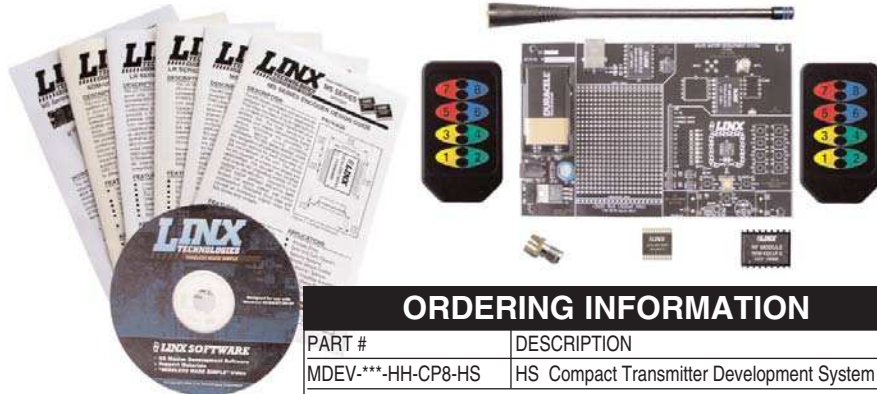# LINX® TECHNOLOGIES
WIRELESS MADE SIMPLE®

MDEV-315-HH-CP8-HS
MDEV-418-HH-CP8-HS
MDEV-433-HH-CP8-HS

HS COMPACT HANDHELD TRANSMITTER
MASTER DEVELOPMENT SYSTEM USER'S GUIDE

ORDERING INFORMATION

PART #	DESCRIPTION
MDEV-***-HH-CP8-HS	HS Compact Transmitter Development System
*** = 315, 418 (Standard), 433MHz	

DESCRIPTION

HS Series encoders and decoders are ideal for remote control and command, applications such as alarm and access control, keyless entry, and virtually any other application requiring a high degree of security. The HS Series allows the status of up to eight buttons or contacts to be securely transferred via a wireless link. This Master Development System is intended to give a designer all the tools necessary to incorporate the HS-based Compact Handheld transmitter, LR Series receiver, and HS Series decoder into a product. This guide will show how to take full advantage of the development board included with the system. Data guides for all of the Linx parts contained in the system are included or may be downloaded from the Linx website. The Master Development System serves several important functions:

- Rapid Evaluation - It allows the performance and features of the transmitter, LR Series receiver, and HS Series encoders and decoders to be quickly evaluated.

- Design - It demonstrates the overall system function and shows how to design with the HS-based OEM transmitter and then interface it with other components.

- Prototype Development - It allows for the addition of circuitry to the development board so that it can act as the first prototype of the product. All of the signals are available on a wire-wrap header for easy connection to external circuitry.

- Benchmarking - It serves as a troubleshooting tool and standardized reference point against which the performance of an end product can be compared.

The kit includes 2 HS Compact Handheld transmitters, 2 LR Series receivers*, 2 HS Series decoders*, 1 development board set up for the receiver and decoder, and 1 CW Series antenna. The decoder board is also populated with 1 QS Series USB module for use with the software on the included CD.

One part is soldered to the board; one extra is for use on your first prototype board.
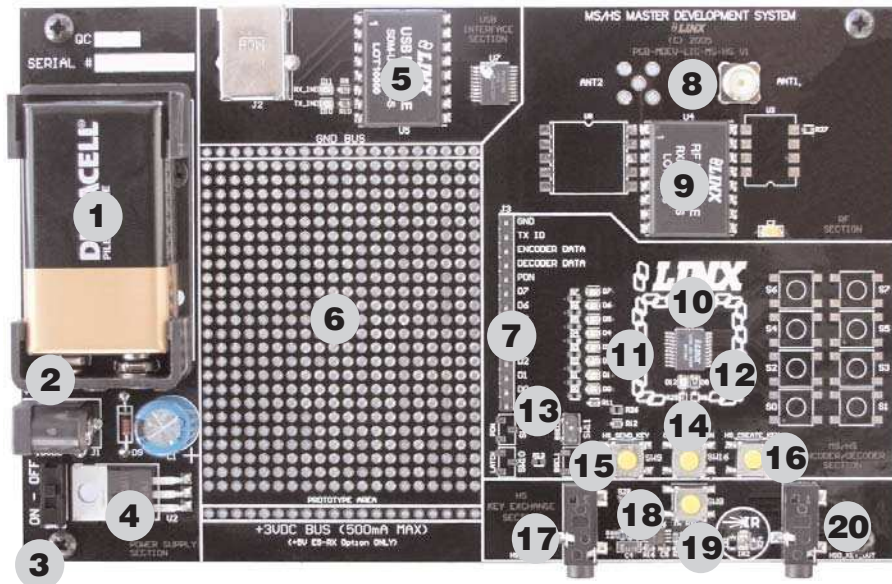
HS SERIES DECODER DEVELOPMENT BOARD

