
Freescal**e** BeeStack™

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About This Book

This document provides a brief overview of the Freescale BeeStack document set. BeeStack is the Freescale implementation of the ZigBee 2006 wireless network protocol stack. The overviews contained in each chapter serve as an aid to finding the proper detailed document for any particular BeeStack topic.

Audience

This document is intended for software developers who write applications for BeeStack-based products using Freescale development tools.

Organization

This document is organized into the following sections.

Chapter 1	Introduction – describes this document.
Chapter 2	Freescale ZigBee Applications User’s Guide – describes, step-by-step, how to install and run the sample applications on Freescale Reference Boards. Describes in detail the user interface for the applications.
Chapter 3	BeeStack Software Reference Manual – describes in detail the API to BeeStack in a reference (not tutorial) style. Also includes an overview of ZigBee networking, including a diagram of the stack components.
Chapter 4	BeeStack Application Development User’s Guide – describes how to develop an application for BeeStack, including discussions on major considerations for commercial applications.
Chapter 5	Freescale Platform Reference Manual – describes in detail the API to the Freescale Platform components shared among Freescale networking solutions (e.g. BeeStack, The Freescale IEEE 802.15.4 MAC and the Freescale Simple MAC). Many components interact with reference hardware such as switches, the LCD and LEDs. Other components include timers and the task scheduler.
Chapter 6	ZigBee Cluster Library Reference Manual – describes the API to the ZigBee Cluster Library, an add-on component used in many ZigBee Application Profiles.
Chapter 7	ZigBee Test Client Reference Manual – describes the API to the ZigBee Test Client (ZTC) test harness software. This component allows a PC to control and monitor the ZigBee node through a USB or a RS-232 port. This document also includes a step-by-step example of using the ZigBee Test Client and how to update the ZigBee Test Client to include new commands and events.

Revision History

The following table summarizes revisions to this document since the previous release (Rev. 0.0).

Revision History

Document Version	Description/Location of Changes
1.0	Updated changes to ZTCRM.

Conventions

This document uses the following formatting conventions when detailing commands, parameters, and sample code:

Courier mono-space type indicates commands, command parameters, and code examples.

Bold style indicates the command line elements, which must be entered exactly as written.

Italic type indicates command parameters that the user must type in or replace, as well as emphasizes concepts or foreign phrases and words.

Definitions, Acronyms, and Abbreviations

ADC	Analog to digital converter
AF	Application framework
API	Application programming interface
APS	Application support sub-layer
Binding	Matching ZigBee devices based on services and needs
Cluster	A collection of attributes associated with a specific cluster-identifier
Endpoint	Component within a unit; a single IEEE 802.15.4 radio may support up to 240 independent endpoints
EVB	Freescale evaluation board
IEEE	Institute of Electrical and Electronics Engineers, a standards body
LED	Light-emitting diode
MAC	Medium access control sub-layer
NCB	Freescale Network Control Board
NWK	Network layer
Profile	Set of options in a stack or an application
SAP	Service access point
SARD	Freescale Sensor Reference Design
SRB	Freescale Sensor Remote Board
Stack	ZigBee protocol stack
ZDO	ZigBee device object(s)
ZDP	ZigBee device profile
802.15.4	An IEEE standard radio specification that underlies the ZigBee Specification

Reference Materials

The following served as references for this manual:

1. Document 053474r13, *ZigBee Specification*, ZigBee Alliance, December 2006
2. Document 06027r04, *ZB_AFG-ZCL_Foundation*, ZigBee Alliance, October 2006
3. Document 053520r16, *ZB_HA_PTG-Home-Automation-Profile*, ZigBee Alliance, September 2006



Chapter 1

Introduction

This overview document provides a high level content description of each Freescale BeeStack document. Use this overview to find the proper document for a particular BeeStack component or task.

Chapter 2

Freescale ZigBee Application User's Guide

This guide describes in step-by-step form, how to install and run the sample applications on Freescale Reference Boards. It describes in detail the user interface for the applications.

