



**ZIC2410 Series**

**ZIC2410 User Guide  
Profile and ZigBee™ Cluster Library  
(ZCL) for the CEL ZigBee Stack  
0005-05-08-04-001  
(Rev B)**

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# 1 INTRODUCTION and PURPOSE

This document explains the ZigBee Cluster Library (ZCL) and the ZigBee Device Profile (ZDP) in the **CEL ZigBee Stack**.

The **CEL ZigBee Stack** supports the IEEE 802.15.4 and ZigBee2006 standards.

The **CEL ZigBee Stack** includes Application Program Interface (API) functions to support the functionality defined in the ZigBee standard and the communication functions defined in the IEEE 802.15.4.

# 2 ZigBee2006 LAYER and FRAME STRUCTURE

Figure 1 and Figure 2 show ZigBee2006 layers and frame structures for each layer.

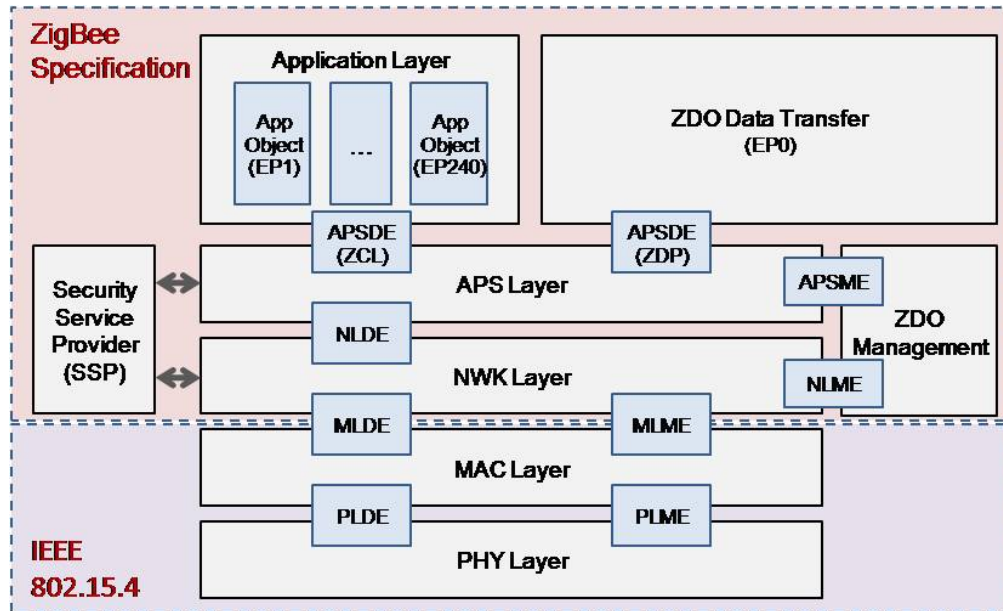


Figure 1 – ZigBee2006 Layers

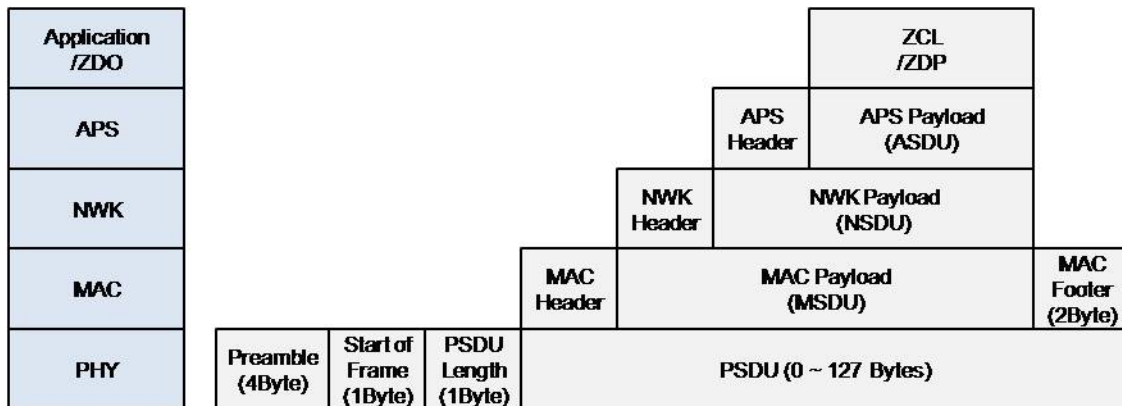


Figure 2 – ZigBee2006 Frame Structures

### 3 ZigBee CLUSTER LIBRARY (ZCL)

The ZCL defines the format of the Application Support Layer (APS) Payload (ASDU) when exchanging data in an application layer. When sending and receiving data using the APS data primitives (*APS-DATA.req*, *APS-DATA.ind*), if the endpoint is 0, the data is for the ZigBee Device Profile (ZDP) and is processed in the ZigBee Device Object (ZDO).

When the endpoint is not 0, data is processed in the application layer. Currently, the APS Payload follows the ZCL format as shown in Figure 3 and Table 1.

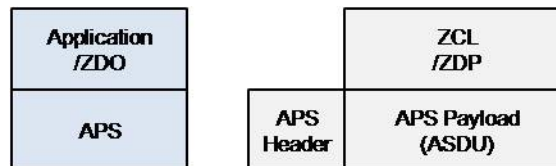


Figure 3 – Application Support Layer Structure

#### 3.1 FRAME FORMAT

Table 1 – ZCL Frame Format

<u>Bits : 8</u>	<u>0/16</u>	<u>8</u>	<u>8</u>	<u>Variable</u>
Frame Control	Manufacturer Code	Transaction Sequence Number	Command ID	Frame Payload
ZCL Header				ZCL Payload

##### 3.1.1 Frame Control Field

Table 2 – Frame Control Field

<u>Bits : 0-1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5-7</u>
