Power Profile Schedule Constraints Request command is generated by client side of the Power Profile cluster in order to request the constraints of the Power Profile of a server, in order to set the proper boundaries for the scheduling when calculating the schedules.

9.5.5.7.1 Payload Format

The Power Profile Schedule Constraints Requestcommand payload is the same as the one used for Power Profile Request command (see 9.7.5.1).

9.5.5.7.1.1 Payload Details

The payload of the Power Profile Schedule Constraints Request command carries the fields defined in Power Profile Request Command.

The Power Profile ID field specifies which profile (among *TotalProfileNum* total profiles number) the constraints are referring to.

9.5.5.7.2 When Generated

This command is generated when the client side of the Power Profile cluster (e.g., a Home gateway device), needs to request the constraints of the power profile to a device supporting the Power Profile cluster server side (e.g., Whitegood).

9.5.5.7.3 Effect on Receipt

The device that receives the Power Profile Schedule Constraints Request command shall reply with a Power Profile Schedule Constraints Response if supported. If the command is not supported, the device shall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification).

If the requested profile data are not available, the device shall reply with a standard ZCL response NOT_FOUND 0x8b (according to ZCL specification).

9.5.5.8 Energy Phases Schedule State Request Command

The Energy Phases Schedule State Request command is generated by a device supporting the client side of the Power Profile cluster to check the states of the scheduling of a power profile, which is supported in the device implementing the server side of Power Profile cluster. This command can be used to re-align the schedules between server and client (e.g., after a client reset).

9.5.5.8.1 Payload Format

The Energy Phases Schedule State Request command payload is the same as the one used for Power Profile Request command (see 9.7.5.1).

9.5.5.8.1.1 Payload Details

The payload of the Energy Phases Schedule State Request command carries the fields defined in 9.7.5.1.

The Power Profile ID field specifies which profile (among *TotalProfileNum* total profiles number) the constraints are referring to.

9.5.5.8.2 When Generated

This command is generated when the client side of the Power Profile cluster (e.g., a Home gateway device), needs to check the schedules of the Power Profile to a device supporting the Power Profile cluster server side (e.g., White Good).

9.5.5.8.3 Effect on Receipt

The server that receives the Energy Phases Schedule StateRequest command shall reply to the client with a Energy Phases Schedule State Response, if supported. If the command is not supported, the servers hall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification).

If the requested profile data are not available (e.g., invalid Power Profile ID), the servers hall reply with a standard ZCL response NOT_FOUND 0x8b (according to ZCL specification).

If the server does not have any schedules set, it shall reply with a Energy Phases Schedule State Response carrying *NumofScheduledPhases* equal to zero (see Format of the Energy Phases Schedule State Response in case of no scheduled phases).

9.5.5.9 Get Power Profile Price Extended Response Command

The Get Power Profile Price Extended Response command allows a device (client) to communicate the cost associated to all Power Profiles scheduled to another device (server) requesting it according to the specific options contained in the Get Power Profile Price Extended Response. If the Price information requested is not available the response shall be a ZCL default response with "NOT FOUND" Status.

9.5.5.9.1 Payload Format

The Get Power Profile Price Extended Response command payload shall be formatted as the Get Power Profile Price Response command.

9.5.5.9.1.1 Payload Details

See Get Power Profile Price Response command payload details.

9.5.5.9.2 When Generated

This command is generated when the command Get Power Profile Price Extended Response is received.

9.5.5.9.3 Effect on Receipt

On receipt of this command, the originator is notified of cost of the scheduled Power Profiles, calculated by the Power Profile cluster server side according to the specific option transmitted in the Get Power Profile Price Extended Response command (e.g., cost at specific PowerProfileStartTime). See 9.7.10.1 for sequence diagrams and examples.

9.5.6 Server Commands Generated

c lists commands are generated by the server.

Table 9.34 Cluster-specific Commands Sent by the Server

Command Identifier Field Value	Description	Mandatory/ Optional
0x00	PowerProfileNotification	M
0x01	PowerProfileResponse	M
0x02	PowerProfileStateResponse	M
0x03	GetPowerProfilePrice	O
0x04	PowerProfilesStateNotification	M
0x05	GetOverallSchedulePrice	O
0x06	EnergyPhasesScheduleRequest	M
0x07	EnergyPhasesScheduleStateResponse	M
0x08	EnergyPhasesScheduleStateNotification	M
0x09	PowerProfileScheduleConstraintsNotification	M
0x0A	PowerProfileScheduleConstraintsResponse	M
0x0B	GetPowerProfilePriceExtended	O

9.5.6.1 Power Profile Notification Command

The Power Profile Notification command is generated by a device supporting the server side of the Power Profile cluster in order to send the information of the specific parameters (such as Peak power and others) belonging to each phase.

9.5.6.1.1 Payload Format

The Power Profile Notification command payload shall be formatted as illustrated in Figure 9.20.

Octets	1	1	1	1	1	2	2	2	2
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer
Field Name	*TotalProfileNum*	*Power Profile ID*	*Num of Transferred Phases*	*Energy PhaseID$_1$*	*Macro PhaseID$_1$*	*Expected Duration$_1$*	*Peak Power$_1$*	*Energy$_1$*	*Max ActivationDelay$_1$*

Octets	…	1	1	2	2	2	2
Data Type	…	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer
Field Name	…	*Energy PhaseID$_n$*	*Macro PhaseID$_n$*	*Expected Duration$_n$*	*PeakPower$_n$*	*Energy$_n$*	*MaxActivationDelay$_n$*

Figure 9.20 Format of the Power Profile Notification Command Payload

9.5.6.1.1.1 Payload Details

The payload of the Power Profile Notification command carries the fields defined in Figure 9.20. Each Power Profile Notification message shall include only one Power Profile.

If multiple phases are transferred within a single Power Profile Notification command (i.e. *Number of Transferred Phases* greater than 1), the parameters of the other phases (*PhaseID*, *ExpectedDuration*, etc) should be carried in the payload. Each phase has a fixed number of parameters and the total length is 10 octets, so that the total length of the payload could be calculated with the following formula:

*Total Payload Length = 1 + 1 + 1 + (Num of Transferred Phases * 10)*

TotalProfileNum

See sub-clause 9.7.4.1 reporting the *TotalProfileNum* attribute description.

PowerProfileID

The PowerProfileID field represents the identifier of the specific profile described by the Power Profile.

This field contains a sequential and contiguous number ranging from 1 to *TotalProfileNum*.

Num of Transferred Phases

This field represents the number of the energy phases of the Power Profile.

MacroPhaseID

The MacroPhaseID field represents the identifier of the specific phase (operational-displayed) described by the Power Profile.

This reference could be used in conjunction with a table of ASCII strings, describing the label of the functional phase. This table is not described in the contest of the Power Profile because it may be not functionally linked with energy management.

EnergyPhaseID

The EnergyPhaseID field indicates the identifier of the specific energy phase described by the Power Profile.

This is a sequential and contiguous number ranging from 1 to the maximum number of phases belonging to the Power Profile.

The value 0xFF shall be used to specify invalid energy phase (e.g., for a Power Profile in IDLE state).

ExpectedDuration

The ExpectedDuration field represents the estimated duration of the specific phase. Each unit is a minute.

PeakPower

The PeakPower field represents the estimated power for the specific phase. Each unit is a Watt.

Energy

The Energy field represents the estimated energy consumption for the accounted phase. Each unit is Watt per hours, according to the formatting specified in the *EnergyFormatting* attribute 9.7.4.3. The Energy value fulfills the following equation:

$Energy \leq PeakPower(Watt) * ExpectedDuration(sec).$

MaxActivationDelay

The MaxActivationDelay field indicates the maximum interruption time between the end of the previous phase and the beginning of the specific phase. Each unit is a minute.

The special value 0x0000 means that it is not possible to insert a pause between the two consecutive phases.

The MaxActivationDelay field of the first energy phase of a Power Profile shall be set to the value 0xFFFF.

9.5.6.1.2 When Generated

This command is generated when the server side of the Power Profile cluster (e.g., a White Good device), need to send the representation of its power profile to a controller device supporting the Power Profile cluster client side (e.g., Home Gateway).

9.5.6.1.3 Effect on Receipt

The device that receives the Power Profile Notification command shall reply with a standard Default response if requested in the ZCL header of the Power Profile Notification command.

9.5.6.2 Power Profile Response Command

This command is generated by the server side of Power Profile cluster as a reply to the Power Profile Request command. If the reception of Power Profile Request command is not supported the device shall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification).

If the profile data requested are not available, the device shall reply with a standard ZCL response INVALID_VALUE 0x87 (as ZCL specification).

9.5.6.2.1 Payload Format

The Power Profile Response Command payload shall be formatted as illustrated in Figure 9.20 (same as Power Profile Notification command).

9.5.6.2.1.1 Payload Details

The payload of the Power Profile Response command carries the fields defined in Figure 9.20 (the same as Power Profile Notification command).

9.5.6.2.2 When Generated

This command is generated by the server side of Power Profile cluster (e.g., White Good) as a reply to the Power Profile Request command sent by the client side (e.g., a Home gateway device).

9.5.6.2.3 Effect on Receipt

The device that receives the Power Profile Response command shall reply with a standard Default response if requested in the ZCL header of the Power Profile Response command.

The device that receives the Power Profile Response command shall reply with a standard ZCL Default response with status UNSUP_CLUSTER_COMMAND 0x81 (as from ZCL specification) if the reception of this command is not supported.

If the profile data requested are not available, the device shall reply with a standard ZCL response INVALID_VALUE 0x87 (as ZCL specification).

9.5.6.3 Power Profile State Response Command

The Power Profile State Response command allows a device (server) to communicate its current Power Profile(s) to another device (client) that previously requested them.

9.5.6.3.1 Payload Format

The Power Profile State Response command payload shall be formatted as illustrated in Figure 9.21.

Octets	1	4	4	...	4
Field Name	Power Profile Count	Power Profile record 1	Power Profile record 2	...	Power Profile record *n*

Figure 9.21 Format of the Power Profile State Response Command Frame

Each Power Profile record shall be formatted as illustrated inFigure 9.22.

Octets	1	1	1	1
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Boolean	8-bit enumeration
Field Name	Power Profile ID	Energy Phase ID	PowerProfileRemoteControl	PowerProfileState

Figure 9.22 Format of the Power Profile Record Field

9.5.6.3.1.1 Payload Details

Power Profile Count

The number of Power Profile Records that follow in the message.

Power Profile Record

The Power Profile record support the following fields:

- **Power Profile ID:** the identifier of the Power Profile as requested;

- **Energy Phase ID:** The current Energy Phase ID of the specific Profile ID;this value shall be set to invalid 0xFF when PowerProfileState indicates a Power Profile in POWER_PROFILE_IDLE state;
- **PowerProfileRemoteControl:** it indicates if the PowerProfile is currently remotely controllable or not; if the Power Profile is not remotely controllable it cannot be scheduled by a Power Profile client;
- **PowerProfileState:** an enumeration field representing the current state of the Power Profile (see PowerProfileState table)

Table 9.35 *PowerProfileState* Enumeration Field

Enumeration	Value	Description
POWER_PROFILE_IDLE	0x00	The PP is not defined in its parameters.
POWER_PROFILE_PROGRAMMED	0x01	The PP is defined in its parameters but without a scheduled time reference
ENERGY_PHASE_RUNNING	0x03	An energy phase is running
ENERGY_PHASE_PAUSED	0x04	The current energy phase is paused
ENERGY_PHASE_WAITING_TO_START	0x05	The Power Profile is in between two energy phases (one ended, the other not yet started). If the first Energy Phase is considered, this state indicates that the whole power profile is not yet started, but it has been already programmed to start
ENERGY_PHASE_WAITING_PAUSED	0x06	The Power Profile is set to Pause when being in the ENERGY_PHASE_WAITING_TO_START state.
POWER_PROFILE_ENDED	0x07	The whole Power Profile is terminated
Reserved	0x02, 0x08 – 0xff	Reserved

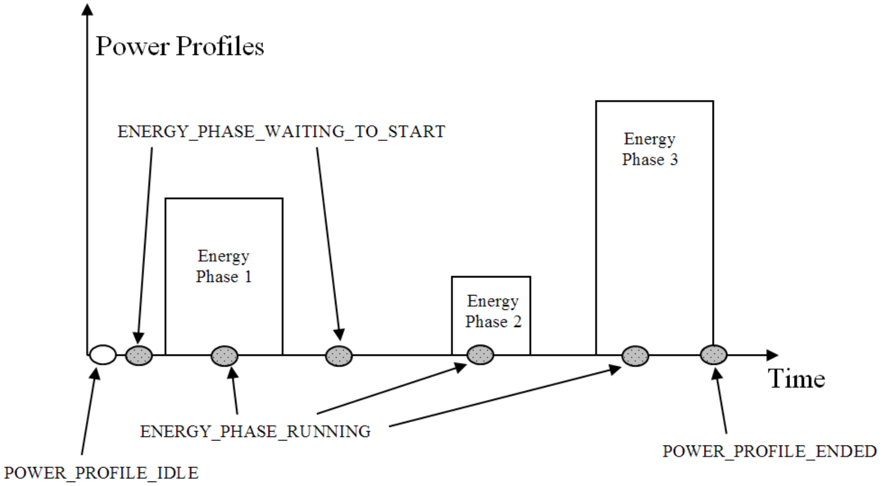


Figure 9.23 Power Profile States

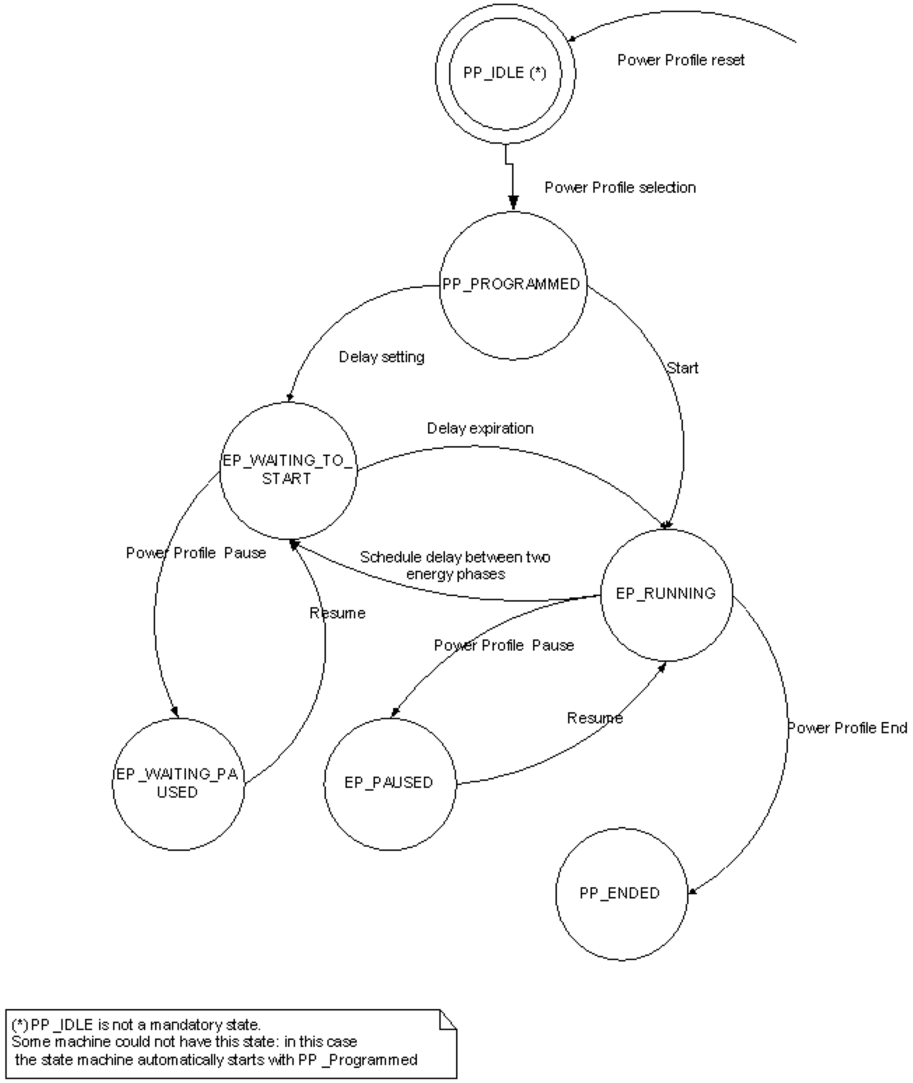


Figure 9.24 Power Profile State Diagram

9.5.6.3.2 When Generated

This command is generated when the command Power Profile State Request is received. Please refer to sub-clause 9.7.5.2.

9.5.6.3.3 Effect on Receipt

On receipt of this command, the originator is notified of the results of its Read Current Power Profiles attempt (i.e. receives the Power Profiles currently running in the server device).

9.5.6.4 Get Power Profile Price Command

The Get Power Profile Price command is generated by the server (e.g., White Goods) in order to retrieve the cost associated to a specific Power Profile. This command has the same payload as the Power Profile Request command (see 9.7.5.1).

9.5.6.4.1 Effects on Receipt

On receipt of this command, the recipient device shall generate a Get Power Profile Price Response command (see 9.7.5.3).

9.5.6.5 PowerProfileStateNotification Command

The Power Profile State Notification command is generated by the server (e.g. White Goods) in order to update the state of the power profile and the current energy phase. It has the same payload as the Power Profile State Response command but it is an unsolicited command.

9.5.6.5.1 Effects on Receipt

On receipt of this command, the recipient device will update its information related to the PowerProfile of the device (e.g., it will update the forecasts of the durations of the Power Profile’s energy phases with the actual data).

9.5.6.6 Get Overall Schedule Price Command

The Get Overall Schedule Price command is generated by the server (e.g., White Goods) in order to retrieve the overall cost associated to all the Power Profiles scheduled by the scheduler (the device supporting the Power Profile cluster client side) for the next 24 hours. This command has no payload.

9.5.6.6.1 Effects on Receipt

On receipt of this command, the recipient device shall generate a Get Overall Schedule Price Response command (9.7.5.4). See 9.7.10.1 for sequence diagrams and examples.

9.5.6.7 Energy Phases Schedule Request Command

The Energy Phases Schedule Request Command is generated by the server (e.g., White Goods) in order to retrieve from the scheduler (e.g., Home Gateway) the schedule (if available) associated to the specific Power Profile carried in the payload. This command has the same payload as 9.7.5.1 (Power Profile Request).

9.5.6.7.1 Effects on Receipt

On receipt of this command, the recipient device shall generate a Energy Phases Schedule Response command (see 9.7.5.6) in order to notify the proper scheduling to the server side of the Power Profile cluster (“solicited” schedule). If the schedule is accepted by the PowerProfile server side (e.g., the appliance) the PowerProfile shall have the state ENERGY_PHASE_WAITING_TO_START (delay start set for the first energy phase of the power profile). If the device receiving the Energy Phases Schedule Response command cannot accept the schedule of the energy phases because the activation delay related to any of carried phases is equal to zero, it shall reply with a standard Default response with the error code NOT_AUTHORIZED (0x7e).

9.5.6.8 Energy Phases Schedule State Response Command

The Energy Phases Schedule State Response command is generated by the server (e.g., White Goods) in order to reply to a Energy Phases Schedule State Request command (see 9.7.6.7) about the scheduling states that are set in the server side. The payload of this command is the same as Energy Phases Schedule Notification. In case the are not scheduled energy phases the following payload shall be used:

Octets	1	1
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer
Field Name	PowerProfile ID	Num of Scheduled Energy Phases=0x00

Figure 9.25 Format of the Energy Phases Schedule State Response in Case of No Scheduled Phases

9.5.6.8.1 Effects on Receipt

On receipt of this command, the recipient device will be notified about the scheduling activity of the server side of the Power Profile Cluster.

Please note that the schedules may be set by the scheduling commands listed in this cluster or by the users (e.g., delay start of an appliance).

9.5.6.9 Energy Phases Schedule State Notification Command

The Energy Phases Schedule State Notification command is generated by the server (e.g., White Goods) in order to notify (un-solicited command) a client side about the scheduling states that are set in the server side. The payload of this command is the same as Energy Phases Schedule State Response.

9.5.6.9.1 Effects on Receipt

On receipt of this command, the recipient devices will be notified about the scheduling activity of the server side of the Power Profile Cluster.

9.5.6.10 Power Profile Schedule Constraints Notification Command

The Power Profile Schedule Constraints Notification command is generated by a device supporting the server side of the Power Profile cluster to notify the client side of this cluster about the imposed constraints and let the scheduler (i.e. the entity supporting the Power Profile cluster client side) to set the proper boundaries for the scheduling.

9.5.6.10.1 Payload Format

The Power Profile Schedule Constraints Notification command payload is reported in Figure 9.26.

Octets	1	2	2
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 16-bit integer
Field Name	PowerProfile ID	Start After	Stop Before

Figure 9.26 Format of the Power Profile Schedule Constraints Notification Command Frame

9.5.6.10.1.1 Payload Details

The payload of the Power Profile Schedule Constraints Notification command carries the following fields:

- The Power Profile ID field specifies which profile (among *TotalProfileNum* total profiles number) the constraints are referring to.
- The *StartAfter* parameter represents the relative time in minutes (in respect to the time of the reception of this command), that limits the start of the Power Profile; it means that the Power Profile should be scheduled to start after a period of time equal to *StartAfter*; if this value is not specified by the device the value shall be 0x0000;
- The *StopBefore* parameter represents the relative time in minutes (in respect to the time of the reception of this command), that limits the end of the Power Profile; it means that the Power Profile should be scheduled to end before a

period of time equal to *StopBefore*; if this value is not specified by the device the value shall be 0xFFFF.

9.5.6.10.2 When Generated

This command is generated when the server side of the Power Profile cluster (e.g., a White Goods device), needs to notify a change in the constraints of the Power Profile (e.g., the user selected boundaries for the specific behavior of the device).

9.5.6.10.3 Effect on Receipt

The device that receives the Power Profile Schedule Constraints Notification command shall use the information carried in the payload of this command to refine the proper schedule of the specific Power Profile indicated in the Power Profile ID field in order to meet the constraints.

9.5.6.11 Power Profile Schedule Constraints Response Command

The Power Profile Schedule Constraints Response command is generated by a device supporting the server side of the Power Profile cluster to reply to a client side of this cluster which sent a Power Profile Schedule Constraints Request. The payload carries the selected constraints to let the scheduler (i.e. the entity supporting the Power Profile client cluster) to set the proper boundaries for completing or refining the scheduling.

9.5.6.11.1 Payload Format

Same as Power Profile Schedule Constraints Notification command (see 9.7.6.10)

9.5.6.11.1.1 When Generated

This command is generated as a reply to the Power Profile Schedule Constraints Request.

9.5.6.11.2 Effect on Receipt

The device that receives the Power Profile Schedule ConstraintsReponse command shall use the information carried in the payload of this command to refine the proper schedule of the specific Power Profile indicated in the Power ProfileID field.

9.5.6.12 Get Power Profile Price Extended Command

The Get Power Profile Price Extended command is generated by the server (e.g., White Goods) in order to retrieve the cost associated to a specific Power Profile considering specific conditions described in the option field (e.g., a specific time).

9.5.6.12.1 Payload Format

The Get Power Profile Price Extended Command payload shall be formatted as illustrated in Figure 9.27.

Octets	1	1	0/2
Data Type	Unsigned 8-bit bitmap	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Options	PowerProfileID	PowerProfileStartTime

Figure 9.27 Format of the Get Power Profile Price Extended Command Payload

Table 9.36 Options Field

Bit	Description
0	Bit0=1 : PowerProfileStartTime Field Present
1	Bit1=0 : provide an estimation of the price considering the power profile with contiguous energy phases Bit1=1 : provide an estimation of the price considering the power profile as scheduled (i.e. taking in account delays between Energy phases set by the EMS)
2 to 7	Reserved

Options

The Options field represents the type of request of extended price is requested to the client side of the power profile cluster (e.g., to a energy management system).

PowerProfileStartTime

The PowerProfileStartTime field represents the relative time (expressed in relative encoding in respect to the current time) when the overall Power Profile can potentially start. The unit is the minute.

9.5.6.12.2 Effects on Receipt

On receipt of this command, the recipient device shall generate a Get Power Profile Price Extended Response command (see 9.7.10.1 for sequence diagrams and examples).

9.5.7 Client Attributes

The client has no attributes.

9.5.8 Client Commands Received

Description is in server side commands generated (sent) description.

9.5.9 Client Commands Generated

Description is in server side commands received description.

9.5.10 Example of Device Interactions Using the Power Profile (Informative Section)

9.5.10.1 Price Information Retrieved by the White Goods

The price of a specific appliance program is estimated by the Home gateway/ EMS, calculated using the Power Profile forecast provided by the appliance and the *PowerProfileStartTime* contained in the *GetPowerProfilePriceExtended* which indicates when the appliance program will start. How the Home Gateway/ EMS retrieves from the utility the information related to tariff schemes and price changes over time is out of scope of this specification.

The appliance may then show to the user on the display the price associated to a specific cycle set (e.g. a washing machine program “Cotton 90 °C” will cost you “1.15€”).

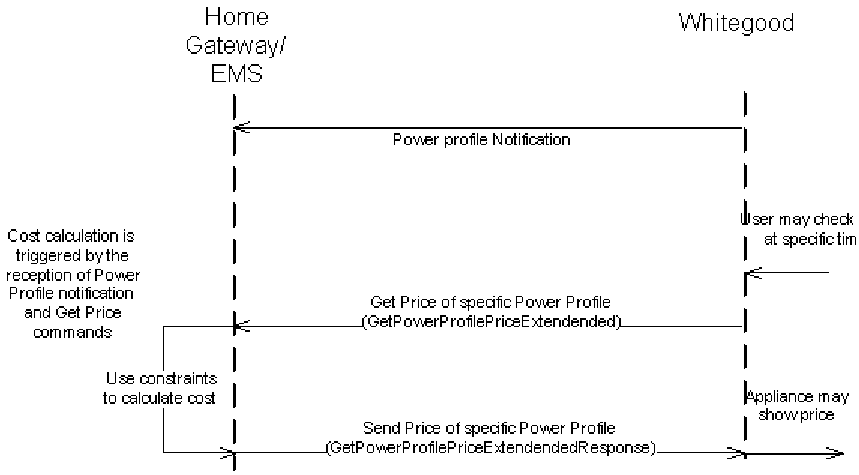
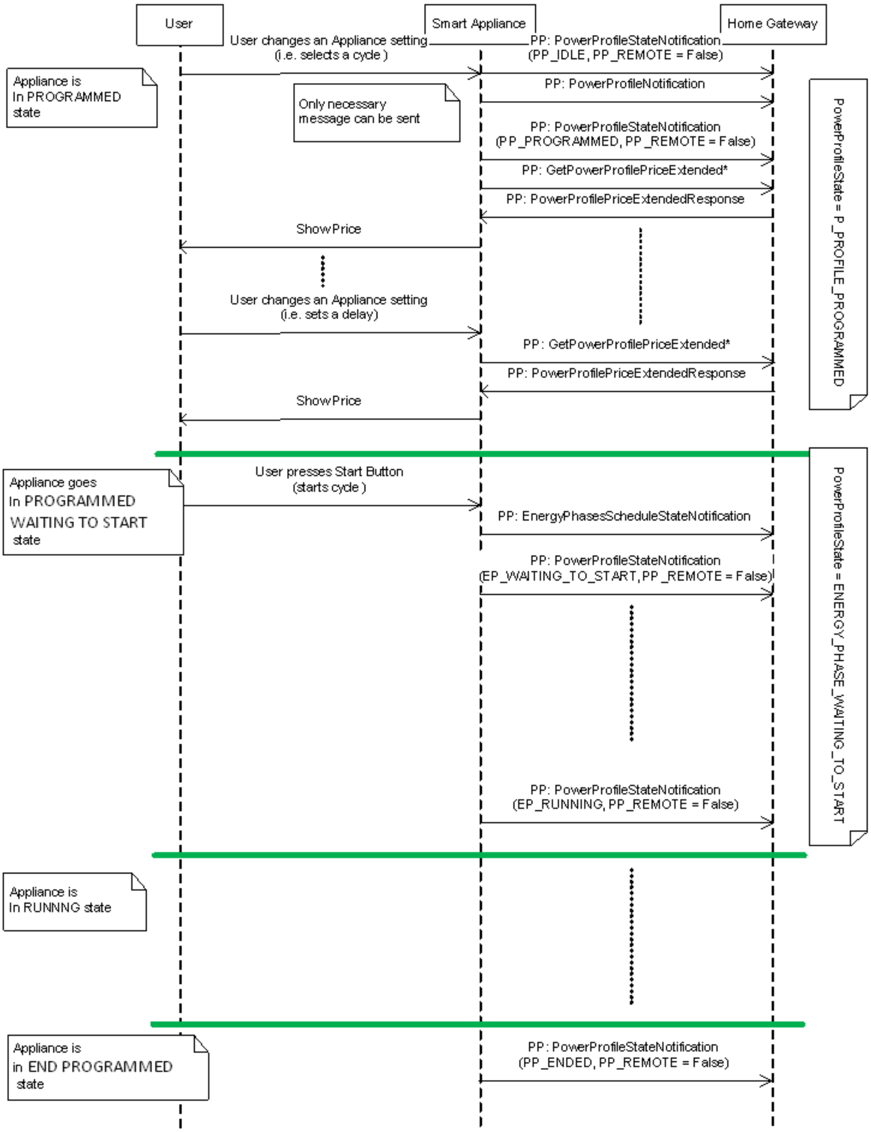

Home Gateway/ EMS
Whitegood
Power profile Notification
User may check price at specific time
Cost calculation is triggered by the reception of Power Profile notification and Get Price commands
Get Price of specific Power Profile (GetPowerProfilePriceExtendended)
Use constraints to calculate cost
Appliance may show price
Send Price of specific Power Profile (GetPowerProfilePriceExtendendedResponse)

Figure 9.28 Visualization of Price Associated to a Power Profile

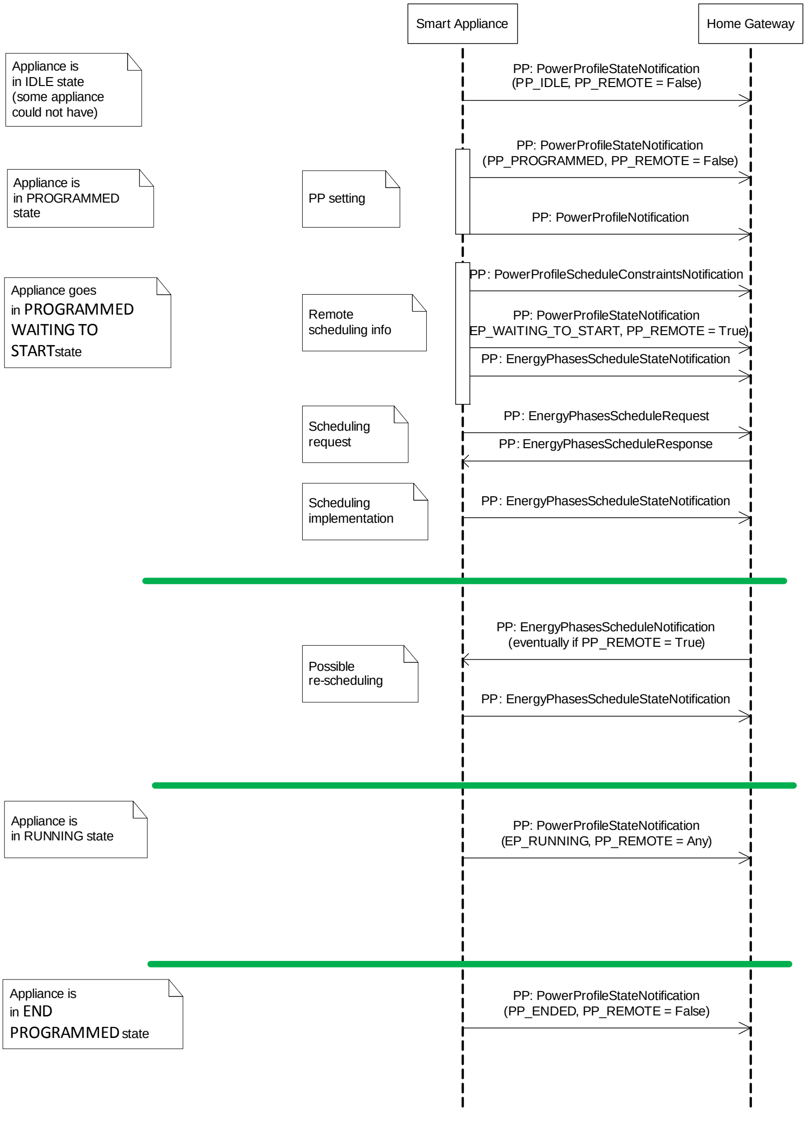
9.5.10.2 Interaction with Power Profile Cluster when Appliance is not Remotely Controllable


User
Smart Appliance
Home Gateway
User changes an Appliance setting
(i.e. selects a cycle)
PP: PowerProfileStateNotification
(PP_IDLE, PP_REMOTE = False)
Appliance is
In PROGRAMMED
state
PP: PowerProfileNotification
Only necessary
message can be sent
PP: PowerProfileStateNotification
(PP_PROGRAMMED, PP_REMOTE = False)
PP: GetPowerProfilePriceExtended*
PP: PowerProfilePriceExtendedResponse
ShowPrice
User changes an Appliance setting
(i.e. sets a delay)
PP: GetPowerProfilePriceExtended*
PP: PowerProfilePriceExtendedResponse
ShowPrice
PowerProfileState = P_PROFILE_PROGRAMMED
User presses Start Button
(starts cycle)
Appliance goes
In PROGRAMMED
WAITING TO START
state
PP: EnergyPhasesScheduleStateNotification
PP: PowerProfileStateNotification
(EP_WAITING_TO_START, PP_REMOTE = False)
PowerProfileState = ENERGY_PHASE_WAITING_TO_START
PP: PowerProfileStateNotification
(EP_RUNNING, PP_REMOTE = False)
Appliance is
In RUNNNG state
Appliance is
in END PROGRAMMED
state
PP: PowerProfileStateNotification
(PP_ENDED, PP_REMOTE = False)

* GetPowerProfilePriceExtended payload includes delay time to start

Figure 9.29 Energy Remote Disabled: Example of Sequence Diagram with User Interaction

9.5.10.3 Interaction with Power Profile Cluster when Appliance is Remotely Controllable (Scheduling of Appliance)


Smart Appliance
Home Gateway
Appliance is in IDLE state (some appliance could not have)
PP: PowerProfileStateNotification (PP_IDLE, PP_REMOTE = False)
PP: PowerProfileStateNotification (PP_PROGRAMMED, PP_REMOTE = False)
Appliance is in PROGRAMMED state
PP setting
PP: PowerProfileNotification
PP: PowerProfileScheduleConstraintsNotification
Appliance goes in PROGRAMMED WAITING TO STARTstate
Remote scheduling info
PP: PowerProfileStateNotification (EP_WAITING_TO_START, PP_REMOTE = True)
PP: EnergyPhasesScheduleStateNotification
Scheduling request
PP: EnergyPhasesScheduleRequest
PP: EnergyPhasesScheduleResponse
Scheduling implementation
PP: EnergyPhasesScheduleStateNotification
PP: EnergyPhasesScheduleNotification (eventually if PP_REMOTE = True)
Possible re-scheduling
PP: EnergyPhasesScheduleStateNotification
Appliance is in RUNNING state
PP: PowerProfileStateNotification (EP_RUNNING, PP_REMOTE = Any)
Appliance is in END PROGRAMMED state
PP: PowerProfileStateNotification (PP_ENDED, PP_REMOTE = False)

* GetPowerProfilePriceExtended can be generated any time by SA if a PP is active

Figure 9.30 EnergyRemote Enabled: Example of Sequence Diagram with User Interaction

9.6 EN50523 Appliance Control Cluster

This section describes the EN50523 Appliance Control cluster.

