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**KH3 Series**  
**Basic Evaluation Kit**  
**User's Guide**

**Wireless made simple<sup>®</sup>**

 **Warning:** Some customers may want Linx radio frequency (“RF”) products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns (“Life and Property Safety Situations”).

**NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS.** No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product’s regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

**Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/decoder to validate the data.** Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

**All RF products are susceptible to RF interference that can prevent communication.** RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

**Do not use any Linx product over the limits in this data guide.** Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

**Do not make any physical or electrical modifications to any Linx product.** This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

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# KH3 Series Basic Evaluation Kit

## User's Guide

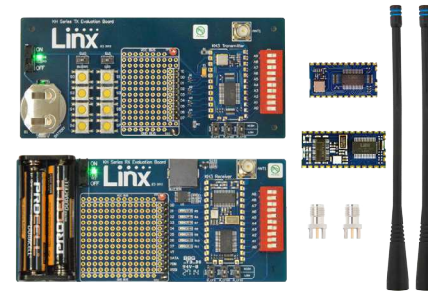


Figure 1: KH3 Series Basic Evaluation Kit

### Introduction

LinX KH3 Series RF modules offer a simple, efficient, and cost-effective method of adding wireless communication capabilities to any product. The Basic Evaluation Kit gives a designer all the tools necessary to correctly and legally incorporate the KH3 Series modules into an end product. The development boards themselves serve several important functions:

- **Rapid Evaluation:** The boards allow the performance of the LinX KH3 Series modules to be evaluated quickly in a user's environment.
- **Range Testing:** Using the on-board encoders and decoders to generate a simplex transmission, a pair of development boards can be used to evaluate the range performance of the modules.
- **Design Benchmark:** The boards provide a known benchmark against which the performance of a custom design may be judged.
- **Application Development:** An on-board prototyping area allows for the development of applications directly on the development board. All signal lines are available on a header for easy access.

The kit includes 2 KH3 Series transmitters\*, 2 KH3 receivers\*, 2 extra PCB-mount RP-SMA connectors, 2 development boards, 2 CW Series antennas, 1 CR2032 battery, 2 AAA batteries and full documentation.

\*One part is soldered to the board, one extra for use on your first prototype board.

## Ordering Information

Ordering Information	
Part Number	Description
EVAL-***-KH3	KH3 Series Basic Evaluation Kit
*** = 315, 418 (Standard), 433MHz	

Figure 2: Ordering Information

## KH3 Series Transmitter / Encoder Evaluation Board

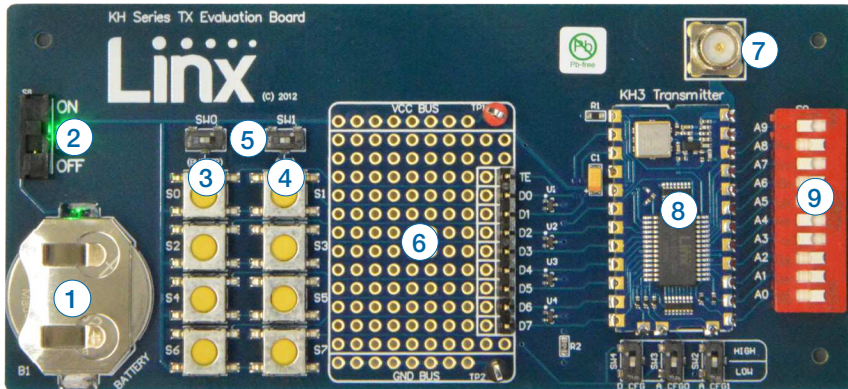


Figure 3: KH3 Transmitter / Encoder Evaluation Board

1. Battery – 3VDC (use a CR2032-style battery only)
2. Power Switch
3. Momentary Pushbutton – S0 (D0)
4. Momentary Pushbutton – S1 (D1)
5. Continuous Transmit Switches
6. Prototyping Area
7. Reverse-Polarity SMA Antenna Connector
8. KH3 Series Transmitter Module
9. 10-Position Address DIP Switch