Frame Type	Manufacturer Specific	Direction	Disable Default Response	Reserved

- **Frame Type**
  - **0:** Command acts across the entire profile. Command ID field has the value compliant to ZCL standard.
  - **1:** Command is specific to a cluster. Command ID field has the value defined in defined cluster.
- **Manufacturer Specific**
  - **1:** There is a Manufacturer Code in the ZCL header.
  - **0:** There is no Manufacturer Code field in the ZCL header.
- **Direction**
  - **1:** Server to Client.
  - **0:** Client to Server
- **Disable Default Response**
  - **0:** Receiver sends Response Command.
  - **1:** Receiver doesn't send Response Command.

### 3.1.2 Manufacturer Code Field

When the profile, cluster and attribute defined by the manufacturer are used, the Manufacturer Code provided from ZigBee Alliance should be included and the Manufacturer Specific sub field of the Frame Control field should be 1.

### 3.1.3 Transaction Sequence Number Field

The sequence number of the frame is increased by 1 for every new ZCL frame generated.

### 3.1.4 Command ID Field

Display command of frame. When subfield of Frame Type is 0, value defined in standard should be included. When it is 1, command defined in each cluster should be used.

## 3.2 FRAME PAYLOAD

It consists of payload of ZCL command. The payload format is different based on the Command ID. The following shows the payload format for the major commands.

### 3.2.1 Read Attributes

It is used to read the attribute value of a remote device.

**Table 3 – Read Attributes**

<u>Octets : variable</u>	<u>2</u>	<u>2</u>	<u>...</u>	<u>2</u>
ZCL Header	Attribute ID 1	Attribute ID 2	...	Attribute ID n

#### 3.2.1.1 Header

FrameType = 0, Command ID = 0x00

### 3.2.2 Read Attribute Response

It is used when the device, which receives 'Read Attribute', responds.

