**Addressing Linx OEM Products**

# Application Note AN-00300

## Introduction

Linx OEM products combine RF modules with remote control encoders and decoders in an enclosure. They have been pre-approved for FCC and Industry Canada and the 433MHz versions also have European CE certifications. They can be quickly cosmetically customized, providing a rapid and inexpensive path to incorporate wireless remote control into OEM products.

In order for OEM products to work together, the encoders and decoders must be set correctly. This application note describes how to set the addresses and associate transmitters and receivers in each of Linx's three OEM product lines; The DS/Holtek family, the MS family and the HS family. It is important to note that the three families do not work together. Their protocols and functionality are completely different.

## The DS / Holtek® Family

Holtek® was a popular brand of encoder and decoder known for its simplicity. Linx created the DS Series to replace the Holtek products when they went obsolete. The DS Series is compatible with products based on the HT640 encoder and HT658 decoder.

The Linx DS Series has ten address lines and eight data lines. During transmission, the encoder outputs a packet with the states of each of these lines. The decoder then looks at the received packet, compares the received address bits with the current states of its own address lines and, if they match, reproduces the received data bits on its data lines. If the addresses do not match, the decoder ignores the packet.

The DS family of OEM products are made with the LR Series transmitter and receiver modules. They are also compatible with the KH3 Series RF modules, which combine a DS Series encoder / decoder with a Linx transmitter or receiver in a single surface-mount module.

### Setting the Addresses

The DS Series has ten address lines: A0 through A9. Not all products use all of the address lines. Figure 1 shows the possible settings for each address bit in each of the DS-based OEM products as well as the KH3 Series modules. Choose the transmitter and receiver you wish to use and find them in the chart. The address lines can be set to the states listed in each cell, but shaded cells cannot be changed. If one device has lines that cannot be changed, those lines on the other device must be set the same in order to communicate. The transmitter and receiver addresses must always match or the transmissions will not be recognized. When the addresses match, the transmitter and receiver operate correctly.

| | Transmitters | | | | Receivers | | |
|---|---|---|---|---|---|---|---|
| Address Bit | CMD-HHCP | CMD-HHLR | CMD-KEY | TXE-XXX-KH3 | FCTN-WALL | FCTN-RLY4 | RXD-XXX-KH3 |
| A0 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float, Gnd | Float, Gnd | Float, Gnd, Vcc |
| A1 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float, Gnd | Float, Gnd | Float, Gnd, Vcc |
| A2 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float, Gnd | Float, Gnd | Float, Gnd, Vcc |
| A3 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float, Gnd | Float, Gnd | Float, Gnd, Vcc |
| A4 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float, Gnd | Float, Gnd, Vcc |
| A5 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float, Gnd | Float, Gnd, Vcc |
| A6 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float, Gnd | Float, Gnd, Vcc |
| A7 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float, Gnd | Float, Gnd, Vcc |
| A8 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float | Float, Gnd, Vcc |
| A9 | Float, Gnd | Float, Gnd | Float, Gnd | Float, Gnd, Vcc | Float | Float | Float, Gnd, Vcc |

Figure 1: Linx OEM Product Address Options

## The DS / Holtek Family Transmitters

### Compact Handheld Transmitter
To set the address of the CMD-HHCP-***, remove the cover plate on the back of the case to reveal the DIP switchs as shown in Figure 2.
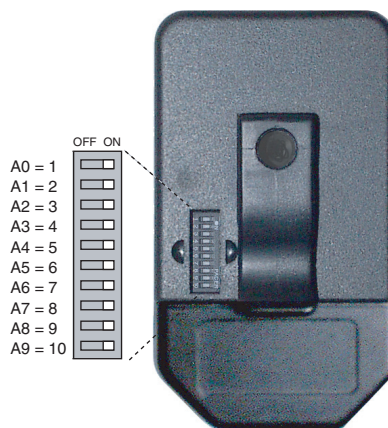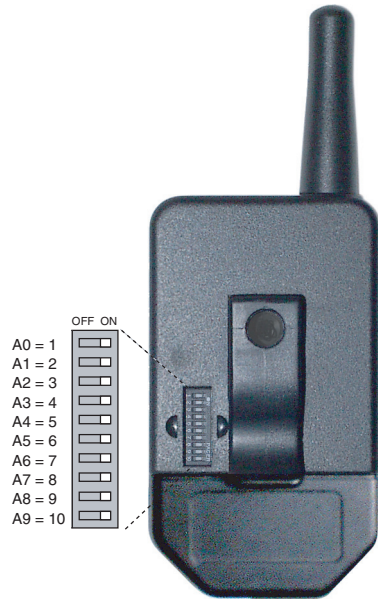