9.6.1 Overview

This cluster provides an interface to remotely control and to program household appliances. Example of control is Start, Stop and Pause commands.

The status "read" and "set" is compliant to the EN50523 "Signal State" and "Execute Command" functional blocks. Appliances parameters (e.g., Duration and Remaining Time) have been added, since they were missing from the original specs.

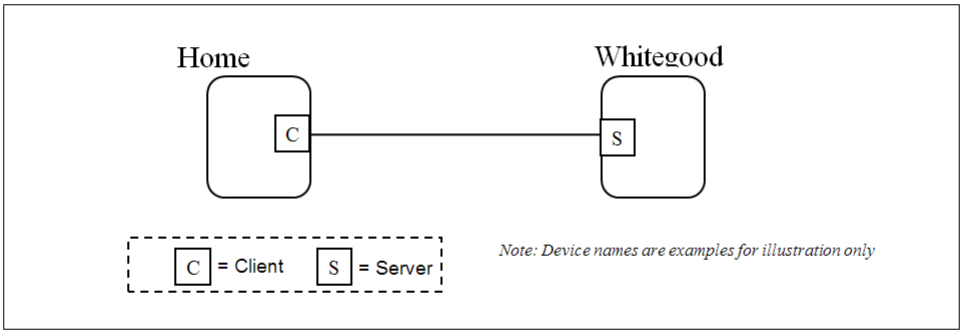


Figure 9.31 Typical Usage of this Cluster

Note: *Where a physical ZigBee node supports multiple endpoints it will often be the case that many of these settings will apply to the whole node, that is they are the same for every endpoint on the device. In such cases they can be implemented once for the node, and mapped to each endpoint.*

9.6.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

9.6.2.1 ZigBee Alliance Documents

075366r00ZB_AFG-ZigBee_Cluster_Library_Public_download_version.pdf – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

105684r00ZB_MWG-Energy@Home_Use_cases.pdf – This document describes the use cases requiring the use of this cluster

105714r00ZB_MWG-Energy@Home.ppt – This document describes the marketing requirements for this new feature of HA

106085r00ZB_HA_PTG-Energy@Home_and_HA.ppt – This document describe the functional requirement of this cluster

106086r00ZB_HA_PTG-E@H_specification_ver0.7.pdf – This document describes the baseline for the definition of this cluster

106123r00ZB_MWG-Energy@Home_MRD.doc – This document describes the marketing requirements for this new feature of HA

BSI British Standards, document BS EN 50523-1:2009, “Household appliances interworking - Part 1: Functional specification”, July 2009.

BSI British Standards, document BS EN 50523-2:2009, *“Household appliances interworking - Part 2: Data structures”*, July 2009

9.6.3 General Description

9.6.3.1 Dependencies

None

9.6.4 Server Attributes

For convenience, the attributes defined in this specification are arranged into sets of related attributes; each set can contain up to 256 attributes. Attribute identifiers are encoded such that the most significant byte specifies the attribute set and the least significant byte specifies the attribute within the set. The currently defined attribute sets are listed in Table 9.37.

Table 9.37 Appliance Control Attribute Set

Attribute Set Identifier	Description
0x00	Appliance Functions
0x01-0xff	Reserved

9.6.4.1 Appliance Functions Attribute Set

The Appliance Functions attribute set contains the attributes summarized in Table 9.38.

These attributes control the Appliance cycle parameters. Each of them, as described below, corresponds to an Appliance internal status configuration.

Table 9.38 Attributes of the Appliance Functions Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x0000	*StartTime*	Unsigned 16-bit integer	0x0000 – 0xffff	Read Only	0x0000	M	Yes
0x0001	*FinishTime*	Unsigned 16-bit integer	0x0000 – 0xffff	Read Only	0x0000	M	Yes
0x0002	*RemainingTime*	Unsigned 16-bit integer	0x0000 – 0xffff	Read Only	0x0000	O	Yes

9.6.4.2 StartTime Attribute

StartTime attribute determines the time (either relative or absolute) of the start of the machine activity. Default format for Oven devices is absolute time. The default format for other appliances is relative time.

Table 9.39 provides details about time encoding which is used for *StartTime* attribute organization.

Table 9.39 Time Encoding

<table>
<tr><th>Bit Range</th><th colspan="2">Function</th></tr>
<tr><td>0..5</td><td colspan="2">Minutes ranging from 0 to 59</td></tr>
<tr><td rowspan="3">6..7</td><td colspan="2">Time encoding</td></tr>
<tr><td><b>Value</b></td><td><b>Enumeration</b></td></tr>
<tr><td>0x0
0x1
0x2..0x3</td><td>RELATIVE
ABSOLUTE
Reserved</td></tr>
<tr><td>8..15</td><td colspan="2">Hours ranging from
0 to 255 if RELATIVE encoding is selected
0 to 23 if ABSOLUTE encoding is selected</td></tr>
</table>

9.6.4.3 FinishTime Attribute

FinishTime attribute determines the time (either relative or absolute) of the expected end of the machine activity. Default format for Oven is absolute time. The default format for other appliances is relative time.

FinishTime attribute exploits time encoding reported in Table 9.39.

9.6.4.4 RemainingTime Attribute

RemainingTime attribute determines the time, in relative format, of the remaining time of the machine cycle. It represents the time remaining to complete the machine cycle and it is updated only during the RUNNING state of the Appliance. During the other states of the Appliance *RemainingTime* attribute is indicated as the not valid value “0”.

RemainingTime attribute exploits time encoding reported in Table 9.39.

9.6.5 Server Commands Received

The command IDs for the Appliance Control cluster are listed in Table 9.40.

Table 9.40 Cluster-specific Commands Received by the Server

Command Identifier Field Value	Description	Mandatory / Optional
0x00	Execution of a Command	O[a]
0x01	Signal State	M
0x02	Write Functions	O
0x03	Overload Pause Resume	O
0x04	Overload Pause	O
0x05	Overload Warning	O
0x06-0xff	Reserved	-

[a] CCB 1770

9.6.5.1 Execution of a Command

This basic message is used to remotely control and to program household appliances. Examples of control are START, STOP and PAUSE.

9.6.5.1.1 Payload Format

The Execution of a Command payload shall be formatted as illustrated in Figure 9.32.

Octets	1
Data Type	8-bit enumerationerator
Field Name	Command Identification

Figure 9.32 Format of the Execution of a Command Payload

9.6.5.1.1.1 Payload Details

The **Command Identification** field: the command identification is an 8-bits in length field identifying the command to be executed. The enumeration used for this field shall match Table 9.41.

Table 9.41 Command Identification Values

Enumeration	**Value**	**Description**
Reserved	0x00	Reserved
Reserved	0x00	Reserved
START	0x01	Start appliance cycle
STOP	0x02	Stop appliance cycle
PAUSE	0x03	Pause appliance cycle
START SUPERFREEZING	0x04	Start superfreezing cycle
STOP SUPERFREEZING	0x05	Stop superfreezing cycle
START SUPERCOOLING	0x06	Start supercooling cycle
STOP SUPERCOOLING	0x07	Stop supercooling cycle
DISABLE GAS	0x08	Disable gas
ENABLE GAS	0x09	Enable gas
Standardized (TBD)	0x0A..0x3f	Standardized (TBD)
Non standardized	0x40..0x7f	Non standardized
Proprietary	0x80..0xff	Proprietary

9.6.5.1.2 Effects on Receipt

On receipt of this command, the appliance shall execute the command given in the Command Identification field. The device application shall be informed of the imposed command (and potential personalized tasks could start, e.g., by means of a message to appliance Main Board controller).

After the command execution, the appliance shall generate a Signal State Notification with the new appliance state.

9.6.5.2 Signal State Command

This basic message is used to retrieve Household Appliances status. This command does not have a payload.

9.6.5.2.1 Effects on Receipt

On receipt of this command, the device shall generate a Signal State Response command.

9.6.5.3 Write Functions Command

This basic message is used to set appliance functions, i.e. information regarding the execution of an appliance cycle. Condition parameters such as start time or finish time information could be provided through this command.

9.6.5.3.1 Payload Format

The Write Functions command frame shall be formatted as illustrated in Figure 9.33.

Octets	Variable
Field Name	Write Functions record

Figure 9.33 Format of the Write Functions Command Frame

Write Functions record shall be formatted as illustrated in Figure 9.34.

Octets	2	1	Variable
Data Type	Unsigned 16-bit integer	8-bit enumerationerator	Variable octets
Field Name	Function identifier (i.e. attribute identifier)	Function data type	Function data

Figure 9.34 Format of the Write Functions Record Field

9.6.5.3.2 Payload Details

The **Function identifier** field: the Function Identifier is 16-bits in length and shall contain the identifier of the function that is to be written.

The **Function data type** field: the function data type field shall contain the data type of the attribute that is to be written.

The **Function data** field: the function data field is variable in length and shall contain the actual value of the function that is to be written.

9.6.5.3.3 Effects on Receipt

On receipt of this command, the appliance shall set the function given in the Function identifier field. The Function identifier is actually changed only when the appliance internal functions have been changed.

If attribute reporting is configured on some function attributes, an attribute reporting command is generated when the internal appliance functions is actually modified. In case attribute reporting is not used, the correct execution of the Write Function command should be verified by using Read Attribute command on the written attribute.

9.6.5.4 Overload Pause Resume Command

This command shall be used to resume the normal behaviour of a household appliance being in pause mode after receiving a Overload Pause command.

9.6.5.4.1 Payload Format

The Overload Pause Resume Command shall have no payload.

9.6.5.4.2 Effects on Receipt

On receipt of this command, the appliance shall resume its operations.

9.6.5.5 Overload Pause Command

This command shall be used to pause the household appliance as a consequence of an imminent overload event.

9.6.5.6 Payload Format

The Overload Pause Command shall have no payload.

9.6.5.7 Effects on Receipt

On receipt of this command, the appliance shall pause its operations. In order to resume the normal operation an Overload Pause Resume command should be issued by the device supporting the client side of the Appliance control cluster.

9.6.5.8 Overload Warning Command

This basic message is used to send warnings the household appliance as a consequence of a possible overload event, or the notification of the end of the warning state.

9.6.5.8.1 Payload Format

The Overload Warning Command payload shall be formatted as illustrated in Figure 9.35.

Octets	2
Data Type	8-bit enumerationerator
Field Name	Warning Event

Figure 9.35 Format of the Overload Warning Payload

9.6.5.8.1.1 Payload Details

The Warning Event field represents the identifier of the events that needs to be communicated to the devices to alert about possible overload.

Event ID	Description
0x00	Warning 1: overall power above “available power” level
0x01	Warning 2: overall power above “power threshold” level
0x02	Warning 3: overall power back below the “available power” level
0x03	Warning 4: overall power back below the “power threshold” level
0x04	Warning 5: overall power will be potentially above “available power” level if the appliance starts

Figure 9.36 Format of the Event ID Enumerator

9.6.5.8.2 Effects on Receipt

On receipt of this command, the appliance shall show the possible warning state on a display (e.g., showing an icon with possible overload condition when activating the appliance in case of Warnings 1-2) or resume the normal state in case of events showing the return on normal state (e.g., Warning 3-4).

9.6.6 Server Commands Generated

Table 9.42 lists commands are generated by the server.

Table 9.42 Cluster-specific Commands Sent by the Server

Command Identifier Field Value	Description	Mandatory / Optional
0x00	Signal State Response	M
0x01	Signal State Notification	M
0x02-0xff	Reserved	-

9.6.6.1 Signal State Response Command

This command shall be used to return household appliance status, according to Appliance Status Values and Remote Enable Flags Values.

9.6.6.1.1 Payload Format

The Signal State Response Command payload shall be formatted as illustrated in Figure 9.37.

The Appliance Status field: the data field is a 8 bits in length enumerator identifying the appliance status. The enumeration used for this field shall match the specifications in Table 9.43.

The Remote Enable Flags and Device Status 2 field: the data field is a 8 bits in length unsigned integer defining remote enable flags and potential appliance status 2 format. The unsigned integer used for this field shall match the specifications in Table 9.44.

The Appliance Status 2 field: the command identification is a 24 bits in length unsigned integer representing potential non-standardized or proprietary data.

Octets	1	1	0/3
Data Type	8-bit enumeration	Unsigned 8-bit integer	Unsigned 24-bit integer
Field Name	Appliance Status	Remote Enable Flags and Device Status 2	Appliance Status 2

Figure 9.37 Format of the Signal State Response Command Payload

9.6.6.1.1.1 Payload Details

ApplianceStatus

ApplianceStatus represents the current status of household appliance.

ApplianceStatus must be included as part of the minimum data set to be provided by the household appliance device.

ApplianceStatus is updated continuously as appliance state changes.

Table 9.43 provides states defined.

Table 9.43 Appliance Status Values

Enumeration	Value	Description
Reserved	0x00	Reserved
OFF	0x01	Appliance in off state
STAND-BY	0x02	Appliance in stand-by

Table 9.43 Appliance Status Values

Enumeration	Value	Description
PROGRAMMED	0x03	Appliance already programmed
PROGRAMMED WAITING TO START	0x04	Appliance already programmed and ready to start
RUNNING	0x05	Appliance is running
PAUSE	0x06	Appliance is in pause
END PROGRAMMED	0x07	Appliance end programmed tasks
FAILURE	0x08	Appliance is in a failure state
PROGRAMME INTERRUPTED	0x09	The appliance programmed tasks have been interrupted
IDLE	0x0a	Appliance in idle state
RINSE HOLD	0x0b	Appliance rinse hold
SERVICE	0x0c	Appliance in service state
SUPERFREEZING	0x0d	Appliance in superfreezing state
SUPERCOOLING	0x0e	Appliance in supercooling state
SUPERHEATING	0x0f	Appliance in superheating state
Reserved	0x10..0x3f	Reserved
Non standardized	0x40..0x7f	Non standardized
Proprietary[a]	0x80..0xff	Proprietary

[a] Reserved, Non Standardised and Proprietary from CECED naming conventions.

RemoteEnableFlags Field

RemoteEnableFlags represents the current status of household appliance correlated with remote control.

RemoteEnableFlags is mandatory and must be included as part of the minimum data set to be provided by the household appliance device.

RemoteEnableFlags is updated continuously when appliance state remote-controllability changes.

Table 9.44 provides details about flags organization.

Table 9.44 Remote Enable Flags Values

Bit Range	Function	
0..3	Remote Enable Flags	
	Value	**Enumeration**
	0x0	DISABLED
	0x7	TEMPORARILY LOCKED/DISABLED
	0xf	ENABLED REMOTE CONTROL
	0x1.	ENABLED REMOTE AND ENERGY CONTROL
	0x2..0x06, 0x8..0xe	Reserved
4..7	Device Status 2 Structure	
	Value	**Enumeration**
	0x0	PROPRIETARY
	0x1	PROPRIETARY
	0x2	IRIS SYMPTOM CODE
	0x3..0xf	Reserved

ApplianceStatus2 Field

ApplianceStatus2 represents a detailed definition of Appliance state. If optionally provided, *ApplianceStatus2* is updated continuously as appliance state change.

This field contains non-standardized or proprietary data. In the case of IRIS Symptom Code, 3 bytes representing the 3 digit encoding is provided (possibly complemented with proprietary bytes).

9.6.6.1.2 Effect on Receipt

On receipt of this command, the device is informed of a Household Appliance status.

9.6.6.2 Signal State Notification Command

This command shall be used to return household appliance status, automatically when appliance status changes.

9.6.6.2.1 Payload Format

The Signal State Notification Command payload shall be formatted as illustrated for the Signal State Response Command Payload.

9.6.6.2.2 Effects on Receipt

On receipt of this command, the device is informed of a Household Appliance status.

9.6.7 Client

9.6.7.1 Dependencies

None

9.6.7.2 Attributes

The client has no attributes.

9.6.7.3 Commands Received

Description is in server side commands generated (sent).

9.6.7.4 Commands Generated

Description is in server side commands received.

9.7 EN50523 Appliance Identification Cluster

9.7.1 Overview

Attributes and commands for determining basic information about a device and setting user device information.

The Appliance Identification Cluster is a transposition of EN50523 “Identify Product” functional block.

Note: *Where a physical ZigBee node supports multiple endpoints it will often be the case that many of these settings will apply to the whole node, that is they are the same for every endpoint on the device. In such cases they can be implemented once for the node, and mapped to each endpoint.*

9.7.2 Server

9.7.2.1 Attributes

For convenience, the attributes defined in this specification are arranged into sets of related attributes; each set can contain up to 16 attributes. Attribute identifiers are encoded such that the most significant three nibbles specify the attribute set and the least significant nibble specifies the attribute within the set. The currently defined attribute sets are listed in Table 9.45.

Table 9.45 Appliance Identification Attribute Sets

Attribute Set Identifier	Description
0x000	Basic Appliance Identification
0x001	Extended Appliance Identification
0x002-0xfff	Reserved

9.7.2.2 Basic Appliance Identification Attribute Set

The Basic Appliance Identification attribute set contains the attributes summarized in Table 9.46.

Table 9.46 Attributes of the Appliance Identification Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x0000	*BasicIdentification*	Unsigned 56-bit integer	(Length: 7 octets)	Read only	-	M	No

9.7.2.3 BasicIdentification Attribute

BasicIdentification is 56-bit bitmap (7 octets) and contains the basic appliance identification.

BasicIdentification is mandatory and must be included as part of the minimum data set to be provided by the household appliance device.

Table 9.47 provides attribute content specification.

Table 9.47 Basic Appliance Identification Content Specification

Attribute Name	Field	Bits
BasicIdentification	Company ID	0x00-0x0f
	Brand ID	0x10-0x1f
	Product Type ID	0x20-0x2f
	Spec. Ver.	0x37-0x30

Company ID and Brand ID fields content could be se according to [B7], Table 5.

Table 9.48 provides Product Type IDs field content, again according to [B7] (see Table 6).

Table 9.48 Product Type IDs

Device (Appliance)	Product Type ID
White Goods	0x0000
Dishwasher	0x5601
Tumble Dryer	0x5602
Washer Dryer	0x5603
Washing Machine	0x5604
Hobs	0x5E03
Induction Hobs	0x5E09
Oven	0x5E01
Electrical Oven	0x5E06
Refrigerator Freezer	0x6601

9.7.2.4 Extended Appliance Identification Attribute Set

The Extended Appliance Identification attribute set contains the attributes summarized in Table 9.49.

Table 9.49 Attributes of the Extended Appliance Identification Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x0010	*CompanyName*	Character String	0 to 16 Octets	Read only	-	O	No
0x0011	*CompanyId*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	-	O	No
0x0012	*BrandName*	Character String	0 to 16 Octets	Read only	-	O	No
0x0013	*BrandId*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only		O	No
0x0014	*Model*	Octet String	0 to 16 Octets	Read only		O	No
0x0015	*PartNumber*	Octet String	0 to 16 Octets	Read only		O	No
0x0016	*ProductRevision*	Octet String	0 to 6 Octets	Read only		O	No
0x0017	*SoftwareRevision*	Octet String	0 to 6 Octets	Read only		O	No

Table 9.49 Attributes of the Extended Appliance Identification Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x0018	*ProductType Name*	Octet String	2 Octets	Read only		O	No
0x0019	*ProductType Id*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only		O	No
0x001A	*CECEDSpecificationVersion*	Unsigned 8-bit integer	0x0000 – 0xffff	Read only		O	No

9.7.2.5 CompanyName Attribute

CompanyName is a ZCL Character String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. Example Company Name labels are “Electrolux”, “Indesit Company”, “Candy”. The complete list of valid labels is defined in [B7], Table 7.

9.7.2.6 CompanyID Attribute

CompanyID is 16-bit in length unsigned integer which defines the appliance company identifier. The complete list of valid company identifiers is defined in [B7], Table 7.

9.7.2.7 BrandName Attribute

BrandName is a ZCL Character String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. Example Brand Name labels are “Rex”, “Ariston”, “Hoover”. The complete list of valid labels is defined in [B7], Table 7.

9.7.2.8 BrandID Attribute

BrandID is 16-bit in length unsigned integer which defines the appliance brand identifier. The complete list of valid brand identifiers is defined in [B7], Table 7.

Note that Brand Ids and Company Ids are independently defined. The advantage is that one brand of one producer may have the same ID as a brand name of another producer.

9.7.2.9 Model Attribute

Model is a ZCL Octet String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. *Model* defines the appliance model name, decided by manufacturer.

9.7.2.10 PartNumber Attribute

PartNumber is a ZCL Octet String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. *PartNumber* defines the appliance part number, decided by manufacturer.

9.7.2.11 ProductRevision Attribute

ProductRevision is a ZCL Octet String field capable of storing up to 6 character string (the first Octet indicates length) encoded in the UTF-8 format. *ProductRevision* defines the appliance revision code, decided by manufacturer.

9.7.2.12 SoftwareRevision Attribute

SoftwareRevision is a ZCL Octet String field capable of storing up to 6 character string (the first Octet indicates length) encoded in the UTF-8 format. *SoftwareRevision* defines the appliance software revision code, decided by manufacturer.

9.7.2.13 ProductTypeName Attribute

ProductTypeName is a 2 Octet in length String field which defines the appliance type label. Example ProductTypeName labels are “WM”, “RE”, “GO”, respectively for Washing Machine, Refrigerator and Gas Oven. The complete list of valid labels is defined in [B7], Table 8.

9.7.2.14 ProductTypeID Attribute

ProductTypeID is a 16-bit in length unsigned integer which defines the appliance type identifier. The structure and complete list of valid *ProductTypeId*s is defined in [B7], Table 7.

9.7.2.15 CECEDSpecificationVersion Attribute

CECEDSpecificationVersion is a 8-bit in length unsigned integer which defines the CECED reference documentation. Compliance and certification of appliance communication capabilities can be defined according to Table 9.50 (see [B7], Table 10).

Table 9.50 CECED Specification Version

Specification Version	Value
Compliant with v1.0, not certified	0x10
Compliant with v1.0, certified	0x1A
Compliant with vX.0, not certified	0xX0
Compliant with vX.0, certified	0xXA
Other values	Reserved

9.7.2.16 Commands Received

No cluster-specific commands are received by the server.

9.7.2.17 Commands Generated

No cluster-specific commands are generated by the server.

9.7.3 Client

9.7.3.1 Attributes

The Client cluster has no attributes.

9.7.3.2 Commands Received

No cluster-specific commands are received by the client.

9.7.3.3 Commands Generated

No cluster-specific commands are generated by the client.

9.8 Meter Identification Cluster

9.8.1 Overview

This cluster provides Attributes and commands for determining advanced information about utility metering device.

Note*: Where a physical ZigBee node supports multiple endpoints it will often be the case that many of these settings will apply to the whole node, that is they are the same for every endpoint on the device. In such cases they can be implemented once for the node, and mapped to each endpoint.*

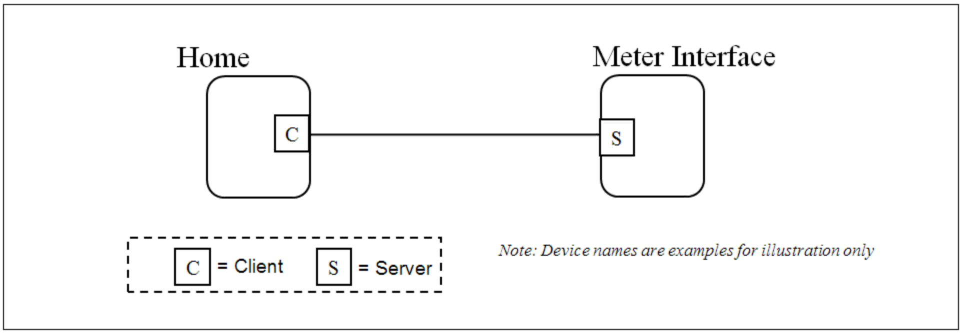


Figure 9.38 Typical Usage of This Cluster

9.8.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

075366r00ZB_AFG-ZigBee_Cluster_Library_Public_download_version.pdf – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

105684r00ZB_MWG-Energy@Home_Use_cases.pdf – This document describes the use cases requiring the use of this cluster

105714r00ZB_MWG-Energy@Home.ppt – This document describes the marketing requirements for this new feature of HA

106085r00ZB_HA_PTG-Energy@Home_and_HA.ppt – This document describe the functional requirement of this cluster

106086r00ZB_HA_PTG-E@H_specification_ver0.7.pdf – This document describes the baseline for the definition of this cluster

106123r00ZB_MWG-Energy@Home_MRD.doc – This document describes the marketing requirements for this new feature of HA

9.8.3 Server

9.8.3.1 Attributes

For convenience, the attributes defined in this specification are arranged into sets of related attributes; each set can contain up to 16 attributes. The currently defined attribute sets are listed in Table 9.51.

Table 9.51 Meter Identification Attribute Sets

Attribute Set Identifier	Description
0x000	Meter Identification
0x001-0xfff	Reserved

9.8.3.2 Meter Identification Attribute Set

Meter Identification attribute set contains the attributes summarized in Table 9.52.

Table 9.52 Attributes of the Meter Identification Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x0000	*CompanyName*	Character String	0 to 16 Octets	Read only	-	M	No
0x0001	*Meter Type ID*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	-	M	No
0x0004	*Data Quality ID*	Unsigned 16-bit integer	0x0000 – 0xffff	Read only	-	M	No
0x0005	*Customer Name*	Character String	0 to 16 Octets	Read / Write	-	O	No
0x0006	*Model*	Octet String	0 to 16 Octets	Read only	-	O	No
0x0007	*PartNumber*	Octet String	0 to 16 Octets	Read only	-	O	No
0x0008	*ProductRevision*	Octet String	0 to 6 Octets	Read only	-	O	No
0x000A	*SoftwareRevision*	Octet String	0 to 6 Octets	Read only	-	O	No
0x000B	*Utility Name*	Character String	0 to 16 Octets	Read only	-	O	No

Table 9.52 Attributes of the Meter Identification Attribute Set (Continued)

Identifier	Name	Type	Range	Access	Default	M/O	Reportable
0x000C	*POD*	Character String	0 to 16 Octets	Read only	-	M	No
0x000D	*Available Power*	Signed 24-bit integer	0x000000 to 0xffffff	Read only	-	M	No
0x000E	*Power Threshold*	Signed 24-bit integer	0x000000 to 0xffffff	Read only	-	M	No

9.8.3.3 CompanyName Attribute

CompanyName is a ZCL Octet String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. Company Name defines the meter manufacturer name, decided by manufacturer.

9.8.3.4 MeterTypeID Attribute

MeterTypeID defines the Meter installation features, decided by manufacturer. Table 9.53 provides Meter Type IDs field content.

Table 9.53 Meter Type IDs

Device	Meter Type ID
Utility Primary Meter	0x0000
Utility Production Meter	0x0001
Utility Secondary Meter	0x0002
Private Primary Meter	0x0100
Private Production Meter	0x0101
Private Secondary Meters	0x0102
Generic Meter	0x0110

9.8.3.5 DataQualityID Attribute

DataQualityID defines the Meter Simple Metering information certification type, decided by manufacturer.

Table 9.54 provides Data Quality IDs field content.

Table 9.54 Data Quality IDs

Device	Meter Type ID
All Data Certified	0x0000
Only Instantaneous Power not Certified	0x0001
Only Cumulated Consumption not Certified	0x0002
Not Certified data	0x0003

9.8.3.6 CustomerName Attribute

CustomerName is a ZCL Character String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the ASCII format.

9.8.3.7 Model Attribute

Model is a ZCL Octet String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. *Model* defines the meter model name, decided by manufacturer.

9.8.3.8 PartNumber Attribute

PartNumber is a ZCL Octet String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the UTF-8 format. *PartNumber* defines the meter part number, decided by manufacturer.

9.8.3.9 ProductRevision Attribute

ProductRevision is a ZCL Octet String field capable of storing up to 6 character string (the first Octet indicates length) encoded in the UTF-8 format. *ProductRevision* defines the meter revision code, decided by manufacturer.

9.8.3.10 SoftwareRevision Attribute

SoftwareRevision is a ZCL Octet String field capable of storing up to 6 character string (the first Octet indicates length) encoded in the UTF-8 format. *SoftwareRevision* defines the meter software revision code, decided by manufacturer.