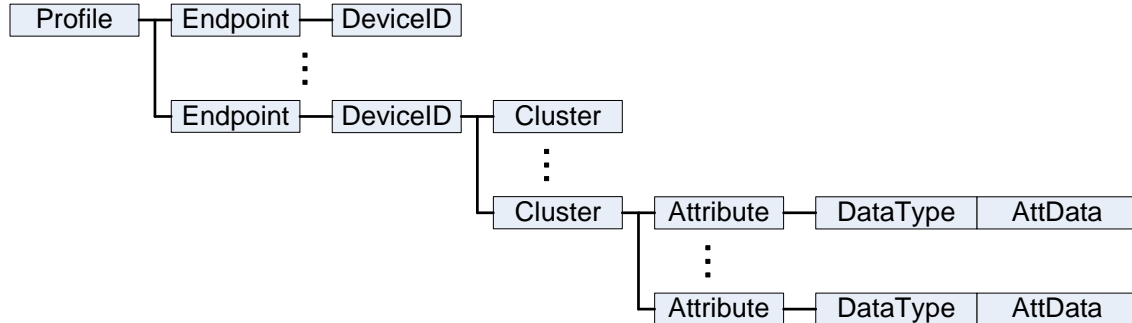
<u>Octets : variable</u>	<u>variable</u>	<u>Variable</u>	<u>...</u>	<u>variable</u>
ZCL Header	Read attribute status record 1	Read attribute status record 2	...	Read attribute status record n

#### 3.2.2.1 Header

FrameType = 0, Command ID = 0x01

## 4 PROFILE

A Profile is a collection of device descriptions, which together form a cooperative application. The Profile defines the data exchange form for the application functions of a ZigBee physical device. A Profile consists of one or more EndPoints, each with one or more clusters and a vertical structure of the attributes. The device, which requests a command, sends data based on the requested application function. The device, which receives the data, analyzes the endpoint cluster and attribute of the received packet, and then performs the functions defined in the attribute.



**Figure 4 – the Structure of a Profile**

When the application layer requests a command by sending data, the *APS-DATA.req* primitive is used. This primitive sets the endpoint of the remote device designated by the command and sets the Cluster ID as a parameter of the primitive. In addition, the data in the APS payload is sent after constructing the information as an attribute (attribute, data type, attribute data) in ZCL format.

The receiving device, receives the *APS-DATA.ind* primitive, and analyzes the endpoint first. If the endpoint is 0, it is a command for the ZDP and the command is processed in the ZDO.

If the endpoint is not 0, it is a command for the ZCL. The analyzed information of the attribute is compared to its own profile by analyzing the Cluster ID parameter of the *APS-DATA.ind* and the APS Payload. If it matches its own profile, the corresponding attribute is controlled or its status is changed.

### 4.1 PROFILE ID

Profile ID is a unique 16-bit field assigned to each profile and used in applications. As shown in Table 4 below, the ID is assigned based whether it is a ZigBee standard or a manufacturer specific application profile.

**Table 4 – Profile ID**

<b>Profile ID</b>	<b>Description</b>
0x0000 ~ 0x7FFF	The ZigBee standard application profile defined by the ZigBee Alliance When a standard profile is used, the Cluster ID, Device ID, Attribute ID and command ID are defined in this range.
0x8000 ~ 0xBFFF	Reserved
0xC000 ~ 0xFFFF	It is a manufacturer specific application profile which a user can define. In this case, the Cluster ID, Device ID, Attribute ID and Command ID can be set as required.

The Profile ID of a home automation profile is 0x0104.

## 4.2 ENDPOINT

EndPoint has a value (1-240) set randomly when creating the profile.

## 4.3 DEVICE ID

Device ID is 16-bit field which shows the device type in the profile.

**Table 5 – Device ID**

Device ID	Description
0x0000 ~ 0xBFFF	ZigBee Standard Device.
0xC000 ~ 0xFFFF	Reserved

In a standard profile, each device ID should have a value from 0x0000 to 0xBFFF. A Manufacturer Specific profile can have a value from 0x0000 to 0xFFFF.

