



# Application Note: JN-AN-1201

## ZigBee HA Intruder Alarm System

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This Application Note demonstrates a typical ZigBee Home Automation (HA) network based on the NXP JN516x wireless microcontroller. The solution employs Intruder Alarm System (IAS) devices from the ZigBee Home Automation Profile Specification version 1.2.2.

The accompanying software uses the HA clusters to transfer data between the devices in a wireless network in order to control IAS devices. The hardware for the devices is implemented using components from the NXP JN516x-EK001 Evaluation Kit. The device software was developed using NXP Application Programming Interfaces (APIs).

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## 1 Introduction

This Application Note provides a ZigBee Home Automation (HA) wireless network solution which uses the NXP JN516x-EK001 Evaluation Kit. It allows the user to demonstrate an Intruder Alarm System (IAS) system. From the evaluation kit:

- One Lighting/Sensor Expansion Board (DR1175) is used as a Warning Device (WD)
- One Lighting/Sensor Expansion Board (DR1175) is used as a Zone device emulating a Vibration and Movement Sensor (VMS)
- The Generic Expansion Board (DR1199) is used as a Zone device emulating Contact Switches (CSW)
- The LCD Expansion Board (DR1215) is used as the display panel for the system's Controlling and Indicating Equipment (CIE) device
- The Touch Remote Controller (DR1159) is used as an Ancillary Control Equipment (ACE) device providing a Keypad

The expansion boards are each fitted to a Carrier Board (DR1174). The evaluation kit and its components are described in the *JN516x-EK001 Evaluation Kit User Guide (JN-UG-3093)*.

The device software was developed using the following NXP Application Programming Interfaces (APIs): ZigBee PRO APIs, JenOS APIs, ZigBee Cluster Library HA APIs and JN516x Integrated Peripherals API. These APIs are described in their own User Guides.

A list of useful reference documents is provided in Section 7.1.

## 1.1 System Overview

This example Intruder Alarm System consists of CIE, ACE, WD and Zone devices from the HA profile, running over a ZigBee PRO network.

- The system includes two sensor devices (which are known as **Zones** in the Security industry) which provide inputs to the controller and central display of the system, the CIE (see below).
- A **Warning Device** provides the means of sounding alarms and squawks (sounds to alert the user that something needs to happen, such as leaving the building when the system is armed, or that they need to disarm the system on entry) and for showing external visible warnings by use of a strobe light.
- The system can be controlled either from the **CIE**, or from a wireless handset, the **ACE**. The user can set and disarm the system, and trigger and cancel alarms. They can also set up profiles of alarms for day and night operation (for example, only arm the Zones on the ground floor of a house at night), or include all the Zones, and also bypass Zones in order to allow the system to be set or armed in the presence of faults. The control logic for the system resides in the CIE, which takes inputs from the Zone devices. Depending on its operating mode, it also sends commands to the Warning Device and system status updates to the ACE. Control of the system can be performed either by using the ACE keypad, or through buttons and a display panel on the CIE.

The sub-sections below provide a brief introduction to these device types. Advanced user information is provided in Section 6.

### 1.1.1 Control and Indicating Equipment (CIE)

The HA CIE device resides on the mains-powered LCD Expansion Board (DR1215 from the evaluation kit), and acts as the Coordinator of the network. The Coordinator device controls joining of other ZigBee PRO devices to the network. When a node joins the network, the CIE identifies whether the node is one of the IAS device types and displays those IAS devices which have joined the network. Through the CIE's menu-driven user interface, the user is able to control the enrolment of IAS devices joined to the CIE and invoke some of their functions. For the operational details, refer to Section 5.5.

Enrolment is a concept used in IAS systems to ensure that only authorised devices can influence the operation of the system. As well as a device being allowed to join the network, it must also be enrolled so that it can be integrated into the system. When enrolled, a device only obeys commands sent from the CIE to which it has been enrolled.

The implemented CIE device includes the mandatory and certain optional cluster features defined for this device in the HA Specification.

### 1.1.2 Ancillary Control Equipment (ACE)

The HA ACE device resides on a battery-powered node that acts as a sleepy End Device in the network. This ACE node attempts to join an HA Coordinator in the network.

For the operational details of this device, refer to Section 5.4.

The implemented ACE device includes the mandatory clusters defined for this device in the HA Specification.

### 1.1.3 Warning Device (WD)

The HA WD device resides on a mains-powered node that acts as Router in the network. This WD node attempts to join an HA Coordinator in the network.

For the operational details of this device, refer to Section 5.3.

The implemented WD device includes the mandatory clusters defined for this device in the HA Specification.

### 1.1.4 Zones (CSW and VMS)

The HA Zone devices reside on battery-powered nodes that act as sleepy End Devices in the network. These Zones attempt to join an HA Coordinator in the network.

For the operational details of these devices, refer to Section 5.1 and Section 5.2.

The implemented Zones include the mandatory clusters defined for this device in the HA Specification.

## 2 Compatibility

The software provided with this Application Note is intended to be used with the following evaluation kit and SDK (Software Developer's Kit) versions:

Product Type	Part Number	Version or Build
Evaluation Kit	JN516x-EK001	-
JN516x ZLL/HA SDK	JN-SW-4168	1620
'BeyondStudio for NXP' Toolchain	JN-SW-4141	1308

## 3 Loading the Application

Table 1 below is a compatibility matrix showing which JN516x-EK001 Evaluation Kit expansion boards can be used with the binary files supplied in this Application Note. Most binaries (except for the ACE device) are provided for JN5168 and JN5169 – in the table below, <x> can be 8 or 9.

Application Binary	Expansion Board ( + Carrier Board )			Remote Control Unit	USB Dongle
	Generic	LCD	Lighting/Sensor		
CIE_JN516<x>.bin		■			
ACE_JN5168_DR1159.bin *				■	
WD_JN516<x>_DR1175.bin			■		
ZONE_JN516<x>_DR1175_VMS.bin			■		
ZONE_JN516<x>_DR1199_CSW.bin	■				

**Table 1: Device Type – Evaluation Kit Compatibility Matrix**

\* Only provided for JN5168 since the DR1159 Remote Control Unit contains this device

The supplied application binaries (see Table 1 above) can be loaded into the corresponding evaluation kit boards using the JN51xx Flash Programmer within BeyondStudio for NXP or the JN51xx Production Flash Programmer (JN-SW-4107).



**Caution:** If loading an application binary for the first time, persistent data must be cleared from the device – refer Section 5.6.

## 4 Running the Demonstration

This section describes how to set up a basic system with CIE, WD and Zone (CSW) devices, and describes the basic operation of those devices.

Section 5 provides complete details on how to operate all the devices in this Application Note.

### 4.1 Forming the Network

As the Coordinator of the network, the CIE is the first device to be started in the system and forms the network (only one CIE is permitted in an IAS network). When powered on from the factory-new state, the CIE will scan for the quietest channel on which to form the network. This is indicated on the LCD, as illustrated below.

Panel
Scanning
Menu Up Down Sel C

Once the network has been formed, the device displays “Network Formed”, as illustrated below.

Panel
Network Formed
Menu Up Down Sel C

At this point, the network will be open for 180 seconds to allow other devices to join the network. This is indicated by LED D3 on the DR1174 Carrier Board being illuminated.

## 4.2 Adding a Warning Device to the Network

The following steps describe how to add the Warning Device (WD) to the network;

1. Power up the Warning Device. LED D4 on the Lighting/Sensor Expansion Board will flash once every two seconds to indicate that it is powered up but has not joined the network or enrolled.
2. If LED D3 on the CIE Carrier Board is illuminated, proceed to Step 3. If not, this means that the network is not currently open for joining. In this case, press the Menu button to open the CIE Main Menu. In this menu, navigate to the 'Enable Join' option and press the Sel button. This will open the network for 180 seconds and illuminate LED D3 on the CIE Carrier Board.

CIE MAIN MENU
Security Devices
Configuration
<b>Enable Join</b>
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

3. Now that the network is open, the Warning Device should automatically join the network. This is indicated by LED D3 on the WD now flashing once per second. Press the Menu button to return to the main menu screen, then select the 'Security Devices' option. The next screen will display the devices that have joined the network, but just the Warning Device will be listed at this point, as shown below:

Security Devices
<b>- Warning 0BE2</b>
Menu Up Down Sel C

- Once a device has joined the network, it must be enrolled in order to perform its function in the alarm system. In order to manually enrol the WD from the CIE, select the Warning Device from the 'Security Devices' screen. The Warning Device screen will be displayed as shown below:

Warning Device									
Sounder									
Status: Not Enrolled									
1	2	T	B	S	R	F	M		
0	0	0	0	0	0	0	0		
Arm Groups: -									
0x10002300abcd5679									
Menu		Up		Down		Sel		C	

- The third line indicates the enrolment status, currently "Not Enrolled". Highlight this line and press the Sel button to change the enrolment status to "Enrolled".

To confirm that the device is enrolled, LED D4 should now be fully illuminated on the WD (not flashing). The WD is now active in the alarm system and will indicate warnings under control of the system.

In the 'Security Devices' screen, devices that are not enrolled are indicated by a dash '-' character and enrolled devices are indicated by a number assigned to the device, as shown below:

Security Devices				
0	Warning		0BE2	
Menu	Up	Down	Sel	C

### 4.3 Adding a Zone Contact Switch Device to the Network

In order to add a Zone device to the network, repeat the steps in Section 4.2 above. However, the following differences apply:

- In Step 1, LED D3 on the Zone Carrier Board will flash to indicate enrolment status (rather than LED D4).
- In Step 4, it will be necessary to select 'Zone' on the Security Devices screen (rather than 'Warning').

After enrolling, the Zone Contact Switch it will be displayed in the Security Devices screen, as shown below.

Security Devices				
0	Warning		0BE2	
1	Zone		6D32	
Menu	Up	Down	Sel	C



## 4.4 Arming the System

The system is armed from the main menu of the CIE. In order to arm the IAS system, there must be no alarms set on any Zone device.

It is possible to check whether there are any alarms set by going to Security Devices from the main menu and selecting the device. The fifth line will show a series of bits. The first two bits show the status of the alarms on the Zone device (1 being enabled, 0 being disabled). In order to arm the zone, these bits must be set to 0 (alarm inactive), as shown below.

Contact Switch
Kitchen
Status: Enrolled
1 2 T B S R F M
0 0 0 0 0 0 0 0
Arm Groups: -
0x10002300abcd5679
Menu Up Down Sel C

If either alarm is enabled, it can be disabled by pressing the corresponding button on the Zone device's Generic Expansion Board - SW2 to disable Alarm1 and SW4 to disable Alarm2 (see Section 5.1 for details).

The system can be armed from the CIE Main Menu as described below.

