




ES Series
Master Development System
User's Guide

Wireless made simple®

 **Warning:** Linx radio frequency ("RF") products may be used 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. No Linx Technologies product is intended for use in any application without redundancies where the safety of life or property is at risk.

The customers and users of devices and machinery controlled with RF products must understand and must use all appropriate safety procedures in connection with the devices, including without limitation, using appropriate safety procedures to prevent inadvertent triggering by the user of the device and using appropriate security codes to prevent triggering of the remote controlled machine or device by users of other remote controllers.

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. This module does not have data validation built in.

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 frequency agility 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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ES Series Master Development System

User's Guide

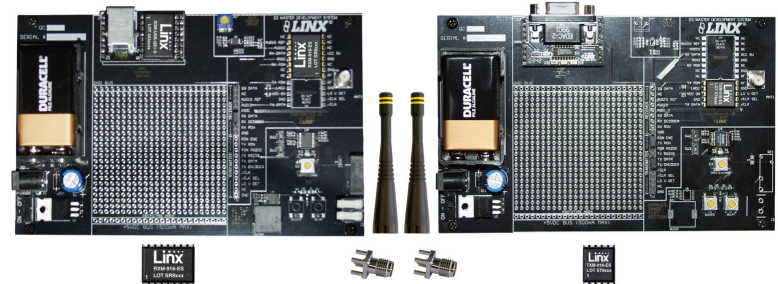


Figure 1: ES Series Master Development System

Introduction

The Linx ES Series RF modules offer a simple, efficient and cost-effective method of adding wireless communication capabilities to any product. The Master Development System gives a designer all the tools necessary to correctly and legally incorporate the ES Series into an end product. The development boards serve several important functions:

- **Rapid Module Evaluation:** The boards allow the performance of the ES Series modules to be quickly evaluated 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 onboard prototyping area allows for the development of custom circuits directly on the development board. All signal lines are available on a header for easy access.
- **Protocol Development -** The development system features a USB or RS-232 interface board, which allows a designer to connect the development board to a PC. Windows-based demonstration software is also included, which allows for a variety of tests.

The Master Development System includes 2 development boards, one set up for the transmitter and the other for the receiver, 2 ES Series transmitters*, 2 ES Series receivers*, two CW Series antennas, 2 9V batteries, demonstration software 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
MDEV-***-ES-USB	ES Series Master Development System - USB
MDEV-***-ES-232	ES Series Master Development System - RS-232
*** = 869, 916MHz	