**Note:** For a Home Automation profile, the Device ID's are defined in Table 6.

**Table 6 – Device ID for Home Automation profile**

Device Group	Device Description	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
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
Closures	Shade	0x0200
	Shade Controller	0x0201
HVAC	Heating/Cooling Unit	0x0300
	Thermostat	0x0301
	Temperature Sensor	0x0302
	Pump	0x0303
	Pump Controller	0x0304
	Pressure Sensor	0x0305
	Flow Sensor	0x0306
Intruder Alarm Systems	IAS Control and Indicating Equipment	0x0400
	IAS Ancillary Control Equipment	0x0401
	IAS Zone	0x0402
	IAS Warning Device	0x0403

## 4.4 CLUSTER ID

A cluster is responsible for data communication. The size of cluster ID is 16-bit. One cluster has one or more attributes which physically execute the commands. When the profile is generated, a cluster is defined as an input or output with the direction not yet determined.

The direction of the profile cluster is determined based on the purpose of the device established during the ZDO configuration process.

**Table 7 – Cluster ID**

<b>Cluster ID</b>	<b>Description</b>
0x0000 ~ 0x7FFF	ZigBee standard cluster
0x8000 ~ 0xFBFF	Reserved
0xFC00 ~ 0xFFFF	Manufacturer Specific: Used when a required cluster is not defined as a standard cluster.

The ZigBee standard clusters are defined in Table 8.

**Table 8 – ZigBee Standard Clusters**

<b>Functional Domain</b>	<b>Cluster Name</b>	<b>Cluster ID</b>
General	Basic	0x0000
	Power Configuration	0x0001
	Device Temperature Configuration	0x0002
	Identify	0x0003
	Groups	0x0004
	Scenes	0x0005
	On/Off	0x0006
	On/Off Switch Configuration	0x0007
	Level Control	0x0008
	Alarms	0x0009
	Time	0x000A
	RSSI Location	0x000B
	Closures	Shade Configuration
HVAC	Pump Configuration and Control	0x0200
	Thermostat	0x0201
	Fan Control	0x0202
	Dehumidification Control	0x0203
	Thermostat User Interface Configuration	0x0204
Lighting	Color Control	0x0300
	Ballast Configuration	0x0301
Measurement and sensing	Luminance Measurement	0x0400
	Luminance Level Sensing	0x0401
	Temperature Measurement	0x0402
	Pressure Measurement	0x0403
	Flow Measurement	0x0404
	Relative Humidity Measurement	0x0405
	Occupancy sensing	0x0406
Security and safety	IAS Zone	0x0500
	IAS ACE	0x0501
	IAS WD	0x0502

#### 4.5 ATTRIBUTE ID

An Attribute in a cluster is responsible for the special command. The size of the attribute ID is 16-bit. ZCL standard cluster defines an attribute based on the cluster and assigns its attribute ID.

**Table 9 – Attribute ID**

<b>Attribute ID</b>	<b>Description</b>
0x0000 ~ 0x3FFF	Standard ZigBee attribute
0x4000 ~ 0xFFFF	Reserved



An attribute defined in the ZCL has a defined value. When the profile is defined, the attribute and the attribute ID should also be defined. On the other hand, a manufacturer specific attribute has a value of 0x0000~0xFFFF and the ZCL data should include the manufacturer code.

#### 4.6 COMMAND ID

It commands the operation of attribute in cluster and the size of it is 8-bit. Standard command ID has the value from 0x00 ~ 0x7F. When using manufacturer specific command, full range can be used and ZCL data should include manufacturer code.

**Table 10 – Command ID**

<u>Command ID</u>	<u>Description</u>
0x00 ~ 0x7F	Standard ZigBee command
0x80 ~ 0xFF	Reserved

Table 11 shows the standard cluster commands.