1. From the main menu, move down to 'Arm Disarm' and press the Sel button.

CIE MAIN MENU
Security Devices
Configuration
Enable Join
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

2. Now select 'Arm All Zones'. If the panel status then shows 'NotReadyToArm' (as illustrated below), this means that an alarm on a Zone device is still enabled and must be disabled before continuing.

Panel: NotReadyToArm
Disarm Or CancelAlarm
Arm All Zones
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

When 'Arm All Zones' has been successfully activated, the panel status will show that the system has entered the 'Exit Delay' state (as shown below) and the lights on the Warning Device will flash.

Panel: ExitDelay
Disarm Or CancelAlarm
<b>Arm All Zones</b>
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

This state will last for 10 seconds and acts as a warning that the system is about to enter an armed mode. When the Exit Delay ends, the CIE will display 'ArmedAway' to indicate the status of the system (as shown below) and the lights on the Warning Device will stop flashing.

Panel: ArmedAway
Disarm Or CancelAlarm
<b>Arm All Zones</b>
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

## 4.5 Triggering the Alarm

In order to trigger the alarm, press either button SW1 or SW3 on the Zone device's Generic Expansion Board, which activate Alarm1 and Alarm2 respectively.

The system will now enter an 'Entry Delay' as illustrated below.

Panel: EntryDelay
Disarm Or CancelAlarm
<b>Arm All Zones</b>
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

This state will last for 10 seconds and the lights on the Warning Device will flash as a warning before the system goes into an alarmed state. While in the alarmed state, the lights on the Warning Device will flash slowly.

Panel: InAlarm
Disarm Or CancelAlarm
<b>Arm All Zones</b>
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

## 4.6 Cancelling the Alarm

To cancel the alarm, select Disarm Or CancelAlarm from the Arm Disarm menu. At this point, the lights on the Warning Device will stop flashing and the system will be returned to the 'ReadyToArm' state, as shown below.

Panel: ReadyToArm
<b>Disarm Or CancelAlarm</b>
Arm All Zones
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

Note that if there is an attempt to arm the system again without first clearing the alarms, 'NotReadyToArm' will be displayed. The alarms needs to be deactivated on the Zone device in order to re-arm the system.

## 5 Device Functionality

This section describes the detailed functions of all devices used in the demonstration.

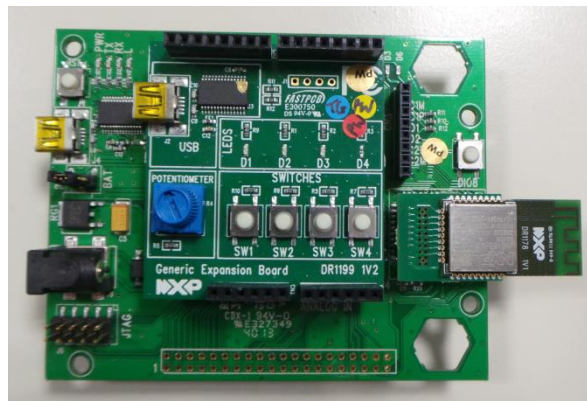
### 5.1 Zone – CSW Functionality

This Zone device acts a latching contact switch in the network. The SW1 and SW3 switches set Alarms 1 and 2 respectively while SW2 and SW4 clear them. LEDs D1 and D2 indicate the status of the alarms. The use of the switches is intended to emulate the operation of sensors such as closure detectors, which are triggered when a door or window are opened.

Once enrolled with a CIE, a Zone is sends notifications of status changes. In this demonstration, the switch informs the CIE about the status changes when any of the switches are pressed. There will be Zone Status Change notification command that will be unicast to the CIE over the air. The CIE takes action on this notification based on the Zone grouping, arming and bypass masks.

The Contact Switch type is 0x0015.

The switch functionality is detailed below:



**Figure 1: Zone CSW**

#### Switches

- DIO8 – Enrol
- SW1 – Alarm1 Set
- SW2 – Alarm1 Clear
- SW3 – Alarm2 Set
- SW4 – Alarm2 Clear

#### Indications

- LED D3 – Joining and Enrol Status Indication
  - LED D2 – Alarm2 Status (On - Set, Off - Clear)
  - LED D1 – Alarm1 Status (On - Set, Off - Clear)
- Please refer to Section 5.7 for more details.



**Note 1:** The CSW device does not go to sleep until it enrolls with a CIE.



**Note 2:** As an End Device, the CSW device sleeps for 7 seconds (SLEEP\_TIME\_IN\_SECS defined in **app\_sleep\_functions.h**) before waking up and polling its parent for pending data or loss of the parent. Since the parent node buffers pending data for 7.68 seconds before discarding it, the sleep period is kept at 7 seconds - if a longer period is used, the End Device may miss the pending data. If there is no data pending or parent loss, the End Device goes back to sleep. On a button-press, the CSW device wakes up to check whether there is any change in the Zone status – if a change is detected, it transmits a Zone Status Change notification and then goes back to sleep.

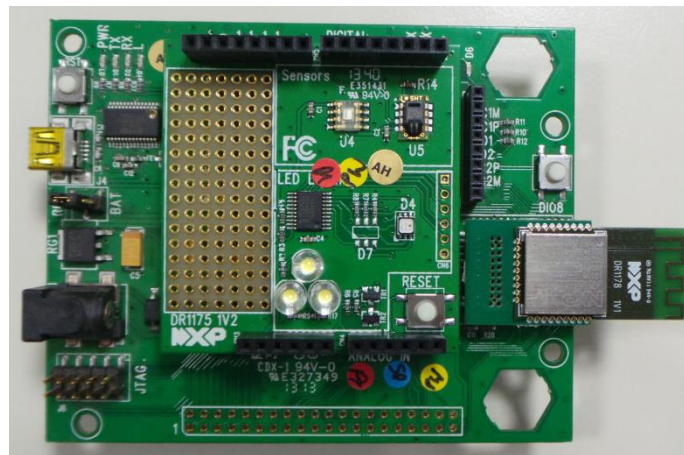


**Note 3:** During the enrolled state, the indicator LEDs (D1, D2 and D3) will be momentarily illuminated, as during sleep all the LEDs are off in order to draw less current.

## 5.2 Zone – VMS Functionality

This Zone has same functionality of notifying a status change to the CIE as the above CSW Zone, but the difference is that it has a light sensor to demonstrate motion detection. The light sensor is intended to emulate the behaviour of a motion detector such as a PIR sensor which would be triggered by movement in the area protected by the Zone. In this application, motion detection is triggered by a reduced light level. The VMS detects the incident light on the light sensor and raises an alarm when the detected light level is below a threshold of 179 counts. It clears the alarm when the incident light on the light sensor is above 350 counts. These thresholds can be changed, according to the operational environment, using constants listed and described in Appendix B.

The Vibration/Movement sensor type is 0x002D.



**Figure 2: Zone VMS**

### Switches

DIO8 – Enrol

### Indications

D4 – Joining and Enrol Status Indication

U4 – Ambient Light Sensor (sets an alarm when the light level is low)

Please refer to Section 5.7 for more details.



**Note 1:** The VMS device does not go to sleep until it enrolls with a CIE.



**Note 2:** As an End Device, the VMS device sleeps for 7 seconds (SLEEP\_TIME\_IN\_SECS defined in **app\_sleep\_functions.h**) before waking up and polling its parent for pending data or loss of the parent. Since the parent node buffers pending data for 7.68 seconds before discarding it, the sleep period is kept at 7 seconds - if a longer period is used, the End Device may miss the pending data. If there is no data pending or parent loss, the End Device goes back to sleep. On a button-press, the VMS device wakes up to check whether there is any change in the Zone status – if a change is detected, it transmits a Zone Status Change notification and then goes back to sleep.



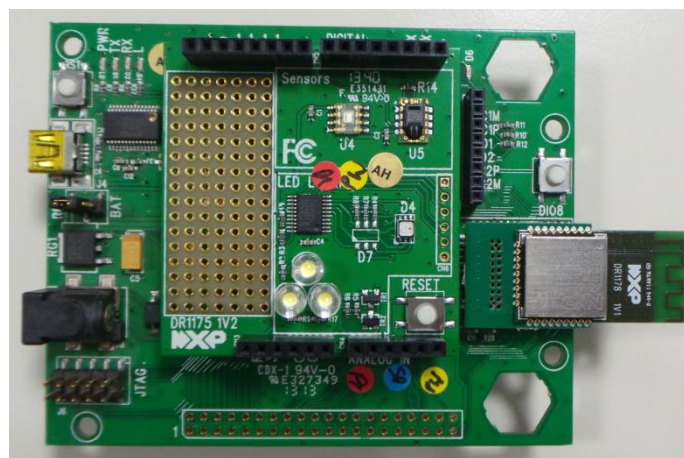


**Note 3:** During the enrolled state, the indicator LED D4 will be momentarily illuminated, as during sleep all the LEDs are off in order to draw less current.

### 5.3 WD Functionality

In an IAS system, the Warning Device (WD) is responsible for generating audio-visual indications corresponding to alarm conditions. For the WD to be part of the IAS system, it needs to be enrolled with the CIE. There can be more than one WD in the system.

The WD is a warning and strobe device in this demonstration. The warning modes are indicated as distinct flash cadences (i.e. different rates and duty-cycles) of the white LEDs. A piezo buzzer can be attached to pins 11 and 40 of the 40-Way header (J1) on the DR1174 carrier board to generate audible alarms and squawks.



**Figure 3: Warning Device (WD)**

#### Switches

DIO8 – Enrol

#### Indications

D4 – Joining and Enrol Status Indication

White LED – Warning/Strobe Indicator Cadences

BURGLAR	1000msec	Time Period
POLICE PANIC	1000msec	Time Period
FIRE	800msec	Time Period
EMERGENCY	200msec	Time Period
ENTRY_EXIT_DELAY	500msec	Time Period

Piezo Buzzer (optional) – Warning/Audible Indications

BURGLAR	Repeated falling tone
POLICE PANIC	Repeated falling tone
FIRE	Repeated rising tone
EMERGENCY	Repeated falling and rising tone
ENTRY_EXIT_DELAY	Repeated constant beeping tone
ARMED	Brief rising tone
DISARMED	Brief falling tone

The strobe duty-cycle and duration is decided by the incoming Start Warning command.

Please refer to Section 5.7 for more details.

## 5.4 ACE Functionality

The ACE device is implemented using the Remote Control Unit (DR1159) from the evaluation kit. Note that an ACE application binary is provided only for JN5168 (and not for JN5169) since the Remote Control Unit in the evaluation kit contains the JN5168 device (which cannot be changed). However, the application can be re-built for the JN5169 device.

The HA profile assumes that the ACE includes a display, which is not present on the Remote Control Unit supplied in the evaluation kit. Instead, this unit is used only as a keypad to generate command inputs to the CIE. The responses that these commands might generate are sent to the Remote Control Unit (where the responses would normally be handled by the ACE) and also used by the CIE to write information to its display. In this way, we emulate the display of the ACE using the display panel on the CIE.