Figure 2: CMD-HHCP DIP Switches

Switch number one is at the top and corresponds to address line A0 as shown in the figure. When the switch is on, the line is connected to ground; otherwise, it is floating.

## Long-Range Handheld Transmitter

To set the address of the CMD-HHLR-***, remove the cover plate on the back of the case to reveal the DIP switch as shown in Figure 3.



Figure 3: CMD-HHLR DIP Switches

Switch number one is at the top and corresponds to address line A0 as shown in the figure. When the switch is on, the line is connected to ground; otherwise, it is floating.

## Keyfob Transmitter

To set the address of the OTX-***-HH-KF#-HT, open the case at the seam. Look for the IC at the top left of the board. Below the IC, there are traces that run from the address lines to ground as shown in Figure 4.
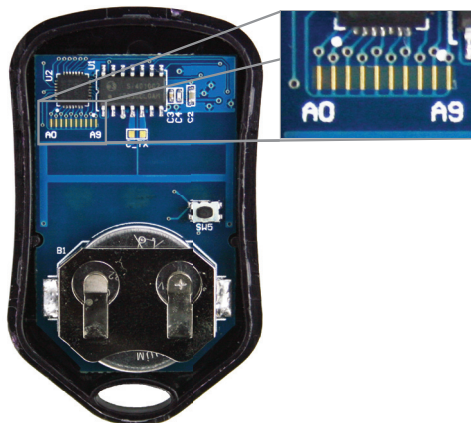


Figure 4: CMD-KEYX DIP Switches

The number next to the trace corresponds to the address line: trace 0 to bit A0, trace 1 to bit A1, etc. To set the address, use a hobby knife or razor blade to cut the traces on the board. If the trace is intact, the line is connected to ground; otherwise, it is floating.

## KH3 Series Transmitter

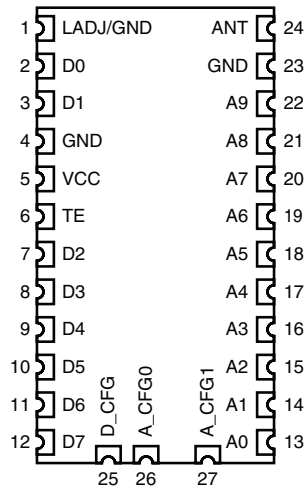The pin diagram for the TXM-***-KH3 transmitter is shown in Figure 6.



Figure 5: KH3 Series Transmitter Pin-Out

The KH3 Series transmitter incorporates the DS Series remote control encoder/ decoder set as an encoder, which is designed to be operable with previous generation products based on Holtek® encoders and decoders. The Holtek® encoders and decoders have tri-state input lines but the DS has bi-state lines. Tri-state inputs are connected to ground for zero bits, $V_{CC}$ for one bits, or left unconnected for open bits. Since the DS cannot match this operation the D_CFG, A_CFG0 and A_CFG1 lines are provided to select the desired interpretation. The settings must match on both ends.