**Table 11 – Standard Cluster Command**

<u>Command ID</u>	<u>Name</u>	<u>Description</u>
0x00	Read Attribute	Acquire the attribute value.
0x01	Read Attribute Response	The response for Read Attribute.
0x02	Write Attribute	Set the attribute value.
0x03	Write Attribute undivided	
0x04	Write Attribute Response	The response for Write Attribute.
0x05	Write Attribute No Response	
0x06	Configure Reporting	
0x07	Configure Reporting Response	
0x08	Read Reporting Configuration	
0x09	Read Reporting Configuration Response	The response for Read Reporting Configuration.
0x0A	Report Attribute	
0x0B	Default Response	
0x0C	Discover Attribute	The response for Discover Attribute.
0x0D	Discover Attribute Response	
0x0E ~ 0xFF	Reserved	

#### 4.7 ATTRIBUTE DATA TYPE ID

It determines the type of attribute data and the size is 8-bit. According to this value, the size of the attribute is determined.

**Table 12 – Data Type ID's**

<u>Type Class</u>	<u>Data Type ID</u>	<u>Type</u>	<u>Length (Octet)</u>	<u>Invalid</u>
NULL	0x00	No Data	0	
General Data	0x08	8-bit Data	1	
	0x09	16-bit Data	2	
	0x0A	24-bit Data	3	
	0x0B	32-bit Data	4	
	Logical	0x10	Boolean	1
Bitmap	0x18	8-bit bitmap	1	
	0x19	16-bit bitmap	2	
	0x1A	24-bit bitmap	3	
	0x1B	32-bit bitmap	4	
Unsigned Integer	0x20	Unsigned 8-bit integer	1	0xFF
	0x21	Unsigned 16-bit integer	2	0xFFFF

Type Class	Data Type ID	Type	Length (Octet)	Invalid
	0x22	Unsigned 24-bit integer	3	0xFFFFFFFF
	0x23	Unsigned 32-bit integer	4	0xFFFFFFFF
Signed Integer	0x28	Signed 8-bit integer	1	0x80
	0x29	Signed 16-bit integer	2	0x8000
	0x2A	Signed 24-bit integer	3	0x800000
	0x2B	Signed 32-bit integer	4	0x80000000
Enumeration	0x30	8-bit enumeration	1	0xFF
	0x31	16-bit enumeration	2	0xFFFF
Floating point	0x38	Semi-precision	2	Not a Number
	0x39	Single precision	4	Not a Number
	0x3A	Double precision	8	Not a Number
String	0x41	Octet String	Defined in first octet	0xFF in first octet
	0x42	Character String	Defined in first octet	0xFF in first octet
Time	0xE0	Time of day	4	0xFFFFFFFF
	0xE1	Date	4	0xFFFFFFFF
Identifier	0xE8	Cluster ID	2	0xFFFF
	0xE9	Attribute ID	2	0xFFFF
	0xEA	BACnet OID	4	0xFFFFFFFF
Miscellaneous	0xF0	IEEE Address	8	0xFFFFFFFF
Unknown	0xFF	Unknown	0	

#### 4.8 ATTRIBUTE DATA

Defined as the data used in an attribute, its size is determined by the attribute data type.

## 5 HOME AUTOMATION PROFILE (an Example)

Figure 5 is an example for a home automation profile which includes an On/Off Light device and an On/Off Light Switch device.