Figure 2: Ordering Information

ES Series Transmitter Development Board

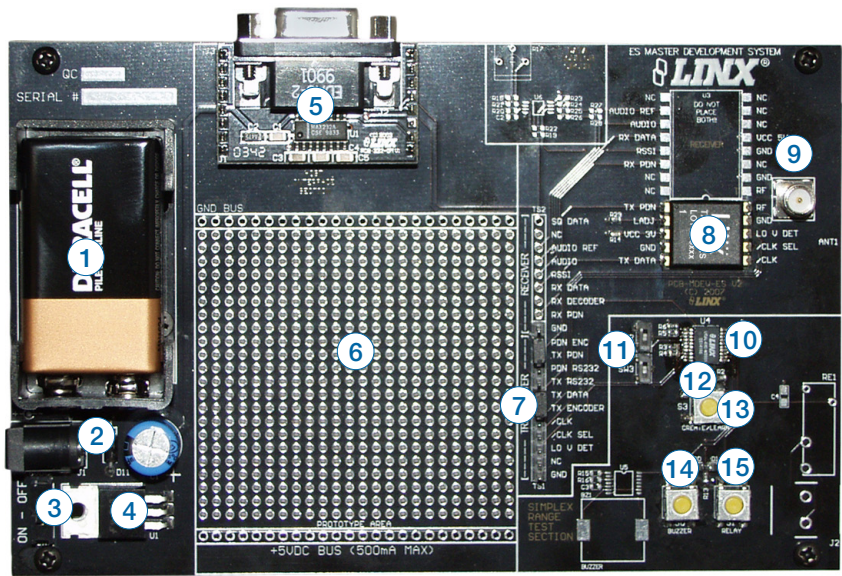


Figure 3: ES Series Transmitter Development Board

1. 9V Battery

2. DC Power Jack

3. On-Off Switch

4. Voltage Regulator

5. Host Interface Module

6. Prototype Area

7. Break-Out Header

8. ES Series Transmitter
9. RP-SMA Antenna Connector

10. MS Series Encoder

11. Baud Rate Selector Switches

12. MODE_IND LED

13. CREATE button

14. Buzzer Button (S3)

15. Relay Button (S2)

ES Series Receiver Development Board

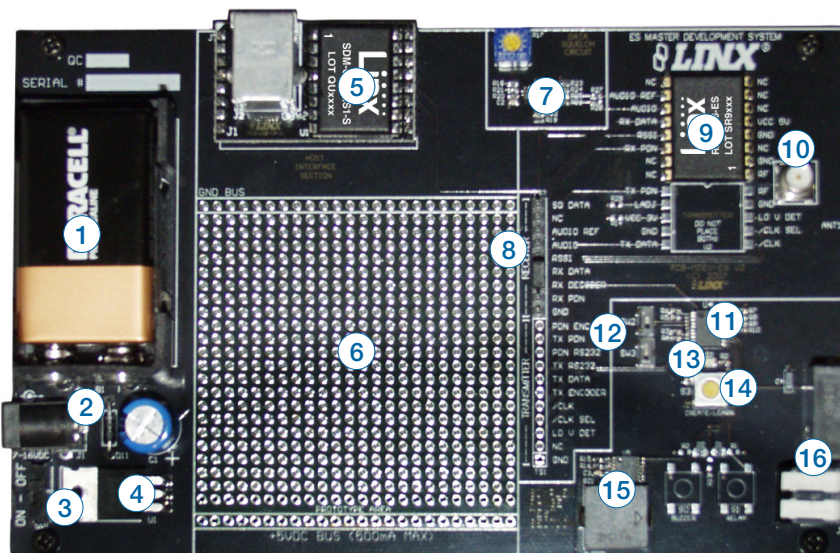


Figure 4: ES Series Receiver Development Board

- | | |
|--------------------------|---------------------------------|
| 1. 9V Battery | 9. ES Series Receiver |
| 2. DC Power Jack | 10. RP-SMA Antenna Connector |
| 3. On-Off Switch | 11. MS Series Decoder |
| 4. Voltage Regulator | 12. Baud Rate Selector Switches |
| 5. Host Interface Module | 13. MODE_IND LED |
| 6. Prototype Area | 14. LEARN Button |
| 7. Data Squelch Circuit | 15. Buzzer |
| 8. Break-Out Header | 16. Relay Output |

Using the Development Boards

All of the module's connections are made available to the designer via the wire-wrap header (TS1 / TS2). Jumper shunts have been provided. These shunts are placed across adjacent pins to control the routing of TX and RX data. After unpacking the development system, attach an antenna to each board, install the supplied 9V battery, and turn on the power switches. The development board is now ready for use.

Troubleshooting

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

- Check the battery to make sure it is not dead.
- Make sure that the antenna is connected.
- Make sure that the jumpers are set correctly.
- Ensure that the baud rate selector switches are set the same on both boards.
- Create and learn a new address.

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

The Prototyping Area

In addition to their evaluation functions, the boards may also be used for actual product development. They feature a prototyping area for the addition of application-specific circuitry. The prototyping area is the same on both boards and contains a large area of plated through-holes so that external circuitry can be placed on the board. The holes are 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. This circuitry can be interfaced with the ES transmitter or receiver through the breakout header to the right. At the bottom of this area is a row connected to the 5V power supply and at the top is a row connected to ground.

Note: The on-board 5-volt regulator has approximately 500mA of headroom available for additional circuitry. If added circuitry requires a higher current, the user must add an additional regulator to the prototype area or power the board from an external supply.

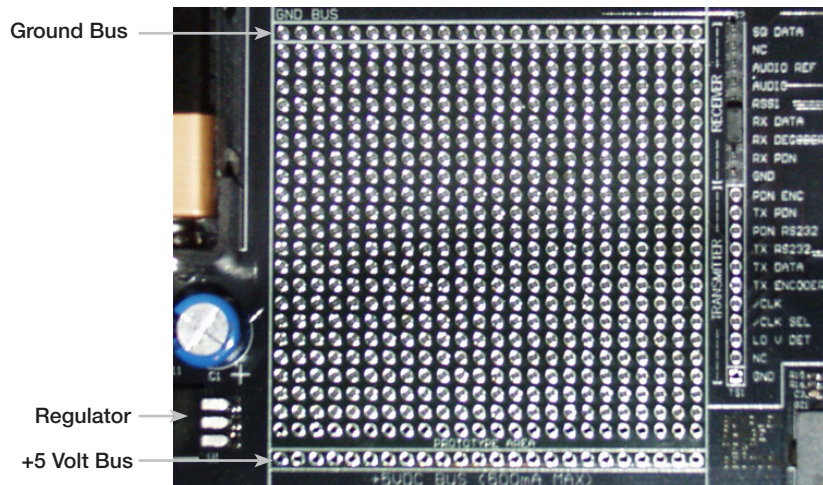


Figure 5: The Development Board Prototyping Area

Using the Simplex Encoder / Decoder Section

The transmitter board features an MS Series remote control encoder with two push buttons and the receiver board features a decoder with a relay output and a buzzer. When a button is pressed on the transmitter board, the status of both buttons is captured and encoded into a data stream for transmission. The data recovered by the receiver is decoded and the decoder's outputs are set to replicate the states of the encoder, driving either the buzzer or the relay.