Pulling the D_CFG line high configures the data inputs as one and zero. A high on a data line is interpreted as a one bit and a low is interpreted as a zero bit. Pulling D_CFG low configures the data inputs as one and open. A high on a data line is interpreted as a one bit and a low on is interpreted as an open bit. The decoder outputs open data bits as logic low. This is shown in Figure 6.

| D_CFG Configuration | | |
|---|---|---|
| **Configuration** | **Bit Interpretation** | |
| **D_CFG** | **High** | **Low** |
| 0 | One | Open |
| 1 | One | Zero |

Figure 6: D_CFG Configuration

A_CFG0 and A_CFG1 are used to select the bit type for the address lines. These are shown in Figure 7.

The configurations apply to all of the lines at once. They are not set individually.

D_CFG is pulled low internally so that a high on a data line is transmitted as a one bit and a low on the line is transmitted as an open bit. A_CFG0 is pulled low and A_CFG1 is pulled high internally so that a high on an address line is interpreted as an open bit and a low as a zero bit.

Figure 7: A_CFG0 and A_CFG1 Configuration

This configuration matches the Linx OEM products and the most common implementation of the legacy KH2 Series. This enables customers using the KH2 Series to populate the KH3 Series without any PCB modifications since pins 25, 26 and 27 can be left unconnected.

## LR Series Transmitter and a DS Series as an Encoder.

If the single package KH3 Series transmitter is not suitable, the discrete LR Series transmitter and DS Series Encoder/Decoder can be used separately. This combination has the same operation as the KH3. Figure 8 shows the typical application circuit for these parts.
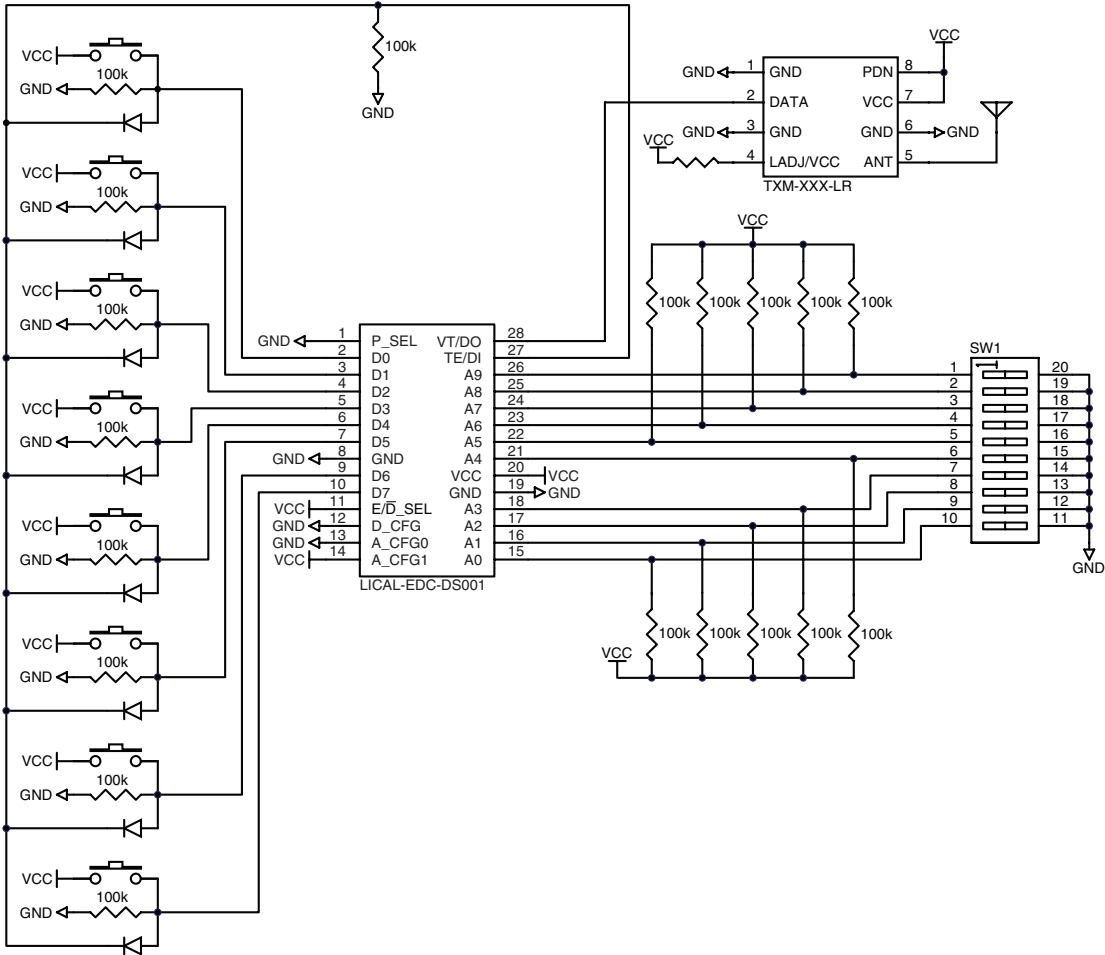
Figure 8: LR Series Transmitter and DS Series Encoder Typical Application Schematic