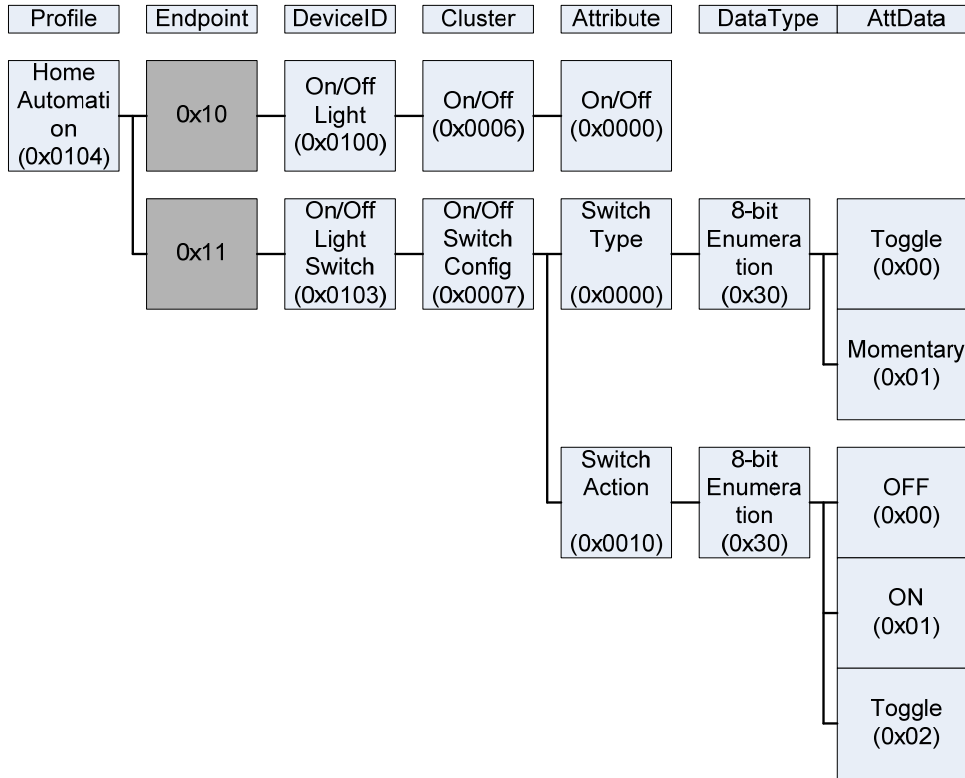


Figure 5 – Home Automation Profile Example

### 5.1 ON/OFF LIGHT DEVICE

- **Endpoint ID:** Determined as a random value from 1 to 240. In the example shown in Figure 5 above, it is set to 0x10.
- **Device ID:** Set to 0x0100 meaning an On/Off Light device (see Table 6).
- **Cluster ID:** Set to 0x0006 meaning an On/Off cluster (see Table 8).
- **Attribute ID:** The On/Off Attribute is defined in the On/Off cluster and is 0x0000.
- **Data Type and Attribute Data:** The On/Off Attribute of the On/Off cluster does not define the data type and the attribute type. Instead, the operation is determined by the command ID of the ZCL header. The Frame Type of the ZCL Header should be set to 1.

Table 13 – ZCL Frame Format

<b>Bits : 8</b>	<b>0/16</b>	<b>8</b>	<b>8</b>	<b>Variable</b>
Frame Control	Manufacturer Code	Transaction Sequence Number	Command ID	Frame Payload
ZCL Header				ZCL Payload

- **Command ID:** When the Frame Type is 1, it will be the same as the ZCL command. For this type of device there are three (0x00 = OFF, 0x01 = ON, 0x02 = Toggle).

## 5.2 ON/OFF LIGHT SWITCH DEVICE

- **Endpoint ID:** Determined as a random value from 1 to 240. In the example shown in Figure 5 above, it is set to 0x11.
- **Device ID:** Set to 0x0103 meaning an On/Off Light Switch device (see Table 6).
- **Cluster ID:** Set to 0x0007 meaning an On/Off Switch Config cluster (see Table 8).
- **Attribute ID:** On/Off Switch Config cluster defines the Switch Type (0x0000) and the Switch Action (0x0010) attribute.
- **Data Type:** Two attributes in the On/Off Switch Config cluster are defined as 8-bit Enumeration (0x30) types (see Table 12).
- **Attribute Data:** Attribute data is also defined for each attribute in On/Off Switch Config cluster. The Switch type attribute can have the value of 0x00(Toggle) and 0x01 (Momentary). The Switch action attribute can have the value of 0x00 (OFF), 0x01 (ON), 0x02 (Toggle).

## 6 REVISION HISTORY

<u>Revision</u>	<u>Date</u>	<u>Description</u>
A	3Sep08	Released
B	13Jan09	Updated Figure 1