Figure 1: HS Series Decoder Development Board

1. 9V Battery
2. Power Jack
3. On-Off Switch
4. Voltage Regulator
5. QS Series USB Module
6. Prototype Area
7. Break-Out Header
8. RP-SMA Antenna Connector
9. LR Series Receiver
10. HS Series Decoder
11. Data Line LEDs
12. Indicator LEDs
13. Function Switch
14. LEARN Button
15. SEND_KEY Button
16. CREATE_KEY Button
17. Key Input Jack (for hardwire key transfer)
18. IR Receiver Enable Button
19. IR Key Transfer Phototransistor and Diode (for IR key transfer)
20. Key Output Jack (for hardwire key transfer)

USING THE DEVELOPMENT BOARDS

After unpacking the development system, attach an antenna to the decoder board, install the supplied 9V battery, and turn on the power switch. **The encoder and decoder are set at the factory and will work straight out of the box.** To create a new operational setup, follow these steps:

1. On the decoder board, press and hold the LEARN button and then press the CREATE_KEY button to enter Create Key Mode. Release the LEARN button and press the CREATE_KEY button ten times to generate the KEY.

2. To use the infrared key transfer, press the GET_KEY button on the back of the transmitter to activate the infrared receiver. Hold the back of the transmitter close to the IR key exchange area on the decoder board until the MODE_IND LED on the board lights up.

3. To set Control Permissions, press the LEARN button on the decoder board.

4. While the decoder's MODE_IND line is flashing, press each button on the transmitter that is to be granted recognition permission.

5. After all the desired data lines have been transmitted, press the LEARN button again, or wait until the 15 second time-out occurs. The permissions will now be saved in the decoder.

6. Transmit with one or all of the authorized data lines to confirm that the learn process was successful.

TROUBLESHOOTING

If the boards fail to work out of the box, then try the following:

- Check the batteries to make sure they are not dead.

- Make sure that the baud rate switch is set correctly on the decoder board.

- Make sure that the antenna is connected.

- Make sure that you set the Encryption Key correctly. This key is created by the decoder and needs to be sent to the encoder before they will communicate.

- Make sure that you set your Control Permissions correctly. If you have not set the handheld transmitter to use a particular line, then when you press a button on the transmitter, the MODE_IND LED on the decoder board will light up, but the data line LED will not light up.

If all of these appear to be in order, then you can call 800-736-6677 or e-mail techsupport@linxtechnologies.com for technical support.

SECURITY OVERVIEW

The HS Compact Handheld transmitter uses the HS Series encoder, which is based on CipherLinx™ technology. CipherLinx™ is a high-security encryption algorithm and wireless protocol designed for remote control and remote keyless entry applications. It provides a much greater level of security and many more features than older technologies on the market, such as fixed address or "rolling code" systems.

CipherLinx Technology™

Additionally, the CipherLinx™ transmission protocol is much more advanced than the simple PWM method employed by many systems. By utilizing an advanced serial protocol for data, CipherLinx™ is able to offer superior noise immunity, greater range, and increased link reliability, all of which are key factors in a wireless system.

CipherLinx™ never sends or accepts the same data twice, never loses sync, and changes codes with every packet, not just every button press. CipherLinx™ encryption is based on the Skipjack cipher developed by the U.S. National Security Agency (NSA), and is widely considered one of the most secure ciphers available. There have been no known successful attacks on the full Skipjack algorithm. Skipjack is a block cipher that has 80-bit keys and 64-bit data blocks. Since each packet is longer that 64 bits, Skipjack is employed in an encryption mode. The particular encryption mode chosen for CipherLinx™ is based on the CMC encryption mode, so that the resulting cipher is a special kind of function known as a "strong PRP" (sPRP). The encryption mode uses several invocations of Skipjack to encrypt the 128 bits in each message.

The Skipjack algorithm used by Linx has been proven secure and is not modified to avoid any compromise of strength. CipherLinx™ is far more than just a Skipjack implementation. CipherLinx's patent-pending technology combines multiple calls to the encryption algorithm with a proprietary mixing algorithm. CipherLinx™encryption, as implemented in the Linx HS Series, has been independently evaluated by Independent Security Evaluators (ISE), a respected security firm that is widely recognized for its expertise in electronic security. They concluded that "the CipherLinx(TM) protocol in the HS Series is well-designed and is an excellent choice for applications requiring a secure unidirectional link." ISE's full evaluation report can be found at www.cipherlinx.com. In summary, CipherLinx™ is a powerful, independently verified, secure encryption technology that is well-suited to a wide range of applications.

In addition to this high level of security, CipherLinx™ also offers a number of features that are unique among remote control products. These include a large number of data lines, internal key generation, "button level" control permissions, an optional encoder PIN, as well as the ability for the decoder to identify the originating encoder. Please refer to the HS Series encoder and decoder data guides for full details.

TYPICAL SYSTEM SETUP

The HS Series Compact Handheld Transmitter is intended to make user setup straightforward while ensuring the highest possible security. Its inherent ease of use can be illustrated by a typical user setup. The Typical Applications section of the HS Series Decoder Data Guide shows the circuit schematics on which the receiver examples are based.

1. Create and exchange a key from the decoder development board

The handheld transmitter includes an on-board infrared receiver designed to receive the decoder's key transmission. Sending the key in this manner preserves security while avoiding the need for a hardwire connection.