9.8.3.11 UtilityName Attribute

UtilityName is a ZCL Character String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the ASCII format.

9.8.3.12 POD Attribute

POD (Point of Delivery) is a ZCL Character String field capable of storing up to 16 character string (the first Octet indicates length) encoded in the ASCII format. POD is the unique identification ID of the premise connection point. It is also a contractual information known by the clients and indicated in the bill.

9.8.3.13 AvailablePower

AvailablePower represents the *InstantaneousDemand* that can be distributed to the customer (e.g., 3.3KW power) without any risk of overload. The *Available Power* shall use the same formatting conventions as the one used in the simple metering cluster formatting attribute set for the *InstantaneousDemand* attribute, i.e. the *UnitOfMeasure* and *DemandFormatting*.

9.8.3.14 PowerThreshold

PowerThreshold represents a threshold of *InstantaneousDemand* distributed to the customer (e.g., 4.191KW) that will lead to an imminent risk of overload. The *PowerThreshold* shall use the same formatting conventions as the one used in the *AvailablePower* attributes and therefore in the simple metering cluster formatting attribute set for the *InstantaneousDemand* attribute, i.e. the *UnitOfMeasure* and *DemandFormatting*.

9.8.3.15 Commands Received

No cluster-specific commands are received by the server.

9.8.3.16 Commands Generated

No cluster-specific commands are generated by the server.

9.8.4 Client

9.8.4.1 Attributes

The Client has no attributes.

9.8.4.2 Commands Received

No cluster-specific commands are received by the client.

9.8.4.3 Commands Generated

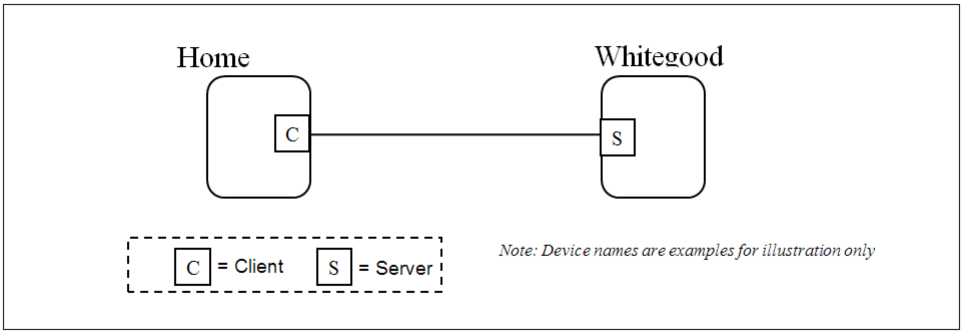
No cluster-specific commands are generated by the client.

9.9 EN50523 Appliance Events and Alerts Cluster

9.9.1 Overview

Attributes and commands for transmitting or notifying the occurrence of an event, such as “temperature reached” and of an alert such as alarm, fault or warning.

It is based on the “Signal event” syntax of EN50523 and completed where necessary.



Note: Device names are examples for illustration only

Figure 9.39 Typical Usage of this Cluster

There are two different types of occurrences: events and alerts.

Each event is described through two fields:

- An event header
- An event identification value;

The server notifies the client about the event occurred. There is no possibility for the client to get the event from the server and to have a response.

Each alert is described through three fields:

- An alert identification value;
- A category: either WARNING, DANGER, or FAILURE.
- A presence/recovery flag, either the alert has been detected or the alert has been recovered.

The server notifies the client regarding the alerts occurred. The client can also request the alerts from the server and receive the related response.

9.9.2 Server

9.9.2.1 Dependencies

None.

9.9.2.2 Attributes

None.

9.9.2.3 Commands Received

The received command IDs for the Appliance Events and Alerts Cluster are listed in Table 9.55.

Table 9.55 Received Commands IDs for the Events and Alerts Cluster

Command Identifier Field Value	Description	Mandatory/Optional
0x00	Get Alerts	M
0x01-0xff	Reserved	-

9.9.2.3.1 Get Alerts Command

This basic message is used to retrieve Household Appliance current alerts.

9.9.2.3.1.1 Payload Format

This command does not have a payload.

9.9.2.3.1.2 Effects on Receipt

On receipt of this command, the device shall generate a Get Alerts Response command.

9.9.2.4 Commands Generated

The generated command IDs for the Appliance Events and Alerts Cluster are listed in Table 9.56.

Table 9.56 Generated Commands IDs for the Appliance Events and Alerts Cluster

Command Identifier Field Value	Description	Mandatory/Optional
0x00	Get Alerts Response	M
0x01	Alerts Notification	M
0x02	Event Notification	M
0x03 – 0xff	Reserved	-

9.9.2.4.1 Get Alerts Response Command

This message is used to return household appliance current alerts.

9.9.2.4.1.1 Payload Format

The payload shall be formatted as illustrated in Figure 9.40.

Octets	1	3	...	3
Data Type	Unsigned 8-bit integer	Unsigned 24-bit integer	...	Unsigned 24-bit integer
Field Name	Alerts Count[a]	Alert structure 1	...	Alert structure *n*

[a] Even if the *ApplianceAlertList* array number of element field is 16-bit in length, the actual content is limited to 0x000*n*, where, in actual implementations, n is lower than 255 (except for the invalid condition, 0xffff). Then, the notification of the Alert count is mapped to a single byte (following appliance interworking specifications).

Figure 9.40 Format of the Get Alerts Response Command Payload

9.9.2.4.1.1.1 Payload Details

The **Alerts Count** field: the data field is a 8 bits in length unsigned integer, containing the following alerts structures count and alert structure type.

Table 9.57 provides details about Alerts Count and Structure field organization.

Table 9.57 Alert Count Organization

Bit range	Function	
0..3	Number of Alerts n.	
4..7	Type of alert.	
	Value	**Enumeration**
	0x0	UNSTRUCTURED
	0x1..0xf	Reserved

Each **Alerts Structure** field shall be formatted as illustrated in Table 9.58.

Table 9.58 Alerts Structure Organization

Bit range	Function	
0..7	Alert id	
8..11	Category	
	Value	**Enumeration**
	0x0	Reserved
	0x1	WARNING
	0x2	DANGER
	0x3	FAILURE
	0x4 – 0xf	Reserved
12..13	Presence recovery	
	Value	**Enumeration**
	0x0	RECOVERY
	0x1	PRESENCE
	0x2 – 0x3	Reserved
14..15	Reserved (set to 0x0)	
16..23	Non-standardised or proprietary	

The **Alert ID** field can have the following values:

- Value 0 is reserved.
- Values ranging from 1 to 63 are standardised.
- Values ranging from 64 to 127 are non-standardised.
- Values ranging from 128 to 255 are proprietary.

9.9.2.4.1.2 Effects on Receipt

On receipt of this command, the device is informed of a Household Appliance warning and fault occurrence.

9.9.2.4.2 Alerts Notification Command

This message is used to notify the current modification of warning and/or fault conditions.

9.9.2.4.2.1 Payload Format

The payload shall be formatted as illustrated in Figure 9.41.

Octets	1	3	...	3
Data Type	Unsigned 8-bit integer	Unsigned 24-bit integer	...	Unsigned 24-bit integer
Field Name	Alerts Count	Alert structure 1	...	Alert structure *n*

Figure 9.41 Format of the Alerts Notification Command Payload

9.9.2.4.2.1.1 Payload Details

See Get Alert Response command.

9.9.2.4.2.2 Effects on Receipt

On receipt of this command, the device is informed of a Household Appliance warning and fault occurrence.

9.9.2.4.3 Event Notification Command

This message is used to notify an event occurred during the normal working of the appliance.

9.9.2.4.3.1 Payload Format

The payload shall be formatted as illustrated in Figure 9.42.

Octets	1	1
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer
Field Name	Event Header	Event Identification

Figure 9.42 Format of the Event Notification Command Payload

9.9.2.4.3.1.1 Payload Details

The **Event Header** is a reserved field set to 0.

The **Event Identification** field: the event identification is an 8-bits in length field identifying the event to be notified. The codes used for this field shall match those shown in Table 9.59 and use the following rules:

- Values ranging from 0 to 63 are standardised.
- Values ranging from 64 to 127 are non-standardised.
- Values ranging from 128 to 255 are proprietary, except from value 0xf7.

Table 9.59 Event Identification

Event Identification	Value	Description
END_OF_CYCLE	0x01	End of the working cycle reached
Reserved	0x02	
Reserved	0x03	
TEMPERATURE_REACHED	0x04	Set Temperature Reached
END_OF_COOKING	0x05	End of cooking process
SWITCHING OFF	0x06	
WRONG_DATA	0xf7	

9.9.2.4.3.2 Effects on Receipt

On receipt of this command, the device is informed of a Household Appliance working event occurrence.

9.9.3 Client

9.9.3.1 Dependencies

None.

9.9.3.2 Attributes

The Client cluster has no attributes.

9.9.3.3 Commands Received

The client side of this cluster receives the cluster-specific commands generated by the server.

9.9.3.4 Commands Generated

The client side of this cluster generates the cluster-specific commands received by the server as required by the application.

9.10 Appliance Statistics Cluster

9.10.1 Overview

This cluster provides a mechanism for the transmitting appliance statistics to a collection unit (gateway). The statistics can be in format of data logs. In case of statistic information that will not fit the single ZigBee payload, the Partition cluster should be used.

9.10.2 Server

9.10.2.1 Attributes

The server side of this cluster contains the following attributes the statistics and log information.

Table 9.60 Server Attributes

Identifier	Description	Type	Read/Write	M/O	Reportable	Default
0x0000	*LogMaxSize*	Unsigned 32-bit integer	Read	M	No	0x0000003C
0x0001	*LogQueueMax Size*	Unsigned 8-bit integer	Read	M	No	0x01

9.10.2.1.1 LogMaxSize Attribute

The *LogMaxSize* attribute describes the maximum size of a log payload that can be transferred using the Log Notification and Log Response commands. In case the *LogMaxSize* attribute is greater than 70 bytes (0x46) the Appliance Statistics commands should be transferred using the partition cluster. This is the case of a “bulk log” transferred from a server side (e.g., White Goods) to a client side (e.g., home gateway) of the Appliance Statistics Cluster.

9.10.2.1.2 LogQueueMaxSize Attribute

The *LogQueueMaxSize* attribute describes the maximum number of logs that are available in the server side of the Appliance Statistics cluster. The logs may be retrieved by the client using the Log Request command.

9.10.2.2 Commands

Table 9.61 Commands Generated by the Appliance Statistics Server

Command ID	Description	Mandatory/ Optional
0x00	Log Notification	M
0x01	Log Response	M
0x02	Log Queue Response	M
0x03	Statistics Available	M

9.10.2.2.1 Log Notification

The Appliance Statistics Cluster server occasionally sends out a Log Notification command to the devices to which it needs to log information related to statistics (e.g., home gateways) which implement the client side of Appliance Statistics Cluster.

9.10.2.2.1.1 Payload Format

Octets	4	4	4	1	…	1
Data Type	UTCTime	Unsigned 32-bit integer	Unsigned 32-bit integer	8-bit data	8-bit data	8-bit data
Field Name	Time Stamp	Log ID	Log Length	Log Payload		

Figure 9.43 Format of the Log Notification Payload

9.10.2.2.1.2 When Generated

The Log Notification command is generated when the appliance needs to send log information related to its statistics to a remote device (e.g., home gateway) without being solicited by the client side. The log information sent with the Log Notification command from the server side is not solicited by specific command generated by the client side of the Appliance Statistics cluster. The Log ID field identifies uniquely the log information contained in the log payload. Log Length field indicated the length in bytes of the log payload and shall be less than *Log MaxSize* attribute.

If the device generating the Log Notification command is not able to generate the time stamp information it shall insert an invalid UTC Time (0xffffffff). In this case the server side of the Appliance statistics cluster (e.g., a home gateway) should insert a timestamp of the received log notification if available before storing or transmitting the log information to backend systems.

9.10.2.2.1.3 Effect Upon Receipt

Upon receipt of the Log Notification command, the Appliance statistics client will respond with a Default Response command if requested or if an error occurs. In case of error the server side of Appliance statistics cluster may store the information in the queue and notify the client that there are statistics available by using the Statistic Available command.

9.10.2.2.2 Log Response

The Appliance Statistics Cluster server sends out a Log Response command to respond to a Log Request command generated by the client side of the Appliance Statistics cluster.

9.10.2.2.2.1 Payload Format

The payload of the Log Response command is the same as the Log Notification command.

9.10.2.2.2.2 When Generated

The Log Response command is generated to respond to Log Request sent from a device supporting the client side of the Appliance Statistics cluster (e.g., home gateway).

9.10.2.2.2.3 Effect Upon Receipt

Upon receipt of the Log Response command, the Appliance statistics client will respond with a Default Response command if requested or if an error occurs.

9.10.2.2.3 Log Queue Response

The Log Queue Reponse command is generated as a response to a Log Queue Request command in order to notify the client side of the Appliance statistics cluster about the logs stored in the server side (queue) that can be retrieved by the client side of this cluster through a Log Request command. Please note that the LogQueueSize field shall be less than the *LogQueueMaxSize* attribute.

9.10.2.2.3.1 Payload Format

Octets	1	4	4	4
Data Type	Unsigned 8-bit integer	Unsigned 32-bit integer	…	Unsigned 32-bit integer
Field Name	Log Queue Size	Log ID	…	Log ID

Figure 9.44 Format of the Log Queue Response Payload

9.10.2.2.3.2 When Generated

The Log Queue Response command is generated to respond to Log Queue Request sent from a device supporting the client side of the Appliance Statistics cluster (e.g., home gateway) to discover the logs that can be currently read through Log Request command. Please note that if Log Queue Size is equal to zero (not logs in the queue), the packet shall not carry Log IDs.

9.10.2.2.3.3 Effect Upon Receipt

Upon receipt of the Log Queue Response command, the Appliance statistics client will respond with a Default Response command if requested or if an error occurs. The client side of the appliance statistics willing to get the logs in the queue shall then use only the Log IDs that have been indicated in the Log Queue Response.

9.10.2.2.4 Statistics Available

The Appliance Statistics Cluster server sends out a Statistic Available command to notify the client side of the Appliance Statistics cluster that there are statistics that can be retrieved by using the Log Request command.

9.10.2.2.4.1 Payload Format

The Statistic Available command is the same as the Log Queue Response command. The Log IDs that can be retrieved by the client are indicated in the payload.

9.10.2.2.4.2 When Generated

The Statistic Available command is generated to notify a device supporting the client side of the Appliance Statistics cluster (e.g., home gateway) to get the statistics information from the log queue as soon as available to perform this operation.

9.10.2.2.4.3 Effect Upon Receipt

Upon receipt of the Statistic Available command, the client side of the Appliance Statistics cluster is notified on the availability of statistics in the server side that can be retrieved by using Log Request commands.

The Appliance statistics client will respond with a Default Response command if requested or if an error occurs.

9.10.3 Client

9.10.3.1 Attributes

There are no attributes on the client side of the Appliance Statistics Cluster.

9.10.3.2 Commands

Table 9.62 Commands Generated by the Appliance Statistics Client

Command ID	Description	Mandatory/ Optional
0x00	Log Request	M
0x01	Log Queue Request	M

9.10.3.2.1 Log Request

The Log Request command is send from a device supporting the client side of the Appliance Statistics cluster (e.g., Home Gateway) to retrieve the log from the device supporting the server side (e.g., appliance).

9.10.3.2.1.1 Payload Format

Octets	4
Data Type	Unsigned 32-bit integer
Field Name	Log ID

Figure 9.45 Format of the Log Request Payload

9.10.3.2.1.2 When Generated

The Log Request command is generated to retrieve a log information from a device supporting the server side of the Appliance Statistics cluster (e.g., appliance). The log information is addressed by referencing it with the Log ID field. In order to get the Log ID that can be retrieved with the Log Request command, the Log Queue Request command may be used.

9.10.3.2.1.3 Effect Upon Receipt

Upon receipt of the Log Request command, the Appliance statistics server will respond with a Log Response command if the log is available or with a Default Response if an error occurs. In case the Log ID is not available in the server side of the cluster the status code carried by the Default Response shall be “ NOT_FOUND”.

9.10.3.2.2 Log Queue Request

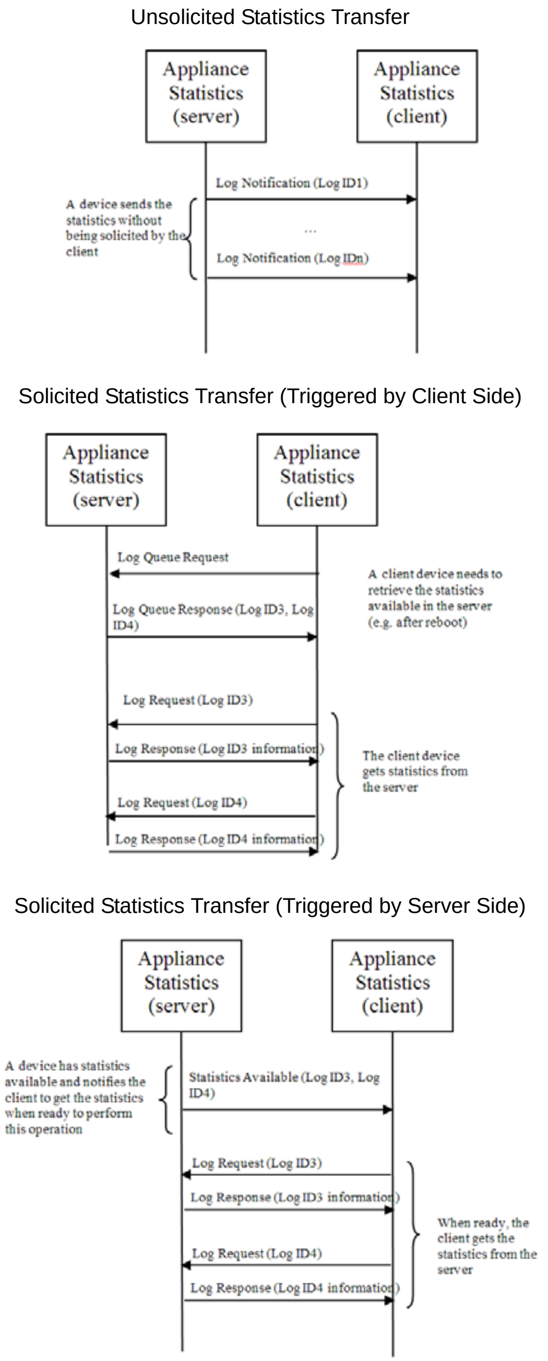
The Log Queue Request command is send from a device supporting the client side of the Appliance Statistics cluster (e.g. Home Gateway) to retrieve the information about the logs inserted in the queue, from the device supporting the server side (e.g. appliance).

9.10.3.2.2.1 Payload Format

The Log Queue Request command has no payload.

9.10.4 Appliance Statistics Cluster Sequence Diagram

Figure 9.46 shows a typical sequence interaction between the client and server sides of the Appliance Statistics Cluster.



Unsolicited Statistics Transfer

Appliance Statistics (server)
Appliance Statistics (client)
Log Notification (Log ID1)
...
Log Notification (Log IDn)
A device sends the statistics without being solicited by the client

Solicited Statistics Transfer (Triggered by Client Side)

Appliance Statistics (server)
Appliance Statistics (client)
Log Queue Request
Log Queue Response (Log ID3, Log ID4)
A client device needs to retrieve the statistics available in the server (e.g. after reboot)
Log Request (Log ID3)
Log Response (Log ID3 information)
Log Request (Log ID4)
Log Response (Log ID4 information)
The client device gets statistics from the server

Solicited Statistics Transfer (Triggered by Server Side)

Appliance Statistics (server)
Appliance Statistics (client)
A device has statistics available and notifies the client to get the statistics when ready to perform this operation
Statistics Available (Log ID3, Log ID4)
Log Request (Log ID3)
Log Response (Log ID3 information)
Log Request (Log ID4)
Log Response (Log ID4 information)
When ready, the client gets the statistics from the server

Figure 9.46 Appliance Statistics Cluster Sequence Diagram

CHAPTER 10

HOME AUTOMATION, ZCL CLUSTER EXTENSIONS

10.1 Door Lock Cluster Extensions

This section describes the recommended practices for Home Automation Door Lock Cluster extensions.

10.1.1 Door Lock Cluster

The door lock cluster provides an interface into a generic way to secure a door. The physical object that provides the locking functionality is abstracted from the cluster. The cluster has a small list of mandatory attributes and functions and a list of optional features.

10.1.2 Server

Generally the door lock itself implements the server side of this cluster. The attributes and commands listed in this cluster were developed to be implemented by a door lock which has the ability to keep track of multiple users and schedules.

10.1.2.1 Alarms, Reports and Events

A door lock implementing all of the optional features provided in this cluster has the ability to push data to a controller in three different forms, Alarms, Reports and Events. Alarms are used to report critical states on the door lock. Reports are used to inform a subscribed device of changes of state in specific attributes on the lock. Events are used to inform a bound device about changes in state related to the operation and programming of the door lock. Event commands are sent to a binding. Examples of events are locking and unlocking the lock and adding or deleting a user on the lock.

10.1.2.1.1 Alarms

The door lock cluster provides several alarms which can be sent when there is a critical state on the door lock. The alarms available for the door lock cluster are listed in the section below outlining the alarm mask attribute. The Alarm cluster is used to generate the actual alarms.

Alarm example: If the first bit of the attribute Alarm Mask is set, any device that is bound to the alarm cluster will be informed each time the deadbolt becomes jammed. If for some reason the door lock became jammed, the door lock would send an alarm command from the alarms cluster with the payload:

Octets	1	2
Data Type	8-bit enumeration	Cluster ID
Field Name	Alarm Code	Cluster Identifier
Field Value	0x00	0x0101

Figure 10.1 Format of the Alarm Cluster

10.1.2.1.2 Reports

The reporting mechanism within the ZCL can be used to subscribe to changes in a specific attribute within the door lock.

Report example: If a coordinator wants to know each time a programming change is made on the door lock, it can use the reporting mechanism to be informed of changes to the Operating Mode attribute. Each time the Operating Mode changes to programming mode, the coordinator will be informed and can then sync its knowledge of user data to make sure that it has an up to date record of user the users supported on the door lock.

10.1.2.1.3 Events

The event mechanism described within this document is unique to the Door Lock Cluster and was designed specifically for this cluster and no other. It is in part modeled on similar mechanisms in other clusters such as the load control events in the Demand Response and Load Control cluster in Smart Energy (DRLC).

The event mechanism in the door lock centers on the transmission of two commands autonomously generated by the server and sent to a bound device. The assumption is that the binding mechanism will be used to commission the server to send these commands.

There are two types of events on the door lock, operational and programmatic. Operational events relate to the general operation of the door lock, when it locks and unlocks for instance. The programmatic events relate to the programming of the door lock, for example when users are added or modified via the keypad.

Events are transmitted using two server commands, the Operation Event Notification Command and Programming Event Notification Command.

A primary key uniquely identifies each event. The key consists of the event's type (operation, programming etc…), source (keypad, RF, manual, etc…) and event code. The event mask bit that matches its type, source and event code controls the generation of each event. A complete list of events is included in the description of their commands along with the specific attribute and bit that control their generation.

10.1.2.2 Door Lock Security

The following functionality has not been validated at a Specification Validation Event and is therefore considered provisional.

Door locks have the ability to require the use of APS encryption for sending and receiving of all cluster messages. The Security Level attribute is used to specify the type of encryption required by the door lock.

The APS key MUST be unique to the door lock device in order to provide the enhanced security needed. Therefore, if APS security setting is selected, the device SHALL use a randomly generated install code to generate the unique APS link key to join to the network and use this unique APS link key to encryption all Door Lock Cluster, Group Cluster, Scene Cluster messages.

The hashing method used to convert install code into APS link key is AES-MMO.

It SHOULD be noted that in order for the device with unique APS link key to join successfully to the network, the Trust Centre (e.g., network coordinator) will need to have a method for the user/installer to input the unique install code for the device.

It should be note that the ZigBee security setting will only take effect when the device is not part of a network. If the user modifies the ZigBee Security Level setting while the device is part of a network, the setting will not be applied until the device leaves the network and commissions to a network again.

10.1.2.3 ZigBee Time

There are various references to the ZigBee LocalTime within this cluster specification.

ZigBee LocalTime (32-bit unsigned integer) represents the number of seconds since January 1 2000, in the local zone with time saving adjusted.

10.1.2.4 PIN/RFID Code Format

The PIN/RFID codes defined in this specification are all in ZCL OCTET STRING format. The first octet in the string specifies the number of octets contained in the remaining of the data field not including itself.

All value in the PIN/RFID code SHALL be ASCII encoded regardless if the PIN/ RFID codes are number or characters. For example, code of “1, 2, 3, 4” SHALL be represented as 0x31, 0x32, 0x33, 0x34.

10.1.2.5 Process for Creating a New User with Schedule

The following is the process that the client device SHALL follow for creating a new user with weekday schedule or yearday schedule. The following process should be implemented as an atomic set and should not be broken up.

1. Set Pin Code
2. Set Weekday Schedule or Set Yearday Schedule
3. Set User Type to the desired schedule user type.

10.1.2.6 Process for Clearing All Schedules for a User

The following is the process that the client device SHALL follow for clearing all weekday schedule or all yearday schedule for a user. The following process should be implemented as an atomic set and should not be broken up.

1. Clear All Weekday Schedule or Clear All Yearday Schedule
2. Set User Type to the Unrestricted User Type

Note: If the User Type is not reset to Unrestricted User, the associated user Code (ex: PIN/RFID) will not have access.

10.1.2.7 Clarification of Changing the User Type

When the user type is changed from a scheduled user to some other user type, the door lock server MAY remove the user's schedule.

10.1.2.8 Clarification for Changing the User Code

When changing the user code, the server SHALL not require that the user code be removed first. [2]

[2] CCB 1772

10.1.2.9 Server Attributes

For convenience, the attributes defined in this specification are arranged into sets of related attributes; each set can contain up to 16 attributes. Attribute identifiers are encoded such that the most significant three nibbles specify the attribute set and the least significant nibble specifies the attribute within the set. The currently defined attribute sets for Door Lock Cluster Server are listed in Table 10.1

Table 10.1 Attribute Sets Description

Attribute Set	Identifier Description
0x0000 – 0x000F	Basic Information Attribute Set
0x0010 – 0x001F	User, PIN, Schedule Information Attribute Set
0x0020 – 0x002F	Operational Settings Attribute Set
0x0030 – 0x003F	Security Settings Attribute Set
0x0040 – 0x004F	Alarm and Event Masks Attribute Set
0x0050 – 0x7FFF	Reserved
0x8000 – 0xFFFF	Reserved for vendor-specific attributes

Attribute within this cluster MAY contain one of the following symbols:

- **Read Only:** Readable, but not writeable
- **Read/Write:** Readable and writable
- **Read*Write:** Readable and Optionally Writable. The ability to write to this attribute is not mandatory but is determined by the vendor supplying the product. If not writable, a READ_ONLY error is returned for any write attempt.

10.1.2.10 Basic Information Attribute Set

Table 10.2 Current Information Attribute Set

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0000Lock State– No change as defined by [B2]						
0x0001	LockType	No change as defined by [B2]				
0x0002	ActuatorEnabled	No change as defined by [B2]				
0x0003	DoorState	No change as defined by [B2]				
0x0004	DoorOpenEvents	No change as defined by [B2]				

Table 10.2 Current Information Attribute Set (Continued)

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0005	DoorClosedEvents	No change as defined by [B2]				
0x0006	OpenPeriod	No change as defined by [B2]				
0x0007 - 0x000F	Reserved					

10.1.2.10.1 LockState Attribute

No change as defined by [B2]

10.1.2.10.2 LockType Attribute

Lock type is indicated by an enumeration:

0x00	Dead bolt (no change as defined by [B2])
0x01	Magnetic (no change as defined by [B2])
0x02	Other (no change as defined by [B2])
0x03	Mortise
0x04	Rim
0x05	Latch Bolt
0x06	Cylindrical Lock
0x07	Tubular Lock
0x08	Interconnected Lock
0x09	Dead Latch
0x0A	Door Furniture
0x0B – 0xff	Reserved

10.1.2.10.3 ActuatorEnabled Attribute

No change as defined by [B2]

10.1.2.10.4 DoorState Attribute

No change as defined by [B2]

10.1.2.10.5 DoorOpenEvents Attribute

No change as defined by [B2]

10.1.2.10.6 DoorCloseEvents Attribute

No change as defined by [B2]

10.1.2.10.7 OpenPeriod Attribute

No change as defined by [B2]

10.1.2.11 User, PIN, Schedule, Log Information Attribute Set

Table 10.3 User, PIN, Schedule, Log Information Attribute Set

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0010	Number of Log Records Supported	Unsigned 16-bit integer	Read Only	O	No	0
0x0011	Number of Total Users Supported	Unsigned 16-bit integer	Read Only	O	No	0
0x0012	Number of PIN Users Supported	Unsigned 16-bit integer	Read Only	O	No	0
0x0013	Number of RFID Users Supported	Unsigned 16-bit integer	Read Only	O	No	0
0x0014	Number of Week Day Schedules Supported Per User	Unsigned 8-bit integer	Read Only	O	No	0
0x0015	Number of Year Day Schedules Supported Per User	Unsigned 8-bit integer	Read Only	O	No	0
0x0016	Number of Holiday Schedules Supported	Unsigned 8-bit integer	Read Only	O	No	0
0x0017	Max PIN Code Length	Unsigned 8-bit integer	Read Only	O	No	0x08
0x0018	Min PIN Code Length	Unsigned 8-bit integer	Read Only	O	No	0x04
0x0019	Max RFID Code Length	Unsigned 8-bit integer	Read Only	O	No	0x14
0x001A	Min RFID Code Length	Unsigned 8-bit integer	Read Only	O	No	0x08

Table 10.3 User, PIN, Schedule, Log Information Attribute Set (Continued)

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x001B - 0x001F	Reserved					

10.1.2.11.1 NumberOfLogRecordsSupported Attribute

The number of available log records.

10.1.2.11.2 NumberOfTotalUsersSupported Attribute

Number of total users supported by the lock. This value is equal to the higher one of [# of PIN Users Supported] and [# of RFID Users Supported]

10.1.2.11.3 NumberOfPINUsersSupported Attribute

The number of PIN users supported.

10.1.2.11.4 NumberOfRFIDUsersSupported Attribute

The number of RFID users supported.

10.1.2.11.5 NumberOfWeekDaySchedulesSupportedPerUser Attribute

The number of configurable week day schedule supported per user.

10.1.2.11.6 NumberOfYearDaySchedulesSupportedPerUser Attribute

The number of configurable year day schedule supported per user.

10.1.2.11.7 NumberOfHolidaySchedulesSupported Attribute

The number of holiday schedules supported for the entire door lock device.

10.1.2.11.8 MaxPINCodeLength Attribute

An 8 bit value indicates the maximum length in bytes of a PIN Code on this device. The default is set to 8 since most lock manufacturers currently allow PIN Codes of 8 bytes or less.

10.1.2.11.9 MinPINCodeLength Attribute

An 8 bit value indicates the minimum length in bytes of a PIN Code on this device. The default is set to 4 since most lock manufacturers do not support PIN Codes that are shorter than 4 bytes.

10.1.2.11.10 MaxRFIDCodeLength Attribute

An 8 bit value indicates the maximum length in bytes of a RFID Code on this device. The value depends on the RFID code range specified by the manufacturer, if media anti-collision identifiers (UID) are used as RFID code, a value of 20 (equals 10 Byte ISO 14443A UID) is recommended.

10.1.2.11.11 MinRFIDCodeLength Attribute

An 8 bit value indicates the minimum length in bytes of a RFID Code on this device. The value depends on the RFID code range specified by the manufacturer, if media anti-collision identifiers (UID) are used as RFID code, a value of 8 (equals 4 Byte ISO 14443A UID) is recommended.