# Receivers

### AC Function Module
The DIP switches for the FCTN-WALL-*** are located on the side that plugs into the outlet as shown in Figure 9.
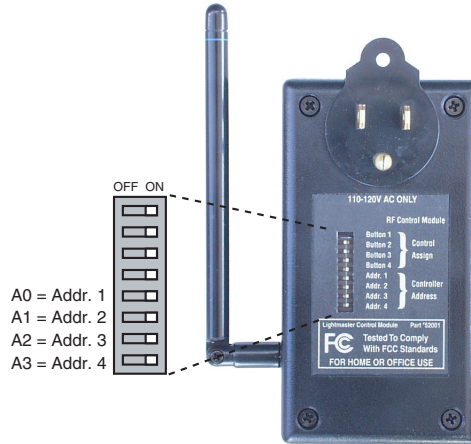


Figure 9: FCTN-WALL DIP Switches

**This module only uses address lines A0 through A3, so the encoder must have A4 through A9 floating.** When the switch is on, the line is connected to ground; otherwise, it is floating. The other four switches determine which button pairs on the transmitter control this module. The data guide describes this feature in more detail and it is described briefly at the end of this note.

### Relay Function Module
The address switches on the FCTN-RLY4-***-2 can be found on one end of the case as shown on the right side of Figure 10.



Figure 10: FCTN-RLY4 DIP Switches

**This module does not make use of address lines A8 and A9, so the transmitter must have these lines floating.** When the switch is on the line it is connected to ground; otherwise, it is floating.

## KH3 Series Receiver

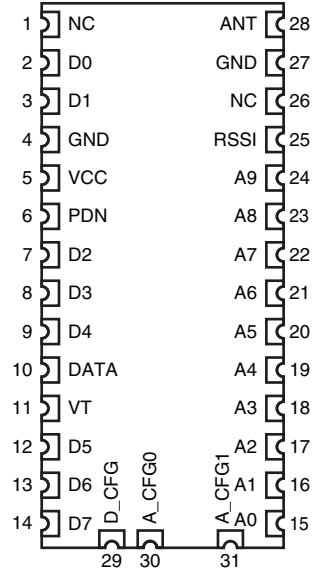The pin diagram for the RXM-***-KH3 receiver is shown in Figure 11.



Figure 11: KH3 Series Receiver Pin-Out

The KH3 Series receiver combines the LR Series receiver with the DS Series encoder/decoder set as a decoder. This module has the same address considerations as the transmitter. The D_CFG, A_CFG0 and A_CFG1 settings must match on both ends.

When correctly addressed and a data line is pulled high on the transmitter, the corresponding data line goes high on the receiver. The output is momentary, going high for only as long as the button is pressed, so if a latched output is needed then an external circuit or microcontroller needs to be used.