Figure 2: Button Access Holes

The high-security key is created and exchanged by placing the decoder in the Create Key Mode. The decoder's MODE_IND LED will light to indicate that the decoder has entered Create Key Mode. The decoder's CREATE_K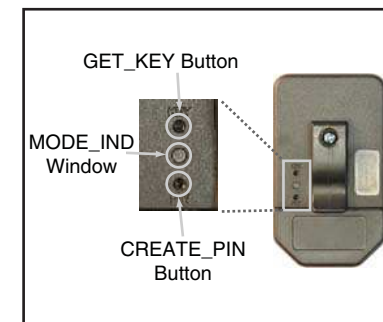EY button is then pressed ten times to create the key. This ensures that the key is random and chosen from among all 2^{80} possible keys. After the tenth press, the MODE_IND LED will turn off and the decoder will output the key via a 900nm infrared diode on the KEY_OUT line. A paper clip is used to press the GET_KEY button on the back of the transmitter. The back of the transmitter is held near the decoder's infrared diode within twenty seconds. Once the key has been transferred, the MODE_IND LEDs on the transmitter and decoder development board illuminate to indicate success.

2. Establish Control Permissions

The user or manufacturer may also set "button level" Control Permissions. Control Permissions determine which buttons on the transmitter will be acknowledged by the decoder. Permission settings are established during set-up, and retained in the decoder's non-volatile memory. The HS Series Control Permissions allow each transmitter in a system to activate different data lines. This is especially useful in applications where differing user access or activation capabilities are desired.

Consider this practical example: a three-door garage houses Dad's Corvette, Mom's Mercedes, and Son's Yugo. With most competitive products, any user's keyfob could open any garage door as long as the addresses match. In an HS-based system, the keyfobs could easily be configured to open only certain doors (guess which one Son gets to open!).

Setting the control permissions is intuitive. The user presses the decoder's LEARN button. The decoder's MODE_IND LED will start flashing and the user simply presses the handheld transmitter buttons that will be recognized. Control Permissions are stored when the LEARN button is pressed again or automatically after seventeen seconds.

There are other powerful options, such as programming a user PIN or copying a decoder, but these two steps are all that is required for a typical setup.

USING THE OPTIONAL KEYPAD PIN

For higher security applications, the HS Series encoder has the option to set a Personal Identification Number (PIN) to control access to the encoder. This PIN is a four-button sequence of the eight available buttons which must be entered before the transmitter will send any commands. It will need to be re-entered after fifteen minutes of inactivity. If no PIN is created, then the transmitter will activate as soon as a button is pressed.

Creation of a keypad PIN

1. Use a paper clip to press the CREATE_KEY button on the back of the transmitter. The MODE_IND LED will begin flashing until either a PIN is successfully entered or fifteen seconds has passed.

2. To enter the PIN, press a sequence of any four buttons. The MODE_IND will stop flashing and the PIN will be created.

3. To cancel Create PIN Mode prior to the fourth entry, either wait for the fifteen second timeout to pass or press the CREATE_KEY button. The MODE_IND LED will stop flashing and no PIN will be created.

4. If a new KEY is created, the PIN will be automatically erased.

Using the PIN

1. The PIN is entered by pressing each button until all four entries have been made. There is a maximum two-second time limit between entries, after which the PIN must be re-entered in its entirety.

2. Once the PIN is successfully entered, the transmitter will be operational unless it is inactive for fifteen minutes, in which case the PIN must be re-entered.

CONTENTION CONSIDERATIONS

It is important to understand that only one transmitter at a time can be activated within a reception area. While the transmitted signal consists of encoded digital data, only one carrier of any particular frequency can occupy airspace without contention at any given time. If two transmitters are activated in the same area at the same time, then the signals will interfere with each other and the decoder will not see a valid transmission, so it will not take any action.

BATTERY REPLACEMENT

The transmitter uses a standard CR2032 lithium button cell. In normal use, it will provide 1 to 2 years of operation. To replace the battery, remove the access cover by pressing firmly on the label area and sliding it off. Once the unit is open, remove the battery by sliding it from beneath the holder. There may be the risk of explosion if the battery is replaced by the wrong type. Replace it with the same type of battery while observing the polarity shown in the adjacent figure.
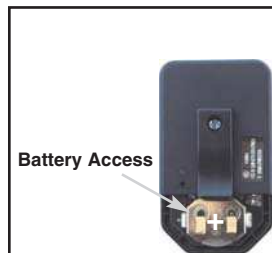
Battery Access