Chapter 1	Provides an overview of the guide.
Chapter 2	Describes the Freescale Development Boards in detail, describing LEDs, the LCD (NCB only), RS-232 port, and USB port. It includes common usage names for the boards.
Chapter 3	Describes the BeeKit configuration tool and the CodeWarrior IDE and C compiler. It describes how to use BeeKit and CodeWarrior together to create applications from BeeKit templates, all the way to the point of downloading sample applications to the Freescale Development Boards.
Chapter 4	Describes the steps involved in running the HaOnOffLight and HaOnOffSwitch application in detail, including which buttons to press and what to expect on the LEDs and LCD display (if the NCB development board is used).
Chapter 5	Describes the common user interface elements and the specific user interface for each sample application available for BeeStack. Sample applications include: <ul style="list-style-type: none">< HaOnOffLight – Simple on-off light, has the ability to report when the state of the light changes. Can control external light on GPIO pin.< HaOnOffSwitch – Simple on-off switch. Can turn lights or other devices on and off.< HaDimmingLight – Simple dimming light. Can scale between fully on and off. Can also be controlled (but not dimmed) by an on-off switch.< HaDimmerSwitch – Switch for dimming light.< HaThermostat – Basic thermostat, can display current temperature in Celsius or Fahrenheit.< HaTemperatureSensor – Reports temperature to thermostat when configured to do so.< HaConfigurationTool – Configures temperature sensor to report to thermostat. Very rudimentary commissioning tool.< HaRangeExtender/HaGenericApp – Application serves no purpose other than extending the range of the ZigBee network and providing a blank Home Automation template for building applications.< Wireless UART – Replace a serial cable with two or more ZigBee nodes. Can multi-hop for extended range using mesh routing. ZigBee is half-duplex and generally low data rate, so it is not applicable for all serial applications.

- 〈 Accelerometer/GenericApp – Sample application shows real-time tilt using the accelerometer built into some Freescale Development Boards. Also shows how to interact with ADC in the BeeStack environment.

Chapter 3

BeeStack Software Reference Manual

This manual describes the API to BeeStack in detail. It also includes an overview of ZigBee networking, including a diagram of the stack components.

Chapter 1	Provides an overview of the <i>BeeStack Software Reference Manual</i> .
Chapter 2	Provides a ZigBee overview and describes (at a high level) how ZigBee networking operates. It also describes the ZigBee stack components and includes concepts such as binding, broadcasting and unicasting.
Chapter 3	Describes the API and source code directory structure.
Chapter 4	Describes the API in the application framework (AF) component of BeeStack, including how to send and receive data over a ZigBee network.
Chapter 5	Describes the ZigBee Application Support Sub-layer (APS), a ZigBee networking component responsible for reliable delivery of packets, and for applying application level meaning to packets through use of application profiles and clusters. It includes <code>binding</code> applications, a virtual wire connecting two or more endpoints.
Chapter 6	Describes the ZigBee Device Object (ZDO) component of the ZigBee specification. This component is responsible for controlling the state of this node on the network (for example, has the node joined the network yet?). ZDO contains various options for how to form or join a ZigBee network.
Chapter 7	Describes the ZigBee Device Profile (ZDP), a common set of over-the-air application services available to all ZigBee nodes.
Chapter 8	Describes the BeeStack Network Layer API. Usually, applications interact with the higher layers listed above, but there are some API calls that communicate directly with the network layer.
Chapter 9	Describes the Application Support Layer (ASL) API, a non-ZigBee, Freescale-specific component that provides a common user interface for most of the sample applications. This component is available in full source code to allow portions to be used in production applications, but it is not intended for inclusion in typical OEM products.
Chapter 10	Describes the API to a set of BeeStack Common Functions. These functions perform common operations (such as creating and searching bit lists and zeroing or copying memory) and may be used by custom applications.
Chapter 11	Describes the large set of User-Configurable BeeStack compile-time options, settable through BeeKit. The options are available to affect behavior of BeeStack and to reduce BeeStack and component code size to allow as much RAM and

Flash as possible for custom applications.