## LR Series Receiver and a DS Series as a Decoder.

If the single package KH3 Series receiver is not suitable, the discrete LR Series receiver and DS Series Encoder/Decoder can be used separately. This combination has the same operation as the KH3. Figure 12 shows the typical application circuit for these parts.
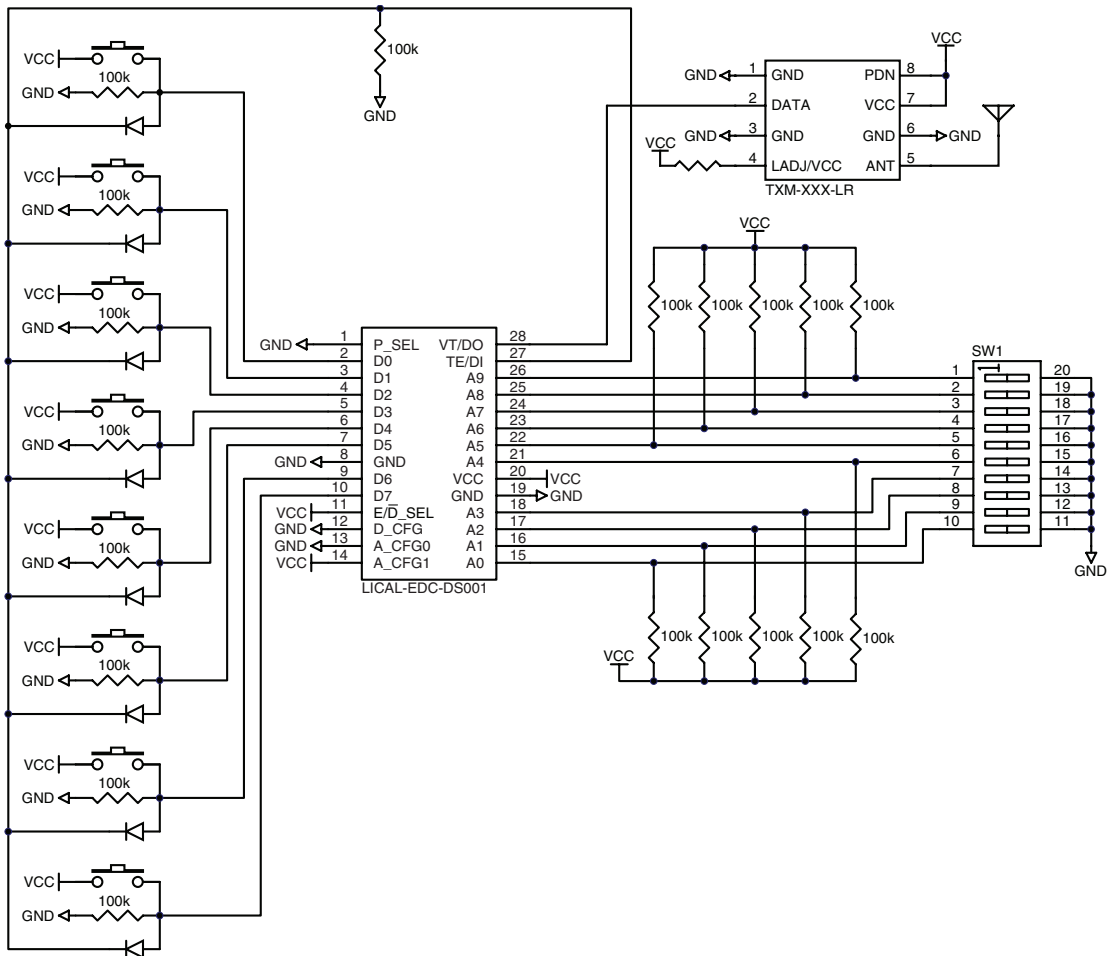
Figure 12: LR Series Receiver and DS Series Decoder Typical Application Schematic

## Data Line Connections

Another important consideration when choosing OEM products is the way each product uses the data lines. Figure 13 shows the relationship between the button locations and the encoder data lines for the handheld transmitters.
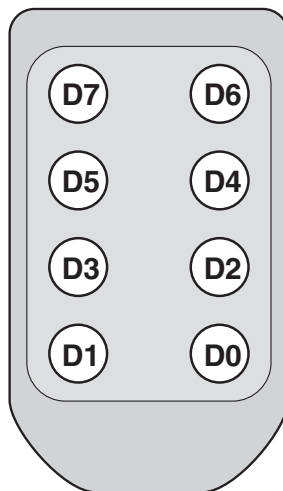