Figure 3: Battery Access

OTX-***-HH-CP8-HS BUTTON ASSIGNMENTS

This diagram illustrates the relationship between the button locations and encoder data lines.
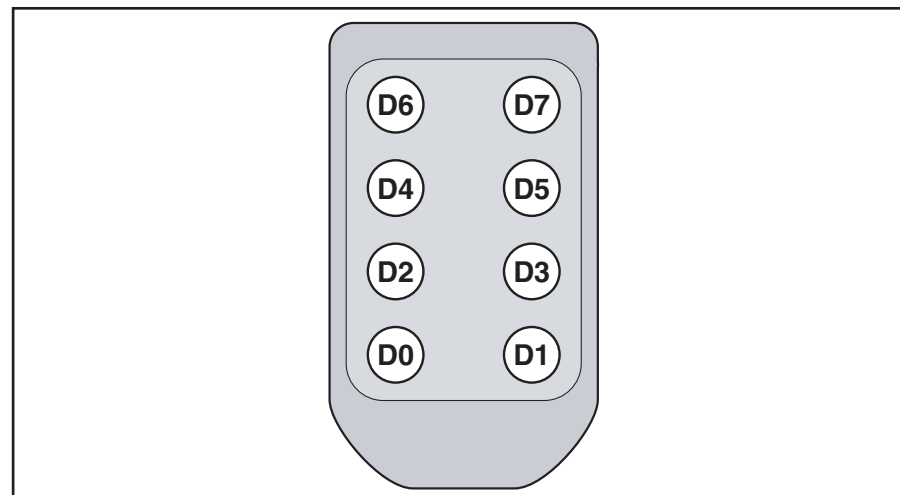
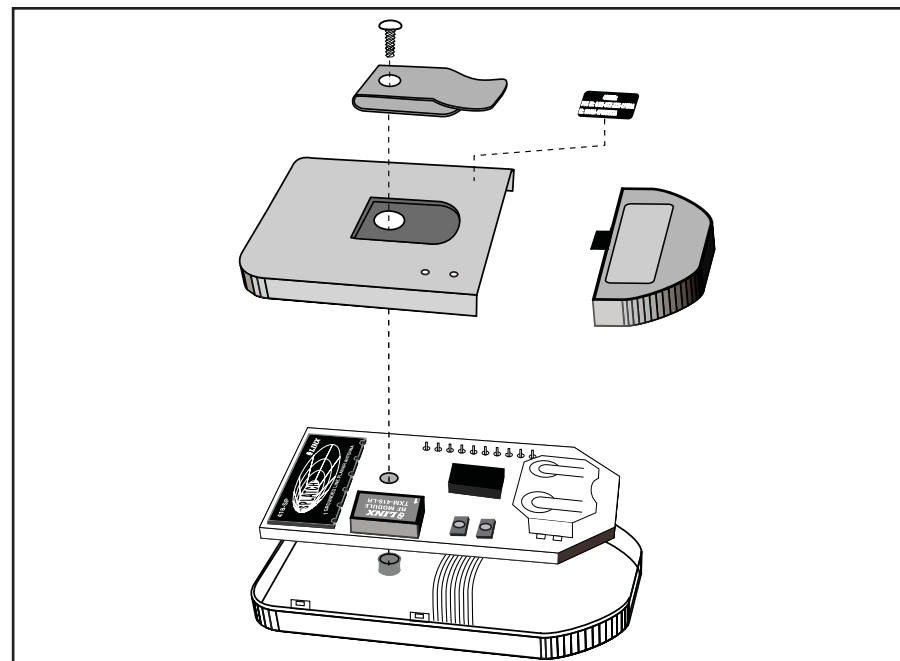Figure 4: OTX-***-HH-CP8-HS Button Assignments

ASSEMBLY DIAGRAM

Figure 5: OTX-***-HH-CP8-HS Assembly

The decoder board has six main sections of interest: the decoder area, the RF area, the USB area, the key exchange area, the power supply, and the prototyping area.

The Decoder Area

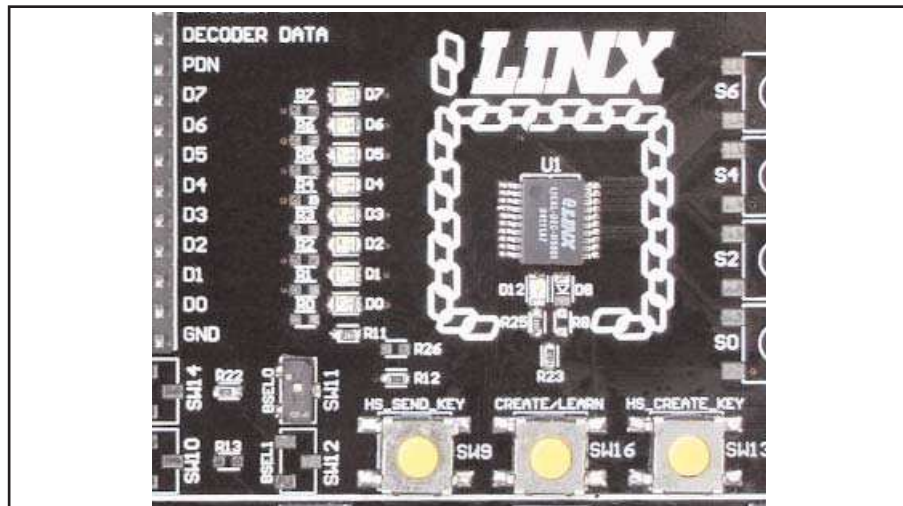The figure below shows the decoder area of the development board.

Figure 6: The Decoder Area

The decoder is located in the center beneath the Linx logo. To the left are LEDs which are connected to the decoder data lines. These will light up when the decoder receives a signal from the encoder to take the data line high. LED D0 corresponds to data line D0, and so forth.