Figure 4: ACE

### Switches

As described in following section.

### Indications

LED1 (above “+”): Join/Enrol Indication

Please refer to Section 5.7 for more details.

### 5.4.1 ACE Command Key Sequences

ACE Command	Key Sequence
Trigger Emergency Indication	<+>
Trigger Fire Indication	<->
Trigger Panic Indication	<arrow>
Observe Devices	<?><*>
Observe Device Status	<?><#>
Observe Panel Status	<?><arrow>
Arm All	< ><A>
Arm Day	< ><B>
Arm Night	< ><C>
Disarm / Cancel Alarm	<O>
Show Bypass List	<#><#>
Add Zones to Bypass List	<#><ZoneId><ZoneId>...<#>  <b>Note:</b> ZoneID 0 is represented by <1> ZoneID 1 is represented by <2> ZoneID 2 is represented by <3> ZoneID 3 is represented by <4> ZoneID 4 is represented by <A> ZoneID 5 is represented by <B> ZoneID 6 is represented by <C> ZoneID 7 is represented by <D>
Clear Persistent Context	<*><+><->



**Note 1:** The ACE device does not go to sleep until it joins a network.



**Note 2:** As an End Device, the ACE device sleeps for 7 seconds (POLL\_MINIMUM\_RATE\_IN\_SECS defined in **zha\_ACE\_NODE.h**) before waking up and polling its parent for pending data or loss of the parent. Since the parent node buffers pending data for 7.68 seconds before discarding it, the sleep period is kept at 7 seconds - if a longer period is used, the End Device may miss the pending data. If there is no data pending or parent loss, the End Device goes back to sleep. When a touch has been detected (which is indicated by both LEDs blinking momentarily), the device comes out of sleep, stays awake for 30 seconds (KEEPALIVE\_TIME as defined in the build configuration) and then goes back to sleep.

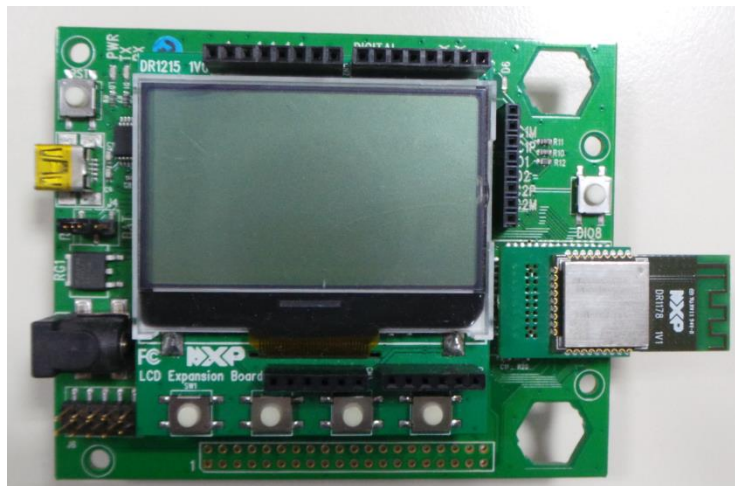


**Note 3:** During sleep, the LEDs are off in order to draw less current.



**Note 4:** Both LEDs will blink continuously to indicate low battery.

## 5.5 CIE Functionality



**Figure 5: CIE**

### Switches

As described in following section.

### Indications

LED D3: Permit Join Indication

#### 5.5.1 Display Functionality

There are two entities in the system which uses the LCD panel on the CIE to display information - the CIE itself and the ACE. The LCD panel has two operating modes, one for displaying messages from the CIE and the other for displaying messages from the ACE.

In order to switch between the two display modes, SW4 (designated the Sel (select) button on the LCD panel) must be pressed and held for longer than 1 second. Switching between displays can be performed at any time.

When the display is operating as the display for the CIE (the Panel display), an indicator in the bottom right-hand corner of the LCD panel shows the letter "C". When showing information from the ACE (the ACE display), the same location shows the letter "A".

On start-up of the CIE, the display mode is Panel, showing messages from the CIE.

In order to indicate that a new message has been written to the 'other' (hidden) display, the indicator letter for the current mode is displayed inverted (as a white character on a black background, rather than the normal black character on a white background). Switching from the current display mode to the other mode and back again cancels the inverted display of the mode character, since the new message which triggered this display format will now have become visible.

[illegible]

The LCD panel provides a display area of approximately 20 characters per line and 8 lines on the screen. Lines 1-7 of the display provide a scrolling area where lines of text are written to the screen. The scrolling area can be thought of as a window on a larger text-buffer. The full text-buffer is 18 lines in length, of which 7 are visible on the display at any time. Once the 18 lines of the text-buffer have filled up, further entries into the buffer cause the oldest line to be discarded, making the text-buffer a circular buffer. If entries are written to the buffer and the display is showing the previous last line of text in the buffer, the new text is inserted in the bottom line of the display and the other lines moved up by one line. The previous top line of the display will disappear off the top of the scrolling area.

The display can be scrolled up or down over the text in the text buffer by pressing the Up or Down buttons on the LCD panel. The Up button is SW2 and the Down button is SW3.

Scrolling area L1				
Scrolling area L2				
Scrolling area L3				
Scrolling area L4				
Scrolling area L5				
Scrolling area L6				
Scrolling area L7				
Menu	Up	Down	Sel	<b>C</b>

### 5.5.3 Menu Functionality

To enter the menu system from the scrolling display, press the Menu button, which is SW1 on the LCD panel. Pressing the Menu button in either the Panel or ACE display mode causes the menu system to be entered.

On entering the menu system, the scrolling area is cleared and the menu options are displayed. The current menu option (also called the highlight in this document) is shown as inverted text, using white characters on a black background rather than the normal black characters on a white background. On entering the menu system, the highlighted menu option is the Menu Entry 1. Pressing the Down button moves the highlight to Menu Entry 2. Pressing the Up button moves the highlight to Menu Entry 1 again.

The layout of the Menu display is shown below:

CIE MAIN MENU
Security Devices
Configuration
Enable Join
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

To select a menu entry, press the Sel button.

To exit from a menu level to the previous level, press the DIO8 button.

At the CIE main menu level, pressing DIO8 returns to the Panel display. As stated previously, if the Sel button is pressed and held for longer than 1 second, the LCD panel switches to the ACE display - this applies both in the Panel display and when displaying the CIE Menu system.

### 5.5.4 Network Set-up

As the Coordinator of the network, the CIE should be the first device to be started in the system and should form the network (only one CIE is permitted in an IAS network). Its progress is indicated to the user through messages on the Panel display (e.g. "Scanning"). An example screen is illustrated below.

Panel
Scanning
Menu Up Down Sel C

Once the network has been formed, the device displays "Network Formed", as illustrated below.

Panel
Network Formed
Menu Up Down Sel C

Any time that a power-on-reset is performed, the above screen will be displayed.

## 5.5.5 Joining

### 5.5.5.1 Permit Joining

The network must be enabled to allow devices to join. This mode is known as “Permit Joining” and can be switched on or off by entering the CIE menu system (press Menu) and then selecting the Enable/Disable Join Menu option. When Permit Joining has been switched on, it is indicated by LED D3 on the CIE (DR1174 board). Therefore, when the LED is illuminated, joining is allowed. The Permit Joining window remains open for 180 seconds and then closes - the indicator LED is then switched off. This window can be re-opened or closed before the 180 seconds have expired using the CIE menu.

CIE MAIN MENU
Security Devices
Configuration
<b>Disable Join</b>
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

The first time the network is formed following the erasure of any persistent context data (see Section 5.6), the Permit Joining window is automatically opened and remains open for 180 seconds.

To go back to the last page, press DIO8.

### 5.5.5.2 Device Joining

When a new device joins the network, if it is an IAS device (Zone, ACE, WD) then a message is displayed on the CIE. The following messages can be displayed:

- Zone Joined
- Keypad Joined
- Warning Joined

If a non-IAS device joins the network, it is shown as “Unknown devices” in the display.



An example of the CIE display is illustrated below.



**Note:** IAS devices should be allowed to join the network one after the other, and not together, since the CIE performs a discovery of security devices immediately after each device has joined.

Panel
Network Formed
Zone Joined
Keypad Joined
Warning Joined
Menu Up Down Sel C

### 5.5.6 Enrolment

To become an active device in the system, an IAS device which has joined the network also needs to be enrolled with the CIE (see also Section 1.1.1). Enrolment is performed by activating the Enrol action on the device to be enrolled when it is in the “Ready to Enrol” state.

Zone servers (Zones, ACE and WDs) implement the Trip-to-Pair and Auto-Enrol-Response methods. Zone clients, such as the CIE, implement the Trip-to-Pair and Auto-Enrol-Response methods. For Trip-to-Pair, this means that Zone enrolment will be invoked by an action on the enrolling device. A Zone server may also be enrolled by the CIE sending a Zone Enrol Response immediately after the CIE has configured the Zone’s *IAS\_CIE\_Address* attribute.

In this release, Auto-Enrol-Response is used to enrol all device types in the system.

For instructions on how to enrol a device using Auto-Enrol-Response, refer to Section 5.5.7.1.

It is possible to configure the CIE to disable enrolment. This is controlled through a configuration option on the CIE Main menu. This causes an enrolment request to fail with the Enrol Response code 0x02 "No Enrol permit". To display the configuration, press the Menu button. The CIE Main menu will be shown as illustrated below.

CIE MAIN MENU
Security Devices
<b>Configuration</b>
Enable Join
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

Move the highlight to the Configuration option using the Up and Down buttons, and select the option by pressing the Sel button for less than one second.

The Configuration screen is illustrated below:

No Enroll Permit Cnfg
<b>Zone Allow</b>
Warning NotAllow
Zone NotAllow
Keypad NotAllow
Menu Up Down Sel C

By default, devices are not permitted to enrol after a reset which clears the context data - to enable "Enrol Permit" for a particular device, move the highlight to the required device entry using the Up and Down buttons, and select the option by pressing the Sel button for less than one second. The display is updated to show that enrolment is now allowed for the selected device.

To exit the Configuration menu and go back to the CIE Main menu, press the DIO8 button.

### 5.5.7 Security Device Display and Edit

The CIE maintains a list of all Security devices joined to the network. It is possible to display the contents of the 'joined device list' on the CIE display. To display this list, press the Menu button. The CIE Main menu will be shown as illustrated below:

CIE MAIN MENU
Security Devices
Configuration
Enable Join
Arm Disarm
Bypass Zones
Panel Status
Menu Up Down Sel C

Move the highlight to the Security Devices option using the Up and Down buttons, and select the option by pressing the Sel button for less than one second.

The display shows the Security Devices list, as illustrated below.