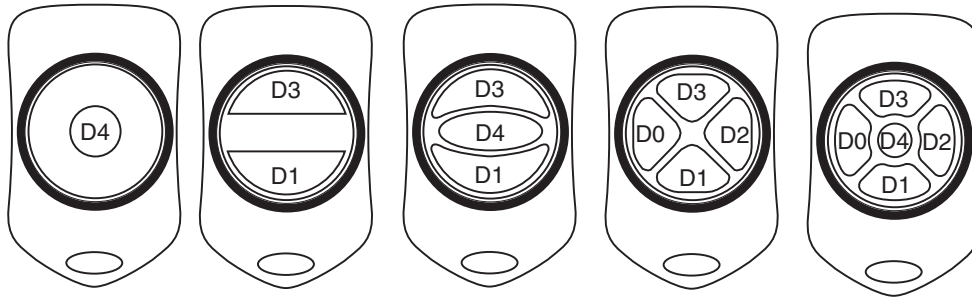Figure 13: Handheld Transmitter Data Line Button Assignments

Figure 14 shows the relationship between the button locations and the encoder data lines for the keyfob transmitter.



Figure 14: Keyfob Transmitter Data Line Button Assignments

The relay function module uses one data line to activate each relay and another one to deactivate each relay. This means that the four relays use all eight data lines as shown in Figure 15.

| Relay | Data Lines | |
| --- | --- | --- |
| | Off | On |
| 1 | D7 | D6 |
| 2 | D5 | D4 |
| 3 | D3 | D2 |
| 4 | D1 | D0 |

Figure 15: Relay Function Module Data Line Assignments

The relay function module uses all eight data lines when in latched mode and only the data lines that turn the relays on in momentary mode. This means that the keyfob transmitter can only control relays 3 and 4 in latched mode and relays 2, 3 and 4 in momentary mode.

The AC function module is also turned on with one data line and turned off with another. This module allows the user to choose which button pairs operate the module. The top four DIP switches are labeled "Button 1" through "Button 4" and correspond to the data line pairs as shown in Figure 16.

| DIP Switch Label | Data Lines | |
| --- | --- | --- |
| | Off | On |
| "Button 1" | D7 | D6 |
| "Button 2" | D5 | D4 |
| "Button 3" | D3 | D2 |
| "Button 4" | D1 | D0 |

Figure 16: Wall Function Module Data Line Assignments

If the DIP switch labeled "Button 1" is set to the ON position, then data line D6 turns the module on and data line D7 turns the module off. If the switches labeled "Button 1" and "Button 2" are both on, lines D4 and D6 turn the module on and lines D5 and D7 turn it off. Likewise, if all of the DIP switches are on, all of the data lines work with the module according to the table above.

## The MS Family

The MS Family is based on the MS Series encoder and decoder. Instead of using DIP switches to set an address, the MS Series randomizes the address based on the length of time a line is held high on the encoder, normally with a button press. The decoder is then placed into a Learn Mode to learn the address and the association is complete.

## Transmitters



Figure 17: MS Family Transmitters

All of the transmitters follow the same procedure. They have a hole in the back of the enclosure that allows access to a CREATE button.
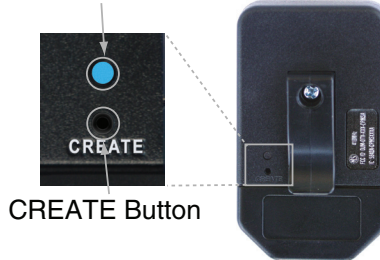


Figure 18: OTX-***-HH-CP8-MS CREATE Button Access



Figure 19: OTX-***-HH-LR8-MS CREATE Button Access

Figure 20: OTX-***-HH-KF5-MS CREATE Button Access

When the button is depressed, an LED lights up in the MODE_IND window, indicating that the address is being created. The address is randomized for as long as the button is held down. When the button is released, the randomized address is saved and the LED begins flashing to indicate that the Control Permissions may now be set.