10.1.2.12 Operational Settings Attribute Set

The attributes within this attribute set affect the physical behaviour on the server device. Some of the setting might not be applicable to the specific device. When the client sends the write attribute request with values that are not applicable to the server device, the server shall send back a Write Attribute Response with error status not equal to ZCL_SUCCESS(0x00). It is suggested that it should respond with a error status of ZCL_INVALID_VALUE (0x87).

Table 10.4 Operational Settings Attribute Set

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0020	Enable Logging	Boolean	Read * Write	O	Yes	0
0x0021	Language	String(3bytes)	Read * Write	O	Yes	0
0x0022	LED Settings	Unsigned 8-bit integer	Read * Write	O	Yes	0
0x0023	Auto Relock Time	Unsigned 32-bit integer	Read * Write	O	Yes	0
0x0024	Sound Volume	Unsigned 8-bit integer	Read * Write	O	Yes	0
0x0025	Operating Mode	8-bit enumeration	Read * Write	O	Yes	0
0x0026	Supported Operating Modes	Bitmap16	Read Only	O	No	0x0001
0x0027	Default Configuration Register	Bitmap16	Read Only	O	Yes	0x00
0x0028	Enable Local Programming	Boolean	Read * Write	O	Yes	0x01
0x0029	Enable One Touch Locking	Boolean	Read / Write	O	Yes	0
0x002A	Enable Inside Status LED	Boolean	Read / Write	O	Yes	0
0x002B	Enable Privacy Mode Button	Boolean	Read / Write	O	Yes	0

Table 10.4 Operational Settings Attribute Set (Continued)

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x002C - 0x002F	Reserved					

10.1.2.12.1 EnableLogging Attribute

Enable/disable event logging. When event logging is enabled, all event messages are stored on the lock for retrieval. Logging events can be but not limited to Tamper Alarm, Lock, Unlock, Autolock, User Code Added, User Code Deleted, Schedule Added, and Schedule Deleted. For a full detail of all the possible alarms and events, please refer to the full list in the Alarm and Event Masks Attribute Set.

10.1.2.12.2 Language Attribute

Modifies the language for the on-screen or audible user interface using three bytes from ISO-639-1. It consists of one byte of length and two bytes for the language code. For example if the language is set to English, the value would be "02 65 6E" for the language code "en".

10.1.2.12.3 OperatingMode Attribute

Table 10.5 shows the current operating mode and which interfaces are enabled during each of the operating mode:

Table 10.5 Operating Modes

Enum	Operating Mode	Interface (E = Enabled; D = Disabled)		
		Keypad	RF	RFID
0x00	Normal	E	E	E
0x01	Vacation	D	E	E
0x02	Privacy	D	D	D
0x03	No RF Lock/Unlock	E	D	E
0x04	Passage	N/A	N/A	N/A

Normal Mode: The lock operates normally. All interfaces are enabled.

Vacation Mode: Only RF interaction is enabled. The keypad cannot be operated.

Privacy Mode: All external interaction with the door lock is disabled. This is intended so that users presumably inside the property will have control over the entrance. Privacy mode assumes that the lock can only be operated from inside by operating the thumb turn or some other means of ending privacy mode.

No RF Lock or Unlock: This mode only disables RF interaction with the lock. It specifically applies to the Lock, Unlock, Toggle & Unlock with Timeout Commands.

Passage Mode: The lock is open or can be open or closed at will without the use of a Keypad or other means of user validation.

Note: For modes that disable the RF interface, the door lock shall respond to Lock, Unlock, Toggle, and Unlock with Timeout commands with a ZCL response of ZCL_GENERAL_FAILURE (0x01) and not take the action requested by those commands. The door lock SHALL NOT disable the radio or otherwise unbind or leave the network. It shall still respond to all other commands and requests.

10.1.2.12.4 SupportedOperatingModes Attribute

This bitmap contains all operating bits of the Operating Mode Attribute supported by the lock. The value of the enumeration in “Operating Mode” defines the related bit to be set. All bits supported by a lock SHALL be set to zero.

Bitmap Number	Description
0	Normal Mode Supported
1	Vacation Mode Supported
2	Privacy Mode Supported
3	No RF Lock or Unlock Mode Supported
4	Passage Mode Supported

10.1.2.12.5 LEDSettings Attribute

The settings for the LED support three different modes:

0x00	Never use LED for signalization
0x01	Use LED signalization except for access allowed events
0x02	Use LED signalization for all events

10.1.2.12.6 AutoRelockTime Attribute

The number of seconds to wait after unlocking a lock before it automatically locks again. 0=disabled. .If set, unlock operations from any source will be timed. For one time unlock with timeout use the specific command.

10.1.2.12.7 SoundVolume Attribute

The sound volume on a door lock has three possible settings: silent, low and high volumes.

0x00	Silent Mode
0x01	Low Volume
0x02	High Volume

10.1.2.12.8 DefaultConfigurationRegister Attribute

This attribute represents the default configuration as they are physically set on the device (example: hardware dip switch setting, etc…) and represents the default setting for some of the attributes within this Operational Setting Attribute Set (for example: LED, Auto Lock, Sound Volume, and Operating Mode attributes).

This is a read-only attribute and is intended to allow clients to determine what changes may need to be made without having to query all the included attributes. It may be beneficial for the clients to know what the device's original settings were in the event that the device needs to be restored to factory default settings.

If the Client device would like to query and modify the door lock server's operating settings, it SHOULD send read and write attribute request to the specific attributes.

For example, the Buzzer bitmap within this attribute is off. It represents the hardware dip switch Buzzer setting (original default setting) is off and the Sound Volume attribute default value is in Silent Mode. However, it is possible that the current Sound Volume is in High Volume. Therefore, if the client wants to query/ modify the current Sound Volume setting on the server, the client SHOULD read/ write to the Sound Volume attribute.

Table 10.6 DefaultConfigurationRegister Attribute

Bitmap Number	Description
0	0 - Enable Local Programming Attribute default value is 0 (disabled) 1 - Enable Local Programming Attribute default value is 1 (enabled)
1	0 –Keypad Interface default access is disabled 1 - Keypad Interface default access is enabled
2	0 - RF Interface default access is disabled 1 - RF Interface default access is enabled
3	Reserved
4	Reserved
5	0 – Sound Volume attribute default value is 0 (Slight Mode) 1 – Sound Volume attribute default value is equal to something other than 0x00

Table 10.6 DefaultConfigurationRegister Attribute

Bitmap Number	Description
6	0 – Auto Relock Time attribute default value = 0x00 1 – Auto Relock Time attribute default value is equal to something other than 0x00
7	0 – Led Settings attribute default value = 0x00 1 – Led Settings attribute default value is equal to something other than 0x00
8-15	Reserved

10.1.2.12.9 EnableLocalProgramming Attribute

Enable/disable local programming on the door lock. The local programming features includes but not limited to adding new user codes, deleting existing user codes, add new schedule, deleting existing schedule on the local door lock interfaces. If this value is set to 0x01 or TRUE then local programming is enabled on the door lock. If it is set to 0x00 or FALSE then local programming is disabled on the door lock. Local programming is enabled by default.

10.1.2.12.10 EnableOneTouchLocking Attribute

Enable/disable the ability to lock the door lock with a single touch on the door lock.

10.1.2.12.11 EnableInsideStatusLED Attribute

Enable/disable an inside LED that allows the user to see at a glance if the door is locked.

10.1.2.12.12 EnablePrivacyModeButton Attribute

Enable/disable a button inside the door that is used to put the lock into privacy mode. When the lock is in privacy mode it cannot be manipulated from the outside.

10.1.2.13 Security Settings Attribute Set

Table 10.7 Security Settings Attribute Set

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0030	Wrong code entry limit	Unsigned 8-bit integer	Read * Write	O	Yes	0
0x0031	User Code Temporary Disable Time	Unsigned 8-bit integer	Read * Write	O	Yes	0

Table 10.7 Security Settings Attribute Set (Continued)

0x0032	Send PIN over the Air	Boolean	Read * Write	O	Yes	0
0x0033	Require PIN for RF Operation	Boolean	Read * Write	O	Yes	0
0x0034	ZigBee Security Level	8-bit enumeration	Read Only	O	Yes	0
0x0035 - 0x003F	Reserved					

10.1.2.13.1 WrongCodeEntryLimit Attribute

The number of incorrect codes or RFID presentment attempts a user is allowed to enter before the door will enter a lockout state. The lockout state will be for the duration of *UserCodeTemporaryDisableTime*.

10.1.2.13.2 UserCodeTemporaryDisableTime Attribute

The number of seconds that the lock shuts down following wrong code entry. 1-255 seconds. Device can shut down to lock user out for specified amount of time. (Makes it difficult to try and guess a PIN for the device.)

10.1.2.13.3 SendPINOverTheAir Attribute

Boolean set to True if it is ok for the door lock server to send PINs over the air. This attribute determines the behavior of the server's TX operation. If it is false, then it is not ok for the device to send PIN in any messages over the air.

The PIN field within any door lock cluster message shall keep the first len byte unchange and masks the actual code by replacing with 0xFF. For example (PIN "1234"): If the attribute value is True, 0x04 0x31 0x32 0x33 0x34 shall be used in the PIN field in any door lock cluster message payload. If the attribute value is False, 0x04 0xFF 0xFF 0xFF 0xFF shall be used.

10.1.2.13.4 RequirePINForRFOperation Attribute

Boolean set to True if the door lock server requires that an optional PINs be included in the payload of RF lock operation events like Lock, Unlock and Toggle in order to function.

10.1.2.13.5 ZigBeeSecurityLevel Attribute

Door locks MAY sometimes wish to implement a higher level of security within the application protocol in additional to the default network security. For instance a door lock MAY wish to use additional APS security for cluster transactions. This protects the door lock against being controlled by any other devices which have access to the network key.

The Security Level attribute allows the door lock manufacturer to indicate what level of security the door lock requires.

There are two levels of security possible within this cluster:

- 0 = Network Security (default)
- 1 = APS Security

This attribute is read only over the ZigBee network to protect security method defined by each manufacturer.

However, manufacturer can provide method to modify the security setting locally on the device. The security setting modification will not take effect when the device is in a network.

10.1.2.14 Alarm and Event Masks Attribute Set

Table 10.8 Alarm and Event Masks Attribute Set

Attribute Identifier	Description	Type	Read/ Write	Mandatory/ Optional	Reportable	Default
0x0040	Alarm Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0041	Keypad Operation Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0042	RF Operation Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0043	Manual Operation Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0044	RFID Operation Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0045	Keypad Programming Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0046	RF Programming Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0047	RFID Programming Event Mask	Bitmap16	Read/ Write	O	Yes	0xFFFF
0x0048 - 0x004F	Reserved					

10.1.2.14.1 AlarmMask Attribute

The alarm mask is used to turn on/off alarms for particular functions. Alarms for an alarm group are enabled if the associated alarm mask bit is set. Each bit represents a group of alarms. Entire alarm groups can be turned on or off by setting or clearing the associated bit in the alarm mask.

Table 10.9 Alarm Code Table

Alarm Code	Bitmap Number	Alarm Condition
0x00	0	Deadbolt Jammed
0x01	1	Lock Reset to Factory Defaults
0x02	2	Reserved
0x03	3	RF Module Power Cycled
0x04	4	Tamper Alarm – wrong code entry limit
0x05	5	Tamper Alarm - front escutcheon removed from main
0x06	6	Forced Door Open under Door Locked Condition

10.1.2.14.2 KeypadOperationEventMask Attribute

Event mask used to turn on and off the transmission of keypad operation events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to Table 10.16.

10.1.2.14.3 RFOperationEventMask Attribute

Event mask used to turn on and off the transmission of RF operation events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to Table 10.17.

10.1.2.14.4 ManualOperationEventMask Attribute

Event mask used to turn on and off manual operation events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to Table 10.18.

10.1.2.14.5 RFIDOperationEventMask Attribute

Event mask used to turn on and off RFID operation events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to Table 10.19.

10.1.2.14.6 KeypadProgrammingEventMask Attribute

Event mask used to turn on and off keypad programming events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to Table 10.22.

10.1.2.14.7 RFProgrammingEventMask Attribute

Event mask used to turn on and off RF programming events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to RF Programming Event Value Section.

10.1.2.14.8 RFIDProgrammingEventMask Attribute

Event mask used to turn on and off RFID programming events. This mask DOES NOT apply to the storing of events in the report table.

For detail event mask value, please refer to RFID Programming Event Value Section.

10.1.2.15 Server Commands Received

Table 10.10 Commands Received by the Server Cluster

Command ID	Description	Mandatory/ Optional
0x00	Lock Door	M
0x01	Unlock Door	M
0x02	Toggle	O
0x03	Unlock with timeout	O
0x04	Get Log Record	O
0x05	Set PIN Code	O
0x06	Get PIN Code	O
0x07	Clear PIN Code	O
0x08	Clear All PIN Codes	O
0x09	Set User Status	O
0x0A	Get User Status	O
0x0B	Set Weekday Schedule	O
0x0C	Get Weekday Schedule	O
0x0D	Clear Weekday Schedule	O

Table 10.10 Commands Received by the Server Cluster (Continued)

Command ID	Description	Mandatory/ Optional
0x0E	Set Year Day Schedule	O
0x0F	Get Year Day Schedule	O
0x10	Clear Year Day Schedule	O
0x11	Set Holiday Schedule	O
0x12	Get Holiday Schedule	O
0x13	Clear Holiday Schedule	O
0x14	Set User type	O
0x15	Get User type	O
0x16	Set RFID Code	O
0x17	Get RFID Code	O
0x18	Clear RFID Code	O
0x19	Clear All RFID Codes	O
0x1A - 0xFF	Reserved	

10.1.2.15.1 Lock Door Command

This command causes the lock device to lock the door. As of HA 1.2, this command includes an optional code for the lock. The door lock MAY require a PIN depending on the value of the [Require PIN for RF Operation attribute].

Octets	Variable
Data Type	ZigBee Octet String
Field Name	PIN/RFID Code

Figure 10.2 Format of the Lock Door Command

10.1.2.15.2 Unlock Door Command

This command causes the lock device to unlock the door. As of HA 1.2, this command includes an optional code for the lock. The door lock MAY require a code depending on the value of the [Require PIN for RF Operation attribute].

Note: If the attribute *AutoRelockTime* is supported the lock will close when the auto relock time has expired.

Octets	Variable
Data Type	ZigBee Octet String
Field Name	PIN/RFID Code

Figure 10.3 Format of the Unlock Door Command

10.1.2.15.3 Toggle

Request the status of the lock. As of HA 1.2, this command includes an optional code for the lock. The door lock MAY require a code depending on the value of the [Require PIN for RF Operation attribute].

Octets	Variable
Data Type	ZigBee Octet String
Field Name	PIN/RFID Code

Figure 10.4 Format of the Toggle Command

10.1.2.15.4 Unlock with Timeout

This command causes the lock device to unlock the door with a timeout parameter. After the time in seconds specified in the timeout field, the lock device will relock itself automatically. This timeout parameter is only temporary for this message transition only and overrides the default relock time as specified in the [Auto Relock Time attribute] attribute. If the door lock device is not capable of or does not want to support temporary Relock Timeout, it SHOULD not support this optional command.

Octets	1	Variable
Data Type	Unsigned 16-bit integer	ZigBee Octet String
Field Name	Timeout in seconds	PIN/RFID Code

Figure 10.5 Format of the Unlock with Timeout Command

10.1.2.15.5 Get Log Record

Request a log record. Log number is between 1 – [Number of Log Records Supported attribute]. If log number 0 is requested then the most recent log entry is returned.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	Log Index

Log record format: The log record format is defined in the description of the GetLogRecordResponse command.

10.1.2.15.6 User Status and User Type Values

The following User Status and User Type values are used in the payload of multiple commands:

User Status

Used to indicate what the status is for a specific user ID.

Table 10.11 User Status Value

Enum	Description
0	Available
1	Occupied / Enabled
2	Reserved
3	Occupied / Disabled
0xff	Not Supported

User Type

Used to indicate what the type is for a specific user ID.

Table 10.12 User Type Value

Enum	Description
0	Unrestricted User (default)
1	Year Day Schedule User
2	Week Day Schedule User
3	Master User
4	Non Access User
0xff	Not Supported

Unrestricted

User has access 24/7 provided proper PIN is supplied (e.g., owner). Unrestricted user type is the default user type.

Year Day Schedule User

User has ability to open lock within a specific time period (e.g., guest).

Week Day Schedule User

User has ability to open lock based on specific time period within a reoccurring weekly schedule (e.g., cleaning worker).

Master User

User has ability to both program and operate the door lock. This user can manage the users and user schedules. In all other respects this user matches the unrestricted (default) user. Master user is the only user that can disable the user interface (keypad, RF, etc…).

Non Access User

User is recognized by the lock but does not have the ability to open the lock. This user will only cause the lock to generate the appropriate event notification to any bound devices.

10.1.2.15.7 Set PIN Code

Set a PIN into the lock.

Octets	2	1	1	Variable
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration	Octet String
Field Name	User ID	User Status	User Type	PIN

Figure 10.6 Format of the Set PIN Code Command

User ID is between 0 - [# of PIN Users Supported attribute]. Only the values 1 (Occupied/Enabled) and 3 (Occupied/Disabled) are allowed for User Status.

10.1.2.15.8 Get PIN Code

Retrieve a PIN Code. User ID is between 0 - [# of PIN Users Supported attribute].

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.7 Format of the Get PIN Code Command

10.1.2.15.9 Clear PIN Code

Delete a PIN. User ID is between 0 - [# of PIN Users Supported attribute].

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.8 Format of the Clear PIN Code Command

Note: If you delete a PIN Code and this user didn't have a RFID Code, the user status is set to "0 Available", the user type is set to the default value and all schedules are also set to the default values.

10.1.2.15.10 Clear All PIN Code

Clear out all PINs on the lock.

Note: On the server, the clear all PIN codes command should have the same effect as the Clear PIN Code command with respect to the setting of user status, user type and schedules.

10.1.2.15.11 Set User Status

Set the status of a user ID. User Status value of 0x00 is not allowed. In order to clear a user id, the Clear ID Command SHALL be used. For user status value please refer to User Status Value.

Octets	2	1
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer
Field Name	User ID	User Status

Figure 10.9 Format of the Set User Status Command

10.1.2.15.12 Get User Status

Get the status of a user.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.10 Format of the Get User Status Command

10.1.2.15.13 Set Week Day Schedule

Set a weekly repeating schedule for a specified user.

Octets	1	2	1	1	1	1	1
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	8-bit Bitmap	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer
Field Name	Schedule ID #	User ID	Days Mask	Start Hour	Start Minute	End Hour	End Minute

Figure 10.11 Format of the Set Week Day Schedule Command

Schedule ID: number is between 0 – [# of Week Day Schedules Per User attribute].

User ID: is between 0 – [# of Total Users Supported attribute].

Days Mask: bitmask of the effective days in the order XSFTWTMS.

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Reserved	Sat	Fri	Thur	Wed	Tue	Mon	Sun

Days mask is listed as bitmask for flexibility to set same schedule across multiple days. For the door lock that does not support setting schedule across multiple days within one command, it SHOULD respond with ZCL INVALID_FIELD (0x85) status when received the set schedule command days bitmask field has multiple days selected.

Start Hour: in decimal format represented by 0x00 – 0x17 (00 to 23 hours).

Start Minute: in decimal format represented by 0x00 – 0x3B (00 to 59 mins).

End Hour: in decimal format represented by 0x00 – 0x17 (00 to 23 hours). End Hour SHALL be equal or greater than Start Hour.

End Minute: in decimal format represented by 0x00 – 0x3B (00 to 59 mins).

If End Hour is equal with Start Hour, End Minute SHALL be greater than Start Minute.

When the Server Device receives the command, the Server Device MAY change the user type to the specific schedule user type. Please refer to Section 10.1.2.5, Process for Creating a New User with Schedule at the beginning of this cluster.[3]

[3] CCB 1772

10.1.2.15.14 Get Week Day Schedule

Retrieve the specific weekly schedule for the specific user.

Octets	1	2
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Schedule ID	User ID

Figure 10.12 Format of the Get Week Day Schedule Command

10.1.2.15.15 Clear Week Day Schedule

Clear the specific weekly schedule for the specific user.

Octets	1	2
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Schedule ID	User ID

Figure 10.13 Format of the Clear Week Day Schedule Command

10.1.2.15.16 Set Year Day Schedule

Set a time-specific schedule ID for a specified user.

Octets	1	2	4	4
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 32-bit integer	Unsigned 32-bit integer
Field Name	Schedule ID	User ID	ZigBee Local Start Time	ZigBee Local End Time

Figure 10.14 Format of the Set Year Day Schedule Command

Schedule ID number is between 0 – [# of Year Day Schedules Supported Per User attribute]. User ID is between 0 – [# of Total Users Supported attribute].

Start time and end time are given in ZigBee LocalTime. End time must be greater than the start time.

When the Server Device receives the command, the Server Device MAY change the user type to the specific schedule user type. Please refer to Section 10.1.2.5, Process for Creating a New User with Schedule at the beginning of this cluster.[4]

[4] CCB 1772

10.1.2.15.17 Get Year Day Schedule

Retrieve the specific year day schedule for the specific user.

Octets	1	2
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Schedule ID	User ID

Figure 10.15 Format of the Get Year Day Schedule Command

10.1.2.15.18 Clear Year Day Schedule

Clears the specific year day schedule for the specific user.

Octets	1	2
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Schedule ID	User ID

Figure 10.16 Format of the Clear Year Day Schedule Command

10.1.2.15.19 Set Holiday Schedule

Set the holiday Schedule by specifying ZigBee local start time and ZigBee local end time with respect to any Lock Operating Mode.

Octets	1	4	4	1
Data Type	Unsigned 8-bit integer	Unsigned 32-bit integer	Unsigned 32-bit integer	8-bit enumeration
Field Name	Holiday Schedule ID	ZigBee Local Start Time	ZigBee Local End Time	Operating Mode During Holiday

Figure 10.17 Format of the Set Holiday Schedule Command

Holiday Schedule ID number is between 0 – [# of Holiday Schedules Supported attribute].

Start time and end time are given in ZigBee LocalTime. End time must be greater than the start time.

Operating Mode is valid enumeration value as listed in operating mode attribute.

10.1.2.15.20 Get Holiday Schedule

Get the holiday Schedule by specifying Holiday ID.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Holiday Schedule ID

Figure 10.18 Format of the Get Holiday Schedule Command

10.1.2.15.21 Clear Holiday Schedule

Clear the holiday Schedule by specifying Holiday ID.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Holiday Schedule ID

Figure 10.19 Format of the Clear Holiday Schedule Command

10.1.2.15.22 Set User Type

Set the type byte for a specified user.

For user type value please refer to User Type Value.

Octets	2	1
Data Type	Unsigned 16-bit integer	8-bit enumeration
Field Name	User ID	User Type

Figure 10.20 Format of the Set User Type Command

10.1.2.15.23 Get User Type

Retrieve the type byte for a specific user.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.21 Format of the Get User Type Command

10.1.2.15.24 Set RFID Code

Set an ID for RFID access into the lock.

Octets	2	1	1	Variable
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration	Octet string
Field Name	User ID	User Status	User Type	RFID Code

Figure 10.22 Format of the Set RFID Code Command

User ID is between 0 - [# of RFID Users Supported attribute]. Only the values 1 (Occupied/Enabled) and 3 (Occupied/Disabled) are allowed for User Status.

User Status: Used to indicate what the status is for a specific user ID. The values are according to “Set PIN” while not all are supported.

User Status Byte	**Value**
Occupied / Enabled (Access Given)	1
Reserved	2
Occupied / Disabled	3
Not Supported	0xff

User Type

The values are the same as used for “Set PIN Code”.

10.1.2.15.25 Get RFID Code

Retrieve an ID. User ID is between 0 - [# of RFID Users Supported attribute].

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.23 Format of the Get RFID Code Command

10.1.2.15.26 Clear RFID Code

Delete an ID. User ID is between 0 - [# of RFID Users Supported attribute]. If you delete a RFID code and this user didn't have a PIN code, the user status has to be set to "0 Available", the user type has to be set to the default value, and all schedules which are supported have to be set to the default values.

Octets	2
Data Type	Unsigned 16-bit integer
Field Name	User ID

Figure 10.24 Format of the Clear RFID Code Command

10.1.2.15.27 Clear All RFID Codes

Clear out all RFIDs on the lock. If you delete all RFID codes and this user didn't have a PIN code, the user status has to be set to "0 Available", the user type has to be set to the default value, and all schedules which are supported have to be set to the default values.

10.1.2.16 Server Commands Generated

Table 10.13 Commands Generated by the Server Cluster

Command ID	Description	Mandatory/ Optional
0x00	Lock Door Response	M
0x01	Unlock Door Response	M
0x02	Toggle Response	O
0x03	Unlock with Timeout Response	O
0x04	Get Log Record Response	O
0x05	Set PIN Code Response	O
0x06	Get PIN Code Response	O
0x07	Clear PIN Code Response	O
0x08	Clear All PIN Codes Response	O
0x09	Set User Status Response	O
0x0A	Get User Status Response	O
0x0B	Set Week Day Schedule Response	O
0x0C	Get Week Day Schedule Response	O
0x0D	Clear Week Day Schedule Response	O
0x0E	Set Year Day Schedule Response	O
0x0F	Get Year Day Schedule Response	O
0x10	Clear Year Day Schedule Response	O
0x11	Set Holiday Schedule Response	O

Table 10.13 Commands Generated by the Server Cluster (Continued)

Command ID	Description	Mandatory/ Optional
0x12	Get Holiday Schedule Response	O
0x13	Clear Holiday Schedule Response	O
0x14	Set User Type Response	O
0x15	Get User Type Response	O
0x16	Set RFID Code Response	O
0x17	Get RFID Code Response	O
0x18	Clear RFID Code Response	O
0x19	Clear All RFID Codes Response	O
0x1A – 0x1F	Reserved	
0x20	Operation Event Notification	O
0x21	Programming Event Notification	O

10.1.2.16.1 Lock Response

This command is sent in response to a Lock command with one status byte payload. The Status field SHALL be set to SUCCESS or FAILURE (see Table 2.16 in [B2]).

The status byte only indicates if the message has received successfully. To determine the lock and/or door status, the client SHOULD query to [Lock State attribute] and [Door State attribute].

10.1.2.16.2 Unlock Door Response

This command is sent in response to a unlock command with one status byte payload. The Status field SHALL be set to SUCCESS or FAILURE (see Table 2.16 in [B2]).

The status byte only indicates if the message has received successfully. To determine the lock and/or door status, the client SHOULD query to [Lock State attribute] and [Door State attribute].

10.1.2.16.3 Toggle Response

This command is sent in response to a Toggle command with one status byte payload. The Status field SHALL be set to SUCCESS or FAILURE (see Table 2.16 in [B2]).

The status byte only indicates if the message has received successfully. To determine the lock and/or door status, the client SHOULD query to [Lock State attribute] and [Door State attribute].

10.1.2.16.4 Unlock with Timeout Response

This command is sent in response to an Unlock With Timeout command with one status byte payload. The Status field SHALL be set to SUCCESS or FAILURE (see Table 2.16 in [B2]).

The status byte only indicates if the message has received successfully. To determine the lock and/or door status, the client SHOULD query to [Lock State attribute] and [Door State attribute].

10.1.2.16.5 Get Log Record Response

Returns the specified log record. If an invalid log entry ID was requested, it is set to 0 and the most recent log entry will be returned.

Octets	2	4	1	1	1	2	Variable
Data Type	Unsigned 16-bit integer	Unsigned 32-bit integer	8-bit enumeration	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	ZigBee String
Field Name	Log Entry ID	Timestamp	Event Type	Source (see sub-clause 10.1.2.16.27.1)	Event ID / Alarm Code (see sub-clause 10.1.2.16.27.2)	User ID	PIN

Figure 10.25 Format of the Get Log Record Response Command

Log Entry ID: the index into the log table where this log entry is stored. If the log entry requested is 0, the most recent log is returned with the appropriate log entry ID.

Timestamp: A ZigBee LocalTime used to timestamp all events and alarms on the door lock.

Event Type: Indicates the type of event that took place on the door lock.

0x00 = Operation

0x01 = Programming

0x02 = Alarm

Source: A source value where available sources are:

0x00 = Keypad

0x01 = RF

0x02 = Manual

0x03 = RFID

0xff = Indeterminate

If the Event type is 0x02 (Alarm) then the source SHOULD be but does not have to be 0xff (Indeterminate).

Event ID: A one byte value indicating the type of event that took place on the door lock depending on the event code table provided for a given event type and source.

User ID: A two byte value indicating the ID of the user who generated the event on the door lock if one is available. If none is available, 0xffff has to be used.

PIN / ID: A ZigBee string indicating the PIN code or RFID code that was used to create the event on the door lock if one is available.

10.1.2.16.6 Set PIN Code Response

Returns status of the PIN set command. Possible values are:

0 = Success

1 = General failure

2 = Memory full

3 = Duplicate Code error

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status

Figure 10.26 Format of the Set PIN Code Response Command

10.1.2.16.7 Get PIN Code Response

Returns the PIN for the specified user ID

Octets	2	1	1	Variable
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration	Octet String
Field Name	User ID	User Status	User Type	Code

Figure 10.27 Format of the Get PIN Code Response Command

If the requested user ID is valid and the Code doesn't exist, Get RFID Code Response shall have the following format:

UserId = requested UserId

UserStatus = 0 (available)

UserType = 0xFF (not supported)

RFID = 0 (zero length)

If requested user ID is invalid, send Default Response with an error status not equal to ZCL_SUCCESS(0x00).

10.1.2.16.8 Clear PIN Code Response

Returns pass/fail of the command.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.28 Format of the Clear PIN Code Response Command

10.1.2.16.9 Clear All PIN Codes Response

Returns pass/fail of the command.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.29 Format of the Clear All PIN Codes Response Command

10.1.2.16.10 Set User Status Response

Returns the pass or fail value for the setting of the user status.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.30 Format of the Set User Status Response Command

10.1.2.16.11 Get User Status Response

Returns the user status for the specified user ID.

Octets	2	1
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer
Field Name	User ID	User Status

Figure 10.31 Format of the Get User Status Response Command

10.1.2.16.12 Set Week Day Schedule Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.32 Format of the Set Week Day Schedule Response Command

10.1.2.16.13 Get Week Day Schedule Response

Returns the weekly repeating schedule data for the specified schedule ID.

Octets	1	2	1	0/1	0/1	0/1	0/1	0/1
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 8-bit integer
Field Name	Schedule ID	User ID	Status	Days mask	Start hour	Start minute	End hour	End minute

Figure 10.33 Format of the Get Week Day Schedule Response Command

10.1.2.16.13.1 Schedule ID Field

The requested Schedule ID.

10.1.2.16.13.2 User ID Field

The requested User ID.

10.1.2.16.13.3 Status

ZCL SUCCESS (0x00) if both Schedule ID and User ID are valid and there is a corresponding schedule entry.

ZCL INVALID_FIELD (0x85)if either Schedule ID and/or User ID values are not within valid range

ZCL NOT_FOUND (0x8B) if both Schedule ID and User ID are within the valid range, however, there is not corresponding schedule entry found.

Only if the status is ZCL SUCCESS that other remaining fields are included. For other (error) status values, only the fields up to the status field SHALL be present.

10.1.2.16.13.4 Days Mask

Days mask is a bitmask of the effective days in the order [E]SMT WTFS. Bit 7 indicates the enabled status of the schedule ID, with the lower 7 bits indicating the effective days mask.

7	0	1	2	3	4	5	6
EN	Sun	Mon	Tue	Wed	Thu	Fri	Sat

Bit 7: Enabled status: 1=enabled, 0=disabled

10.1.2.16.13.5 Start Hour

The Start Hour of the Week Day Schedule: 0-23

10.1.2.16.13.6 Start Minute

The Start Min of the Week Day Schedule: 0-59

10.1.2.16.13.7 End Hour

The End Hour of the Week Day Schedule: 0-23, must be greater than Start Hour

10.1.2.16.13.8 End Minute

The End Min of the Week Day Schedule: 0-59

10.1.2.16.14 Clear Week Day Schedule ID Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.34 Format of the Clear Week Day Schedule ID Response Command

10.1.2.16.15 Set Year Day Schedule Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.35 Format of the Set Year Day Schedule Response Command

10.1.2.16.16 Get Year Day Schedule Response

Returns the weekly repeating schedule data for the specified schedule ID.