Security Devices
1 ACE 0x1234
2 Zone 0x3322
3 Warning 0x0023
- Zone 0x0122
Menu Up Down Sel C

Each entry shows the Zone ID, the device type and the network (short) address of the device. If the device is not enrolled, the ZoneID position shows a "-" (dash) character. In the example above, Zone 0x0122 is not enrolled in the system, so has no ZoneID allocated. To display more information about a particular device, position the highlight over the relevant list entry and press the Sel button for less than one second.

To exit the Security Devices menu and go back to CIE Main menu, press the DIO8 button.

The Zone Information is shown below:

Motion Sensor
Bedroom 1
Status: Enrolled
1 2 T B S R F M
1 0 0 0 1 1 0 0
Arm Groups: N D B
0x10002300abcd5679
Menu Up Down Sel C

The first line of the display contains the Zone label of the device. Zone Labels are normally assigned by an installer using a special tool during system commissioning. Here, since adding alphanumeric labels is limited by the ACE having only a restricted set of keys, the Zone labels are hardcoded and assigned by the CIE as devices join the system.

Each Zone device is allocated a label from the following list:

- Kitchen
- Bedroom 1
- Bedroom 2
- Lounge
- Bathroom
- Hallway
- Bedroom 3
- Utility Room

For example, the CSW zone is labelled as Kitchen and the VMS zone is labelled as Bedroom 1.

The ACE has the label “Keypad”, the CIE has the label “Panel” and the Warning Device has the label “Sounder”.

The second line of the display indicates the type of sensor, interpreted from the Zone’s *ZoneType* attribute.

The third line indicates the enrolment status, “Enrolled” or “Not Enrolled”. Pressing the Sel button changes the enrolment status. Selecting Enrolled for a device in this way also sets the enrol permission to Allow and enrolls the device from the CIE.

The fourth line gives the headings for the status bits of the *ZoneStatus* attribute:

- 1 – Alarm1
- 2 – Alarm2
- T – Tamper
- B – Battery
- S – Supervision reports
- R – Restore Reports
- F – Failure / Trouble
- M - Mains

The fifth line shows the status bit for the corresponding *ZoneStatus* attribute.

The sixth line shows the Arm groups of which the zone is a member - D indicates Day zones and N indicates Night zones. B indicates that the zone is eligible to be bypassed. If the device is not in any of these zones or not eligible to be bypassed a “-” (dash) character is displayed. Implicitly, all zones are a member of the All Arm group. The zones and bypass settings can be altered by pressing the Sel button whilst the field is selected.

The seventh line shows the extended (MAC/IEEE) address of the device and cannot be changed.

The values of the enrolment status and Arm groups entries can be changed. The highlight is moved to select either the Status or Arm Groups item, and the Sel button is pressed to select the item. Selecting any other line in the menu has no effect.

To exit the Zone Information menu and go back to the Security Devices menu, press the DIO8 button. Then, to exit the Security Devices menu and go back to CIE Main menu, press the DIO8 button again.

### 5.5.7.1 Enrolling and Un-enrolling Devices

Devices can be added to or removed from the list of Zones enrolled with a CIE. This type of enrolment is called Auto-Enrol-Response.

To change the enrolment state of a device, move the highlight to the enrolment Status and press Sel for less than one second. This causes the Status item to toggle from “Enrolled” to “Not enrolled” or vice versa.

- **Enrolment**

On changing the status from Not Enrolled to Enrolled, the CIE writes its address to the Zone's *IAS\_CIE\_Address* attribute. After writing *IAS\_CIE\_Address*, the CIE immediately sends a Zone Enrol Response. After the enrolment has completed, the Status item on the panel display is changed from “Not Enrolled” to “Enrolled”. This action automatically sets the permit enrolment configuration option for the device allowing it to be enrolled immediately.

On changing state to Enrolled, the CIE allocates an unused ZoneID (in the range 0 to 7) to the device. In the Zone list, the first character of the line shows the new ZoneID for the device.

- **Un-enrolment**

On changing status from Enrolled to Not Enrolled, the CIE writes all zeros to the Zone's *IAS\_CIE\_Address* attribute. The Zone checks that the address of the device performing the write is the same as that stored in the Zone's *IAS\_CIE\_Address* attribute. After the un-enrolment has completed, the Status item on the panel display is changed from "Enrolled" to "Not Enrolled".

After un-enrolment, a Zone is no longer a part of the Zone Table and its ZoneID is deleted. This ZoneID may then be reused. In the Zone list, the ZoneID is replaced with a "-" (dash) character.

When a device is not enrolled, it is removed from all Arm groups, and is not present in the All, Day or Night Arm groups. It not possible to add an un-enrolled device to an Arm group - the user interface checks the enrolment status of a device before it allows the device to be assigned to an Arm group. On enrolment, a device automatically becomes part of the All Arm group.

After un-enrolment, even if the Zone status indicates that the device is enrolled, any notifications it sends have no effect and will not trigger an alarm, since it is no longer in the list of devices being checked.

It is possible to re-enrol a device which has been previously un-enrolled but still remains joined to the network. This is done by initiating the enrolment process described above.



**Note:** Since the ACE and Zones are sleepy End Devices that wake every 7 seconds to obtain any pending data from their parent, the enrol/un-enrol procedure should not be performed repeatedly more frequently than every 10 seconds.

#### 5.5.7.2 Assigning a Zone to an Arm group

To assign an enrolled Zone to one or more Arm groups, the Arm Groups item on the Zone Information screen is used. Select the Arm Groups item by moving the highlight to the Arm Groups and press Sel for less than one second. The displayed screen is illustrated below.

Zone				
Arm Groups				
Day	Yes			
Night	No			
Bypass	No			
Menu	Up	Down	Sel	C

The Zone type is shown in line 1 of the display.

The title “Arm Groups” is shown in line 2.

The presence of the Zone in the Night or Day group is shown by the entries on lines 3 and 4. Whether or not the Zone can be bypassed is indicated in line 5 (see Section 5.5.15).

The allocation of the Zone to an Arm group can be changed by moving the highlight over the line for the relevant group. Pressing the Sel button for less than one second causes the setting to toggle between the values No and Yes.

To exit the Arm Groups menu, press the DIO8 button.



**Note:** Although the CIE will allow the on-screen editing of the Arm groups of a device which is not enrolled in the system, these Arm group changes will not be saved.

### 5.5.8 Bypass using Panel

The CIE maintains a list of Zone IDs (and hence devices) which are currently not included when evaluating the state of the whole system – this is the Bypass list.

It is possible to add and remove Zone IDs from the Bypass list using the CIE menu system and also to make zones eligible to be bypassed. Enter the menu system by pressing the Menu button and select the “Bypass Zones” option on the CIE Main menu using the Up and Down buttons, and then press the Sel button.

The Bypass menu appears, as illustrated below.

Bypassed				
0	Zone	No		
1	Keypad	No		
2	Warning	No		
3	Zone	Yes		
Menu	Up	Down	Sel	C

In this example, there are four zones enrolled in the system with Zone IDs 0, 1, 2 and 3. The Bypass list shows that Zone 3 is bypassed. To toggle between Yes and No (i.e. in the Bypass list or not), move the highlight over the required entry and press the Sel button for less than one second.

The Bypass list is cleared each time the system is disarmed.

To exit this menu and to go back to CIE Main menu, press the DIO8 button.

### 5.5.9 Arm/Disarm

The CIE can arm or disarm a system using the 'Arm Disarm' option in CIE Main menu.

CIE MAIN MENU
Security Devices
Configuration
Enable Join
<b>Arm Disarm</b>
Bypass Zones
Panel Status
Menu Up Down Sel C

Move the highlight to the 'Arm Disarm' option using the Up and Down buttons, and select the option by pressing the Sel button for less than one second.

The Arm/Disarm menu appears, as illustrated below.

Panel: Ready To Arm
<b>Disarm Or CancelAlarm</b>
Arm All Zones
Arm Day Zones
Arm Night Zones
Menu Up Down Sel C

The first line indicates the current Panel status of the CIE device.

To exit this menu and to go back to CIE Main menu, press the DIO8 button.

#### 5.5.9.1 Disarming the System and Cancelling Alarms

The CIE device can be used to disarm the system and cancel any alarms by selecting the 'Disarm or CancelAlarm' option in the Arm/Disarm menu. This option cancels a warning by sending a Start Warning command to the Warning Device with the Warning Mode field set to Stop (0) and also disarms the system (i.e. it enters the "Ready to Arm" state). It also clears the Bypass list of the system. It can be used to move the CIE from "Not Ready to Arm" state.



### 5.5.9.2 Arming All Zones

The CIE device can be used to arm all zones by selecting the “Arm All Zones” option in the Arm/Disarm menu. The CIE can transit to this state only from “Ready to Arm” state, otherwise this option has no effect on the system. Please refer to Section 5.5.11 for more information. In the absence of an ACE device, the Disarm option should be used to move from the “Not Ready to Arm” state (which happens if any of the Zones were in alarm while arming the system).

### 5.5.9.3 Arming Day Zones

The CIE device can be used to arm Day Zones by selecting the “Arm Day Zones” option in the Arm/Disarm menu. The CIE can transit to this state only from “Ready to Arm” state, otherwise this option has no effect on the system. Please refer to Section 5.5.11 for more information. In the absence of an ACE device, the Disarm option should be used to move from the “Not Ready to Arm” state (which happens if any of the Day Zones were in alarm while arming the system).

### 5.5.9.4 Arming Night Zones

The CIE device can be used to arm Night Zones by selecting the “Arm Night Zones” option in the Arm/Disarm menu. The CIE can transit to this state only from the “Ready to Arm” state, otherwise this option has no effect on the system. Please refer to Section 5.5.11 for more information. In the absence of an ACE device, the Disarm option should be used to move from the “Not Ready to Arm” state (which happens if any of the Night Zones were in alarm while arming the system).

## 5.5.10 Panel Status

The CIE device can show the Control Panel (CIE) status, which can be accessed by selecting the “Panel Status” option in the CIE Main menu. Move the highlight to the Panel Status option using the Up and Down buttons, and press the Sel button for less than one second.

The Panel Status menu appears, as illustrated below.

Panel Status				
Panel: Ready To Arm				
Alarm: No Alarm				
Sound: Mute				
Seconds Left: 00				
Menu	Up	Down	Sel	C

### 5.5.11 Arming the System

The IAS system is put into the armed state using the ACE or the CIE (Arm/Disarm menu). The following modes of alarm operation are available: All, Day/Home and Night/Sleep. The ACE can be configured (as indicated in the ZigBee IAS specification) to require a security code (Arm/Disarm code) to be entered before the system can be Armed or Disarmed. The ACE in this demonstration does not require a security code and the Arm command is sent with the Arm/Disarm code field set to "00000000" (UTF-8 characters).