Press the buttons on the front of the transmitter that the user will have the authority to access. Press the CREATE button with the paper clip again or wait 17 seconds for it to time out. The address and Control Permissions are now set. The decoder now needs to learn the address before it will accept any transmissions.

## Receivers

An example application circuit for a MS-based receiver is shown in Figure 21.
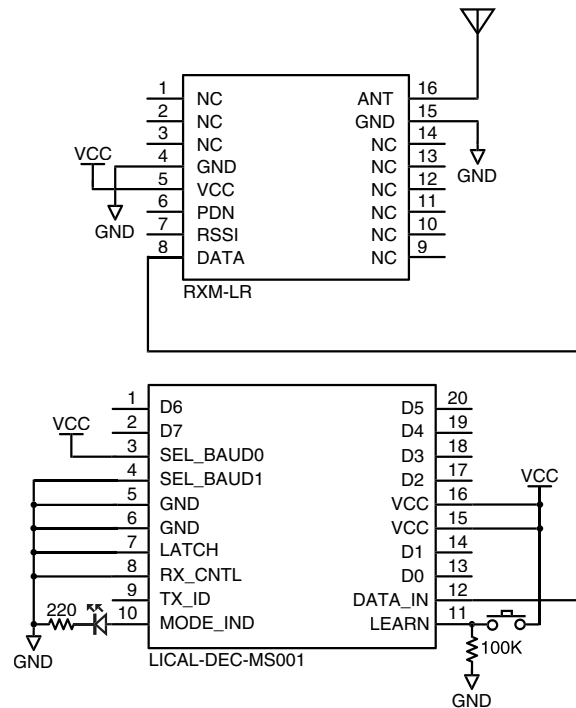


Figure 21: LR Series Receiver and MS Series Decoder Typical Application Schematic

To learn an address, the button connected to the LEARN line is pressed, placing the decoder into Learn Mode. The LED connected to the MODE_IND line starts flashing, indicating that the decoder is ready to accept an address. Any of the authorized buttons on the front of the transmitter are pressed to send a transmission to the decoder. Press the LEARN button again to exit Learn Mode. Otherwise, the decoder times out after 17 seconds. The units are now associated and will operate together.

When the decoder receives a valid transmission, it turns on the MODE_IND LED. If the LED is turning on when a transmission is sent but the data line is not, check the Control Permissions settings. That line was likely not authorized for use when the address was created.

## The HS Family
The HS Family is based on the HS Series encoder and decoder. The HS Series utilizes CipherLinx®, an encrypted remote control technology that provides a very high level of security. In this family, the user creates a key in the decoder and transfers the key to the encoder. The transmission can only be decrypted if both sides use the same key.

## Creating and Transferring a Key
Creating a key begins with the decoder. A typical application circuit is shown in Figure 22.
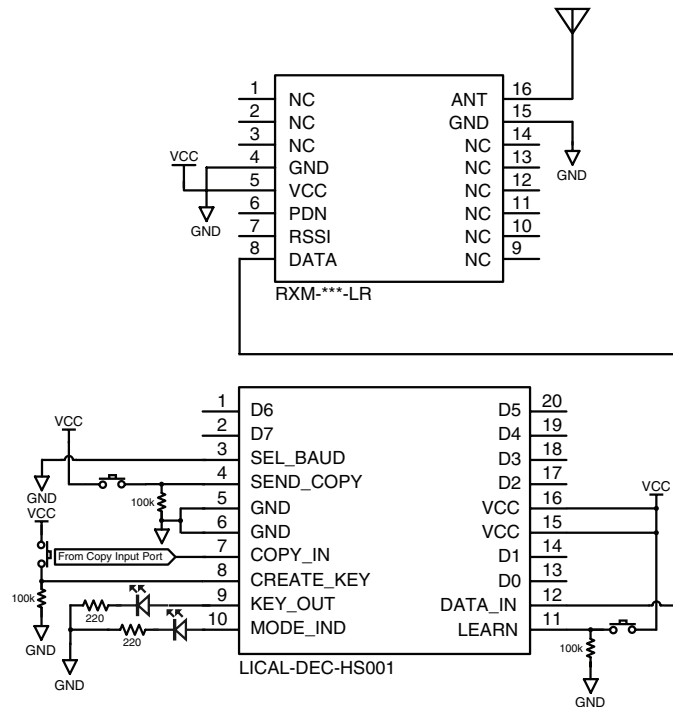