Octets	1	2	1	0/4	0/4
Data Type	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 8-bit integer	Unsigned 32-bit integer	Unsigned 32-bit integer
Field Name	Schedule ID	User ID	Status	ZigBee Local Start Time	ZigBee Local End Time

Figure 10.36 Format of the Get Year Day Schedule Response Command

10.1.2.16.16.1 Schedule ID Field

The requested Schedule ID.

10.1.2.16.16.2 User ID Field

The requested User ID.

10.1.2.16.16.3 Status

ZCL SUCCESS (0x00) if both Schedule ID and User ID are valid and there is a corresponding schedule entry.

ZCL INVALID_FIELD (0x85) if either Schedule ID and/or User ID values are not within valid range

ZCL NOT_FOUND (0x8B) if both Schedule ID and User ID are within the valid range, however, there is not corresponding schedule entry found.

Only if the status is ZCL SUCCESS that other remaining fields are included. For other (error) status values, only the fields up to the status field SHALL be present.

10.1.2.16.16.4 ZigBee Local Start Time

Start Time of the Year Day Schedule representing by ZigBee LocalTime.

10.1.2.16.16.5 ZigBee Local End Time

End Time of the Year Day Schedule representing by ZigBee LocalTime.

10.1.2.16.17 Clear Year Day Schedule Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.37 Format of the Clear Year Day Schedule Response Command

10.1.2.16.18 Set Holiday Schedule Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.38 Format of the Set Holiday Schedule Response Command

10.1.2.16.19 Get Holiday Schedule Response

Returns the Holiday Schedule Entry for the specified Holiday ID.

Octets	1	1	0/4	0/4	0/1
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 32-bit integer	Unsigned 32-bit integer	8-bit enumeration
Field Name	Holiday Schedule ID	Status	ZigBee Local Start Time	ZigBee Local End Time	Operating Mode During Holiday

Figure 10.39 Format of the Get Holiday Schedule Response Command

10.1.2.16.19.1 Holiday Schedule ID

The requested Holiday Schedule ID

10.1.2.16.19.2 Status

ZCL SUCCESS (0x00) if both Schedule ID and User ID are valid and there is a corresponding schedule entry.

ZCL INVALID_FIELD (0x85) if either Schedule ID and/or User ID values are not within valid range

ZCL NOT_FOUND (0x8B) if both Schedule ID and User ID are within the valid range, however, there is not corresponding schedule entry found.

Only if the status is ZCL SUCCESS that other remaining fields are included. For other (error) status values, only the fields up to the status field SHALL be present.

10.1.2.16.19.3 ZigBee Local Start Time

Start Time of the Year Day Schedule representing by ZigBee LocalTime.

10.1.2.16.19.4 ZigBee Local End Time

End Time of the Year Day Schedule representing by ZigBee LocalTime.

10.1.2.16.19.5 Operating Mode

Operating Mode is valid enumeration value as listed in operating mode attribute

10.1.2.16.20 Clear Holiday Schedule Response

Returns pass/fail of the command

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.40 Format of the Clear Holiday Schedule Response Command

10.1.2.16.21 Set User Type Response

Returns the pass or fail value for the setting of the user type.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.41 Format of the Set User Type Response Command

10.1.2.16.22 Get User Type Response

Returns the user type for the specified user ID.

Octets	2	1
Data Type	Unsigned 16-bit integer	8-bit enumeration
Field Name	User ID	User Type

Figure 10.42 Format of the Get User Type Response Command

10.1.2.16.23 Set RFID Code Response

Returns status of the Set RFID Code command. Possible values are:

0 = Success

1 = General failure

2 = Memory full

3 = Duplicate ID error

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status

Figure 10.43 Format of the Set RFID Code Response Command

10.1.2.16.24 Get RFID Code Response

Returns the RFID code for the specified user ID:

Octets	2	1	1	Variable
Data Type	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration	Octet String
Field Name	User ID	User Status	User Type	RFID Code

Figure 10.44 Format of the Get RFID Code Response Command

If the requested user ID is valid and the Code doesn't exist, Get RFID Code Response shall have the following format:

UserId = requested UserId

UserStatus = 0 (available)

UserType = 0xFF (not supported)

RFID = 0 (zero length)

If requested user ID is invalid, send Default Response with an error status not equal to ZCL_SUCCESS(0x00).

10.1.2.16.25 Clear RFID Code Response

Returns pass/fail of the command.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.45 Format of the Clear RIFD Code Response Command

10.1.2.16.26 Clear All RFID Codes Response

Returns pass/fail of the command.

Octets	1
Data Type	Unsigned 8-bit integer
Field Name	Status
Field Value	0=pass 1=fail

Figure 10.46 Format of the Clear All RIFD Codes Response Command

10.1.2.16.27 Operation Event Notification

The door lock server sends out operation event notification when the event is triggered by the various event sources. The specific operation event will only be sent out if the associated bitmask is enabled in the various attributes in the Event Masks Attribute Set.

All events are optional.

Octets	1	1	2	1	4	Variable/0
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 8-bit integer	Unsigned 32-bit integer	String
Field Name	Operation Event Source	Operation Event code	User ID	PIN	ZigBeeLocalTime	Data

Figure 10.47 Format of the Operation Event Notification Command

10.1.2.16.27.1 Operation Event Sources

This field indicates where the event was triggered from.

Table 10.14 Operation Event Source Value

Value	**Source**
0x00	Keypad
0x01	RF
0x02	Manual
0x03	RFID
0xFF	Indeterminate

10.1.2.16.27.2 Operation Event Codes

The door lock optionally sends out notifications (if they are enabled) whenever there is a significant operational event on the lock. When combined with a source from the Event Source table above, the following operational event codes constitute an event on the door lock that can be both logged and sent to a bound device using the Operation Event Notification command.

Not all operation event codes are applicable to each of the event source. Table 10.15 marks each event code with “A” if the event code is applicable to the event source.

Table 10.15 Operation Event Code Value

Value	Operation Event Code	Keypad	RF	Manual	RFID
0x00	UnknownOrMfgSpecific	A	A	A	A
0x01	Lock	A	A	A	A
0x02	Unlock	A	A	A	A
0x03	LockFailureInvalidPINorID	A	A		A
0x04	LockFailureInvalidSchedule	A	A		A
0x05	UnlockFailureInvalidPINorID	A	A		A
0x06	UnlockFailureInvalidSchedule	A	A		A
0x07	OneTouchLock			A	
0x08	KeyLock			A	
0x09	KeyUnlock			A	
0x0A	AutoLock			A	
0x0B	ScheduleLock			A	
0x0C	ScheduleUnlock			A	
0x0D	Manual Lock (Key or Thumbturn)			A	
0x0E	Manual Unlock (Key or Thumbturn)			A	
0x0F	Non-Access User Operational Event	A			

10.1.2.16.27.3 User ID

The User ID who performed the event.

10.1.2.16.27.4 PIN

The PIN that is associated with the User ID who performed the event.

10.1.2.16.27.5 LocalTime

The ZigBee LocalTime that indicates when the event is triggered. If time is not supported, the field SHALL be populated with default not used value 0xFFFFFFFF.

10.1.2.16.27.6 Data

The operation event notification command contains a variable string, which can be used to pass data associated with a particular event. Generally this field will be left empty. However, manufacturer can choose to use this field to store/display manufacturer-specific information.

10.1.2.16.27.7 Keypad Operation Event Notification

Keypad Operation Event Notification feature is enabled by setting the associated bitmasks in the [Keypad Operation Event Mask attribute].

Table 10.16 Keypad Operation Event Value

Event Source	Operation Event Code	Attribute Bitmask	Event Description
0x00	0x00	BIT(0)	Unknown or manufacturer-specific keypad operation event
0x00	0x01	BIT(1)	Lock, source: keypad
0x00	0x02	BIT(2)	Unlock, source: keypad
0x00	0x03	BIT(3)	Lock, source: keypad, error: invalid PIN
0x00	0x04	BIT(4)	Lock, source: keypad, error: invalid schedule
0x00	0x05	BIT(5)	Unlock, source: keypad, error: invalid code
0x00	0x06	BIT(6)	Unlock, source: keypad, error: invalid schedule
0x00	0x0F	BIT(7)	Non-Access User operation event, source keypad.

10.1.2.16.27.8 RF Operation Event Notification

RF Operation Event Notification feature is enabled by setting the associated bitmasks in the [RF Operation Event Mask attribute].

Table 10.17 RF Operation Event Value

Event Source	Operation Event Code	Attribute Bitmask	Event Description
0x01	0x00	BIT(0)	Unknown or manufacturer-specific RF operation event
0x01	0x01	BIT(1)	Lock, source: RF
0x01	0x02	BIT(2)	Unlock, source: RF
0x01	0x03	BIT(3)	Lock, source: RF, error: invalid code
0x01	0x04	BIT(4)	Lock, source: RF, error: invalid schedule
0x01	0x05	BIT(5)	Unlock, source: RF, error: invalid code
0x01	0x06	BIT(6)	Unlock, source: RF, error: invalid schedule

10.1.2.16.27.9 Manual Operation Event Notification

Manual Operation Event Notification feature is enabled by setting the associated bitmasks in the [Manual Operation Event Mask attribute] attribute.

Table 10.18 Manual Operation Event Value

Event Source	Operation Event Code	Attribute Bitmask	Event Description
0x02	0x00	BIT(0)	Unknown or manufacturer-specific manual operation event
0x02	0x01	BIT(1)	Thumbturn Lock
0x02	0x02	BIT(2)	Thumbturn Unlock
0x02	0x07	BIT(3)	One touch lock
0x02	0x08	BIT(4)	Key Lock
0x02	0x09	BIT(5)	Key Unlock
0x02	0x0A	BIT(6)	Auto lock
0x02	0x0B	BIT(7)	Schedule Lock
0x02	0x0C	BIT(8)	Schedule Unlock
0x02	0x0D	BIT(9)	Manual Lock (Key or Thumbturn)
0x02	0x0E	BIT(10)	Manual Unlock (Key or Thumbturn)

10.1.2.16.27.10 RFID Operation Event Notification

RFID Operation Event Notification feature is enabled by setting the associated bitmasks in the [RFID Operation Event Mask attribute].

Table 10.19 RFID Operation Event Value

Event Source	Operation Event Code	Attribute Bitmask	Event Description
0x03	0x00	BIT(0)	Unknown or manufacturer-specific keypad operation event
0x03	0x01	BIT(1)	Lock, source: RFID
0x03	0x02	BIT(2)	Unlock, source: RFID
0x03	0x03	BIT(3)	Lock, source: RFID, error: invalid RFID ID
0x03	0x04	BIT(4)	Lock, source: RFID, error: invalid schedule
0x03	0x05	BIT(5)	Unlock, source: RFID, error: invalid RFID ID
0x03	0x06	BIT(6)	Unlock, source: RFID, error: invalid schedule

10.1.2.16.28 Programming Event Notification

The door lock server sends out a programming event notification whenever a programming event takes place on the door lock.

As with operational events, all programming events can be turned on and off by flipping bits in the associated event mask.

The programming event notification command includes an optional string of data that can be used by the manufacturer to pass some manufacturer-specific information if that is required.

Octets	1	1	2	1	1	1	4	Variable/0
Data Type	Unsigned 8-bit integer	Unsigned 8-bit integer	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration	Unsigned 8-bit integer	Unsigned 32-bit integer	String
Field Name	Program Event Source	Program Event Code	User ID	PIN	User Type	User Status	ZigBee LocalTime	Data

Figure 10.48 Format of the Programming Event Notification Command

10.1.2.16.28.1 Operation Event Sources

This field indicates where the event was trigger from.

Table 10.20 Operation Event Source Value

Value	Source
0x00	Keypad
0x01	RF
0x02	Reserved (Manual in Operation Event)
0x03	RFID
0xFF	Indeterminate

10.1.2.16.28.2 Programming Event Codes

The door lock optionally sends out notifications (if they are enabled) whenever there is a significant programming event on the lock. When combined with a source from the Event Source table above, the following programming event codes constitute an event on the door lock that can be both logged and sent to a bound device using the Programming Event Notification command.

Not all event codes are applicable to each of the event source. Table 10.21 marks each event code with “A” if the event code is applicable to the event source.

Table 10.21 Programming Event Codes

Value	Programming Event Code	Keypad	RF	RFID
0x00	UnknownOrMfgSpecific	A	A	A
0x01	MasterCodeChanged	A		
0x02	PINCodeAdded	A	A	
0x03	PINCodeDeleted	A	A	
0x04	PINCodeChanged	A	A	
0x05	RFIDCodeAdded			A
0x06	RFIDCodeDeleted			A

10.1.2.16.28.3 User ID

The User ID who performed the event

10.1.2.16.28.4 PIN

The PIN that is associated with the User ID who performed the event

10.1.2.16.28.5 User Type

The User Type that is associated with the User ID who performed the event

10.1.2.16.28.6 User Status

The User Status that is associated with the User ID who performed the event

10.1.2.16.28.7 LocalTime

The ZigBee LocalTime that indicates when the event is triggered. If time is not supported, the field SHALL be populated with default not used value 0xFFFFFFFF.

10.1.2.16.28.8 Data

The programming event notification command contains a variable string, which can be used to pass data associated with a particular event. Generally this field will be left empty. However, manufacturer can choose to use this field to store/display manufacturer-specific information.

10.1.2.16.28.9 Keypad Programming Event Notification

Keypad Programming Event Notification feature is enabled by setting the associated bitmasks in the [Keypad Programming Event Mask attribute].

Table 10.22 Keypad Programming Event Value

Event Source	Program Event Code	Attribute Bitmask	Event Description
0x00	0x00	BIT(0)	Unknown or manufacturer-specific keypad programming event
0x00	0x01	BIT(1)	Master code changed, source: keypad, User ID: master user ID. PIN: default or master code if codes can be sent over the air per attribute. User type: default User Status: default

Table 10.22 Keypad Programming Event Value (Continued)

Event Source	Program Event Code	Attribute Bitmask	Event Description
0x00	0x02	BIT(2)	PIN added, source: keypad User ID: user ID that was added. PIN: code that was added (if codes can be sent over the air per attribute.) User type: default or type added. User Status: default or status added.
0x00	0x03	BIT(3)	PIN deleted, source: keypad User ID: user ID that was deleted. PIN: code that was deleted (if codes can be sent over the air per attribute.) User type: default or type deleted. User Status: default or status deleted.
0x00	0x04	BIT(4)	PIN changed Source: keypad User ID: user ID that was changed PIN: code that was changed (if codes can be sent over the air per attribute.) User type: default or type changed. User Status: default or status changed.

10.1.2.16.28.10 RF Programming Event Notification

RF Programming Event Notification feature is enabled by setting the associated bitmasks in the [RF Programming Event Mask attribute].

Table 10.23 RF Programming Event Value

Event Source	Program Event Code	Attribute Bitmask	Event Description
0x01	0x00	BIT(0)	Unknown or manufacturer-specific RF programming event.
0x01	0x02	BIT(2)	PIN added, source RF Same as keypad source above
0x01	0x03	BIT(3)	PIN deleted, source RF Same as keypad source above.
0x01	0x04	BIT(4)	PIN changed Source RF Same as keypad source above

10.1.2.16.28.11 RFID Programming Event Notification

RFID Programming Event Notification feature is enabled by setting the associated bitmasks in the [RFID Programming Event Mask attribute].

Table 10.24 RFID Programming Event Value

Event Source	Program Event Code	Attribute Bitmask	Event Description
0x03	0x00	BIT(0)	Unknown or manufacturer-specific keypad programming event
0x03	0x05	BIT(5)	ID Added, Source: RFID User ID: user ID that was added. ID: ID that was added (if codes can be sent over the air per attribute.) User Type: default or type added. User Status: default or status added.
0x03	0x06	BIT(6)	ID Deleted, Source: RFID User ID: user ID that was deleted. ID: ID that was deleted (if codes can be sent over the air per attribute.) User Type: default or type deleted. User Status: default or status deleted.

10.1.2.17 Scene Table Extension

If the Scene server cluster is implemented, the following extension field is added to the Scene table:

- **Lock State**
  When the Lock State attribute is part of a Scene table, the attribute is treated as a writeable command, that is, setting the Lock State to lock will command the lock to lock, and setting the Lock State to unlocked will command the lock to unlock. Setting the Lock State attribute to “not fully locked” is not supported. The transition time field in the Scene table will be treated as a delay before setting the Lock State attribute, that is it is possible to activate a scene with the lock actuation some seconds later.

Locks that do not have an actuation mechanism SHOULD not support the Scene table extension.

10.1.3 Client

10.1.3.1 Dependencies

None

10.1.3.2 Attributes

The client has no attributes.

10.1.3.3 Commands Received

The client receives the cluster-specific commands generated by the server as shown in Table 10.13.

10.1.3.4 Commands Generated

The client generates the cluster-specific commands that will be received by the server as shown in Table 10.10.

10.2 Thermostat Cluster Extensions

This section describes the recommended practices for Home Automation Thermostat Cluster extensions.

10.2.1 Introduction

10.2.1.1 Scope and Purpose

This document describes the proposed addition to the Home Automation specification and the ZigBee Cluster Library for the thermostat cluster. Many programmable thermostats have scheduling capabilities that would be beneficial to control in a standard way. The proposal set out in this document would provide a standard framework for setting and retrieving the schedule for a thermostat. This extension also provided new standard commands and attributes to retrieve HVAC relay status for a thermostat.

10.2.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.2.2.1 ZigBee Alliance Documents

1. ZigBee Document 075366r03, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.
2. ZigBee Document 115593, HA-ThermostatCluster-Temperature-Conversion-Sample-Code – this document provides sample code on how to convert the temperature from Fahrenheit to Celsius and vice versa

10.2.3 General Description

This document mirrors the existing Thermostat Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.2.3.1 Thermostat Temperature Conversion

Many Thermostats store internally or have the capability to display the temperature in degree Fahrenheit format. The ZCL Thermostat Cluster standardizes temperature representation in degree Celsius format when transferred over the air. Sample code has been provided in the ZigBee document 115593, HA-ThermostatCluster-Temperature-Conversion-Sample-Code. Manufacturers should use the conversion algorithm provided to convert temperature from Fahrenheit to Celsius and vice versa.

10.2.3.2 Thermostat Schedule Feature Mandatory Requirement

The *StartOfWeek* Attribute is the indicator to show that the Weekly schedule extension is supported. If the Weekly schedule extension feature is supported, it is mandatory to also support the *StartOfWeek* Attribute, *NumberOfWeeklyTransitions* Attribute, *NumberOfDailyTransitions* Attribute, Set Weekly Schedule Command and Get Weekly Schedule Command.

10.2.3.3 Server Attributes

10.2.3.3.1 Thermostat Information Attribute Set

Table 10.25 Thermostat Information Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0000 – 0x0008	No Change					
0x0009	*HVACSystemTypeConfiguration*	8-bit Bitmask	00xxxxxx	Read/ Write	00000000	O

10.2.3.3.1.1 HVACSystemTypeConfiguration Attribute

The *HVACSystemTypeConfiguration* attribute specifies the HVAC system type controlled by the thermostat. If the thermostat uses physical DIP switches to set these parameters, this information shall be available read-only from the DIP switches. If these parameters are set via software, there shall be read/write access in order to provide remote programming capability. The meanings of individual bits are detailed in Table 10.26. Each bit represents a type of system configuration.

Table 10.26 HVAC System Type Configuration Values

Bit Number	Description
0 – 1	**Cooling System Stage** 00 – Cool Stage 1 01 – Cool Stage 2 10 – Cool Stage 3 11 – Reserved
2 – 3	**Heating System Stage** 00 – Heat Stage 1 01 – Heat Stage 2 10 – Heat Stage 3 11 – Reserved
4	**Heating System Type** 0 – Conventional 1 – Heat Pump
5	**Heating Fuel Source** 0 – Electric / B 1 – Gas / O
6 – 7	Reserved

10.2.3.3.2 Thermostat Settings Attribute Set

Table 10.27 Thermostat Setting Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0010	No Change					
0x0011	*OccupiedCoolingSetpoint*	Signed 16-bit integer	*MinCoolSetpointLimit - MaxCoolSetpointLimit*	Read/ Write	0x0a28 (26°C)	M*
0x0012	OccupiedHeatingSetpoint	Signed 16-bit integer	MinHeatSetpointLimit - MaxHeatSetpointLimit	Read / Write	0x07d0 (20°C)	M*
0x0013 – 0x001d	No Change					
0x001e	ThermostatRunningMode	8-bit enumeration	0x00 - 0x04	Read	0x00	O
0x001f	Reserved					

***Note:** "M*" designates that a server SHALL implement at least one of the attributes designated "M*". For example, a radiator valve implementing the Thermostat Cluster server would only implement the OccupiedHeatingSetpoint attribute. Thermostats SHOULD implement both OccupiedCoolingSetpoint and OccupiedHeatingSetpoint attributes. The "M*" designation allows HVAC devices to implement the portions of Thermostat cluster germane to their operation.*

10.2.3.3.2.1 ThermostatRunningMode Attribute

ThermostatRunningMode represents the running mode of the thermostat. The thermostat running mode can only be Off, Cool or Heat. This attribute is intended to provide additional information when the thermostat's system mode is in auto mode. The attribute value is maintained to have the same value as the *SystemMode* attribute.

Table 10.28 *ThermostatRunningMode* Attribute Values

Enumeration Field Value	Description
0x00	Off
0x01 – 0x02	Reserved

Table 10.28 ***ThermostatRunningMode*** **Attribute Values (Continued)**

Enumeration Field Value	Description
0x03	Cool
0x04	Heat
0x05 – 0xFF	Reserved

10.2.3.3.2.2 System Mode

Table 10.29 ***SystemMode*** **Attribute Values**

Enumeration Field Value	Description
0x00 – 0x07	No change
0x08	Dry
0x09	Sleep
0x0A – 0xff	Reserved

10.2.3.3.2.2.1 Dry

This mode is required to remove the moisture content from the air inside the room.

10.2.3.3.2.2.2 Sleep

This mode is intended for automatic temperature adjustment and low noise. It is called sleep because it is used when the user goes to sleep. The device is configured to provide maximum comfort without disrupting the user’s sleep.

10.2.3.3.3 Thermostat Schedule & HVAC Relay Attribute Set

Table 10.30 Thermostat Schedule & HVAC Relay Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
Schedule Attribute Set 0x0020 – 0x0028						
0x0020	*StartOfWeek*	8-bit enumeration	0x00 – 0x06	Read	-	O
0x0021	*NumberOfWeeklyTransitions*	8-bit unsigned	0x00 – 0xFF	Read	N/A	O
0x0022	*NumberOfDailyTransitions*	8-bit unsigned	0x00 – 0xFF	Read	N/A	O
0x0023	*TemperatureSetpointHold*	8-bit enumeration	0x00-0x01	Read/ Write	0x00	O

Table 10.30 Thermostat Schedule & HVAC Relay Attribute Set (Continued)

Identifier	Name	Type	Range	Access	Default	M/O
0x0024	*TemperatureSetpointHoldDuration*	16-bit unsigned	0xFFFF – 0x05A0	Read/ Write	0xFFFF	O
0x0025	*ThermostatProgrammingOperationMode*	8-bit bitmap	00xxxxxx	Read/ Write	00000000	O
HVAC Relay Attribute Set 0x0029 – 0x002F						
0x0029	*ThermostatRunningState*	16-bit bitmap		Read	N/A	O

10.2.3.3.3.1 StartOfWeek Attribute

StartOfWeek represents the day of the week that this thermostat considers to be the start of week for weekly set point scheduling. The possible values are given in Table 10.31:

Table 10.31 *StartOfWeek* Enumeration Values

Enumeration Field Value	Description
0x00	Sunday
0x01	Monday
0x02	Tuesday
0x03	Wednesday
0x04	Thursday
0x05	Friday
0x06	Saturday
0x07 – 0xFF	Reserved

If the Weekly schedule extension is supported this attribute shall be supported.

This attribute may be able to be used as the base to determine if the device supports weekly scheduling by reading the attribute. Successful response means that the weekly scheduling is supported.

10.2.3.3.3.2 NumberOfWeeklyTransitions Attribute

NumberOfWeeklyTransitions attribute determines how many weekly schedule transitions the thermostat is capable of handling.

10.2.3.3.3.3 NumberOfDailyTransitions Attribute

NumberOfDailyTransitions attribute determines how many daily schedule transitions the thermostat is capable of handling.

10.2.3.3.3.4 TemperatureSetpointHold Attribute

TemperatureSetpointHold specifies the temperature hold status on the thermostat. If hold status is on, the thermostat should maintain the temperature set point for the current mode until a system mode change. If hold status is off, the thermostat should follow the setpoint transitions specified by its internal scheduling program. If the thermostat supports setpoint hold for a specific duration, it should also implement the *TemperatureSetpointHoldDuration* attribute.

Table 10.32 *TemperatureSetpointHold* Attribute Values

Enumeration Field Value	Description
0x00	Setpoint Hold Off
0x01	Setpoint Hold On
0x02 – 0xFF	Reserved

10.2.3.3.3.5 TemperatureSetpointHoldDuration Attribute

TemperatureSetpointHoldDuration sets the period in minutes for which a setpoint hold is active. Thermostats that support hold for a specified duration should implement this attribute.The valid range is from 0x0000 – 0x05A0 (1440 minutes within a day). A value of 0xFFFF indicates the field is unused. All other values are reserved.

10.2.3.3.3.6 ThermostatProgrammingOperationMode Attribute

The *ThermostatProgrammingOperationMode* attribute determines the operational state of the thermostat's programming. The thermostat SHALL modify its programming operation when this attribute is modified by a client and update this attribute when its programming operation is modified locally by a user. The thermostat MAY support more than one active *ThermostatProgrammingOperationMode*. For example, the thermostat MAY operate simultaneously in Schedule Programming Mode and Recovery Mode. If a thermostat supports *Thermostat Programming Operation Mode* attribute, it SHALL support attribute reporting for this attribute. Any locally-initiated changes to the *ThermostatProgrammingOperationMode* shall be updated and reported to all clients configured to receive such reports.

The meanings of individual bits are detailed in Table 10.33. Each bit represents a type of operation.

Table 10.33 *ThermostatProgrammingOperationMode* Values

ThermostatProgramming OperationMode **Attribute**	**Description**
0	0 – Simple/setpoint mode. This mode means the thermostat setpoint is altered only by manual up/down changes at the thermostat or remotely, not by internal schedule programming. 1 – Schedule programming mode. This enables or disables any programmed weekly schedule configurations. **Note:** *it does not clear or delete previous weekly schedule programming configurations.*
1	0 - Auto/recovery mode set to OFF 1 – Auto/recovery mode set to ON
2	0 – Economy/EnergyStar mode set to OFF 1 – Economy/EnergyStar mode set to ON
3 – 7	Reserved

10.2.3.3.3.7 ThermostatRunningState Attribute

ThermostatRunningState represents the current relay state of the heat, cool, and fan relays.

Table 10.34 HVAC Relay State Values

Bit Number	**Description**
0	Heat State On
1	Cool State On
2	Fan State On
3	Heat 2nd Stage State On
4	Cool 2nd Stage State On
5	Fan 2nd Stage State On
6	Fan 3nd Stage State On
7 – 15	Reserved

10.2.3.3.4 ThermostatSetpointChangeTracking Attribute Set

Table 10.35 Thermostat Setting Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0030	*SetpointChangeSource*	8-bit enumeration	0x00 – 0xff	Read	0x00	O
0x0031	*SetpointChangeAmount*	Signed 16-bit integer	0x0000 – 0xffff	Read	0x8000	O
0x0032	*SetpointChangeSourceTimestamp*	Int32 (UTCTime)	0x00000000 – 0xfffffffe	Read	0x00000000	O

10.2.3.3.4.1 SetpointChangeSource Attribute

The *SetpointChangeSource* attribute specifies the source of the current active *OccupiedCoolingSetpoint* or *OccupiedHeatingSetpoint* (i.e., who or what determined the current setpoint).

SetpointChangeSource attribute enables service providers to determine whether changes to setpoints were initiated due to occupant comfort, scheduled programming or some other source (e.g., electric utility or other service provider). Because automation services may initiate frequent setpoint changes, this attribute clearly differentiates the source of setpoint changes made at the thermostat.

Table 10.36 *SetpointChangeSource* Values

SetpointChangeSource Attribute	Description
0x00	Manual, user-initiated setpoint change via the thermostat
0x01	Schedule/internal programming-initiated setpoint change
0x02	Externally-initiated setpoint change (e.g., DRLC cluster command, attribute write)
0x03 – 0x0ff	Reserved

10.2.3.3.4.2 SetpointChangeAmount Attribute

The *SetpointChangeAmount* attribute specifies the delta between the current active *OccupiedCoolingSetpoint* or *OccupiedHeatingSetpoint* and the previous active setpoint. This attribute is meant to accompany the *SetpointChangeSource* attribute; devices implementing *SetpointChangeAmount* SHOULD also implement *SetpointChangeSource*.

Table 10.37 *SetpointChangeAmount* Values

SetpointChangeAmount Attribute	Description
0x0000 – 0xffff	The signed difference in 0.01 degrees Celsius between the previous temperature setpoint and the new temperature setpoint.

10.2.3.3.4.3 SetpointChangeSourceTimestamp Attribute

The *SetpointChangeSourceTimestamp* attribute specifies the time in UTC at which the *SetpointChangeSourceAmount* attribute change was recorded.

10.2.3.3.5 AC Information Attribute Set

Table 10.38 Attributes of the AC Information Attribute Set

Identifier	Name	Type	Range	Access	Default	M/O
0x0040	*ACType*	8-bit enumeration	0x00 – 0x04	Read/ Write	0x00	O
0x0041	*ACCapacity*	Unsigned 16-bit integer	0x0000 – 0xffff	Read/ Write	0x00	O
0x0042	*ACRefrigerantType*	8-bit enumeration	0x00-0x03	Read/ Write	0x00	O
0x0043	*ACCompressorType*	8-bit enumeration	0x00-0x03	Read/ Write	0x00	O
0x0044	*ACErrorCode*	32-bit bitmap[a]	0x00000000 – 0xffffffff	Read/ Write	0x00000000	O
0x0045	*ACLouverPosition*	8-bit enumeration	0x00 – 0x05	Read/ Write	0x00	O
0x0046	*ACCoilTemperature*	Signed 16-bit integer	0x954d – 0x7fff	Read	-	O
0x0047	*ACCapacityFormat*	8-bit enumeration	0x00 – 0xff	Read/ Write	0x00	O

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10.2.3.3.5.1 AC Type

Indicates the type of Mini Split *ACType* of Mini Split AC is defined depending on how Cooling and Heating condition is achieved by Mini Split AC.

Table 10.39 ***ACType*** **Enumeration**

Enumeration Field Value	Description
0x00	Reserved
0x01	Cooling and Fixed Speed
0x02	Heat Pump and Fixed Speed
0x03	Cooling and Inverter
0x04	Heat Pump and Inverter

10.2.3.3.5.2 ACCapacity

Indicates capacity of Mini Split AC in terms of the format defined by the *ACCapacityFormat* attribute

10.2.3.3.5.3 ACRefrigerantType

Indicates type of refrigerant used within the Mini Split AC.

Table 10.40 ***ACRefrigerantType*** **Enumeration**

Enumeration Field Value	Description
0x00	Reserved
0x01	R22
0x02	R410a
0x03	R407c

10.2.3.3.5.4 ACCompressor Type

This indicates type of Compressor used within the Mini Split AC.

Table 10.41 ***ACCompressorType*** **Enumeration**

Enumeration Field Value	Description
0x00	Reserved
0x01	T1, Max working ambient 43 °C
0x02	T2, Max working ambient 35 °C
0x03	T3, Max working ambient 52°C

10.2.3.3.5.5 ACError Code

This indicates the type of errors encountered within the Mini Split AC. Error values are reported with four bytes values. Each bit within the four bytes indicates the unique error.