## KH3 Series Receiver / Decoder Evaluation Board

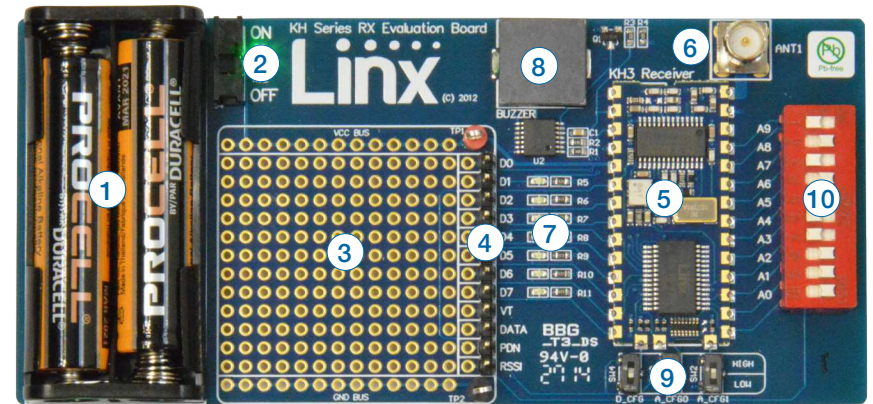


Figure 4: KH3 Receiver / Decoder Evaluation Board

1. Battery – 3VDC (use 2 AAA style batteries)
2. Power Switch
3. Prototyping Area
4. Breakout Header
5. KH3 Series Receiver / Decoder Module
6. Reverse-Polarity SMA Antenna Connector
7. LEDs – D1–D7
8. Buzzer – D0
9. Holtek Configuration Switches
10. Address Configuration DIP Switch

## Theory of Operation

### Transmitter Evaluation Board

The transmitter board is powered by a 3V CR2032 lithium battery. It has eight SPST pushbutton switches, the states of which are encoded into a data stream by the module. When a switch is closed, the module captures the settings of the 10 address lines (connected to a DIP switch) and the eight pushbutton lines for encoding and transmission. The transmitter continuously transmits when any switch is closed or when the Transmit Enable (TE) line is pulled high. The board has a prototyping area with all of the transmitter lines wired to a header for easy access by external circuitry.

### Decoder Evaluation Board

The receiver board is powered by two AAA batteries. The data recovered by the KH3 Series receiver is internally decoded. If the settings of the 10-position DIP switch on the receiver board match the address setting of the transmitter board, the data lines are updated to match the state of the data lines (or pushbuttons) on the transmitter board. To demonstrate this, one data line is used to activate a buzzer while the others are used to activate LEDs. This board has a prototyping area with all of the receiver lines brought out to a header for easy access by external circuitry.

## Using the Kit

Using the kit is straightforward. Simply attach the antennas, turn on the power, set the 10-position DIP switches on both boards the same and press one or more of the buttons on the transmitter board. When S0 is pressed, the buzzer sounds. When S1–S7 are pressed, the corresponding LEDs turn on.

## Setting the Address

The address is made of ten inputs from the DIP switch, resulting in 1,022 ( $2^{10} - 2$ ) possible combinations. Both the encoder and decoder board must have matching addresses.

**Note:** All address lines high or all low is not allowed, so at least one line must be different from the others.



**Warning:** When designing remote control applications, it is very important to use unique addressing between devices. This eliminates opportunities for accidental triggering of unintentional devices within range. For example, if next door neighbors have matching addresses for their garage doors, each person would open both garage doors when transmitting from a single remote controller. For this reason it is important to set the address to a unique configuration.

Note: The KH3 Series has 10 address inputs which can be set to over a thousand combinations. It is extremely important to mix up the address logic, making the address more likely to be unique. Simple addressing schemes, such as the first 9 address pins set to the same logic and the 10th address pin being inverted is NOT recommended.

## Development Using the Prototyping Area

In addition to their evaluation functions, the boards may also be used for product development. They feature a prototyping area for the addition of application-specific circuitry. This area has connections to  $V_{CC}$  at the top and to ground at the bottom that can be used to power any circuitry that is added.

**Note:** The CR2032-style battery on the transmitter board has very low current capacity with, only about 3mA available for external circuitry. If added circuitry requires a higher current, the battery must be removed and the board powered from an external source.

The holes are plated and set at 0.1" on center with a 0.04" diameter, making it easy to add most industry-standard SIP and DIP packages to the board.