Beneath the decoder is an LED that is connected to the MODE_IND line. This will light up as described in the HS Series Decoder Data Guide.

Beneath the LED are three buttons. The one on the left labeled HS_SEND_KEY is connected to the SEND_COPY line on the decoder. The one in the middle is connected to the LEARN line, and the one on the right is connected to the CREATE_KEY line. The HS_SEND_KEY button will cause the decoder to begin sending a copy of its User Data when pressed at the same time as the LEARN button. The LEARN button is used to learn the Control Permissions from the encoder and, with the other two buttons, to make the decoder enter special modes. The CREATE_KEY button will cause the decoder to create a new key when pressed at the same time as the LEARN button. All of these functions are described in detail in the HS Series Decoder Data Guide.

There is one function switch to the left of the CREATE button. BSEL0 is used to set the baud rate of the decoder as described in Table 1.

Important The encoder must be set to the same baud rate in order for the signal to be received correctly. The HS Series Compact Handheld Transmitter is set to 4,800bps, so this switch must be in the down position.

BSEL0	Baud Rate (bps)
0	4,800
1	28,800

Table 1: Baud Rate Selection Table

The Decoder Board RF Area

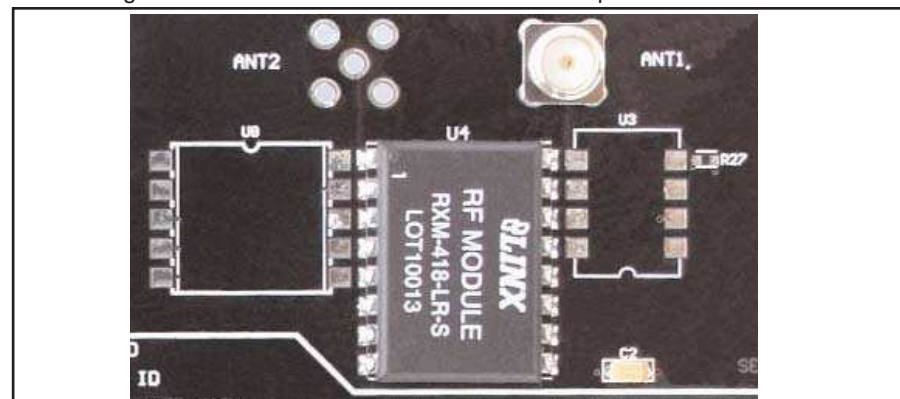The figure below shows the RF area of the development board.

Figure 7: The Decoder Board RF Area

This board is populated with the LR Series receiver. The ANT1 connector is provided for attachment of the included antenna.

The Decoder Board USB Area

The decoder development board has a Linx SDM-USB-QS-S module for use with the included development software. This module is powered by the USB bus, so it will not pull any current from the battery. The figure below shows the USB area on the decoder board.
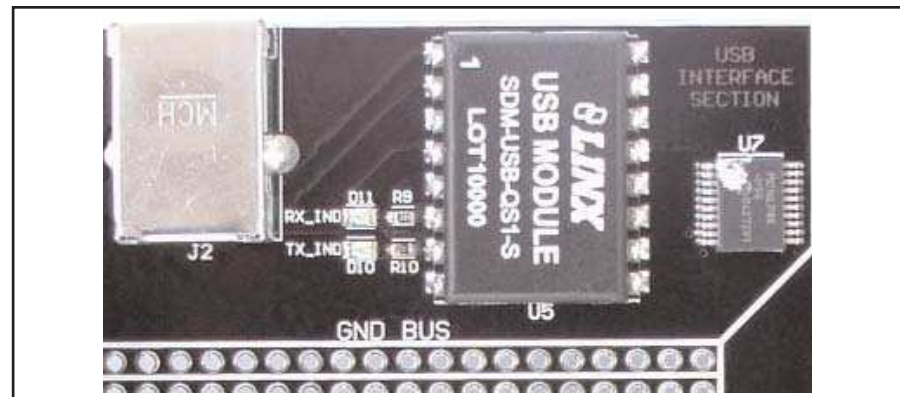

Figure 8: The Decoder Board USB Area

The microcontroller on the right monitors the decoder data lines and generates commands that are sent to the development software on the PC via the QS Series USB module. The RX_IND LED to the left of the module will flash to indicate that data is being received from the microcontroller.

THE DECODER BOARD (CONT.)