Table 10.42 *ACErrorCode* Values

Bit	Value
0	Compressor Failure or Refrigerant Leakage
1	Room Temperature Sensor Failure
2	Outdoor Temperature Sensor Failure
3	Indoor Coil Temperature Sensor Failure
4	Fan Failure
5 – 31	Reserved

10.2.3.3.5.6 ACLouverPosition

This attribute indicates the position of Louver on the AC.

Attributes values are listed below.

Table 10.43 *ACLouverPosition* Values

Louver Position Byte	Value
Fully Closed	0x01
Fully Open	0x02
Quarter Open	0x03
Half Open	0x04
Three Quarters Open	0x05
Reserved	0x06 – 0xFF

10.2.3.3.5.7 ACCoilTemperature Attribute

ACCoilTemperature represents the temperature in degrees Celsius, as measured locally or remotely (over the network) as follows:

- *ACCoilTemperature* = 100 x temperature in degrees Celsius.
- Where -273.15°C <= temperature <= 327.67 ºC, corresponding to a *ACCoilTemperature* in the range 0x954d to 0x7fff.
- The maximum resolution this format allows is 0.01 ºC.
- *ACCoilTemperature* of 0x8000 indicates that the temperature measurement is invalid.

10.2.3.3.5.8 ACCapacity Format

Format for the *ACCapacity* attribute.

Table 10.44 AC Refrigerant Type Enumeration

Enumeration Field Value	Description
0x00	BTUh

10.2.3.4 Server Commands Received

The command IDs for the Thermostat cluster are listed in Table 10.45.

Table 10.45 Server Commands RX Command ID

Command Identifier Field Value	Description
0x00	Setpoint Raise/Lower (no change)
0x01	Set Weekly Schedule
0x02	Get Weekly Schedule
0x03	Clear Weekly Schedule
0x04	Get Relay Status Log
0x05– 0xff	Reserved

10.2.3.4.1 Set Weekly Schedule

10.2.3.4.1.1 Payload Format

The set weekly schedule command payload shall be formatted as shown in Figure 10.49 and 10.50.

Octets	**1(Header)**	**1(Header)**	**1(Header)**	2	2/0	2/0
Data Type	8-bit enumeration	8 bits bitmap	8 bits bitmap	Unsigned 16-bit integer	Signed 16-bit integer	Signed 16-bit integer
Field Name	Number of Transitions for Sequence	Day of Week for Sequence	Mode for Sequence	Transition Time 1	Heat Set Point 1	Cool Set Point 1

Figure 10.49 Set Weekly Schedule Command Payload Format (1 of 2)

Octets	Variable	2	2/0	2/0
Data Type	…	Unsigned 16-bit integer	Signed 16-bit integer	Signed 16-bit integer
Field Name	…	Transition Time 10	Heat Set Point 10	Cool Set Point 10

Figure 10.50 Set Weekly Schedule Command Payload Format (2 of 2)

The set weekly schedule command is used to update the thermostat weekly set point schedule from a management system. If the thermostat already has a weekly set point schedule programmed then it should replace each daily set point set as it receives the updates from the management system. For example if the thermostat has 4 set points for every day of the week and is sent a Set Weekly Schedule command with one set point for Saturday then the thermostat should remove all 4 set points for Saturday and replace those with the updated set point but leave all other days unchanged. If the schedule is larger than what fits in one ZigBee frame or contains more than 10 transitions, the schedule shall then be sent using multiple Set Weekly Schedule Commands.

Each Set Weekly Schedule Command has 3 header bytes – Number of Transitions for Sequence, Day of Week for Sequence & Mode for Sequence. The application shall decode the payload according to what has specified in the 3 header bytes.

10.2.3.4.1.2 Number of Transitions for Sequence

The Number of Transitions for Sequence field indicates how many individual transitions to expect for this sequence of commands. If a device supports more than 10 transitions in its schedule they can send this by sending more than 1 “Set Weekly Schedule” command, each containing the separate information that the device needs to set.

10.2.3.4.1.3 Day of Week for Sequence

This field represents the day of the week at which all the transitions within the payload of the command should be associated to. This field is a bitmap and therefore the associated set point could overlap onto multiple days (you could set one transition time for all “week days” or whatever combination of days the implementation requests). Table 10.46 displays the bitmap values:

Table 10.46 Day Of Week for Sequence Values

Bit Number	Description
0	Sunday
1	Monday
2	Tuesday

Table 10.46 Day Of Week for Sequence Values (Continued)

Bit Number	Description
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Away or Vacation

Each set point transition will begin with the day of week for this transition. There can be up to 10 transitions for each command.

10.2.3.4.1.4 Mode for Sequence

This field determines how the application shall decode the Set Point Fields of each transition for the remaining of the command. This field is a bitmap and the values are presented in Table 10.47.

Table 10.47 Mode for Sequence Values

Bit Number	Description
0	Heat Setpoint Field Present in Payload
1	Cool Setpoint Field Present in Payload

If the Heat Bit is On and the Cool Bit is Off, the Command shall be represented as the following:

Octets	1(Header)	1(Header)	1(Header)	2	2
Data Type	8-bit enumeration	8 bits bitmap	8 bits bitmap	Unsigned 16-bit integer	Signed 16-bit integer
Field Name	Number of Transitions for sequence	Day of Week for Sequence	0x01 (Heat)	Transition Time 1	Heat Set Point 1

Figure 10.51 Set Heat Weekly Schedule Command Payload Format (1 of 2)

Octets	Variable	2	2
Data Type	…	Unsigned 16-bit integer	Signed 16-bit integer
Field Name	…	Transition Time 10	Heat Set Point 10

Figure 10.52 Set Heat Weekly Schedule Command Payload Format (2 of 2)

If the Heat Bit is Off and the Cool Bit is On, the Command shall be represented as the following:

Octets	1(Header)	1(Header)	1(Header)	2	2
Data Type	8-bit enumeration	8 bits bitmap	8 bits bitmap	Unsigned 16-bit integer	Signed 16-bit integer
Field Name	Number of Transitions for Seq	Day of Week for Sequence	0x02 (Cool)	Transition Time 1	Cool Set Point 1

Figure 10.53 Set Cool Weekly Schedule Command Payload Format (1 of 2)

Octets	Variable	2	2
Data Type	…	Unsigned 16-bit integer	Signed 16-bit integer
Field Name	…	Transition Time 10	Cool Set Point 10

Figure 10.54 Set Cool Weekly Schedule Command Payload Format (2 of 2)

If both the Heat Bit and the Cool Bit are On, the Command shall be represented as the following:

Octets	1(Header)	1(Header)	1(Header)	2	2	2
Data Type	8-bit enumeration	8 bits bitmap	8 bits bitmap	Unsigned 16-bit integer	Signed 16-bit integer	Signed 16-bit integer
Field Name	Number of Transitions for sequence	Day of Week for Sequence	0x03 (Head & Cool)	Transition Time 1	Heat Set Point 1	Cool Set Point 1

Figure 10.55 Set Heat & Cool Weekly Schedule Command Payload Format (1 of 2

Octets	Variable	2	2	2
Data Type	…	Unsigned 16-bit integer	Signed 16-bit integer	Signed 16-bit integer
Field Name	…	Transition Time 10	Heat Set Point 10	Cool Set Point 10

Figure 10.56 Set Heat & Cool Weekly Schedule Command Payload Format (2 of 2

At least one of the bits in the Mode For Sequence byte shall be on.

10.2.3.4.1.5 Transition Time Field

This field represents the start time of the schedule transition during the associated day. The time will be represented by a 16 bits unsigned integer to designate the minutes since midnight. For example, 6am will be represented by 0x0168 (360 minutes since midnight) and 11:30pm will be represented by 0x0582 (1410 minutes since midnight)

10.2.3.4.1.6 Heat Set Point Field

If the heat bit is enabled in the *Mode For Sequence* byte, this field represents the heat setpoint to be applied at this associated transition start time. The format of this attribute represents the temperature in degrees Celsius with 0.01 deg C resolution.

10.2.3.4.1.7 Cool Set Point Field

If the cool bit is enabled in the *Mode For Sequence* byte, this field represents the cool setpoint to be applied at this associated transition start time. The format of this attribute represents the temperature in degrees Celsius with 0.01 deg C resolution.

10.2.3.4.1.8 Effect on Receipt

The weekly schedule for updating set points shall be stored in the thermostat and should begin at the time of receipt. A default response shall always be sent as a response. If the total number of transitions sent is greater than what the thermostat supports a default response of INSUFFICIENT_SPACE (0x89) shall be sent in response to the last command sent for that transition sequence. If any of the set points sent in the entire sequence is out of range of what the thermostat supports (AbsMin/MaxSetPointLimit) then a default response of INVALID_VALUE (0x87) shall be sent in return and the no set points from the entire sequence should be used. If the transitions could be added successfully a default response of SUCCESS(0x00) shall be sent. Overlapping transitions is not allowed. If an overlap is detected and a default response of FAILURE(0x01) shall be sent. The

Day of Week for Sequence and Mode for Sequence fields are defined as bitmask for the flexibility to support multiple days and multiple modes within one command. If thermostat cannot handle incoming command with multiple days and/or multiple modes within one command, it shall send default response of INVALID_FIELD (0x85) in return.

10.2.3.4.2 Get Weekly Schedule

Octets	1	1
Data Type	8-bit bitmap	8-bit bitmap
Field Name	Days To Return	Mode To Return

Figure 10.57 Format of the Get Weekly Schedule Command Payload

10.2.3.4.2.1 Days To Return

This field indicates the number of days the client would like to return the set point values for and could be any combination of single days or the entire week. This field has the same format as the Day of Week for Sequence field in the **Set Weekly Schedule command.**

10.2.3.4.2.2 Mode To Return

This field indicates the mode the client would like to return the set point values for and could be any combination of heat only, cool only or heat&cool. This field has the same format as the Mode for Sequence field in the **Set Weekly Schedule command.**

10.2.3.4.2.3 Effect on Receipt

When this command is received the unit should send in return the Current Weekly Schedule command. The Days to Return and Mode to Return fields are defined as bitmask for the flexibility to support multiple days and multiple modes within one command. If thermostat cannot handle incoming command with multiple days and/or multiple modes within one command, it shall send default response of INVALID_FIELD (0x85) in return.

10.2.3.4.3 Clear Weekly Schedule

The Clear Weekly Schedule command is used to clear the weekly schedule. The Clear weekly schedule has no payload

10.2.3.4.3.1 Effect on Receipt

When this command is received, all transitions currently stored shall be cleared and a default response of SUCCESS (0x00) shall be sent in response. There are no error responses to this command.

10.2.3.4.4 Get Relay Status Log

The Get Relay Status Log command is used to query the thermostat internal relay status log. This command has no payload

10.2.3.4.4.1 Effect on Receipt

When this command is received, the unit shall respond with Relay Status Log command if the relay status log feature is supported on the unit.

10.2.3.5 Server Commands Sent

Table 10.48 Server Commands Sent Command ID

Command Identifier Field Value	Description
0x00	Get Weekly Schedule Response
0x01	Get Relay Status Log Response
0x02 – 0xff	Reserved

10.2.3.5.1 Get Weekly Schedule Response

This command has the same payload format as the Set Weekly Schedule. Please refer to the payload detail in Section 10.2.3.4.1, Set Weekly Schedule, of this chapter.

10.2.3.5.2 Get Relay Status Log Response

This command is sent from the thermostat cluster server in response to the Get Relay Status Log. After the Relay Status Entry is sent over the air to the requesting client, the specific entry will be cleared from the thermostat internal log.

10.2.3.5.2.1 Payload Format

The relay status log command payload shall be formatted as shown in Figure 10.58.

Octets	2	2	2	1	2	2
Data Type	Unsigned 16-bit integer	16 bits bitmap	Signed 16-bit integer	Unsigned 8-bit integer	Signed 16-bit integer	Unsigned 16-bit integer
Field Name	Time of Day	Relay Status	Local Temperature	Humidity in Percentage	Set Point	Unread Entries

Figure 10.58 Format of the Relay Status Log Payload

10.2.3.5.2.2 Time of Day Field

Represents the sample time of the day, in minutes since midnight, when the relay status was captured for this associated log entry. For example, 6am will be represented by 0x0168 (360 minutes since midnight) and 11:30pm will be represented by 0x0582 (1410 minutes since midnight).

10.2.3.5.2.3 Relay Status Field

Presents the relay status for thermostat when the log is captured. Each bit represents one relay used by the thermostat. If the bit is on, the associated relay is on and active. Each thermostat manufacturer can create its own mapping between the bitmask and the associated relay.

10.2.3.5.2.4 Local Temperature Field

Presents the local temperature when the log is captured. The format of this attribute represents the temperature in degrees Celsius with 0.01 deg C resolution.

10.2.3.5.2.5 Humidity Field

This field presents the humidity as a percentage when the log was captured.

10.2.3.5.2.6 Setpoint Field

Presents the target setpoint temperature when the log is captured. The format of this attribute represents the temperature in degrees Celsius with 0.01 deg C resolution.

10.2.3.5.2.7 Unread Entries Field

This field presents the number of unread entries within the thermostat internal log system.

10.2.3.6 Client Commands Received

Description is in server side commands sent description.

10.2.3.7 Client Commands Sent

Description is in server side commands received description.

10.3 Thermostat User Interface Configuration Cluster Extensions

This section describes the recommended practices for Thermostat User Interface Configuration Cluster extensions.

10.3.1 Introduction

10.3.1.1 Scope and Purpose

This document provides extensions to the existing thermostat user interface configuration cluster included in the ZigBee Cluster Library specification.

10.3.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.3.2.1 ZigBee Alliance Documents

1. ZigBee Document 053520r26, The ZigBee Alliance Home Automation Profile
2. ZigBee Document 075366r01, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

10.3.3 General Description

This document mirrors the existing Thermostat User Interface Configuration Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.3.3.1 Server Attributes

Table 10.49 Thermostat User Interface Configuration Cluster Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0000 – 0x0001	No Change					
0x0002	*ScheduleProgrammingVisibility*	8-bit enumeration	0x00-0x01	Read / Write	0x00	O

10.3.3.1.1 ScheduleProgrammingVisibility

The *ScheduleProgrammingVisibility* attribute is used to hide the weekly schedule programming functionality or menu on a thermostat from a user to prevent local user programming of the weekly schedule. The schedule programming may still be performed via a remote interface, and the thermostat may operate in schedule programming mode.

This command is designed to prevent local tampering with or disabling of schedules that may have been programmed by users or service providers via a more capable remote interface. The programming schedule SHALL continue to run even though it is not visible to the user locally at the thermostat.

It shall be set to one of the non-reserved values in Table 10.50.

Table 10.50 *ScheduleProgrammingVisibility* Attribute Values

ScheduleProgrammingVisibility **Attribute**	**Description**
0x00	Local schedule programming functionality is enabled at the thermostat
0x01	Local schedule programming functionality is disabled at the thermostat
0x02 – 0xFF	Reserved

10.3.4 Sample Conversion Code

Sample code provided to ensure consistent Fahrenheit to Celsius and vice versa conversion between devices and across vendors.

```
For degF: the value is a int8u representing 2x temperature
value in Farenheit (to get 0.5 resolution).


For degC: the value is a int16s representing Celsius in
0.01 resolution as expected by the ZCL format.
```

```
/*
 * Function   : translateZclTemp()
 * Description: Converts the temperature setpoints in ZCL
 *              to the half degF format.
 *              The half degF format is 8-bit unsigned,
 *              and represents 2x temperature value in
 *              Farenheit (to get 0.5 resolution).
 *              The format used in ZCL is 16-bit signed
 *              in Celsius and multiplied by 100
 *              to get 0.01 resolution.
 *              e.g. 2500(25.00 deg C) ---> 0x9A (77 deg F)
 * Input Para : Temperature in ZCL (degC)format
 * Output Para: Temperature in half DegF format
 */
int8u translateZclTemp(int16s temperature)
{
   int32s x = temperature;
   //rearrangement of
   // = (x * (9/5) / 100 + 32) * 2;
   // the added 250 is for proper rounding.
   // a rounding technique that only works
   // with positive numbers

   return (int8u) ((x*9*2 + 250)/ (5*100) + 64);
}

/*
 * Function   : translateDegFTemp
 * Description: Converts the temperature in DegF
 *              protocol to the format
 *              expected by the cluster attribute
 *              Measured Value in the
 *              Temperature Measurement
 *              Information Attribute Set.
 *              The half deg F format is 8-bit
 *              unsigned, and represents
 *              2x temperature value in
 *              Farenheit (to get 0.5 resolution).
 *              The format expected by cluster
 *              is 16-bit signed in Celsius and
 *              multiplied by 100 to get
 *              0.01 resolution.
 *              e.g. 0x9A(77 deg F) ---> 2500 (25.00 deg C)
 * Input Para : temperature in DegF format
 * Output Para: temperature in ZCL format
 */
int16s translateDegFTemp(int8u temperature)
{
   int32s x = temperature;

   // rearrangement of
   // = 100 * (x/2 - 32) * 5/9
   // *1000 (should be 100), +90, then /10,
   // is for rounding.

   return (int16s) (((x - 64)*5*1000 + 90) / (10*2*9));
}
```

10.4 Level Control Cluster Extensions

This section describes the recommended practices for Home Automation Level Control Cluster extensions.

10.4.1 Introduction

10.4.1.1 Scope and Purpose

This document provides extensions to the existing level control cluster included in the ZigBee Cluster Library specification.

10.4.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.4.2.1 ZigBee Alliance Documents

1. ZigBee Document 053520r26, The ZigBee Alliance Home Automation Profile
2. ZigBee Document 075366r01, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

10.4.3 General Description

This document mirrors the existing Level Control Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.4.3.1 Server Attributes

Table 10.51 Level Control Server Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0010 – 0x0011	No Change					
0x0012	*OnTransitionTime*	Unsigned 16-bit integer	0x0000 – 0xfffe	Read/Write	-	O
0x0013	*OffTransitionTime*	Unsigned 16-bit integer	0x0000 – 0xfffe	Read/Write	-	O
0x0014	*DefaultMoveRate*	Unsigned 8-bit integer	0x00 – 0xFE	Read/Write	-	O

10.4.3.1.1 OnTransitionTime Attribute

The *OnTransitionTime* attribute represents the time taken to move the current level from a value of 0 to a value of 255 when an On command is received by an On/Off cluster on the same endpoint. It is specified in 10ths of a second. If this command is not implemented, or contains a value of 0xffff, the On/*OffTransitionTime* will be used instead.

10.4.3.1.2 OffTransitionTime Attribute

The *OffTransitionTime* attribute represents the time taken to move the current level from a value of 255 to a value of 0 when an Off command is received by an

On/Off cluster on the same endpoint. It is specified in 10ths of a second. If this command is not implemented, or contains a value of 0xffff, the On/*OffTransitionTime* will be used instead.

10.4.3.1.3 DefaultMoveRate Attribute

The *DefaultMoveRate* attribute determines the movement rate, in units per second, when a Move command is received with a Rate parameter of 0xFF.[5]

10.4.3.2 Server Commands Received

The On/Off Cluster Extensions adds a modification to the interpretation of the Rate Field in the Move Command (0x01).

10.4.3.2.1 Rate Field

The Rate field specifies the rate of movement in units per second. The actual rate of movement should be as close to this rate as the device is able. If the Rate field is 0xFF, then the value in *DefaultMoveRate* attribute shall be used. If the Rate field is 0xFF and the *DefaultMoveRate* attribute is not supported, then the device should move as fast as it is able. If the device is not able to move at a variable rate, this field may be disregarded.[6]

Also, when using the transition time parameter in Level Control commands, it is defined as the time it takes for the device to move from its current level to the provided level over the transition time. If a device (say a button) is sending a “Move To Level” with a level of 255 and a rate of 100, this will give you (visually) very different results depending on if the CurrentLevel is at 0 or 128. Or, if you want to transition from 0 to 255 over 8 seconds, but have to stop in the middle, you cannot reissue the same command to resume. You have to read the current level and do calculations to adjust this.

10.5 On/Off Switch Configuration Cluster Extensions

This section describes the recommended practices for Home Automation On/Off Switch Configuration Cluster extensions.

10.5.1 Introduction

10.5.1.1 Scope and Purpose

This document provides extensions to the existing level control cluster included in the ZigBee Cluster Library specification.

[5] CCB 1777

[6] CCB 1777

10.5.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.5.2.1 ZigBee Alliance Documents

1. ZigBee Document 053520r26, The ZigBee Alliance Home Automation Profile
2. ZigBee Document 075366r01, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

10.5.3 General Description

This document mirrors the existing On/Off Switch Configuration Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.5.4 SwitchType Attribute

SwitchType attribute value 0x02 indicates a multi-function switch. Multi-function switch does more than just toggle or momentary functionality.

Table 10.52 Values for the *SwitchType* Attribute

***SwitchType* Attribute Value**	**Description**	**Details**
0x00 – 0x01	No Change	
0x02	Multi-Function	A switch that behaves differently depending on user input. Under some conditions it may send a toggle or in some other conditions a move command. The behavior of the switch is application-specific but the nature of the switch is clear, it is a multi-function switch.

10.6 Over the Air Bootload Cluster Extensions

10.6.1 Overview

The over-the-air (OTA) bootload cluster provides a common mechanism to manage and serve up upgrade images for devices from different manufacturers in the same network. Servers provide firmware images to clients to download, controlling the timing for downloads and when the actual upgrade to a new version of software ism a de. Clients periodically query the server for new images and then can download the image at a rate according to their capabilities or policies.

Details for the over-the-air bootload cluster are maintained in a separate document, reference [095264r19].

Home Automation devices may optionally support the over-the-air bootload cluster client or server.

10.6.2 OTA Bootloading Timing Considerations

The OTA cluster defines the message formatting used to pass device images but does not specify when to use the cluster. The following policies specify how and when to use the OTA cluster such that all devices in an SE network will upgrade at predictable intervals.

OTA clients shall perform service discovery to find the OTA server after registration has completed.

1 OTA clients SHALL perform service discovery to find the OTA server after registration has completed.

2 OTA client device that does not find an OTA server in the network SHALL periodically attempt a new discovery once a day.

3 All devices SHALL query the OTA server at least once a day for information about the next version to upgrade to. Non-sleepy devices in the network may be instructed to begin a new download at any point time via the Image Notify command.

4 All client devices may download data as quickly as their capabilities allow, but at a minimum rate of one block per 10 minutes. This means that at a rate of 1block (50 bytes) per 10 minutes, a 128k file will take 18 days to download.

5 Upon rebooting the device shall determine if it is already joined into the network. If it is joined into a network and has the OTA client cluster it SHALL send a OTA Cluster Query Next Image Command to the server. This command shall be sent at some random point within the first 5 minutes.

10.7 IAS Zone Cluster Extensions

10.7.1 Introduction

10.7.1.1 Scope and Purpose

This document describes the proposed addition to the Home Automation specification and the ZigBee Cluster Library for the IAS Zone cluster. The existing attributes and enumerations do not meet Underwriters Laboratory requirements for IASes. This proposal would add attributes and commands to meet these requirements.

Note: *These Cluster Extensions are provisionary and not certifiable. This feature set may change before reaching certifiable status in a future revision of this specification.*

10.7.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.7.2.1 ZigBee Alliance Documents

1. ZigBee Document 075366r03, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.
2. ZigBee Document 120409r00, IAS Zone Alarm Cluster Change Proposal

10.7.3 General Description

This document mirrors the existing IAS Zone Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.7.4 Server

10.7.4.1 Dependencies

No change to existing spec.

10.7.4.2 Attributes

10.7.4.2.1 Zone Information Attribute Set

No change to existing spec.

10.7.4.2.1.1 ZoneStatus Attribute

Table 10.53 Values of the *ZoneStatus* Attribute

***ZoneStatus* Attribute Bit Number**	**Meaning**	**Values**
0 – 7	No Change	
8	Test	1 – Sensor is in test mode 0 – Sensor is in operation mode
9	Battery Defect	1 – Sensor detects a defective battery 0 – Sensor battery is functioning normally
10 – 15	Reserved	

10.7.4.2.2 Zone Settings Attribute Set

Table 10.54 Zone Settings Attribute Set

Identifier	**Name**	**Type**	**Range**	**Access**	**Default**	**M/O**
0x0010	No Change					
0x0011	*Zone ID*	Unsigned 8-bit integer	0x00 – 0xFF	Read-only	0xFF	M

10.7.4.2.2.1 *ZoneID* Attribute

A unique reference number allocated by the CIE at zone enrollment time.

Used by IAS devices to reference specific zones when communicating with the CIE. The *ZoneID* of each zone stays fixed until that zone is un-enrolled.

10.7.4.3 Commands Generated

10.7.4.3.1 Zone Status Change Notification

10.7.4.3.1.1 Payload Format

Figure 10.59 Format of the Zone Status Change Notification Command Payload

Bits	16	8	8	16
Data Type	16-bit Bitmap*	8-bit Bitmap*	Unsigned 8-bit integer	Unsigned 16-bit integer
Field Name	Zone Status	Extended Status	Zone ID	Delay

*Currently, ZCL incorrectly describes Zone Status and Extended Status as an enumerated attribute. Corrected figure text to bitmap for this command payload.

10.7.4.3.1.2 Zone Status Parameter

The Zone Status field shall be the current value of the *ZoneStatus* attribute.

10.7.4.3.1.3 Extended Status Parameter

The Extended Status field is reserved for additional status information and shall be set to zero.

10.7.4.3.1.4 Zone ID Parameter

Zone ID is the index of the Zone in the CIE's zone table (Table 8.11 in document [B2], the ZigBee Cluster List document). If none is programmed, the Zone ID default value SHALL be indicated in this field.

10.7.4.3.1.5 Delay Parameter

The Delay field is defined as the amount of time, in quarterseconds, from moment when a change takes place in one or more bits of the *ZoneStatus* attribute and the successful transmission of the Zone Status Change Notification. This is designed to help congested networks or offline servers quantify the amount of time from when an event was detected and when it could be reported to the client.

10.8 IAS ACE Cluster Extensions

10.8.1 Introduction

10.8.1.1 Scope and Purpose

This document describes the proposed addition to the Home Automation specification and the ZigBee Cluster Library for the IAS ACE cluster. The existing attributes and enumerations do not meet Underwriters Laboratory requirements for ACEs and lack certain features that service providers require. This proposal would add attributes and commands to meet these requirements.

Note: *These Cluster Extensions are provisionary and not certifiable. This feature set may change before reaching certifiable status in a future revision of this specification.*

10.8.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.8.2.1 ZigBee Alliance Documents

1. ZigBee Document 075366r03, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

10.8.3 General Description

This document mirrors the existing IAS ACE Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.8.4 Server

10.8.4.1 Dependencies

No change to existing spec.

10.8.4.2 Attributes

No change to existing spec.

10.8.4.3 Commands Received

10.8.4.3.1 Arm Command

10.8.4.3.1.1 Payload Format

Bits	8	64	8
Data Type	8-bit enumeration	UTF-8 String	Unsigned 8-bit integer
Field Name	Arm Mode	Arm/Disarm Code	Zone ID

Figure 10.60 Format of the Arm Command Payload

10.8.4.3.1.2 Arm Mode Parameter

No change to existing spec.

10.8.4.3.1.3 Arm/Disarm Code Parameter

The Arm/Disarm Code SHALL be a code entered into the ACE client (e.g., security keypad) or system by the user upon arming/disarming. The server MAY validate the Arm/Disarm Code received from the ACE client in Arm command payload before arming or disarming the system. If the client does not have the capability to input an Arm/Disarm Code (e.g., keyfob) or the system does not require one, the client SHALL transmit the default value “00000000”.

If the ACE client (e.g., security keypad) does not support eight character codes, it SHALL preface the code with zeros (e.g., “00001234”, “00ABCDEF”).

10.8.4.3.1.4 Zone ID Parameter

Zone ID is the index of the Zone in the CIE's zone table (Table 8.11 in document [B2], the ZigBee Cluster List document). If none is programmed, the Zone ID default value SHALL be indicated in this field.

10.8.4.4 Commands Generated

Table 10.55 Commands Added[a]

Command	**Command ID**
Zone Status Changed	0x07
Panel Status Changed	0x08

a. CCB 1779

10.8.4.4.1 Arm Response Command

10.8.4.4.1.1 Payload Format

No change to the existing specification.

10.8.4.4.1.2 Arm Notification Field

The Arm Notification Field shall one of the values shown in Table 10.56.

Table 10.56 Arm Notification Values

Arm Mode Attribute Value	Meaning
0x00 – 0x03	No change
0x04	Invalid Arm/Disarm Code
0x05-0xfe	Reserved

10.8.4.4.2 Zone Status Changed Command

This command updates ACE clients in the system of changes to zone status recorded by the ACE server (e.g., IAS CIE device).

10.8.4.4.2.1 Payload Format

The Zone Status Changed Command shall be formatted as illustrated in Figure 10.61.

Bits	8	16	128
Data Type	Unsigned 8-bit integer	16-bit enumeration	UTF-8 String
Field Name	Zone ID	Zone Status	Zone Label

Figure 10.61 Format of the Zone Status Changed Command Payload

10.8.4.4.2.2 Zone ID Parameter

The index of the Zone in the CIE's zone table (Table 8.11 in document [B2], the ZigBee Cluster List document). If none is programmed, the *ZoneID* attribute default value SHALL be indicated in this field.

10.8.4.4.2.3 Zone Status Parameter

The current value of the *ZoneStatus* attribute.

10.8.4.4.2.4 Zone Label Parameter

The first 16 bytes of the *ZoneLabel* attribute programmed into the AES client during installation or other programming step. If none is programmed, the *ZoneLabel* default value SHALL be indicated in this field.

10.8.4.4.3 Panel Status Changed Command

This command updates ACE clients in the system of changes to panel status recorded by the ACE server (e.g., IAS CIE device).

10.8.4.4.3.1 Payload Format

The Panel Status Changed Command shall be formatted as illustrated in Figure 10.62.

Bits	8	8
Data Type	8-bit enumeration	Unsigned 8-bit integer
Field Name	Panel Status	Seconds Remaining

Figure 10.62 Format of the Panel Status Changed Command Payload

10.8.4.4.3.2 PanelStatus Parameter

The *PanelStatus* parameter shall be formatted as illustrated in Table 10.57.

Table 10.57 *PanelStatus* Field Values

***PanelStatus* Enumerations**	**Description**
0x00	Panel disarmed (all zones disarmed) and ready to arm
0x01	Armed stay
0x02	Armed night
0x03	Armed away
0x04	Exit delay
0x05	Entry delay
0x06	Not ready to arm
0x07 – 0xFF	Reserved

10.8.4.4.3.3 SecondsRemaining Parameter

Indicates the number of seconds remaining for the server to be in the state indicated in the *PanelStatus* parameter.

The *SecondsRemaining* parameter SHALL be provided if the *PanelStatus* parameter has a value of 0x04 (Exit delay) or 0x05 (Entry delay).

The default value SHALL be 0x00.

10.9 IAS WD Cluster Extensions

10.9.1 Introduction

10.9.1.1 Scope and Purpose

This document describes the proposed addition to the Home Automation specification and the ZigBee Cluster Library for the IAS WD cluster. The existing attributes and enumerations lack certain features that service providers require. This proposal would add attributes and commands to meet these requirements.

10.9.2 References

The following standards and specifications contain provisions, which through reference in this document constitute provisions of this specification. All the standards and specifications listed are normative references. At the time of publication, the editions indicated were valid. All standards and specifications are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specifications indicated below.

10.9.2.1 ZigBee Alliance Documents

1. ZigBee Document 075366r03, The ZigBee Cluster Library – this document describes the ZigBee Cluster Library framework and it is essential that it be understood in order to use this cluster definition document.

10.9.3 General Description

This document mirrors the existing IAS WD Cluster in the ZigBee Cluster Library Specification. The following heading numbers are used to reference the actual sections in the Cluster Library Specification document.

10.9.4 Server

10.9.4.1 Dependencies

No change to existing spec.

10.9.4.2 Attributes

No change to existing spec.