**Note:** If the CIE receives an Arm command from an un-enrolled ACE, it will not perform any action and will send back an Arm response with the notification field set to "Not Ready to Arm". In addition, the ACE display will not be updated.

#### 5.5.11.1 Initial Checks

There are several conditions which must be met to allow the system to enter the armed state. The current status of all Zones in the Zone set referenced by the Arm command (All, Day/Home and Night/Sleep) must be clear of alarms. The CIE checks the status of each of the Zones within the Zone set from this command as the first step in the arming procedure - that is, the status flags Alarm1, Alarm2, Tamper, Trouble and AC (mains) must all be 0 to indicate no pending alarm conditions. If an alarm bit is set for a Zone, the CIE informs the ACE that the Panel is not ready to be armed by sending the Panel Status Changed command with a PanelStatus parameter of 0x06 (Not Ready to Arm). Zones which have been bypassed are not included. If an alarm condition is detected in the status of one or more Zones, the CIE will not move from its current state.

A message "Not Ready to Arm" is shown on the ACE mode display indicating that the CIE has not been armed. The ACE sends a Get Zone Status Request command to the CIE in order to determine which Zones are in a fault condition (i.e. have pending alarms). The CIE responds with a Get Zone Status Response command containing the list of Zone IDs and their status matching the Get Zone Status List command parameters. The CIE then goes back to its last panel status state. This information is also shown on the ACE mode display as "Check Zones" <Zone ID list>.

Below is an example of an attempt to arm the system which failed because Zones 1 and 3 showed one or more of the alarm conditions:

ACE display
Ready to Arm
Not Ready to Arm
Check Zones
1 3
Ready To Arm
Menu Up Down Sel A

The CIE can move to the armed state only from the “Ready to Arm” state. If the CIE was already armed and receives an Arm command, the CIE informs the ACE that the Panel is not ready to be armed by sending the Panel Status Changed command with a PanelStatus parameter of 0x06 (Not Ready to Arm). The ACE then sends a Get Zone Status Request command to the CIE in order to determine whether any zones are in a fault condition (i.e. have pending alarms). The CIE responds with a Get Zone Status Response command containing the list of Zone IDs and their status matching the Get Zone Status List command parameters. The CIE then goes back to its last panel status state. The message “Not Ready to Arm” is shown on the ACE mode display indicating that the CIE has not executed the request.

Below is an example of an attempt to arm the system which failed because CIE was already armed.

ACE display
ArmedDay
Not Ready to Arm
Already Armed
ArmedDay
Menu Up Down Sel A

### 5.5.11.2 Exit Delay

When the system has been successfully set, (i.e. there are no alarms conditions registered on the Zones that are not excluded by being present on the Bypass list), the CIE indicates a state of “Exit Delay”. This means that a time-delay is being applied to allow users to leave the building or area before the system responds to alarms. After this time has expired, the system reacts to alarm conditions. In this demonstration, the Exit Delay is 10 seconds. In order to warn users about this state, the CIE instructs the Warning Device to produce a warning that the Exit Delay is in progress.

In order to inform the ACE of the change in Panel state, the CIE sends Panel Status Changed commands indicating the system is in the Exit Delay state and then armed. During the exit delay, if the CIE finds that any of the zones (which are going to be armed) are in a fault condition (based on Zone Status Change Notifications received from the zones), it stops its transition by suspending the count-down and it remains in the Exit Delay state for as long as the fault condition is present on the zone. During this period, the CIE sends a Start Warning to the Warning Device every second. The system will continue its transition from the Exit Delay state once the CIE detects that the relevant zone is clear of any fault conditions (when it receives a Zone Status Change Notification with the status flags Alarm1, Alarm2, Tamper, Trouble and AC (mains) all set to 0, indicating no pending alarm conditions). After this, the CIE sends a Start Warning command to the Warning Device for remaining time of the count-down and moves to armed state after this period.

The CIE sends the armed squawk command to the WD to trigger an audible indication (if the optional piezo buzzer is fitted) when the exit delay ends and the system is armed.

If the user is not able to clear the pending alarm condition on the zone, they can disarm the system and add this zone into the bypassed list before arming the system again.

The progression through these various states is also shown on the ACE mode display, as illustrated below. The example shows the messages for the system being armed in Day mode.

ReadyToArm
ArmingStay
ExitDelay
ArmedDay
Menu Up Down Sel A

### 5.5.12 Armed Operation: Entry Delay

On receiving a Zone Status Change Notification message, the CIE can use the contents to update an internal record of the status of the Zone. If the CIE is in the armed state, it will also perform alarm processing. First it checks whether the Zone is in its arm list (i.e. the Zones in the Zone set with those in the Bypass list removed). If not, the notification can be ignored. If the Zone is in the arm list, it will check the status and if any of the status flags Alarm1, Alarm2, Tamper, Trouble or AC (mains) have been set to 1 then the CIE indicates a state of "EntryDelay". This means that a time-delay is being applied to allow a user to enter the building or area and disarm the system. In this demonstration, the Entry Delay is 10 seconds. In order to warn users about this state, the CIE instructs the Warning Device to produce a warning that the Entry Delay is in progress.

The CIE also sends a Panel Status Changed command to the ACE to show the new status. The ACE ignores the message, but the change of state is shown on the ACE display, as illustrated below.

ACE display
ArmingDay
ExitDelay
ArmedDay
EntryDelay
Menu Up Down Sel A

### 5.5.13 Alarm

If the Entry Delay timer expires and the system has not been disarmed, the system moves to the “InAlarm” state. The CIE sends a Start Warning command to the Warning Device with the Warning Mode set to 0x01 (Burglar) and the Strobe field set to 1 (use strobe). The Warning Duration field is set to 30 to allow the warning to sound/indicate for 30 seconds. The CIE also sends a Panel Status Changed command to the ACE to show the “In Alarm” status - the change of state is shown on the ACE display, as illustrated below.

If the system is not disarmed, further notifications from active Zones may be received by the CIE, and further Start Warning commands sent to the Warning Device.

ACE display
ArmingStay
ExitDelay
ArmedDay
EntryDelay
InAlarm
Menu Up Down Sel A

### 5.5.14 Disarming the System

There are two methods that can be used to disarm the system:

- The ACE may send a Disarm command to the CIE
- The user can use the 'Arm Disarm' entry in the CIE menu (see Section 5.5.9)

On receiving the instruction, the CIE exits the armed state. Any further Status Change Notification messages received from Zones do not cause the Warning Device to be activated.

The CIE sends the disarmed squawk command to the WD to trigger an audible indication (if the optional piezo buzzer is fitted) when the system is disarmed.

In the case where a warning is in progress when the CIE receives a Disarm command, the CIE stops the Warning Device from indicating an alarm by sending a Start Warning command to the Warning Device with the Warning Mode set to Stop and the Strobe field set to 0. The CIE also indicates the change of state on the ACE display. It also clears the bypassed list.

ACE display
ArmingDay
ExitDelay
ArmedDay
EntryDelay
InAlarm
Ready To Arm
Menu Up Down Sel A

### 5.5.15 Bypassing Zones - ACE

Zones can be bypassed either through the CIE menu, as described in Section 5.5.8, or by receiving a Bypass command from the ACE.

To see which Zones are in the Bypass list, the key sequence <#><#> can be used, which causes the ACE to send a Get Bypassed Zone List command to the CIE, which replies with a Set Bypass Zone List command. This results in a message on the ACE display, as illustrated below.

Ace display				
Bypassed Zones				
1 3				
Menu Up Down Sel A				

Here, the Bypass list is showing two entries with Zone IDs 1 and 3.

The key sequence on the ACE for adding a Zone to the Bypass list on the CIE is as follows:

<#><ZoneId><ZoneId>... <#>

where the list of Zone IDs consists of the Zones to be bypassed (i.e. added to the Bypass list). This results in a Bypass command being sent from the ACE to the CIE.

On receiving the Bypass command, the CIE responds by sending a Bypass Response indicating the status of each Zone in the list included in the Bypass command.

To allow a Zone to be bypassed, the Bypass setting for the Zone must be enabled, as described in Section 5.5.8.

If the Bypass command was successful (i.e. all the Zone IDs in the list returned in the Bypass Response command had the Bypass Result set to 0x00) then the ACE display is updated to show the new Bypass list contents.



If the Bypass command failed (i.e. one or more Zone IDs in the list returned in the Bypass Response command had the Bypass Result set to a non-zero value) then the ACE display shows the Zone IDs which failed and the reason for the failure. The information is read-only.

ACE display
Adding bypass zones
2 Bypassed
3 Not Allowed
4 Unknown zone
Menu Up Down Sel A



**Note:** If the CIE receives a Bypass command from an un-enrolled ACE, it will not perform any action and will send back a Bypass response with the Status field set to “Not Bypassed”. The ACE display will also not be updated.

### 5.5.16 Observing Enrolled Devices

It is possible to display the contents of the Zone table (enrolled devices) on the ACE display using the following key sequence:

<?><\*>

This causes the ACE to send Get Zone ID Map and Get Zone Information commands to the CIE. For each entry in the Zone table, the ACE display shows the Zone ID, Zone type, IEEE/MAC address of the Zone and the Zone label. The information is read-only. For each entry, the first line consists of the Zone ID and Zone label, followed by the Zone type and the IEEE/MAC address on subsequent lines. This is illustrated below.



**Note:** If the CIE receives a Get Zone Information command from an un-enrolled ACE device, the ACE display is not updated.

ACE display				
1	Zone			
	Kitchen			
	0x10000023acbe0001			
2	KeyPad			
	KeyPad			
	0x10000023acbe010c			
Menu	Up	Down	Sel	A

If the number of entries in the list is too long for the screen, it is possible to scroll up and down through the list using the Up and Down buttons.

### 5.5.17 Observing Status of Devices

It is possible to show the status of the enrolled devices in the system on the ACE display using the following key sequence:

<?><#>

This causes the ACE to send Get Zone Status commands to the CIE, which replies with corresponding Get Zone Status Response commands. The information is read-only. The information includes the Zone ID, Zone type, Zone status and Zone label of the Zone. The format of each Zone's entry is as illustrated below:

ACE display									
1 Zone									
Kitchen									
1	2	T	B	S	R	F	M		
0	0	0	0	1	1	0	0		
2 KeyPad									
KeyPad									
Menu	Up	Down	Sel	A					



**Note:** If the CIE receives a Get Zone Status command from an un-enrolled ACE device, the ACE display is not updated.

### 5.5.18 Observing Panel Status

It is possible to show the status of the control Panel (CIE) on the ACE display using the following key sequence:

<?><arrow>

This causes the ACE to send a Get Panel Status command to the CIE, which replies with a Get Panel Status Response command. The returned information is shown on the ACE display and this information is read-only. It includes the Panel Status, Alarm Status, Seconds Remaining (only when Panel Status is Entry Delay or Exit Delay) and the audible warning (if active). The format of the Panel Status information is illustrated below:

ACE display
Panel: ArmedAway
Alarm: No Alarm
Sound: Default
Seconds left: 00
Menu Up Down Sel A



**Note:** If CIE receives a Get Panel Status command from an un-enrolled ACE device, the ACE display is not updated.

### 5.5.19 ACE-Triggered Warnings

It is possible to trigger three types of warning from the ACE at any time - Emergency, Fire and Panic.