On the transmitter board, the data lines and the TE line from the encoder have been wired out to a header on the right side of the prototyping area. On the receiver board, the data, PDN and DATA lines from the receiver have been wired out. This allows for easy access to connect external circuitry to the modules, the encoder, and the decoder. Data line D0 is connected to the buzzer and the rest are connected to LEDs.

## Range Testing

Several complex mathematical models exist for determining path loss in many environments. These models vary as the transmitter and receiver are moved from indoor operation to outdoor operation. Although these models can provide an estimation of range performance in the field, the most reliable method is to simply perform range tests using the transmitter and receiver in the intended operational environment.

Simple range testing can be performed with the transmitter and receiver evaluation boards. To prepare the board for range testing, simply turn it on by switching the power switch to the ON position. Pressing S0 on the transmitter activates the buzzer on the receiver board, while S1 activates the LED. Switches SW0 and SW1 have been provided to jumper the buttons and continuously transmit. This allows the designer to turn on the transmitter and walk with the receiver.

As the maximum range of the link in an area is approached, it is not uncommon for the signal to cut in and out as the transmitter moves. This is normal and can result from other interfering sources or fluctuating signal levels due to multipath. Multipath results in cancellation of the transmitted signal as direct and reflected signals arrive at the receiver at differing times and phases. The areas in which this occurs are commonly called "nulls" and simply walking a little further usually restores the signal. If this does not restore the signal, then the maximum effective range of the link has been reached.

Since the evaluation boards are intended for use by design engineers, they are not FCC certified. The transmitter has been set to approximate legal limits by resistor R1 so that the range test results will approximate the results from a well-designed, certified product. For applications where Part 15 limits are not applicable, R1 can be changed according to the attenuation graph in the KH3 Series Transmitter Data Guide.

To achieve maximum range, keep objects such as your hand away from the antenna and ensure that the antenna on the transmitter has a clear and unobstructed line-of-sight path to the receiver board. Range performance is determined by many interdependent factors. If the range you are able to achieve is significantly less than specified by Linx for the products you are testing, then there is likely a problem with either the board or the ambient RF environment in which the board is operating. First, check the battery, switch positions, and antenna connection. Next, measure the receiver's

RSSI voltage with the transmitter turned off to determine if ambient interference is present. If this fails to resolve the issue, please contact Linx technical support.

## Using the Boards as a Design Reference

The basic evaluation boards included in this kit are very simple, yet they illustrate some important techniques that should be incorporated into the board layout. The module's mounting pads extend slightly past the edge of the part. This eases hand assembly and allows for better heat conduction under the part if rework is necessary. A full ground plane fill is placed on the bottom of the board. This ground plane serves three important purposes:

First, since a quarter-wave antenna is employed, the ground plane is critical to serve as a counterpoise (please see Application Note AN-00500 "Antennas: Design, Application, and Performance" for details on how a ground plane affects antenna function).

Second, a ground plane suppresses the transfer of noise between stages of a product as well as unintentional radiation of noise into free space.

Third, a ground plane allows for the implementation of a microstrip feed between the module and the antenna. The term microstrip refers to a PCB trace running over a ground plane that is designed to serve as a 50-ohm transmission line. See the module's data guide or the calculator available on our website for details on microstrip calculations.

## About Antennas

The choice of antennas is one of the most critical and often overlooked design considerations. The range, performance, and legality of an RF link are critically dependent upon the type of antenna employed. Linx offers a variety of antenna styles that can be considered for a design. Included with the kit is a Linx CW Series connectorized whip antenna that should be connected prior to using the kit. Despite the fact that the antenna is not centered on the board's ground plane, it exhibits a VSWR of <1.7 and suitably demonstrates the module's best practical performance.

## In Closing

Here at Linx, "Wireless Made Simple" is more than just our motto, it is our commitment. A commitment to the highest caliber of product, service, and support. That is why, should you have questions or encounter any difficulties using the evaluation kit, you'll be glad to know many resources are available to assist you. First, check carefully for the obvious, then visit our website at [www.linxtechnologies.com](http://www.linxtechnologies.com) or call +1 541 471 6256 between 8AM and 4PM Pacific Time to speak with an application engineer.

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