10.9.4.3 Commands Received

10.9.4.3.1 Start Warning Command

10.9.4.3.1.1 Payload Format

The Start Warning command payload shall be formatted as illustrated in Figure 10.63.

Bits	4	2	2	16	8	8
Data Type	6-bit Bitmap		32-bit enumeration	Unsigned 16-bit integer	Unsigned 8-bit integer	8-bit enumeration
Field Name	Warning mode	Strobe	Siren Level	Warning duration	Strobe duty cycle	Strobe level

Figure 10.63 Format of the Start Warning Command Payload

The Warning mode, Strobe, and Siren Level subfields are concatenated together to a single byte. The groups of bits these subfields occupy are used as follows.

10.9.4.3.1.2 Warning Mode Field

No change to existing spec.

10.9.4.3.1.3 Strobe Field

No change to existing spec.

10.9.4.3.1.4 Siren Level Field

Indicates the intensity of audible squawk sound as shown in Table 10.58.

Table 10.58 Siren Level Field Values

***SirenLevel* Enumerations**	**Description**
0x0	Low level sound
0x1	Medium level sound
0x2	High level sound
0x3	Very High level sound

Note: If a siren level is 0x3 (very high level sound), and the siren only allows a high level sound, then start warning with SirenLevel = 0x2 (high).

10.9.4.3.1.5 Warning Duration Field

No change to existing spec.

10.9.4.3.1.6 Strobe Duty Cycle Field

Indicates the length of the flash cycle. This provides a means of varying the flash duration for different alarm types (e.g., fire, police, burglar). Valid range is 0-100 in increments of 10. All other values shall be rounded to the nearest valid value. Strobe SHALL calculate duty cycle over a duration of one second. The ON state shall precede the OFF state. For example, if Strobe Duty Cycle Field specifies “40”, then the strobe SHALL flash ON for 4/10ths of a second and then turn OFF for 6/10ths of a second.

The default value for this field SHALL be 0x00.

10.9.4.3.1.7 Strobe Level Field

Indicates the intensity of the strobe as shown in Table 10.59. This attribute is designed to vary the output of the strobe (i.e., brightness) and not its frequency, which is detailed in Section 10.9.4.3.1.6, Strobe Duty Cycle Field.

Table 10.59 Strobe Level Field Values

***StrobeLevel* Enumerations**	**Description**
0x00	Low level strobe
0x01	Medium level strobe
0x02	High level strobe
0x03	Very High level strobe
0x04 – 0xFF	Reserved

10.10 Power Configuration Cluster Extensions

10.10.1 Power Configuration Cluster Attribute Set

Table 10.60 Power Configuration Cluster Attribute Set

Attribute Set Identifier	**Description**
0x000 – 0x003	No change
0x004	Battery Source 2 Information
0x005	Battery Source 2 Settings

Table 10.60 Power Configuration Cluster Attribute Set (Continued)

Attribute Set Identifier	Description
0x006	Battery Source 3 Information
0x007	Battery Source 3 Settings
0x008 – 0xfff	Reserved

10.10.2 BatteryInformationAttribute Set

Table 10.61 Battery Information Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0020	No Change					
0x0021	*BatteryPercentageRemaining*	Unsigned 8-bit integer	0x00-0xff	Read-only	0	O

Manufacturers SHOULD measure the battery voltage and capacity at a consistent moment (e.g., the moment of radio transmission (i.e., peak demand) in order to avoid unnecessary fluctuation in reporting the attribute, which can confuse users and make them call into question the quality of the device.

Manufacturers SHOULD employ a hysteresis algorithm appropriate for their battery type in order to smooth battery reading fluctuations and avoid sending multiple battery warning messages when crossing the voltage thresholds defined for warnings.

10.10.2.1 BatteryPercentageRemaining Attribute

Specifies the remaining battery life as a half integer percentage of the full battery capacity (e.g., 34.5%, 45%, 68.5%, 90%) with a range between zero and 100%, with 0x00 = 0%, 0x64 = 50%, and 0xC8 = 100%. This is particularly suited for devices with rechargeable batteries.

The value 0xff indicates an invalid or unknown reading.

This attribute SHALL be configurable for attribute reporting.

10.10.3 Battery Settings Attribute Set

Table 10.62 Battery Settings Attributes

Identifier	Name	Type	Range	Access	Default	M/O
0x0030 – 0x0036	No change					
0x0037	*BatteryVoltageThreshold1*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x0038	*BatteryVoltageThreshold2*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x0039	*BatteryVoltageThreshold3*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x003a	*BatteryPercentageMinThreshold*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x003b	*BatteryPercentageThreshold 1*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x003c	*BatteryPercentageThreshold 2*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x003d	*BatteryPercentageThreshold 3*	Unsigned 8-bit integer	0x00 – 0xff	Read * Write	0x00	O
0x003e	*BatteryAlarmState*	32-bit Bitmap	0x00… x	Read	0x000… 0	O
0x003f	Reserved					

10.10.3.1 BatteryAlarmMask Attribute

The *BatteryAlarmMask* attribute specifies which battery alarms must be generated, as listed in Table 10.63. A “1” in each bit position enables the alarm.

Table 10.63 Values of the *BatteryAlarmMask* Attribute

BatteryAlarmMask* Attribute Bit Number	**Description**
0	Battery voltage too low to continue operating the device's radio (i.e., BatteryVoltageMinThreshold value has been reached)
1	Battery Alarm 1 (i.e., Battery Voltage Threshold 1 or Battery Percentage Threshold 1 value has been reached)
2	Battery Alarm 2 (i.e., Battery Voltage Threshold 2 or Battery Percentage Threshold 2 value has been reached)
3	Battery Alarm 3 (i.e., Battery Voltage Threshold 3 or Battery Percentage Threshold 3 value has been reached)
4 – 7	Reserved

Manufacturers are responsible for determining the capability to sense and levels at which the alarms are generated. See Section 10.3.2, References for additional recommendations on measuring battery voltage.

10.10.3.2 BatteryVoltageMinThreshold Attribute

Specifies the low battery percentage alarm threshold, measured in percentage (i.e., zero to 100%), for the *BatteryPercentageRemaining* attribute at which the device can no longer operate or transmit via ist radio (i.e., last gasp).

If the value of *BatteryVoltage* drops below the threshold specified by *BatteryVoltageMinThreshold*, an appropriate alarm shall be generated and/or the corresponding bit shall be updated in the *BatteryAlarmState* attribute.

In order to report to Power Configuration clients, servers that implement *BatteryVoltageMinThreshold* attribute SHALL implement alarming via the Alarm Cluster, attribute reporting via the *BatteryAlarmState* attribute, or both.

For servers that implement alarming via the Alarm Cluster, the appropriate alarm is specified in the Alarm Code field (see 3.11.2.3.1) included in the generated alarm SHALL be one of the values in Table 10.64. The host determines which alarm code to populate based on the *BatteryAlarmMask* attribute and the *BatteryVoltageMinThreshold* attribute reached. For example, when the *BatteryVoltage* attribute reaches the value specified by the *BatteryVoltageMinThreshold* attribute, an alarm with the Alarm Code Field Enumeration "0x10" SHALL be generated.

For servers that implement battery alarm reporting via the *BatteryAlarmState* attribute, the bit corresponding to the threshold level reached shall be set to TRUE. See the *BatteryAlarmState* attribute details for more information.

Table 10.64 Alarm Code Field Enumerations for Battery Alarms

Alarm Code Field Enumerations	Description
0x10	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 1
0x11	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 1
0x12	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached for Battery Source 1
0x13	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached for Battery Source 1
0x14 – 0x19	Reserved
0x20	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 2
0x21	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 2
0x22	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached Battery Source 2
0x23	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached Battery Source 2
0x24 – 0x29	Reserved
0x30	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 3
0x31	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 3
0x32	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached Battery Source 3
0x33	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached Battery Source 3
0x34 – 0xfe	Reserved
0xff	Alarm shall not be generated

10.10.3.3 BatteryVoltageThreshold 1-3 Attributes

Specify the low voltage alarm thresholds, measured in units of 100mV, for the *BatteryVoltage* attribute.

If the value of *BatteryVoltage* drops below the threshold specified by a *BatteryVoltageThreshold*, an appropriate alarm SHALL be generated and/or the corresponding bit SHALL be updated in the *BatteryAlarmState* attribute.

The *BatteryVoltageThreshold1-3* attributes SHALL be ordered in ascending order such that the *BatteryVoltage* level specified to trigger:

- *BatteryVoltageThreshold3* is higher than the level specified to trigger *BatteryVoltageThreshold2*
- *BatteryVoltageThreshold2* is higher than the level specified to trigger *BatteryVoltageThreshold1*
- *BatteryVoltageThreshold1* is higher than the level specified to trigger *BatteryVoltageMinThreshold*

The appropriate alarm is specified in the Alarm Code field (see 3.11.2.3.1) included in the generated alarm SHALL be one of the values in Table 10.64. The host determines which alarm code to populate based on the *BatteryAlarmMask* attribute and the *BatteryVoltageThreshold1-3* attribute reached.

If this attribute takes the value 0xff then this alarm shall not be generated.

10.10.3.4 BatteryPercentageMinThreshold Attribute

Specifies the low battery percentage alarm threshold, measured in percentage (i.e., zero to 100%), for the *BatteryPercentageRemaining* attribute (see sub-clause 10.10.2.1).

If the value of *BatteryPercentageRemaining* drops below the threshold specified by a *BatteryPercentageThreshold*, an appropriate alarm shall be generated.

The appropriate alarm is specified in the Alarm Code field (see table 3.11.2.3.1 in document [B2], the ZigBee Custer List) included in the generated alarm SHALL be the value in Table 10.64 that corresponds with this threshold being reached for a given battery source. The host determines which alarm code to populate based on the *BatteryAlarmMask* attribute.

If this attribute takes the value 0xff then this alarm shall not be generated.

10.10.3.5 BatteryPercentageThreshold 1-3 Attributes

Specify the low battery percentage alarm thresholds, measured in percentage (i.e., zero to 100%), for the *BatteryPercentageRemaining* attribute (see sub-clause 10.10.2.1).

If the value of *BatteryPercentageRemaining* drops below the threshold specified by a *BatteryPercentageThreshold*, an appropriate alarm shall be generated.

The *BatteryPercentageThreshold1-3* attributes SHALL be ordered in ascending order such that the *BatteryPercentageRemaining* level specified to trigger:

- *BatteryPercentageThreshold3* is higher than the level specified to trigger *BatteryPercentageThreshold2*
- *BatteryPercentageThreshold2* is higher than the level specified to trigger *BatteryPercentageThreshold1*
- *BatteryPercentageThreshold1* is higher than the level specified to trigger *BatteryPercentageMinThreshold*

The appropriate alarm is specified in the Alarm Code field (see 3.11.2.3.1) included in the generated alarm SHALL be one of the values in Table 10.64. The host determines which alarm code to populate based on the *BatteryAlarmMask* attribute and the *BatteryPercentageThreshold1-3* attribute reached.

If this attribute takes the value 0xff then this alarm shall not be generated.

10.10.3.6 BatteryAlarmState Attribute

Specifies the current state of the device's battery alarms. This attribute provides a persistent record of a device's battery alarm conditions as well as a mechanism for reporting changes to those conditions, including the elimination of battery alarm states (e.g., when a battery is replaced).

If implemented, the server SHALL support attribute reporting for *BatteryAlarmState* attribute. This provides clients with a mechanism for reading the current state in case they missed the initial attribute report and also reduces network and battery use due to repeated polling of this attribute when it has not changed. It also provides a way of notifying clients when battery alarm conditions no longer exist (e.g., when the batteries have been replaced).

Table 10.65 *BatteryAlarmState* Enumerations

Bit	Description
0	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 1
1	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 1
2	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached for Battery Source 1

Table 10.65 *BatteryAlarmState* Enumerations (Continued)

Bit	Description
3	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached for Battery Source 1
4 – 9	Reserved
10	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 2
11	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 2
12	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached Battery Source 2
13	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached Battery Source 2
14 – 19	Reserved
20	BatteryVoltageMinThreshold or BatteryPercentageMinThreshold reached for Battery Source 3
21	BatteryVoltageThreshold1 or BatteryPercentageThreshold1 reached for Battery Source 3
22	BatteryVoltageThreshold2 or BatteryPercentageThreshold2 reached Battery Source 3
23	BatteryVoltageThreshold3 or BatteryPercentageThreshold3 reached Battery Source 3
24 – 31	Reserved

Manufacturers are responsible for determining the capability to sense and levels at which the alarms are generated. See10.10.2 for additional recommendations on measuring battery voltage.

10.10.4 Battery Information 2 Attribute Set

This attribute set is an exact replica of all the attributes, commands, and behaviors contained within the Battery Information Attribute Set and provides a host with the ability to represent battery information for a secondary battery bank or cell.

10.10.5 Battery Settings 2 Attribute Set

This attribute set is an exact replica of all the attributes, commands, and behaviors contained within the Battery Settings Attribute Set and provides a host with the ability to represent battery settings for a secondary battery bank or cell.

10.10.6 Battery Information 3 Attribute Set

This attribute set is an exact replica of all the attributes, commands, and behaviors contained within the Battery Information Attribute Set and provides a host with the ability to represent battery information for a tertiary battery bank or cell.

10.10.7 Battery Settings 3 Attribute Set

This attribute set is an exact replica of all the attributes, commands, and behaviors contained within the Battery Settings Attribute Set and provides a host with the ability to represent battery settings for a tertiary battery bank or cell.

CHAPTER 11

HOME AUTOMATION CCBs

This chapter describes the new Home Automation ZigBee Cluster Library CCBs that shall be applied when developing an HA application.

11.1 CCB #1169

Clarification of the Thermostat cluster.

The following attributes sets the limits to other attributes that are mandatory. If the limits are different than the default value, the attributes shall be included.

• 0x0015	*MinHeatSetpoint* Limit
• 0x0016	*MaxHeatSetpoint* Limit
• 0x0017	*MinCoolSetpoint* Limit
• 0x0018	*MaxCoolSetpoint* Limit
• 0x0019	*MinSetPointDead* Band

11.2 CCB #1097

ZCL Default response clarification.

Table 11.1 ZCL Default Response Clarification

Frame Type	MSP	Description	Range
00 = command acts on entire profile	0 = not manufacturer-specific	This set of commands is described in the ZCL spec in the section "General Command Frames". These commands read, write, report, etc. for clusters described in the ZCL spec.	1
00 = command acts on entire profile	1 = manufacturer-specific	This set of commands is described in the ZCL spec in the section "General Command Frames". These commands read, write, report, etc. for manufacturer-specific clusters that are not described in the ZCL spec, or for manufacturer-specific attributes of clusters that are described in the ZCL spec. See notes below.	2
01 = command is specific to a cluster	0 = not manufacturer-specific	These commands are described in the individual cluster sections within the ZCL spec or within the application profiles (when clusters have been defined or extended within these specs).	3
01 = command is specific to a cluster	1 = manufacturer-specific	This range of commands is reserved for manufacturer-specific commands defined by a particular manufacturer. The meaning of the command is interpreted using the manufacturer code and these commands should be ignored by a device that does not recognize the manufacturer code. See notes below	4

Range 2: Any response to a command in this range should have the manufacturer bit set and use the same manufacturer ID as the original command.

For instance, if a command is not understood, the response will be a default response with status set to ZCL_UNSUP_MANUF_GENERAL_COMMAND, with frame control set to "00 = command acts on entire profile" and manufacturer bit set to "1 = manufacturer-specific" and it will use the same manufacturer ID as the original command

Range 4: Any response to a command in this range should have the manufacturer bit set and use the same manufacturer ID as the original command.

For instance, if a command is not understand, the response will be a default response with status set to ZCL_UNSUP_MANUF_CLUSTER_COMMAND, with frame control set to "01 = command is specific to a cluster" and manufacturer bit set to "1 = manufacturer-specific" and it will use the same manufacturer ID as the original command

Notes: *If a manufacturer wishes to invent manufacturer-specific commands, these should be in range 4 ("command is specific to a cluster" and "manufacturer-specific"). It is not allowed to create new commands in range 1 or 3. It is not recommended to create new commands in range 2 ("command acts on the entire profile" and "manufacturer-specific") since the command IDs cannot be differentiated by the manufacturing code (a manufacturer-specific command here* *means manufacturer-specific attributes). If a new command is created in range 2, it cannot overlap with any existing command IDs and will cause confusion if it overlaps with future command IDs.*

11.3 CCB #1092

Correction to the ZCL spec 075123r02 Section: 4.8 (Occupancy Sensing Cluster) changes are in bold

- 4.8.2.2.2.1 *PIROccupiedToUnoccupiedDelay* Attribute

The *PIROccupiedToUnoccupiedDelay* attribute is 8-bits in length and specifies the time delay, in seconds, before the PIR sensor changes to its unoccupied state when the sensed area becomes **unoccupied**. This attribute, along with PIRUnoccupiedToOccupiedTime, may be used to reduce sensor 'chatter' when used in an area where occupation changes frequently.

- 4.8.2.2.2.2 *PIRUnoccupiedToOccupiedDelay* Attribute

The *PIRUnoccupiedToOccupiedDelay* attribute is 8-bits in length and specifies the time delay, in seconds, before the PIR sensor changes to its **occupied** state when the sensed area becomes occupied.

- 4.8.2.2.3.1 *UltraSonicOccupiedToUnoccupiedDelay* Attribute

The *UltraSonicOccupiedToUnoccupiedDelay* attribute specifies the time delay, in seconds, before the ultrasonic sensor changes to its **unoccupied** state when the sensed area becomes unoccupied. This attribute, along with *UltraSonicUnoccupiedToOccupiedTime*, may be used to reduce sensor ‘chatter’ when used in an area where occupation changes frequently.

- 4.8.2.2.3.2 *UltraSonicUnoccupiedToOccupied Delay* Attribute

The *UltraSonicUnoccupiedToOccupied Delay* attribute specifies the time delay, in seconds, before the ultrasonic sensor changes to its **occupied** state when the sensed area becomes occupied.

11.4 CCB #1093

Additional optional attributes added to the ZCL spec 075123r02 Section: 4.8 (Occupancy Sensing Cluster).

These new attributes, *PIRUnoccupiedToOccupiedThreshold* and *UltraSonicUnoccupiedToOccupiedThreshold* can be used in conjunction with either the *PIRUnoccupiedToOccupiedDelay* or the *UltraSonicUnoccupiedToOccupiedDelay* attributes to reduce false positives (occupancy wrongly detected). In order to properly discount false positives in detection (such as isolated motion triggers not due to a change in occupancy), the sensor device firmware needs to take into account the frequency of occurrence in the detection events, meaning it has to have both a time duration and a number of sensor indications to accurately calculate the rate of occupancy events occurring in the detection region.

Attribute additions:

Name: *PIRUnoccupiedToOccupiedThreshold*
Identifier: 0x0012
Type: Unsigned 8-bit integer
Range: 0x00 – 0xFE
Access: Read/Write
Default: 0x01 (since 0 events over a time period isn't meaningful)
Mandatory/Optional: Optional

Name: *UltraSonicUnoccupiedToOccupiedThreshold*
Identifier: 0x0022
Type: Unsigned 8-bit integer
Range: 0x00 – 0xFE
Access: Read/Write
Default: 0x01 (since 0 events over a time period isn't meaningful)
Mandatory/Optional: Optional

11.5 CCB #1094

Attribute Type changes to the ZCL spec 075123r02 Section: 4.8 (Occupancy Sensing Cluster).

The attributes *PIROccupiedToUnoccupiedDelay* and *UltraSonicOccupiedToUnoccupiedDelay* should be type "Unsigned 16-bit integer" instead of "Unsigned 8-bit integer".

The attributes *PIROccupiedToUnoccupiedDelay* and *UltraSonicOccupiedToUnoccupiedDelay* are used to decide how much inactivity constitutes "No Occupancy". An 8-bit integer quantity in number of seconds is not sufficient for some use cases. This is saying that the maximum amount of time a detection area can be tracked for inactivity is 254 seconds, which is less than 5 minutes. Changing these attributes to 16-bit Unsigned integers, allows a valid range of 0-65535 seconds (over 18 hours) of sensor inactivity before the area is considered Unoccupied.

11.6 CCB #1085

When the Binary Input (Basic) cluster is used for a open/close sensor (contact sensor) the value of *presentValue* attribute needs to be specified so devices can be interoperable.

For a contact sensor the meaning of the *presentValue* attribute is:

1 = Open

0 = Closed

11.7 CCB #1770

Not all whitegoods devices can accept the Execution of a Command command so it should be marked as optional instead of mandatory.

11.8 CCB #1771

Some whitegoods are not able to support Appliance statistics cluster(as validated in HA 1.2 SVE), therefore the Appliance Statistics cluster should be optional for Whitegoods devices.

11.9 CCB #1772

Add the following 4 new sections to the beginning of the door lock cluster (After section 10.1.2.4):

10.1.2.5 Process for creating a new user with schedule The following is the process that the client device SHALL follow for creating a new user with weekday schedule or yearday schedule. The following process should be implemented as an atomic set and should not be broken up. #1 Set Pin Code #2 Set Weekday Schedule or Set Yearday Schedule #3 Set User Type to the desired schedule user type.

10.1.2.6 Process for clearing all schedules for a user The following is the process that the client device SHALL follow for clearing all weekday schedule or all yearday schedule for a user. The following process should be implemented as an atomic set and should not be broken up. #1 Clear All Weekday Schedule or Clear All Yearday Schedule #2 Set User Type to the Unrestricted User Type *Note: If the User Type is not reset to Unrestricted User, the associated user Code (ex: PIN/ RFID) will not have access.

10.1.2.7 Clarification of changing the user type When the user type is changed from a scheduled user to some other user type, the door lock server MAY remove the user's schedule.

10.1.2.8. Clarification for changing the user code When changing the user code, the server SHALL not require that the user code be removed first.

Insert the following text to the end of both (10.1.2.15.16 Set Year Day Schedule) & (10.1.2.15.13 Set Week Day Schedule) command sections. When the Server Device receives the command, the Server Device MAY change the user type to the specific schedule user type. Please refer to Section 10.1.2.5 at the beginning of this cluster.

11.10 CCB #1773

The network level multicast is an optional feature in the ZigBee Pro stack. We should only be using APS layer multicasts instead of network level multicasts so that we guarantee that all devices will hear multicasts intended for them. Add a SHALL statement to the network configuration section in the HA spec. Devices in an HA network SHALL NOT use Network Level multicast, instead they SHALL use APS level multicast for all multicast functions. Furthermore all devices in the HA network SHALL have the stack primitive nwkUseMulticast=FALSE.

11.11 CCB #1774

For the Window Covering Cluster Server (Section 9.3.2) in regards to Table 9.21, Attributes 0x0008 and 0x0009 should be Mandatory if device is a “CLOSED” loop, not a "OPEN" loop.

11.12 CCB #1777

The new HA 1.2 spec re-defines the rate field in the Level Control cluster Move command as a time duration, instead of a rate (unit of movement per second). This breaks compatibility with older HA level control devices, and also ZLL devices. Remedy outline: revert the definition of the rate back to be units of movement per second. Replace older text under the mentioned sections with following text: Section 10.4.3.1.3 *DefaultMoveRate* Attribute The *DefaultMoveRate* attribute determines the movement rate, in units per second, when a Move command is received with a Rate parameter of 0xFF Section 10.4.3.2.1 Rate Field The Rate field specifies the rate of movement in units per second. The actual rate of movement should be as close to this rate as the device is able. If the Rate field is 0xFF, then the value in *DefaultMoveRate* attribute shall be used. If the Rate field is 0xFF and the *DefaultMoveRate* attribute is not supported, then the device should move as fast as it is able. If the device is not able to move at a variable rate, this field may be disregarded.

11.13 CCB #1779

Both the commands (Arm and Panel Status Changed) are both *generated* by the Server rather than received. Move the entire contents of the Commands Received section to the Commands Generated section.

11.14 CCB #1780

Commands contain parameters rather than attributes. Calling a parameter "PanelStatus Attribute" is confusing. Rename section header and update section text to refer to "Panel Status parameter”.

11.15 CCB #1782

Update the entire section 9.4.6.3 with the following text: "When the checkin interval attribute is changed (provided that the new value is valid and within acceptable range), the device should reset the internal check in interval timer. And send check-in command according to the new check-in interval value."

11.16 CCB #1783

Add to the end of Section 9.4.5.3 Check-In Response "If the FastPollTimeout parameter in the CheckInResponse command is greater than the *FastPollTimeoutMax* attribute value, the Server Device shall respond with a default response of error status not equal to ZCL_SUCCESS. It is suggested to use the Error Status of ZCL_INVALID_FIELD (0x85).

11.17 CCB# 1790

There is a typo on Line 14246 the ACErrorCode is listed as a Enum32, a type which doesn't exist. From the text explaining the attribute it is clear that the type should be 32 bit bitmap instead.

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CHAPTER 12

DISCOVER COMMANDS

12.1 New Discover Commands

Table 12.1 ZCL Command Frames

Command Identifier Field Value	Description	Reference	M/O
0x00	Read attributes	2.4.1	O
0x01	Read attributes response	2.4.2	M
0x02	Write attributes	2.4.3	O
…	…	…	
0x11	Discover commands received	2.4.18	O
0x12	Discover commands received response	2.4.19	O
0x13	Discover commands generated	2.4.20	O
0x14	Discover commands generated response	2.4.21	O
0x15	Discover attributes extended	2.4.22	O
0x16	Discover attributes extended response	2.4.23	O
0x17 – 0xff	Reserved	-	

12.1.1 Discover Commands Received Command

This command may be used to discover all commands processed (received) by this cluster, including optional or manufacturer-specific commands.

12.1.1.1 Discover Commands Received Command Frame Format

The discover server commands command frame shall be formatted as follows.

Octets: Variable	1	1
ZCL header	Start command identifier	Maximum command identifiers

Figure 12.1 Format of the Discover Server Commands Command Frame

12.1.1.1.1 ZCL Header Fields

The frame control field shall be specified as follows. The frame type sub-field shall be set to indicate a profile wide command (0b00). The manufacturer-specific sub-field shall be set to 0 to discover standard commands in a ZigBee cluster or 1 to discover manufacturer-specific commands in either a standard or a manufacturer-specific cluster. A manufacturer ID in this field of 0xffff (wildcard) will discover any manufacture-specific commands. The direction bit shall be 0 (client to server) to discover commands that the server can process. The direction bit shall be 1 (server to client) to discover commands that the client can process.

The command identifier field shall be set to indicate the discover commands received command (see Table 12.1).

12.1.1.1.2 Start Command Identifier Field

The start command identifier field is 8-bits in length and specifies the value of the identifier at which to begin the command discovery.

12.1.1.1.3 Maximum Command Identifiers Field

The maximum command identifiers field is 8-bits in length and specifies the maximum number of command identifiers that are to be returned in the resulting discover commands received response.

12.1.1.2 When Generated

The discover commands received command is generated when a remote device wishes to discover the optional and mandatory commands the cluster to which this command is sent can process.

12.1.1.3 Effect on Receipt

On receipt of this command, the device shall construct an ordered list of command identifiers. This list shall start with the first command that has an identifier that is equal to or greater than the identifier specified in the start command identifier field. The number of command identifiers included in the list shall not exceed that specified in the maximum command identifiers field.

12.1.2 Discover Commands Received Response

The discover commands received response command is sent in response to a discover commands received command, and is used to discover which commands a particular cluster can process.

12.1.2.1 Discover Commands Received Response Frame

The discover commands received response command frame shall be formatted as shown in Figure 12.2.

Octets: Variable	1	1	1	…	1
ZCL Header	Discovery complete	Command identifier 1	Command identifier 2	…	Command identifier n

Figure 12.2 Format of the Discover Commands Received Response Frame

12.1.2.1.1 ZCL Header Fields

The frame control field shall be specified as follows. The frame type sub-field shall be set to indicate a profile wide command (0b00). The manufacturer-specific sub-field shall be set to the same value included in the original discover commands command, with the exception that if the manufacture ID is 0xffff (wildcard), then the response will contain the manufacture ID of the manufacturer-specific commands, or will not be present if the cluster supports no manufacturer-specific extensions, or the manufacturer wishes to hide the fact that it supports extensions.

The command identifier field shall be set to indicate the discover commands received response command (see Table 12.1).

12.1.2.1.2 Discovery Complete Field

The discovery complete field is a boolean field. A value of 0 indicates that there are more commands to be discovered. A value of 1 indicates that there are no more commands to be discovered.

12.1.2.1.3 Command Identifier Field

The command identifier field shall contain the identifier of a discovered command. Commands shall be included in ascending order, starting with the lowest attribute identifier that is greater than or equal to the start attribute identifier field of the received discover server commands command.

12.1.2.2 When Generated

The discover commands received response is generated in response to a discover commands received command.

12.1.2.3 Effect on Receipt

On receipt of this command, the device is notified of the results of its command discovery request.

Following the receipt of this command, if the discovery complete field indicates that there are more commands to be discovered, the device may choose to send subsequent discover command request commands to obtain the rest of the command identifiers. In this case, the start command identifier specified in the next command discovery request command should be set equal to one plus the last command identifier received in the discover commands received response.

12.1.3 Discover Commands Generated Command

This command may be used to discover all commands which may be generated (sent) by the cluster, including optional or manufacturer-specific commands.

12.1.3.1 Discover Commands Generated Command Frame Format

With the exception of the command ID in the ZCL header, the discover commands generated command frame shall be formatted as described in sub-clause 12.1.1.1 and its subsections.

12.1.3.2 When Generated

The discover commands generated command is generated when a remote device wishes to discover the commands that a cluster may generate on the device to which this command is directed.

12.1.3.3 Effect on Receipt

On receipt of this command, the device shall construct an ordered list of command identifiers. This list shall start with the first command that has an identifier that is equal to or greater than the identifier specified in the start command identifier field. The number of command identifiers included in the list shall not exceed that specified in the maximum command identifiers field.

12.1.4 Discover Commands Generated Response

The discover client commands response command is sent in response to a discover client commands command, and is used to discover which commands a particular cluster supports.

12.1.4.1 Discover Commands Generated Response Frame

With the exception of the command ID in the ZCL header, the discover commands generated command frame shall be formatted as described in sub-clause 12.1.2.1 and its subsections.

12.1.4.2 When Generated

The discover commands generated response is generated in response to a discover commands generated command.

12.1.4.3 Effect on Receipt

On receipt of this command, the device is notified of the results of its command discovery request.

Following the receipt of this command, if the discovery complete field indicates that there are more commands to be discovered, the device may choose to send subsequent discover client command request commands to obtain the rest of the command identifiers. In this case, the start command identifier specified in the next command discovery request command should be set equal to one plus the last command identifier received in the discover commands generated response.

12.1.5 Discover Attributes Extended Command

This command is similar to the discover attributes command, but also includes a field to indicate whether the attribute is readable, writeable or reportable.

12.1.5.1 Discover Attributes Extended Command Frame Format

The discover attributes extended command frame shall be formatted as illustrated as follows.

Octets: Variable	2	1
ZCL Header	Start attribute identifier	Maximum attribute identifiers

Figure 12.3 Format of the Discover Attributes Extended Command Frame

12.1.5.1.1 ZCL Header Fields

The frame control field shall be specified as follows. The frame type sub-field shall be set to indicate a profile wide command (0b00). The manufacturer-specific sub-field shall be set to 0 to discover standard attributes in a ZigBee cluster or 1 to discover manufacturer-specific attributes in either a standard or a manufacturer-specific cluster. A manufacturer ID in this field of 0xffff (wildcard) will discover any manufacture-specific attributes. The direction bit shall be 0 (client to server) to discover attributes that the server hosts. The direction bit shall be 1 (server to client) to discover attributes that the client may host.

The command identifier field shall be set to indicate the discover attributes extended command (see Figure 12.3).

12.1.5.1.2 Start Attribute Identifier Field

The start attribute identifier field is 16-bits in length and specifies the value of the identifier at which to begin the attribute discovery.

12.1.5.1.3 Maximum Attribute Identifiers Field

The maximum attribute identifiers field is 8 bits in length and specifies the maximum number of attribute identifiers that are to be returned in the resulting discover attributes response command.