The key sequences to invoke these warnings are as follows

- Emergency      <+>
- Fire            <->
- Panic          <arrow>

These sequences result in the ACE sending the respective Emergency, Fire and Panic commands to the CIE, which reacts by sending a Start Warning command to instruct the Warning Device to indicate the warning appropriate for the trigger. The duration parameter of the Start Warning command is set to 30 seconds, after which the Warning Device stops indicating the warning, but the system remains in the InAlarm state until cancelled. The ACE display shows that the system has entered the InAlarm state when the warning is invoked, as illustrated below.

ACE display
ArmingStay
ExitDelay
ArmedDay
Ready To Arm
InAlarm
Menu   Up   Down   Sel   A

The indications can be cancelled by using either the Disarm/Cancel key (<O>) on the ACE or the 'Disarm or CancelAlarm' option in the Arm/Disarm menu on the CIE (see Section 5.5.9).



**Note:** If the CIE receives warnings from an un-enrolled ACE device, the CIE does not take any action and the ACE display is not updated.

## 5.6 Clearing Context Data on the Devices

When loading the application for the first time, any persistent context data must be cleared in each of the devices.

### 5.6.1 ACE Device

On the ACE device, context can be cleared using the following key sequence:

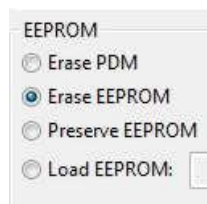
<\*><+><->

### 5.6.2 CIE, Warning and Zone Devices

On the CIE, Warning and Zone devices, context data can be cleared by pressing and releasing the Reset (RST) button while holding down the DIO8 button on the DR1174 Carrier Board.

### 5.6.3 Using the Flash Programmer

The CIE, CSW, VMS, WD and ACE devices use JN516x internal EEPROM for storage. The context data for these devices can be cleared using the JN51xx Flash Programmer within BeyondStudio for NXP by selecting the option **Erase EEPROM** in the **Program serial device** dialogue box (see image below). For information on using this Flash programmer, refer to the *BeyondStudio for NXP Installation and User Guide (JN-UG-3098)*.



## 5.7 Forming the Network

The network is formed by the CIE upon a factory-reset. By default, the channel used by this demonstration is 15. The first time that the CIE starts up with the context data cleared, the network will be open for 180 seconds to allow other devices to join the network. Note that these devices can be any ZigBee HA devices, not just the IAS devices provided in this demonstration.

The network 'Permit Joining' setting can be controlled from the CIE menu. The LED D3 on the DR1174 Carrier board indicates the status of the network:

- LED On – Network Join permitted
- LED Off – Network Join not permitted

Except for the CIE device, all devices in this demonstration are programmed to scan through all the channels and join any open HA network available. When a device joins the network, the CIE performs a service discovery for the IAS Zone cluster on the joined device and writes the *IAS\_CIE\_Address* attribute. During this process, the following behaviour will be displayed by the status LED of the device.

LED Behaviour	Meaning
Flash at 0.5Hz, 50% duty-cycle (1 sec on, 1 sec off)	Powered up but not joined to a network
Flash at 1Hz, 50% duty cycle (0.5 sec on, 0.5 sec off)	Joined to the network but not enrolled
Flash at 2Hz, 50% duty cycle (0.25 sec on, 0.25 sec off)	Ready to enrol, <i>IAS_CIE_Address</i> written by CIE
Steady on	Enrolled

**Table 2: Status LED Behaviour on Joining Network**

If a device becomes un-enrolled but remains in the network, the LED indicates the state “Joined to the network but not enrolled”.

If a device is reset and is no longer part of the network, or it loses connectivity, the LED indicates “Powered up but not joined to a network”.

Joining is invoked autonomously when in the “Powered up but not joined to network” state.

## 5.8 Enrolment

Before IAS devices can actively participate in the security system and perform their functions, they must enrol with the CIE. There are two methods available to perform the enrolment of such a device.

### 5.8.1 Enrolment from Devices

Enrolment is performed by activating the Enrol action on a device when it is in the ‘Ready to Enrol’ state (see Table 2: Status LED Behaviour on Joining Network).

For the Zone devices and the Warning Device, the Enrol action can be activated by pressing the DIO8 button on the DR1174 Carrier board of the device to be enrolled. In this process, the device sends an Enrol Request command to the CIE and receives back an Enrol Response. This is called the Trip-to-Pair enrolment process. The permit enrol setting for the device must be set to Allow in the configuration screen of the CIE for this to be successful.



**Note:** Once a device has been un-enrolled from the CIE, it is no longer possible to enrol the device using the Trip-to-Pair process. Further enrolment can be performed from the CIE only using Auto-Enrol. For more information, refer to Appendix D.

The ACE is always enrolled from the CIE, as described in the next section.

### 5.8.2 Enrolment from CIE

The IAS devices can be enrolled automatically by the CIE without needing to perform an Enrol action on the devices. This method uses the menu-driven enrolment process described in Section 5.5.6 and is triggered by setting the value of the Status field on the Device’s screen (this automatically sets the permit enrolment to Allow for the device in the Configuration screen). This is called the Auto-Enrol-Response process, where the CIE device discovers and writes the CIE address, as well as sending an Enrol Response command to the IAS device.

## 5.9 Communication

As part of the enrolment process between the CIE and the IAS device being enrolled, both devices create a binding for the clusters present on the application endpoints. Hence, most of the communication taking place between devices in the IAS system uses bound or unicast transmissions.

There is no group transmission in this demonstration, nor is there any auto-reporting of attributes.

## 5.10 Re-joining the Network

As part of the parent loss detection or network channel update, the End Devices (ACE, CSW and VMS) go through the re-join procedure. The Zone (CSW and VMS) devices automatically re-join their parents. However, on a sleeping ACE device, manual intervention (that is, by pressing any button) is required to wake the device and prompt it to re-join the network.

# 6 Advanced User Information

## 6.1 Saving Network Context

All device types are protected from losing their network configuration during a power outage by means of context saving. The required network parameters are automatically preserved in non-volatile memory by the ZigBee PRO Stack (ZPS). On restart, the radio channel, Extended PAN ID (EPID) and security keys are restored.

Application-specific information can also be preserved in the non-volatile memory, which is most commonly used to preserve the application's operating state.

The CSW, VMS, WD and ACE devices have their application context saved to EEPROM. The CIE device has its application context saved to external Flash memory.

## 6.2 Security Key

The HA profile uses a public pre-configured link key. This link key can be obtained from the *ZigBee HA Profile Specification*.

## 6.3 Adding More Devices to the Network

The maximum number of IAS devices in the network is set to 8 in the application. As the ZigBee Coordinator, the CIE is configured to support a network of up to 25 devices. However, this value can be increased to allow more HA devices in the network and is limited by resource availability. This is achieved by modifying the ZigBee Network Parameters in the ZPS Configuration Editor. These parameters and the editor are described in the *ZigBee PRO Stack User Guide (JN-UG-3101)*.



## 7 Developing with the Application Note

This section provides additional information that may be useful when developing with this Application Note.

### 7.1 Useful Documents

Before commencing a ZigBee Home Automation development, you are recommended to familiarise yourself with the following documents:

- [R1] - JN-UG-3101 ZigBee PRO User Guide
- [R2] - JN-UG-3075 JenOS User Guide
- [R3] - JN-UG-3076 ZigBee Home Automation User Guide
- [R4] - JN-UG-3103 ZigBee Cluster Library User Guide
- [R5] - JN-UG-3087 JN516x Integrated Peripherals API User Guide
- [R6] - ZigBee HA Profile Specification
- [R7] - ZigBee Cluster Library (ZCL) Specification
- [R8] - docs-13-0553-37-00ha-ha-1-2-errata-document

The latest versions of [R1] to [R5] can be obtained from the [Wireless Connectivity](#) area of the NXP web site, while [R6] to [R8] can be found on the ZigBee Alliance web site.

### 7.2 Debugging the Demonstration Application

#### 7.2.1 Serial Debug

Each node in the demonstration prints out debug information via the UART port based on the debug flags set in the Makefile. This debug information can be viewed using terminal emulator software, e.g. Tera Term. Connect the node of interest to a PC using the Mini-USB cable (supplied in the evaluation kit) and configure the terminal emulator's COM port as follows:

BAUD Rate	115200
Data	8 bits
Parity	None
Stop bit	1 bit
Flow Control	None

Debug can be disabled for production by setting the 'Trace' flag in the relevant node's Makefile to zero. The Makefile also defines a subset of debug flags that allows localised debug statements to be collectively enabled or disabled, e.g. TRACE\_START.

#### 7.2.2 JTAG Debug

The application on a node can be debugged from BeyondStudio for NXP via a JTAG connection. This method requires additional hardware to form the JTAG interface on the node, including a JTAG expansion board and JTAG adaptor/dongle. JTAG debugging is fully described in the Application Note *JN516x JTAG Debugging in BeyondStudio (JN-AN-1203)*.

## 7.3 Building and Downloading the Application

This section provides application build instructions. If you simply wish to use the supplied application binaries, refer to Section 3.

### 7.3.1 Pre-requisites and Installation

Before you start to build and load the application, please ensure that you have following installed on your development PC:

- BeyondStudio for NXP (JN-SW-4141)
- JN516x ZigBee Home Automation SDK (JN-SW-4168)



**Note:** For the installation instructions, please refer to *BeyondStudio for NXP Installation and User Guide (JN-UG-3098)* and the Release Notes supplied with the JN516x ZigBee Home Automation SDK (JN-SW-4168).

In order to build the application, this Application Note (JN-AN-1201) must be unzipped into the directory:

**<BeyondStudio for NXP installation root>\workspace**

where **<BeyondStudio for NXP Installation root>** is the path into which BeyondStudio for NXP was installed (by default, this is **C:\NXP\bstudio\_nxp**). The **workspace** directory is automatically created when you start BeyondStudio for NXP.

All files should then be located in the directory:

**...\workspace\JN-AN-1201-ZigBee-Intruder-Alarm-System**

There is a sub-directory for each application, each having **Source** and **Build** sub-directories.

### 7.3.2 Build Instructions

The software provided with this Application Note can be built for the JN5168 or JN5169 device.

The applications can be built from the command line using the makefiles or from BeyondStudio for NXP – makefiles and Eclipse-based project files are supplied.