The Decoder Board Key Exchange Area

The figure below shows the key exchange area of the development board.
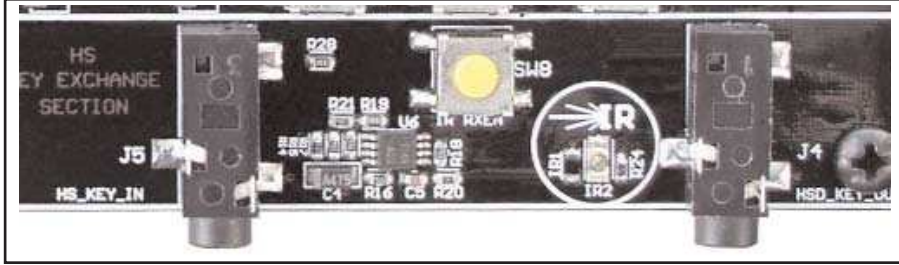

Figure 9: The Decoder Board Key Exchange Area

The key is created in the decoder and transferred to the transmitter with an infrared (IR) link. This consists of an infrared diode (IR2) that is modulated by the KEY_OUT line of the decoder and an infrared receiver built into the transmitter. Once the key is created, the decoder will begin to output the key information through this circuit. The clear plastic window on the back of the transmitter should be held within a few inches of the infrared diode and the key transfer will happen automatically. Jack J4 is also connected to the KEY_OUT line and is available for wired transfer of the key, but the handheld transmitter is not adapted to accept a wired connection. The rest of the circuitry is used for sending and receiving copies of the decoder's User Data, as described in the HS Series Decoder Data Guide, but is not required for operation of this development system.

The Power Supply

The power supply consists of a standard 9V battery and a power jack connected to a 3.0V voltage regulator. The regulator can provide approximately 500mA of current to the prototyping area. If the added circuitry will need more than this, then the designer must add an external supply. If the circuit will consistently draw more than 100mA of current, it might be better to use the power jack, as the battery will run down fairly quickly, reducing testing and development time.

The jack accepts a standard 5.5mm plug with the tip ground and the outer shell 7 to 16VDC positive supply. A reverse voltage protection diode has been included on the board to protect the circuitry in case the voltage on the plug is reversed, but it is still a good idea to double-check the polarity.

The Prototyping Area

The prototyping area contains a large area of plated through holes so that external circuitry can be placed on the board. This circuitry can be interfaced with the HS decoder through the breakout header to the right. At the bottom of this area is a row connected to the 3V power supply and at the top is a row connected to ground.

All of the data lines are connected to a wire-wrap header to the right, allowing easy access from the prototyping area. The decoder DATA_IN and TX_ID lines are also available on the header, as well as the PDN line from the receiver. This allows complete control of the entire system from the prototyping area, giving the designer a great deal of flexibility in using the boards.
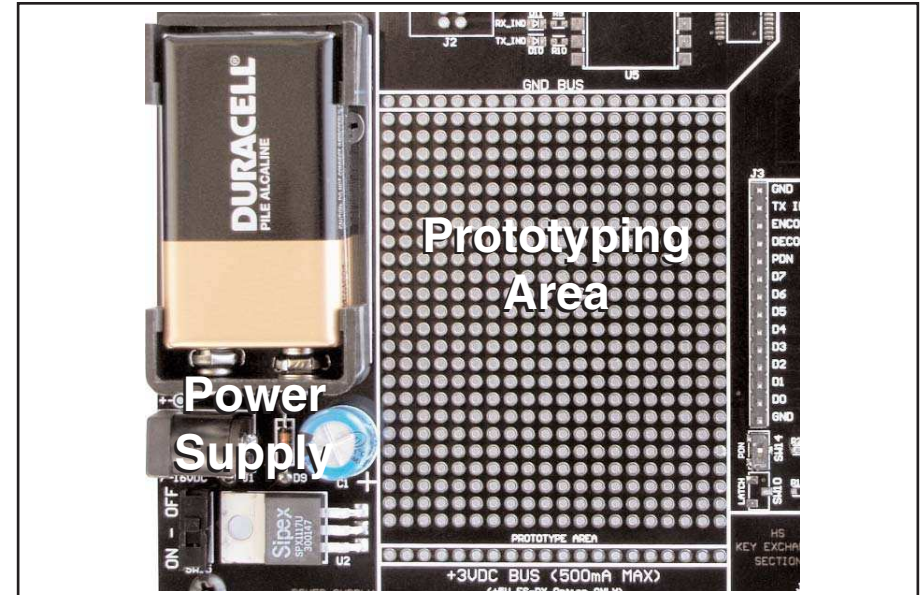

Figure 10: The Power Supply and Prototyping Area

INSTALLING THE SOFTWARE AND DRIVERS

The Master Development System uses a QS Series USB module to provide a simple serial interface to a PC via a USB connection. The module requires drivers to be installed on the PC before it can function properly. The QS Series Direct Drivers are included on the CD with the software.

The first time the QS module is plugged into the computer, Windows will display the Found New Hardware Wizard, which will guide you through installing the drivers. Application Note AN-00201 describes the installation of the drivers in detail. The drivers should be installed before running the Development Software.