12.1.5.2 When Generated

The discover attributes extended command is generated when a remote device wishes to discover the identifiers and types of the attributes on a device which are supported within the cluster to which this command is directed, including whether the attribute is readable, writeable or reportable.

12.1.5.3 Effect on Receipt

On receipt of this command, the device shall construct an ordered list of attribute information records, each containing a discovered attribute identifier and its data type, in ascending order of attribute identifiers. This list shall start with the first attribute that has an identifier that is equal to or greater than the identifier specified in the start attribute identifier field. The number of attribute identifiers included in the list shall not exceed that specified in the maximum attribute identifiers field.

12.1.6 Discover Attributes Extended Response Command

This command is sent in response to a discover attribute extended command, and is used to determine if attributes are readable, writable or reportable.

12.1.6.1 Discover Attributes Extended Response Command Frame Format

The discover attributes extended response command frame shall be formatted as illustrated as follows.

Octets: Variable	1	4	4	…	4
ZCL header	Discovery complete	Extended attribute information 1	Extended attribute information 2	…	Extended attribute information n

Figure 12.4 Format of the Discover Attributes Extended Response Command Frame

Each extended attribute information field shall be formatted as follows.

Octets: 2	1	1
Attribute identifier	Attribute data type	Attribute access control

Figure 12.5 Format of the Extended Attribute Information Fields

12.1.6.1.1 ZCL Header Fields

The frame control field shall be specified as follows. The frame type sub-field shall be set to indicate a profile wide command (0b00). The manufacturer-specific sub-field shall be set to the same value included in the original discover commands command, with the exception that if the manufacture ID is 0xffff (wildcard), then the response will contain the manufacture ID of the manufacturer-specific commands, or will not be present if the cluster supports no manufacturer-specific extensions.

The command identifier field shall be set to indicate the discover attributes response command (see Figure 12.4).

12.1.6.1.2 Discovery Complete Field

The discovery complete field is a boolean field. A value of 0 indicates that there are more attributes to be discovered. A value of 1 indicates that there are no more attributes to be discovered.

12.1.6.1.3 Attribute Identifier Field

The attribute identifier field shall contain the identifier of a discovered attribute. Attributes shall be included in ascending order, starting with the lowest attribute identifier that is greater than or equal to the start attribute identifier field of the received discover attributes command.

12.1.6.1.4 Attribute Data Type Field

The attribute data type field shall contain the data type of the attribute in the same attribute report field (see Figure 12.5).

12.1.6.1.5 Attribute Access Control Field

The attribute access control field shall indicate whether the attribute is readable, writable, and/or reportable. This is an 8-bit bitmask field as shown in figure 2.42. The bits are in little endian order (bit 0 is listed first).

Bits:1	1	1	5
Readable	Writeable	Reportable	Reserved

Figure 12.6 Format of the Attribute Access Control Field

12.1.6.2 When Generated

The discover attributes extended response command is generated in response to a discover attributes extended command.

12.1.6.3 Effect on Receipt

On receipt of this command, the device is notified of the results of its extended attribute discovery request.

Following the receipt of this command, if the discovery complete field indicates that there are more attributes to be discovered, the device may choose to send subsequent discover extended attribute request commands to obtain the rest of the attribute identifiers and access control. In this case, the start attribute identifier specified in the next extended attribute discovery request command should be set equal to one plus the last attribute identifier received in the discover attributes extended response command.

CHAPTER 13

GREEN POWER IN HOME AUTOMATION

13.1 Introduction

13.1.1 Scope

This document describes all the best practices aspects related with the Green Power feature usage in HA.

13.1.2 Purpose of the Document

This document describes best practices for Green Power usage in HA networks.

This document is intended as part of HA specification as a referenced document to describe how to configure Green Power feature used in a HA device.

13.2 References

13.2.1 Normative References

13.2.1.1 ZigBee Alliance Documents

[B26] ZigBee document 053474, ZigBee Specification

[B27] ZigBee document 08006, ZigBee-2007 Layer PICS and Stack Profiles

[B28] ZigBee document 075123, ZigBee Cluster Library Specification

[B29] ZigBee document 125474, Home Automation Profile 1.2 Specification

[B30] ZigBee document 094991, Green Power Technical Requirements Document (TRD)

[B31] ZigBee document 105879, Draft CO2 Level Cluster

[B32] ZigBee document 095499, Green Power 1.0 specification

[B33] ZigBee document 105521, Green Power 1.0 test specification

[B34] ZigBee document 105850, Green Power 1.0 PICS

[B35] ZigBee document 053874, ZigBee Manufacturer Code Database

[B36] ZigBee document 106138, Recommendation for ZigBee PRO Interoperability Across Profiles

[B37] ZigBee document 120177, EZ- Mode Commissioning

13.2.1.2 ISO / IEEE Standards Documents

[B38] Institute of Electrical and Electronics Engineers, Inc., IEEE Std. 802.15.4 2003, IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low Rate Wireless Per-sonal Area Networks (WPANs). New York: IEEE Press. 2003

[B39] FIPS Pub 198, The Keyed-Hash Message Authentication Code (HMAC), Federal Information Pro-cessing Standards Publication 198, US Department of Commerce/N.I.S.T., Springfield, Virginia, March 6, 2002. Available from http://csrc.nist.gov/.

13.2.2 Informative References

13.2.2.1 ZigBee Alliance Documents

[B40] ZigBee document 105859, Draft ZigBee Building Automation Profile Specification

[B41] ZigBee document 11196, GP best practices for ZBA

13.3 Definitions

13.3.1 Conformance Levels

Expected: A key word used to describe the behavior of the hardware or software in the design models assumed by this profile. Other hardware and software design **models may also be implemented.**

May: A key word indicating a course of action permissible within the limits of the **standard (may equals is permitted).**

Shall: A key word indicating mandatory requirements to be strictly followed in order to conform to the standard; deviations from shall are prohibited (shall equals is required to).

Should: 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 (should equals is rec-ommended that).

13.3.2 Conventions

13.3.2.1 Number Formats

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

13.3.2.2 Transmission Order

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

13.3.2.3 Reserved Values

Unless otherwise specified, all reserved fields appearing in a frame structure shall be set to zero on transmission and ignored upon reception. Reserved values appearing in multi-value fields shall not be used.

13.3.3 ZigBee Definitions

Attribute: A data entity which represents a physical quantity or state. This data is communicated to other devices using commands.

Cluster: A collection of related attributes and commands, which together define a communications interface between two devices. The devices implement server and client sides of the interface respectively.

Cluster Identifier: A 16-bit number unique within the scope of an application profile which identifies a specific cluster.

Device: A device consists of one or more ZigBee device descriptions and their corresponding application profile(s), each on a separate endpoint, that share a single 802.15.4 radio (see [12]). Each device has a unique 64-bit IEEE address.

Device Description: A collection of clusters and associated functionality implemented on a ZigBee endpoint. Device descriptions are defined in the scope of an application profile. Each device description has a unique identifier that is exchanged as part of the discovery process.

Node: Same as a device.

Product: A product is a unit that is intended to be marketed. It may implement a combination of private, published, and standard application profiles.

Trust Center: The device trusted by devices within a ZigBee network to distribute keys for the purpose of network and end-to-end application configuration management (see [1]).

ZigBee Coordinator: An IEEE 802.15.4-2003 PAN coordinator (see [12]).

ZigBee End Device: An IEEE 802.15.4-2003 RFD (Reduced Function Device) or FFD (Full Function Device) (see [12]) participating in a ZigBee network, which is neither the ZigBee coordinator nor a ZigBee router.

ZigBee Router: An IEEE 802.15.4-2003 FFD (Full Function Device) participating in a ZigBee network, which is not the ZigBee coordinator but may act as an IEEE 802.15.4-2003 coordinator within its personal operating space, that is capable of routing messages between devices and supporting associations.

13.3.4 Definitions Specific to this Feature

Application Endpoint: Any endpoint other than the dedicated Green Power Endpoint, hosting application control functionality.

(In)active (Proxy Table) Entry: Proxy Table entry, for which the EntryActive flag is set to TRUE(FALSE), respectively.

(In)valid (Proxy Table) Entry: Proxy Table entry, for which the EntryValid flag is set to TRUE(FALSE), respectively.

Broadcast: Whenever NWK level broadcast transmission is mentioned within this specification without further description for the ZGP-defined commands, or where no further description is provided by the ZigBee specification for the ZigBee-defined commands, the RxOnWhenIdle=TRUE (0xfffd) broadcast address shall be used.

Direct Mode: GPS receiving directly the GPFS in GP frame format sent by GPD, if in the radio range of the GPD.

Fully Compliant ZigBee Device: Device implemented according to ZigBee 2007 or ZigBee PRO stack profile, having the role of either ZR or ZED.

Green Power Device Frame (GPDF): Special frame format according to the Green Power specification, which is transmitted by or received by GPD.

Groupcast: One of the communication modes used for tunneling GPD commands between the GPPs and GPSs. In ZigBee terms, it is the APS level multicast, with NWK level broadcast to the RxOnWhenIdle=TRUE (0xfffd) broadcast address.

Pairing: The unidirectional logical link between a Green Power Device and a destination endpoint, which may exist on one or more GP Sinks, which makes the GPS handle the commands received from this particular GPD. Of particular importance is the configuration procedure leading to the establishment of this special relationship.

Portability: Ability to reestablish communication on different location, without interruption or re-commissioning.

Green Power EndPoint (EP GP): A dedicated reserved endpoint, residing on top of the GP stub, hosting the Green Power cluster.

Tunnelled Mode: GPS receiving the GPFS forwarded by a GPP located in the radio range of the GPD. This forwarding uses a normal ZigBee frame format but a specific ZCL command from the Green Power cluster: the GP Notification command (see [7]).

Data GPDF: Any GPDF that carries a GPD Command other than GPD Commissioning (0xE0) or GPD Commissioning Reply (0xF0) or GPD Decommissioning (0xE1).

GPD Data Command: Any GPD Command other than GPD Channel Request (0xE3), GPD Channel Configuration (0xF3), GPD Commissioning (0xE0) or GPD Commissioning Reply (0xF0), GPD Success (0xE2) or GPD Decommissioning (0xE1) (see [7]).

Green Power Device (GPD): A self-powering, energy-harvesting device that implements the Green Power feature.

Green Power Proxy (GPP) or Proxy: A fully compliant ZigBee device, which in addition to a core ZigBee specification also implements the proxy functionality of the Green Power feature. The proxy is able to handle GPDFs and acts as an intermediate node between the GPD and GPSs on the ZigBee network.

Green Power Proxy Minimum (GPPm) or Minimum Proxy: A GPP that only implements the minimum GP feature set, as defined in section A.3.2.9-A.3.2.10 of [7].

Green Power Sink (GPS) or Sink: Term used for describing any of GP Target or GP Target+ or GP Combo Minimum or the Target functionality of the GP Combo (see section A.3.2.9-A.3.2.10 of [7]), referring to the capability to receive and process tunneled GPD commands.

Green Power Target (GPT) or Target: A fully compliant ZigBee device, which in addition to a core ZigBee specification also implements the sink functionality of Green Power cluster, allowing for receiving, processing and executing tunneled GPD commands.

Green Power Target+ (GPT+) or Target+: A Target which also implements the GP stub. A Target+ can thus receive, process and execute both tunneled and directly received ZGPD commands.

Green Power Combo (GPC) or Combo: A fully compliant ZigBee device, which in addition to a core ZigBee specification also implements both the proxy and the sink functionality of the Green Power feature. A Combo can thus receive, process and execute both tunneled and directly received GPD commands (in its sink role), as well as forward them to other GP nodes (in its proxy role).

Green Power Combo Minimum (GPCm) or Minimum Combo: A GPC that only implements the minimum GP feature set, as defined in section A.3.2.9-A.3.2.10 of [7].

Common Green Power Stub (cGP): A term used for describing the common functionality of Green Power for sending and receiving data packets.

Dedicated Green Power Stub (dGP): A term used for describing the dedicated Green Power application.

Dedicated LPED Stub (dLPED): A term used for describing the dedicated Low Power End Device Application (defined by the Low Power End Device task group).

13.4 Acronyms and Abbreviations

ACK	Acknowledgement
AIB	Application support layer Information Base
APDU	Application Protocol Data Unit
APS	Application Support Sub-layer
BTT	Broadcast Transaction Table
CBA	ZigBee Commercial Building Automation application profile
cGP	Common Green Power stub
dGP	Dedicated Green Power stub
EP GP	Green Power End Point
GPDF	Green Power Device Frame
GPFS	Green Power Frame Sequence
HA	ZigBee Home Automation application profile
HMAC	Keyed Hash Message Authentication Code
MAC	Medium Access Control layer
MIC	Message Integrity Code
MPDU	MAC Protocol Data Unit
NPDU	Network Protocol Data Unit
PAN	Personal Area Network
SAP	Service Access Point
SrcID	GPD Source identifier
ZCL	ZigBee Cluster Library
ZED	ZigBee End Device
GP	Green Power
GPC	Green Power Combo Device
GPCm	Green Power Combo Minimum Device
GPD	Green Power Device
GPP	Green Power Proxy Device
GPPm	Green Power Proxy Minimum Device
GPS	Green Power Sink Device
GPT	Green Power Target Device

GPT+	Green Power Target Plus device
ZR	ZigBee Router
ZSE	ZigBee Smart Energy

13.5 GP Best Practices for Home Automation

13.5.1 Profile-specific Settings for HA Devices

In order for a HA device to support Green Power feature, it shall implement the Green Power cluster as defined in [B32].

Any GP feature, attribute or parameter which doesn't have HA-specific configuration or value defined in the following sections shall be implemented according to GP spec [B32].

13.5.1.1 GP Functionality Supported per GP Infrastructure Device for HA

HA doesn't request specific configuration of GP functionality supported per GP infrastructure device.

13.5.1.2 GreenPower Cluster Command Support per GP Infrastructure Device for HA

HA doesn't request specific support of Green Power cluster command per GP infrastructure device.

13.5.1.3 Profile-specific Default Attribute Values for the Green Power Cluster

Table 13.1 defines the HA profile-specific attribute values for the Green Power cluster.

Table 13.1 HA-specific Green Power Cluster Attribute Values

ID	Name	Access	HA M/O	HA Default Value
0x0004	GreenPowerEZ-Mode	R/W	O (default)	3 mins (0x00B4)

Please note that HA device shall implement Green Power cluster attributes as defined in GP spec [B32] except for attributes with specific HA value.

13.5.1.4 Profile-specific Parameter Values for the Green Power Cluster

Table 13.2 defines the HA profile-specific parameter values for Green Power cluster.

Table 13.2 HA-specific Green Power Cluster Parameter Values

Name	HA Default Value
gppCommissioningWindow	60 s (0x003c) Note: The gppCommissioningWindow should be long enough to allow for required user interaction on the GPD, and for subsequent protocol exchange.
gppSecurityWindow	1

Please note that HA device shall implement Green Power cluster parameters as defined in GP spec [B32] except for parameters with specific HA value.

13.5.1.5 Channel Support

The HA networks with GP-capable devices may need to operate with minimum-functionality GPD devices, not supporting bidirectional commissioning.

To simplify the channel commissioning process for the user (most probably requiring manual channel selection by means of DIP switches, toggling through the channels, etc.), it is strongly recommended, that the HA networks with GP use the following channels as the preferred channels: 11, 15, 20, 25.

Analogously, it is strongly recommended, that the GPD not supporting the bidirectional commissioning support at least the following set of channels: 11, 15, 20, 25. Supporting less reduces the GPD’s adaptability, supporting more – may lead to commissioning interaction too complicated for the user.

13.5.2 HA-specific GP operation

13.5.2.1 Introduction

In the consumer systems, maximum ease of use of commissioning and operation is desired. Because the user can make any of the devices at any times unavailable (e.g. by unplugging or putting them out of range), the system shall be able to cope with it, without forcing the user to re-commission.

13.5.2.2 HA-specific GPS Operation

13.5.2.2.1 Behaviour in Commissioning

If a GPS receives a GP Notification or Data GPDF with AutoCommissioning flag set to 0b0 while in commissioning mode, it shall execute the command. If a GPS receives a Data GPDF with Auto-Commissioning flag set to 0b1 when in commissioning mode (whether directly, in GP Commissioning Notification or in GP Notification), it shall not execute the GPD Command.

The intention behind this behavior is to give at time of commissioning a consistent, only commissioning-related feedback to the user.

13.5.2.2.2 Maintenance of Proxy Tables

On receipt of a GP Notification command for which any mismatch in SecurityLevel, SecurityKey or an old GPD security frame counter value is discovered, a GPS shall send a GP Pairing command with the correct sub-field values and/or the required security fields present, carrying the correct values for this GPD.

13.5.2.2.3 GPD Maintenance

In the event of ZigBee operational channel change, the GPS may attempt to update the paired Rx-capable GPDs by sending appropriately protected GPD Channel Configuration command.

In the event of shared key change, the GPS may attempt to update the paired Rx-capable GPDs by sending appropriately protected GPD Commissioning Reply command.

13.5.2.3 HA-specific GPP Operation

13.5.2.3.1 Commissioning Behaviour

On receipt of Data GPDF with Auto-Commissioning sub-field set to 0b0 when in commissioning mode, if the Proxy Table entry for this SrcID already contains sink information, the proxy shall schedule transmission of the GP Notification command to the paired GPSs in the requested communication mode, whereby the commands shall be sent in the following order: GP Tunneling Stop command first, then unicast GP Notifications and groupcast GP Notifications (if any), then broadcast GP Notification (if any).

On receipt of Data GPDF with Auto-Commissioning sub-field set to 0b1 when in commissioning mode, the proxy shall not schedule transmission of GP Notification, even if it has active Proxy Table entry for this SrcID storing some pairing.

13.5.2.3.2 Maintenance of Proxy Tables

The GP Pairing Search command shall be sent as broadcast, using proxy aliasing, and gppDiscoveryDelay. If within gppDiscoveryDelay, GP Pairing Search or broadcast GP Notification for the same SrcID and communication modes is receives, the scheduled transmission should be dropped.

13.6 HA-specific Commissioning

It is mandatory for the HA devices that implement GP infrastructure device functionality to support the GP commissioning method as specified in section A.3.9 of the GP specification [B32].

It is left to the implementers of GPS according to this specification, when to update the pairings in the Sink Table (add or remove, dependent on different or the same user interaction, applications internal state, etc.), and when to exit commissioning mode (upon successful/failed pairing, timeout, user interaction, etc.). It is recommended, that the implementers make the GPS behavior understandable to the user (e.g. via a user manual and/or appropriate user feedback). Also, the GPPs in the system shall be instructed to behave accordingly (e.g. using the GP Commissioning Mode command).

13.6.1 Device Indications

With respect to notification of installers and users in order to support the commissioning process, the following practices are recommended.

A GPS should be able to indicate to the user:

- That the device is open for establishing a new pairing (in commissioning mode),
- That a new pairing with a GPD has been created,
- That it has failed to be paired to a GPD. It is recommended that two different types of pairing failures are indicated by different feedback:
    - the pairing failure is permanent, no point in re-trying (e.g. in case of failure because of application mismatch)
    - the pairing failure is solvable by re-trying the pairing procedure by retriggering it, at least on the GPD side (e.g. in case of failure because of a timeout).
- If GPD/pairing removal is supported: that GPD/pairing has been removed.

These indications may be implemented in a number of ways including indicator light(s) or an audible indicator.

13.7 HA – GP Commissioning Message Sequence Charts

The message sequence charts in this section illustrate how GP proxy-based commissioning method (as defined in section A.3.9 of the GP specification [B32]) can be seamlessly integrated into the HA EZ-mode commissioning (as defined in sec. 8 of HA 1.2 specification [B29] and the dedicated document [B37]), allowing for one any the same user interaction to enable either.

Please note: the GP commissioning procedure encompasses both network joining and pairing, while the HA EZ-mode commissioning covers only pairing of devices already operating (securely) on the same network.

The diagrams below are the recommended solution for enabling both commissioning methods with the same user interaction.

Implementers of GP-enabled HA devices may decide to enable each with a separate user action; this of course requires the user to be able to differentiate the capabilities of the devices to be paired.

13.7.1 HA – HA Commissioning

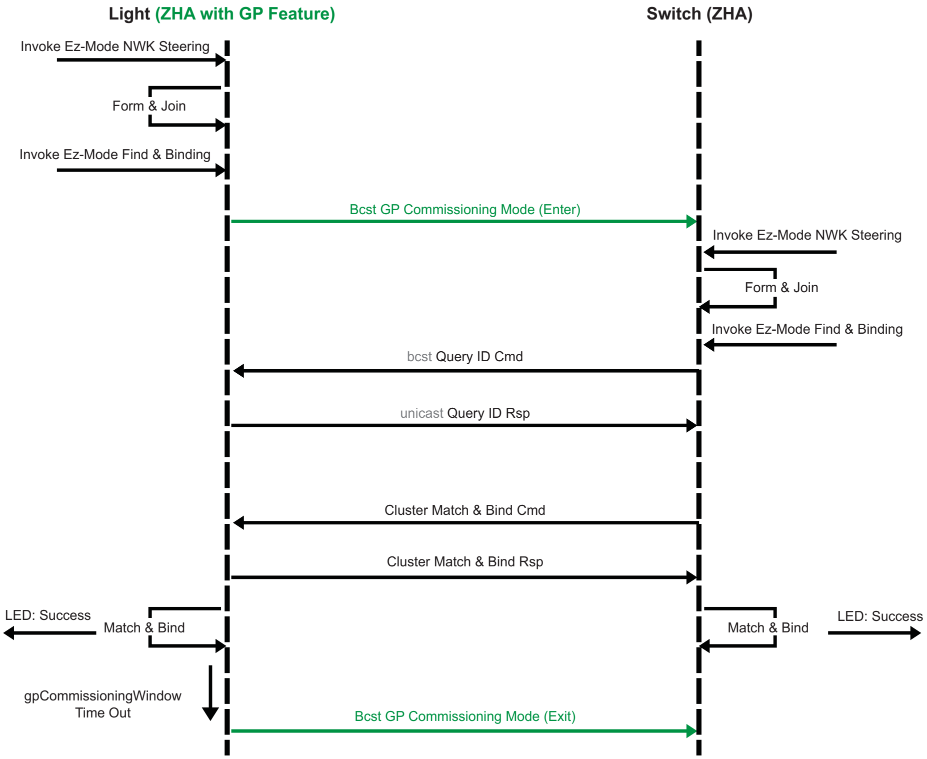
Light (ZHA with GP Feature)
Switch (ZHA)
Invoke Ez-Mode NWK Steering
Form & Join
Invoke Ez-Mode Find & Binding
Bcst GP Commissioning Mode (Enter)
Invoke Ez-Mode NWK Steering
Form & Join
Invoke Ez-Mode Find & Binding
bcst Query ID Cmd
unicast Query ID Rsp
Cluster Match & Bind Cmd
Cluster Match & Bind Rsp
LED: Success
Match & Bind
Match & Bind
LED: Success
gpCommissioningWindow
Time Out
Bcst GP Commissioning Mode (Exit)

Figure 13.1 HA - HA Commissioning with a GP-enabled HA Device

13.7.2 HA – GP Commissioning

When the GPD device is being added to the network, the HA sink it is to be paired to shall be already operational on the ZigBee network. This is to make sure that GPD gets configured with the operational parameters of the network.

If the HA sink is not yet operational on the network, it shall be added to the ZigBee network before attempting the GPD commissioning.

If there is no HA network established yet, the HA sink, if capable, shall assume the role of a ZC and TC, selecting the operational parameters for the ZigBee network, incl. operational channel and security key. This shall happen at the latest after enabling commissioning on the HA sink.

If the HA sink is not capable of assuming ZC/TC role and it is not operational on the ZigBee network at the time commissioning is enabled, the GPD commissioning should be denied.

13.7.2.1 HA-GP Bidirectional in Range Commissioning

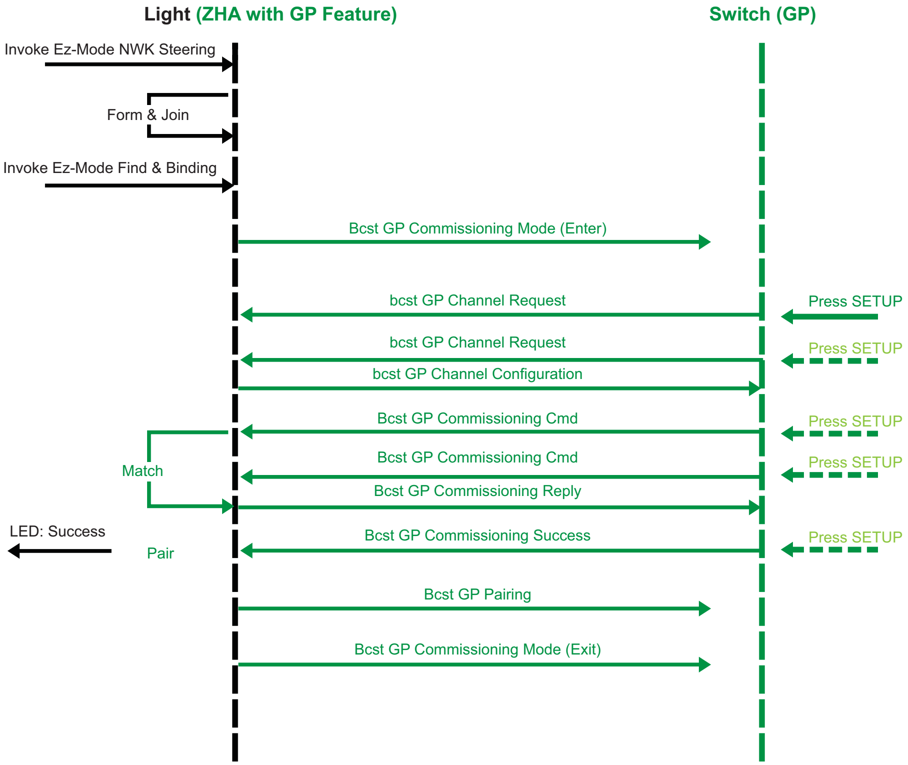
Light (ZHA with GP Feature)
Switch (GP)
Invoke Ez-Mode NWK Steering
Form & Join
Invoke Ez-Mode Find & Binding
Bcst GP Commissioning Mode (Enter)
bcst GP Channel Request
Press SETUP
bcst GP Channel Request
Press SETUP
bcst GP Channel Configuration
Bcst GP Commissioning Cmd
Press SETUP
Match
Bcst GP Commissioning Cmd
Press SETUP
Bcst GP Commissioning Reply
LED: Success
Pair
Bcst GP Commissioning Success
Press SETUP
Bcst GP Pairing
Bcst GP Commissioning Mode (Exit)

Figure 13.2 HA - GP Bidirectional In Range Commissioning

13.7.2.2 HA – GP Bidirectional Out of Range Commissioning

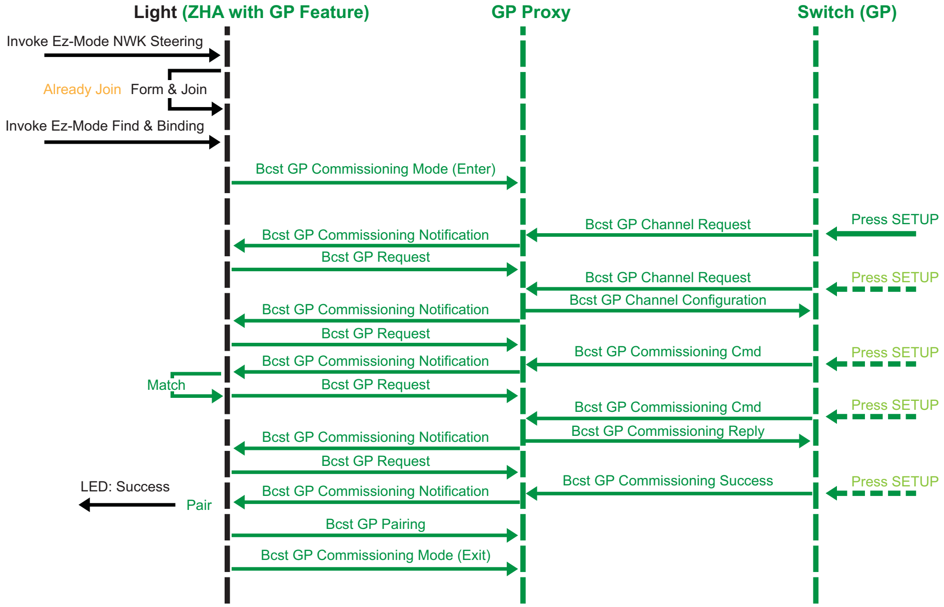
Light (ZHA with GP Feature)
GP Proxy
Switch (GP)
Invoke Ez-Mode NWK Steering
Already Join
Form & Join
Invoke Ez-Mode Find & Binding
Bcst GP Commissioning Mode (Enter)
Bcst GP Channel Request
Press SETUP
Bcst GP Commissioning Notification
Bcst GP Request
Bcst GP Channel Request
Press SETUP
Bcst GP Channel Configuration
Bcst GP Commissioning Notification
Bcst GP Request
Bcst GP Commissioning Cmd
Press SETUP
Bcst GP Commissioning Notification
Match
Bcst GP Request
Bcst GP Commissioning Cmd
Press SETUP
Bcst GP Commissioning Reply
Bcst GP Commissioning Notification
Bcst GP Request
LED: Success
Pair
Bcst GP Commissioning Notification
Bcst GP Commissioning Success
Press SETUP
Bcst GP Pairing
Bcst GP Commissioning Mode (Exit)

Figure 13.3 HA - GP Bidirectional Out of Range Commissioning

13.7.2.3 HA – GP Unidirectional Out of Range Commissioning

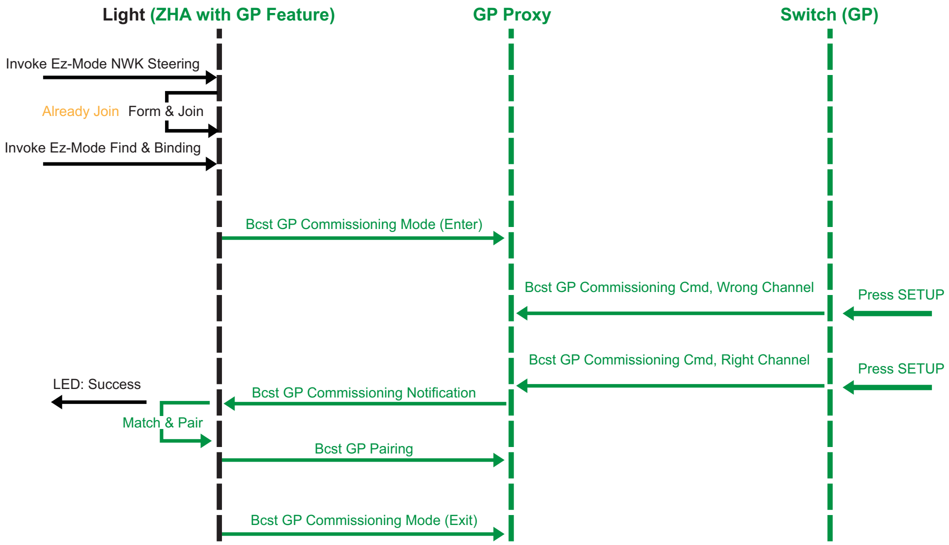
Light (ZHA with GP Feature)
GP Proxy
Switch (GP)
Invoke Ez-Mode NWK Steering
Already Join
Form & Join
Invoke Ez-Mode Find & Binding
Bcst GP Commissioning Mode (Enter)
Bcst GP Commissioning Cmd, Wrong Channel
Press SETUP
Bcst GP Commissioning Cmd, Right Channel
Press SETUP
LED: Success
Bcst GP Commissioning Notification
Match & Pair
Bcst GP Pairing
Bcst GP Commissioning Mode (Exit)

Figure 13.4 HA - GP Unidirectional Out of Range Commissioning