- To build using makefiles, refer to Section 7.3.2.1.
- To build using BeyondStudio for NXP, refer to Section 7.3.2.2.

### 7.3.2.1 Using Makefiles

This section describes how to use the supplied makefiles to build the applications. Each application has its own **Build** directory, which contains the makefiles for the application.

To build an application and load it into a JN5168 or JN5169 device, follow the instructions below.



**Note:** The make commands given below will build the application according to the default build options in the makefile (e.g. device type). To use alternative build options, these must be specified in the make command. The required options for different builds can be obtained from the build configurations provided in BeyondStudio for NXP.

1. Ensure that the project directory is located in  
**<BeyondStudio for NXP installation root>\workspace**
2. Start an MSYS shell by following the Windows Start menu path:  
**All Programs > NXP > MSYS Shell**
3. Navigate to the **Build** directory for the application to be built and follow the instructions below for your chip type:

**For JN5168:**

At the command prompt, enter:

```
make clean all
```

**For JN5169:**

At the command prompt, enter:

```
make JENNIC_CHIP=JN5169 clean all
```

In both of the above cases, the binary file will be created in the **Build** directory, the resulting filename indicating the chip type (e.g. **5168**) for which the application was built.


4. Load the resulting binary file into the device. You can do this from the command line using the JN51xx Production Flash Programmer (described in the *JN51xx Production Flash Programmer User Guide (JN-UG-3099)*).

### 7.3.2.2 Using BeyondStudio for NXP

This section describes how to use BeyondStudio for NXP to build the demonstration application.

To build the applications and load them into JN5168 or JN5169 devices, follow the instructions below:

1. Ensure that the project directory is located in  
**<BeyondStudio for NXP installation root>\workspace**
2. Start the BeyondStudio for NXP and import the relevant project as follows:
  - a) In BeyondStudio, follow the menu path **File>Import** to display the **Import** dialogue box.
  - b) In the dialogue box, expand **General**, select **Existing Projects into Workspace** and click **Next**.
  - c) Enable **Select root directory** and browse to the **workspace** directory.
  - d) In the **Projects** box, select the project to be imported and click **Finish**.
3. In the makefile(s) for application(s) to be built, ensure that the JN516x chip on which the application is to run is correctly specified in the line beginning JENNIC\_CHIP. For example, in the case of the JN5169 device, this line should be:  

```
JENNIC_CHIP=JN5169
```
4. Build an application. To do this, ensure that the project is highlighted in the left panel of BeyondStudio and use the drop-down list associated with the hammer icon  in the toolbar to select the relevant build configuration – once selected, the application will automatically build. Repeat this to build the other applications.  
The binary files will be created in the relevant **Build** directories for the applications.
5. Load the resulting binary files into the devices. You can do this using the integrated Flash programmer, as described in the *BeyondStudio for NXP Installation and User Guide (JN-UG-3098)*.

## 7.4 Application Start-up

This section describes the typical start-up flow of an NXP ZigBee PRO device. Note that not all devices sleep, hence the 'Warm Start' path is not always applicable.

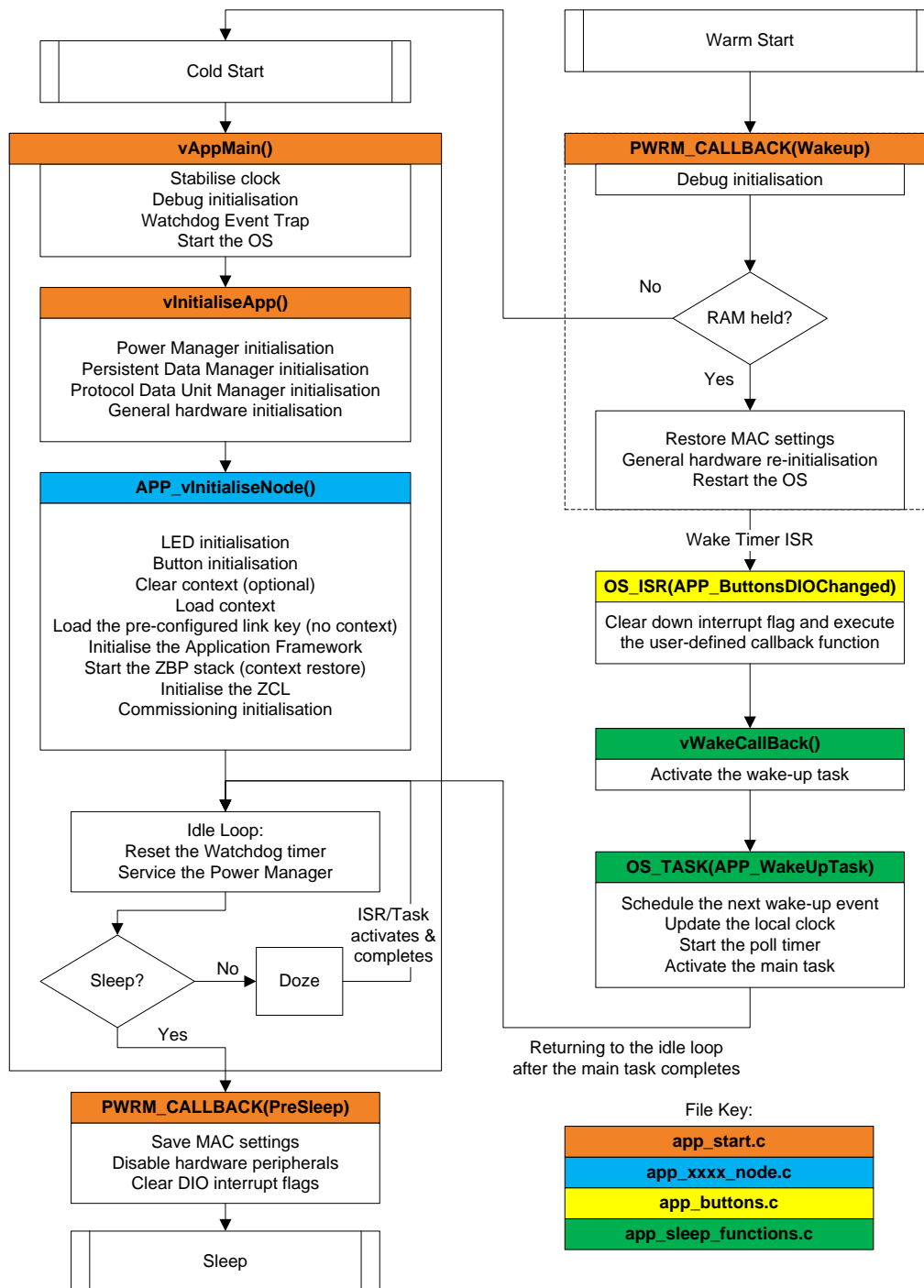


Figure 2: Typical Start-up Flow

## 7.5 HA Device Start-up

The start-up flow for the device is decided according to the state of the device that is saved in the non-volatile memory.

### 7.5.1 E\_STARTUP

In this demonstration, the device state `E_STARTUP` will mean that the device is new to the network without any earlier association with the CIE. Therefore, the start-up flow will follow the joining procedure as described above.

The `haEzJoin.c` file implements the state machine to attempt the joining. It scans a channel multiple times and continues to scan all the channels as long as the state is `E_STARTUP`. Therefore, the application should periodically call the function:

- `vHandleStartUp()` on a CIE or WD
- `vHandleJoinAndRejoinNWK()` on an ACE or Zone device

with the stack event as parameter until the device state changes to the `E_RUNNING`, indicating the device has joined the network.

### 7.5.2 E\_RUNNING

Once the device is part of the network, the device state will be `E_RUNNING`, which will be saved to the non-volatile memory. The device state will then be loaded as `E_RUNNING` upon the next power-on, after which the device can skip the joining process and directly start communicating in the network.

All the application functions related to cluster communication should be carried out in this state.

### 7.5.3 E\_REJOINING

Once an End Device has detected the loss of its parent, its device state will be changed to `E_REJOINING`. The device will remain in this state until it rejoins the network.

## 7.6 Guidelines for Modifying the Application

This section highlights key areas of interest within the code for a developer who wishes to modify the application.

### 7.6.1 Operational State Machine

The operational state machine (`sDeviceDesc.eNodeState`) for each of node is located within the file `zha_<Device>_node.c`. If further operational modes are required, additional states must be added to the switch statement.

### 7.6.2 Handling Cluster events

All the cluster events for the device endpoint are handled in the file `zha_<Device>_zcl_task.c`. Any cluster event handling that needs to be added must go in the endpoint callback function's switch statement.

For detailed cluster events and commands, refer to the *ZCL User Guide (JN-UG-3103)*. The following section presents an overview of the functionality in each of the files for this demonstration application.

### 7.6.3 IAS Discovery and CIE Address Write

The CIE device should discover any IAS device that has joined the network and must write the CIE address to the corresponding server attribute (if allowed). All the discovered IAS devices in the network are populated and maintained in an array of discovered device data. The array size is determined by the macro `MAX_ZONE_SERVER_NODES` and the default size is 10. This value must be greater than the number of Zones that the CIE can enrol.

The IAS devices are discovered by the CIE device as soon they join the network. The following sequence of event occurs as part of the discovery process. The application file **`app_zone_client.c`** holds the following logic for the IAS discovery process. Any modification to the discovery process should be carried out in this file.

1. The node joins the Coordinator and broadcasts a `Device_Annce`.
2. The `Device_Annce` stack event is raised on the CIE.
3. The CIE unicasts a Match Descriptor Request to the above device with the IAS Zone cluster server as the match parameter.
4. The CIE receives the response and populates the discovery table.
5. The CIE sends an IEEE look-up back to the device from which it received the response.
6. The CIE receives an IEEE look-up response, stores it in the discovery table against the network (short) address and reads the Zone cluster server attributes of the node.
7. The CIE receives the read response and populates the table against the appropriate member address.
8. The CIE sends a write request to the node in order to set the CIE address attribute.



**Note 1:** If same device rejoins the CIE then the CIE will not go through the discovery process since it already has all the information related to the device.



**Note 2:** The ACE creates a Binding table entry for the CIE device whenever the *IAS\_CIE\_Address* attribute is written. The ACE removes this Binding table entry when it is un-enrolled from the CIE.

After the above steps, the IAS device is ready to be enrolled. During the enrolment process, Binding table entries are created in both the IAS device and CIE.

Most of the enrolment process is carried out through the Zone cluster commands and the ZCL general read/write functions in the **`app_<device>_zcl_task.c`** file.

### 7.6.4 Adding More Zones to the CIE

The application allows eight Zones in the CIE, by default. To add more Zones to the CIE, the ACE cluster server macro `CLD_IASACE_ZONE_TABLE_SIZE` must be re-defined in the `zcl_options.h` file.