The HS Master Development Software will automatically start when the CD is inserted and the player in the figure below will appear.
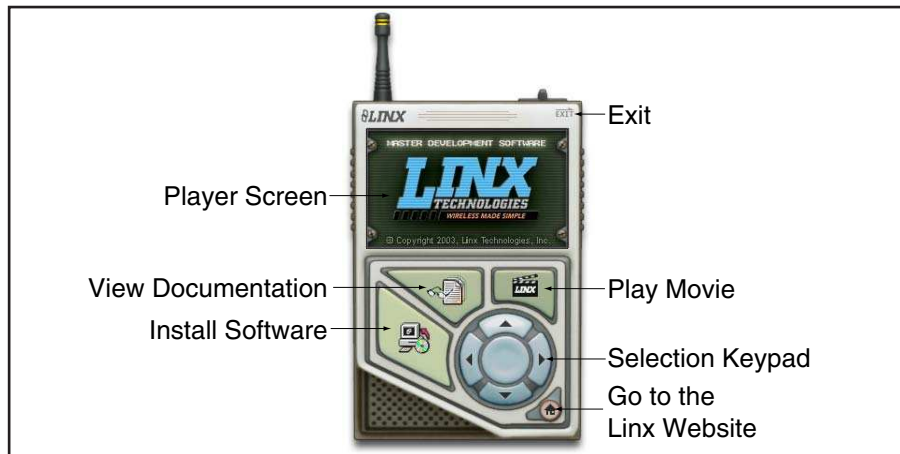

Figure 11: Software Installer

Clicking the Install Software button will start the Installation Wizard, which will guide you through the installation of the development software. The View Documentation button will show a list of the application notes and manuals related to the HS Series. Selecting one of these will open the file in Adobe Acrobat. The Play Movie button will play a short video about Linx on the Player Screen, which can be controlled with the Selection Keypad. Clicking the button on the bottom right of the player will open the Linx Technologies website in the computer's default browser.

The View Documentation list allows for the installation of Adobe Acrobat Reader so that the documents may be viewed. There is also the option of installing Flash, which may be required if the Linx video does not play correctly.

MASTER DEVELOPMENT SOFTWARE

This software is designed to give a complete understanding of how the HS Series encoders and decoders work together, as well as providing an idea of how they can be used in a system.

The Master Development software can be used in one of two modes. The default mode is a software simulation of the system and does not require any hardware. It simulates two handheld transmitters as well as two receiving devices. This is a good way to illustrate how the HS Series can work in a system by turning on lights and opening doors.

The second mode is for use with the Master Development System. When the decoder development board is plugged into a USB port on the PC, the transmitter can be used to activate the features in the software. When the LEDs on the development board turn on, then the LEDs in the program will also turn on and activate the corresponding data line function.
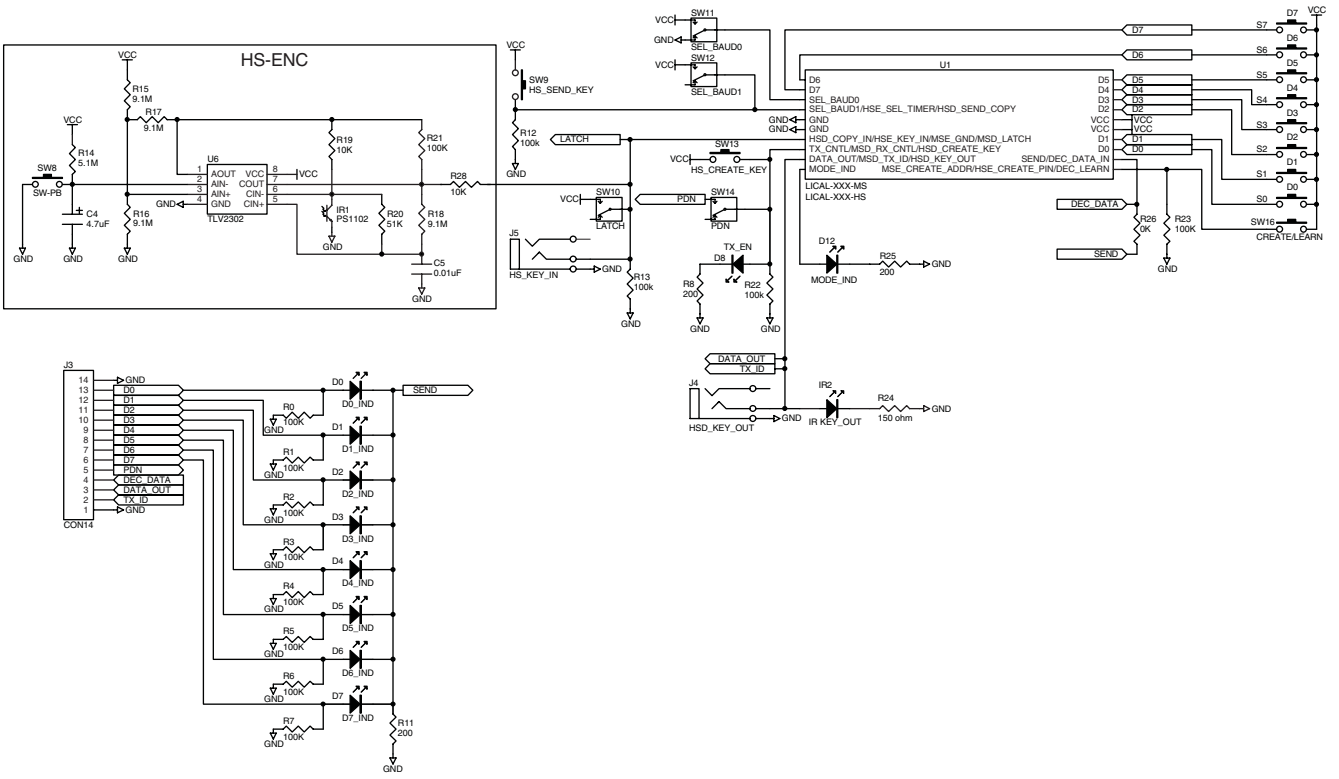
The figure below is a screen shot of the program set up in Software Operation Mode for simulating the operation of the system.
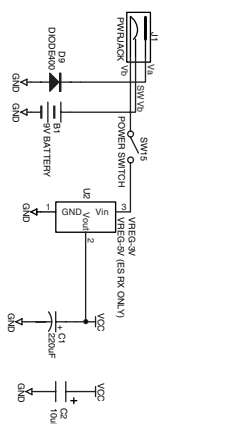