Figure 22: LR Series Receiver and HS Series Decoder Typical Application Schematic

A key is created by placing the decoder into Create Mode. This is done by taking the CREATE_KEY line high while the LEARN line is high, so press and hold the LEARN button then press the CREATE_KEY button. When the MODE_ IND LED turns on, release both buttons. Press the CREATE_KEY button ten times to generate a key. The MODE_IND LED turns off after the 10th press to indicate that the key has been created. The decoder then automatically outputs the key on the KEY_OUT line. This line is connected to a 900nm infrared (IR) diode for short-range wireless transmission. The key is output for 17 seconds.

Now the transmitter's IR receiver circuit needs to be activated. This is done by using a paper clip or probe to press the GET_KEY button on the back of the transmitter.
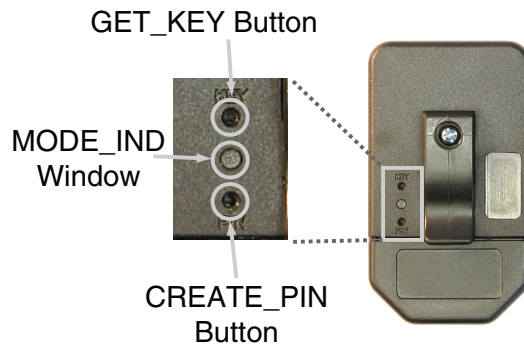


Figure 23: OTX-***-HH-CP8-HS Button Access Holes
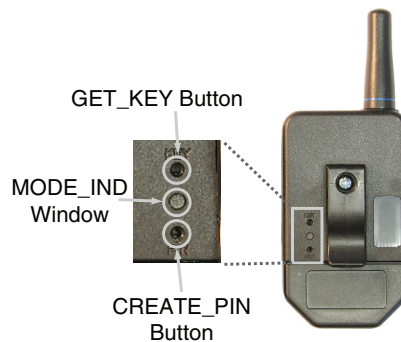


Figure 24: OTX-***-HH-LR8-HS Button Access Holes

Once the button is pressed, the IR circuit is active for approximately 15 seconds. Hold the MODE_IND window near the decoder's IR diode. The MODE_IND LED on both the transmitter and receiver light up for one second when the key transfer is successful. Again, the key is output from the decoder for 17 seconds and the IR receiver circuit on the transmitter is active for 15 seconds.

Once the key has been transferred, Control Permissions must be created. The decoder is placed into Learn Mode by pressing the LEARN button. The MODE_ IND LED starts flashing to indicate the decoder is ready to accept control permissions. Press the buttons on the transmitter that are to be authorized. Press the LEARN button on the decoder again to exit Learn Mode or wait for the decoder to time out after 17 seconds. The buttons on the transmitter that were pressed now activate the appropriate decoder data lines.

When the decoder receives a valid transmission, it turns on the MODE_IND LED. If the LED is turning on when a transmission is sent but the data line is not, check the Control Permissions settings. That line was likely not authorized for use when the permissions were set.

## Summary

Linx OEM products provide a rapid and cost effective way to add wireless functionality to a wide variety of end applications. Correctly setting the product's address is necessary for proper functionality. If you have any questions after reviewing this application note, please contact Linx technical support at (800) 756-6677 or +1 (541) 471-6256 if outside the United States.

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