If additional Zones are added in CIE Zone table, this requires the discovery table size `MAX_ZONE_SERVER_NODES` to be also increased, since if Zones are joined simultaneously but not enrolled then the table should be able to display all the joined Zones for the Auto-Enrol-Response process, at a minimum.

### 7.6.5 Pinging the CIE

It is possible for a child node (End Device) to have a Child table entry in a Warning Device (Router) as well as in the CIE (Co-ordinator), in which case the child will not be able to directly communicate with the CIE at the heart of the IAS system. To avoid this scenario, there is a mechanism in this application to ping the CIE every 120 seconds. The ping is a Read Attribute Request for attribute 0 of the Basic cluster. If there is no response from the CIE, the child pings the CIE three more times before attempting to rejoin the network. The application file **PingParent.c** contains this logic.

## 8 Release Details

### 8.1 New Features

There are no new features in this release.

### 8.2 Known Issues

There are no known issues in this release.

### 8.3 Bug Fixes

There are no bug fixes in this release.



## Appendix A - Source File Descriptions

### Automatically Generated Files

Each device has several files that are automatically generated at build-time from the JenOS and ZPS configurations. These files are not generally used by the developer but are located in the respective device's **\Source** folders, in case they are of interest.

### Common Files

A number of common files are used across all device types and are located within the **\Common\Source** folder. The following table gives a brief description of each of the common files.

Filename	Description
AgeChildren.c/.h	Child aging algorithm for the Router and Coordinator nodes.
PingParent.c/.h	Pinging parent mechanism for End Devices.
PDM_IDs.h	PDM ID for the application.
app.zpscfg	ZPS configuration for the application. The entire network needs to be configured in the application in this file. Any new node introduced should modify this configuration.
app_buttons.c/.h	Button process.
app_common.h	Common header files with the common macro and type definitions used across the application.
app_events.h	Application events data structure definitions.
app_exceptions.c/.h	Exception routines.
app_ias_enroll_req.c/.h	Enrolment request routine.
app_ias_indicator.c/.h	IAS device joining and enrolment indication.
app_ias_save.c/.h	IAS Zone device context saving.
app_ias_unenroll_req.c/.h	IAS device un-enrolment request.
app_manage_temperature.c/.h	Temperature compensation algorithm (not used in this release but applicable to many HA applications and devices).
app_pdm.c/.h	PDM debug functions.
app_scenes.c/.h	Scenes routines for saving and loading (IAS does not have scene requirements, hence not implemented).
app_zbp_utilities.c/.h	ZBP utilities for debug.
app_zone_client.c/.h	IAS discovery and enrolment routines. CIE Zone client routines to manipulate the discovery table.
DriverPiezo.c/h	Driver software to sound tones and play tunes on a piezo buzzer using a PWM output.
haEzFindAndBind.c/.h	'Find and Bind' routines (not used as the binding is validated along with the CIE address).
haEzJoin.c/.h	Scanning and joining of the network. This must be used for all the new nodes that need to be added to this application.
os_msg_types.h	OS message types.

## <DeviceType> Source Files

The following table gives a brief description of the files used by the entire IAS device, which are located in the \<DeviceType>\Source folder.

Filename	Description
<b>App_&lt;Device&gt;_JN516x.oscfgdiag</b>	This is the JenOS configuration diagram file, which is used to configure certain application building blocks, such as pre-emptive tasks, software timers, mutexes and Interrupt Service Routines. For more information, refer to the <i>JenOS User Guide (JN-UG-3075)</i> .
<b>app_start_&lt;Device&gt;.c</b>	Start-up module with <b>vAppMain</b> and sleep/wake-up callback functions. All the initialisation for start-up and wake-up is available in this module.
<b>app_zcl_&lt;Device&gt;_task.c/.h</b>	ZCL event handler for the node - the endpoint callback function is part of this module. This also has the node task and functional state machine.
<b>zcl_options.h</b>	ZCL cluster options that are required by the application.
<b>zha_&lt;Device&gt;_node.c/.h</b>	Initialisation and hardware hooks for the device. Application-specific send/receive functions.

## Device-specific Source Files

The following table gives a brief description of the device-specific source files, located in the \<Device>\Source\ folder.

Filename	Description
<b>app_captouch_buttons.c/.h</b>	ACE device application key maps for the touch controller.
<b>app_led_control.c/.h</b>	ACE device LED indicator initialisation and toggle routines
<b>DriverCapTouch.c/.h</b>	ACE device touch-control driver.
<b>app_CIE_display.c/.h</b>	CIE display routines, constants and variables - any new display menu item needs to go in this file.
<b>app_CIE_save.c/.h</b>	IAS CIE device context saving.
<b>zha_WD_generation.c/.h</b>	WD warning generation routines. It has timer callback to generate warnings based on the parameters provided.
<b>app_scenes.c/.h</b>	Scenes saving and loading routines for WD.
<b>App_sleep_functions.c/.h</b>	Zone devices use this for sleep functionality.

## Appendix B – Pre-processor Macros Description

Compile-time macros to manipulate ZigBee Cluster Library functionality are defined in the **zcl\_options.h** file for the respective device. Other than these ZCL-specific macros, the demonstration application uses the following macros for ease of development and testing.

Macro	Description
HALT_ON_EXCEPTION	Stops execution in the case of an exception. Otherwise, allows the application to continue after a reset following an exception.
MAX_DISCOVERY_ATTEMPT_PER_CHANNEL	Maximum discovery per channel during attempt to join. The default value is 3.
EZ_MAX_NETWORK_DESCRIPTOR	Maximum MAC beacons that the NWK descriptor can hold during discovery. The default value is 8.
DISCOVERY_TIMEOUT_IN_MS	Discovery timeout, in milliseconds, per channel
JOINING_TIMEOUT_IN_MS	Joining timeout or timeout to get the NWK key during a join attempt, in seconds. The default value is 5 seconds.
POLL_MINIMUM_RATE_IN_SECS	The period, in seconds, after which the ACE device will initiate a poll. This macro is defined in the <b>zha_ACE_node.c</b> file and the default value is 7 seconds.
KEEP_ALIVETIME	The period, in seconds, for which the device remains active before going to sleep. This macro is used by the ACE device and is defined in the build configuration. The default value is 30 seconds.
SLEEP_TIME_IN_SECS	The period, in seconds, for which the Zones will sleep. This macro is defined in <b>app_sleep_functions.h</b> and the default value is 7 seconds. On a VMS, along with sleep functionality, this is the sampling period to detect a presence.
MAX_ZONE_SERVER_NODES	Maximum number of Zone servers in the network that the CIE will be able to discover and enrol. The default value is 10.
ENTRY_EXIT_DELAY_WARNING_DURATION	Entry exit alarm duration, in seconds. The default value is 10.
ALARM_WARNING_DURATION	Alarm duration, in seconds, for Burglar, Panic, Emergency and Fire.
CLD_IASACE_PANEL_PARAMTER_SECONDS_REMAINING	Same as ENTRY_EXIT_DELAY_WARNING_DURATION
WARNING_MODE_STROBE_AND_SIREN_LEVEL_<Warning mode>	The warning mode strobe and siren levels used to distinguish between warnings. <Warning mode> can be: BURGLAR 0x17 FIRE 0x27 EMERGENCY 0x37 ENTRY_EXIT_DELAY 0x47
WARNING_<Warning Type>_PERIOD	The warning period (or inverse of frequency), in milliseconds, for the different warning types. <Warning type> can be: BURGLAR 1000 FIRE 800 EMERGENCY 200 ENTRY_EXIT_DELAY 500
LIGHT_SENSOR_THRESHOLD_FOR_RESETTING_MASK	If light falling on the light sensor is greater than this value then the status bit will be reset for VMS zone. This macro is defined in <b>zha_ZONE_node.h</b> and the default value is 350.
LIGHT_SENSOR_THRESHOLD_FOR_SETTING_MASK	If light falling on the light sensor is less than this value then the status bit will be set for VMS zone. This macro is defined in <b>zha_ZONE_node.h</b> and the value is 179.

## Appendix C - Build File Descriptions

### Common Build Files

The following table gives a brief description of the build files, located in the \<DeviceType>\Build folders.

Filename	Description
<b>Makefile</b>	This common Makefile is used to build the binary for the specific HA IAS device based on input

### Device-specific Linker Files

The following table gives a brief description of the device-specific linker files, located in the \<DeviceType>\Build\ folders.

Filename	Description
<b>APP_stack_size_JN5168.ld</b>	Linker command file defining the default application stack size. Can adjust _stack_size for the desired stack size.
<b>APP_stack_size_JN5169.ld</b>	Linker command file defining the default application stack size. Can adjust _stack_size for the desired stack size.

## Appendix D - Limitations

ID	Severity	Description
1	Low	During join, if the device gets reset, the read attribute from the CIE fails and hence the device is shown as unknown in the CIE display.
2	Low	Trip-to Pair cannot be initiated from a Zone device once it has been un-enrolled from the CIE - the reason is that the Zone will go back to 'device joined' state and thus need another device to write to its IAS_CIE_IEEE attribute (which can be done using a configuration tool or in our application from the CIE using auto-enrol).
3	Low	ACE device can communicate with the CIE only when the binding entry for the CIE device is created in the ACE device.

## Appendix E - Application Code Size Statistics

The demonstration application of this Application Note has the following memory footprint on the JN5168 device, using the JN516x ZigBee Home Automation SDK (JN-SW-4168).

Components	Text Size (In Bytes)	Data Size (In Bytes)	BSS Size (In Bytes)
<b>ACE_JN5168_DR1159.bin</b>	112458	2040	23099
<b>WD_JN5168_DR1175.bin</b>	127650	1856	21539
<b>ZONE_JN5168_DR1175_VMS.bin</b>	108634	1948	21711
<b>ZONE_JN5168_DR1199_CSW.bin</b>	108082	1952	21699
<b>CIE_JN5168.bin</b>	142033	1964	23209

## Revision History

Version	Notes
1.0	First release
1.1	Child Aging and Ping Parent sections added
1.2	Updated for ZigBee Home Automation Specification 1.2.2 and 'BeyondStudio for NXP' toolchain
1.3	Updated to support JN5169 device
1.4	Binaries rebuilt on JN-SW-4168 SDK v1279 for improved radio settings
1.5	Additional information to clarify commissioning process Updated for changed soft-button names in CIE Description of new audible alarms and squawks in WD
1.6	Tested with version 1364 of the JN516x ZigBee HA/ZLL SDK (JN-SW-4168)
1.7	Binaries rebuilt on JN-SW-4168 SDK v1461
1.8	Reworked "Running the Demonstration" section Binaries rebuilt on JN-SW-4168 SDK v1470
1.9	Added deferred confirm queue required for new JN-SW-4168 SDK v1595
2.0	Binaries rebuilt on JN-SW-4168 SDK v1611
2.1	Binaries rebuilt on JN-SW-4168 SDK v1620

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