Figure 12: HS Encoder / Decoder Demonstration Software

The transmitters are on the right hand side and the receivers are at the bottom. Complete instructions for using the software can be found by clicking on the Help label at the top right of the window.
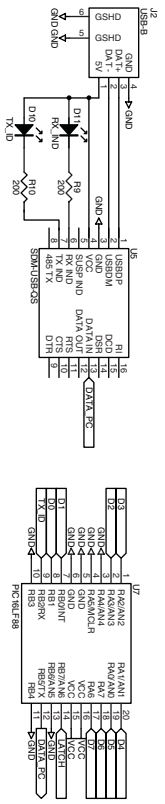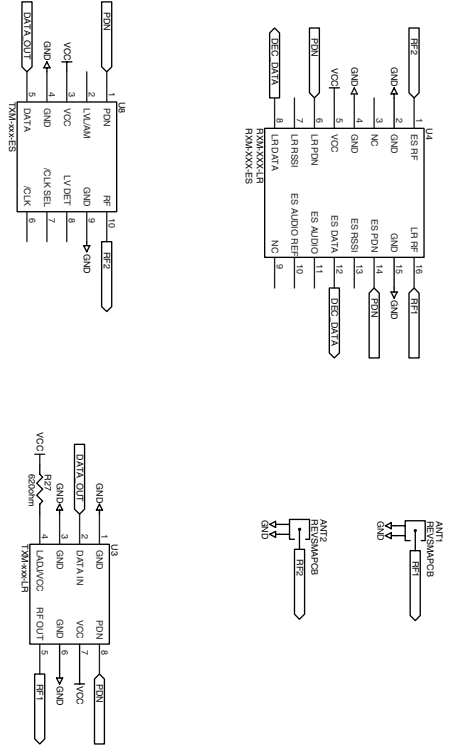
ENCODER / DECODER SECTION

HS-ENC

VCC
R15 9.1M
R17 9.1M
R14 5.1M
VCC
SW8 SW-PB
C4 4.7uF
R16 9.1M
GND

U6
AOUT 1
AIN- 2
AIN+ 3
GND 4
VCC 8
COUT 7
CIN- 6
CIN+ 5
TLV2302
VCC

R19 10K
R21 100K
R28 10K
IR1 PS1102
R20 51K
R18 9.1M
C5 0.01uF
GND

VCC
SW9 HS_SEND_KEY
R12 100k
LATCH
GND

VCC SW11
GND SEL_BAUD0
VCC SW12
GND SEL_BAUD1

SW13
VCC HS_CREATE_KEY

VCC SW10
LATCH

PDN SW14
PDN

J5
HS_KEY_IN GND
R13 100k
GND

D6
D7
SEL_BAUD0
SEL_BAUD1/HSE_SEL_TIMER/HSD_SEND_COPY
GND
GND
HSD_COPY_IN/HSE_KEY_IN/MSE_GND/MSD_LATCH
TX_CNTL/MSD_RX_CNTL/HSD_CREATE_KEY
DATA_OUT/MSD_TX_ID/HSD_KEY_OUT
MODE_IND
LICAL-XXX-MS
LICAL-XXX-HS
U1
D5
D4
D3
D2
D1
VCC
VCC
D1
D0
SEND/DEC_DATA_IN
MSE_CREATE_ADDR/HSE_CREATE_PIN/DEC_LEARN

TX_EN
D8
R8 200
R22 100k
GND GND
DATA_OUT
TX_ID
J4
HSD_KEY_OUT GND
IR2
R24 150 ohm
IR_KEY_OUT GND

D12
MODE_IND
R25 200
GND

D7 VCC
S7 D7
S6 D6
S5 D5
S4 D4
S3 D3
S2 D2
S1 D1
S0 D0
SW16
CREATE/LEARN

DEC_DATA
R26 10K
R23 100K
SEND
GND

J3
14 GND
13 D0
12 D1
11 D2
10 D3
9 D4
8 D5
7 D6
6 D7
5 PDN
4 DEC_DATA
3 DATA_OUT
2 TX_ID
1 GND
CON14

D0 D0_IND SEND
R0 100K D1 D1_IND
R1 100K D2 D2_IND
R2 100K D3 D3_IND
R3 100K D4 D4_IND
R4 100K D5 D5_IND
R5 100K D6 D6_IND
R6 100K D7 D7_IND
R7 100K
R11 200
GND

POWER SUPPLY SECTION

USB SECTION

RF SECTION

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