Chapter 12

Describes how to enable, disable and configure security within BeeStack.

Chapter 4

BeeStack Application Development Guide

This guide describes how to develop an application for BeeStack, including discussions on major considerations for commercial applications.

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| Chapter 1 | Provides an overview of the BeeStack Application Development Guide, including what is and not included in the guide. This guide also describes a basic development process using both BeeKit and CodeWarrior. Note that this is in concept only. This guide is not a user guide for either BeeKit or CodeWarrior. |
| Chapter 2 | Provides a step-by-step example of creating a custom sample application. |
| Chapter 3 | Describes designing a new custom-profile application, including selecting a profile, clusters, attributes and endpoints. It also describes ZigBee 2006 security options. |
| Chapter 4 | Describes selecting the appropriate hardware-related platform components, including the use of non-volatile memory, LEDs, the keyboard, RS-232 port, and general hardware selection. |
| Chapter 5 | Describes using the non-hardware-related platform components appropriately, including the use of timers, messages, data queues, the task scheduler and low power library. It also describes how to determine how much RAM and Flash is available to the application and what to do if an application exceeds memory size. |
| Chapter 6 | Describes debugging BeeStack applications, including use of the BDM, LEDs, ZigBee Test Client and ZigBee protocol over-the-air sniffers. |

Chapter 5

Freescale Platform Reference Manual

This manual describes in detail the API to the Freescale Platform components shared among Freescale networking solutions (For example, BeeStack, the Freescale IEEE 802.15.4 MAC, and the Freescale Simple MAC). Many components interact with reference hardware such as switches, the LCD and LEDs. Other components include timers and the task scheduler.

Chapter 1	Provides an overview of all the platform components and where they can be found in the directory structure in a BeeStack project.
Chapter 2	Describes the task scheduler API and compile-time options.
Chapter 3	Describes the timer API and compile-time options.
Chapter 4	Describes the LED API and compile-time options.
Chapter 5	Describes the LCD API and compile-time options.
Chapter 6	Describes the keyboard API and compile-time options.
Chapter 7	Describes the UART (SCI) API and compile-time options.
Chapter 8	Describes the non-volatile memory API and compile-time options.
Chapter 9	Describes the lower power API and compile-time options.

Chapter 6

ZigBee Cluster Library Reference Manual

This manual describes the API to the ZigBee Cluster Library, an add-on component used in many ZigBee Application Profiles, including Home Automation.

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| Chapter 1 | Provides an overview of the ZigBee Cluster Library, as well as its purpose and use in Home Automation. It also contains a concise list of the devices, clusters and attributes and commands supported by BeeStack. |
| Chapter 2 | Describes the BeeStack API and compile-time options for the ZigBee Cluster Library. |
| Chapter 3 | Describes how attributes, clusters and devices are defined and instantiated. It provides an example of adding a custom attribute to an existing cluster, and adding a custom cluster to an existing device. |

Chapter 7

ZigBee Test Client Reference Manual

This manual describes the API to the ZigBee Test Client (ZTC) test harness software. This component allows a PC to control and monitor the ZigBee node through a USB port or RS-232 port. It includes a step-by-step example of using the ZigBee Test Client and how to expand the ZigBee Test Client to include new commands and events.

Chapter 1	Provides an overview of the ZigBee Test Client, including the architecture and PC requirements.
Chapter 2	Outlines the required BeeKit development tools, their installation, and provides step-by-step installation and setup instructions to prepare both the host computer and ZigBee devices for a test network.
Chapter 3	Details how users can modify the Test Tool for new applications.
Chapter 4	Gives several examples of standard wireless sniffer tests for monitoring packets between wireless network devices.
Chapter 5	ZTC Frame Format - Describes the protocol frame format used by the ZTC.
Appendix A	Includes the full list of commands and events supplied with this software, including the OpCode group identification number, the OpCode number, and the associated primitive.