To activate this area of the board, the module DATA line must be routed to the encoder / decoder. Configure the transmitter board for encoding and transmission by placing a jumper across TX DATA and ENCODER and across TX PDN and PDN ENC on header TS1. Configure the receiver board for reception and decoding by placing a jumper across RX DATA and DECODER on header TS2.

TS1	TS2
<div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> PDN ENC </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> TX PDN </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> PDN RS232 </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> TX RS232 </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> TX DATA </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> TX ENCODER </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> /CLK </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> /CLK SEL </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> LO V DET </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> NC </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> GND </div>	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> SQ. DATA </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> NC </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> AUDIO REF </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> AUDIO </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> RSSI </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> RX DATA </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> RX DECODER </div> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="width: 10px; height: 10px; background-color: black; margin-bottom: 2px;"></div> RX PDN </div>
TX	RX

Figure 6: Jumper Configuration

Once the boards have been configured, place the receiver board on a flat surface and turn it on. Turn on the transmitter board and press button S0. You should hear the buzzer on the receiver board sound. Walk away from the receiver to ascertain the useable range of the link in the environment.

Button S1 activates the relay on the receiver board. The relay's SPST contacts can be connected at J2. Any device up to 5A at 30VDC / 120VAC may be switched through the relay. An external siren or light can be connected to aid range testing if the on-board buzzer is not loud enough.

Using the Data Squelch Circuit

A data squelch circuit is provided on the receiver development board. This circuit is used to add both hysteresis and squelching capabilities as detailed in the ES Series Receiver Data Guide. Since the ES Series receiver output is not internally squelched, its output continually switches when no transmission is present. This can cause interrupts and buffer overflows in external circuitry. A squelch circuit helps eliminate this noise by providing a qualification threshold for incoming data based on signal strength. This circuit is not a substitute for robust protocol since squelch can be broken by unintended interference.

To get a better idea of the circuit's operation, clip an oscilloscope probe on both RX DATA and SQ. DATA (Squelch Data). With the transmitter off, the SQ. DATA line is high (which means that the output is squelched) while RX DATA is switching randomly. Squelching is accomplished by comparing RSSI with a voltage reference created by R17 (potentiometer), R18, and R21. When the RSSI falls below the voltage set by this reference, the output of the comparator (U6) is pulled to ground. This disables the data slicer created with the additional comparator contained within U6. Figure 14 shows the schematic of this circuit.

Setting a higher squelch threshold reduces the random noise on the DATA line but also reduces range. The squelch level affects only the threshold of the data going to the RS-232 serial port and the SQ DATA line on TS2.

To set squelch, turn off the transmitter and turn on the receiver. Place an oscilloscope probe on the SQ DATA line, and adjust R17 until SQ DATA remains high. Two resistors (R27 and R28) are used to connect the module to the squelch circuit. These may be removed to disconnect the squelch circuit and prevent it from slightly loading the AUDIO and AUDIO REF lines.

Using the Encoder and Decoder

The MS Series encoder and decoder use a 24-bit address to provide uniqueness to the transmission and to prevent unintended activation. The development boards come with a default address. To create a new address, press and hold the CREATE button on the transmitter board. The address is randomized for as long as the button is held down. Once released, the MODE_IND LED begins flashing to indicate that the encoder is ready to accept Control Permissions. Press the Buzzer and/or Relay buttons to tell the encoder that they will be used. Press the Create button again to exit Create Mode, or let the encoder time out after 15 seconds.

On the decoder board, press the LEARN button and the MODE_IND LED begins flashing to indicate that the decoder is ready to learn a new address. Press one of the authorized buttons on the transmitter board to send a signal. Press the LEARN button again to exit Learn Mode, or let the decoder time out after 17 seconds and the system is ready for use.

The encoder and decoder operate on one of four different baud rates as set by the baud rate selector switches. A faster baud rate gives a faster response time. Please see the encoder or decoder data guide for the settings. If the switch is up then it is connected to Vcc, if it is down then it is connected to GND.

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 development boards. Pressing S0 on the transmitter activates the buzzer on the receiver board, while S1 activates the relay.

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 R29 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 or output levels can be legally raised due to protocol duty cycle, R29 can be changed according to the attenuation graph in the ES 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.

Host Interface Module

The ES Master Development System features a Host Interface socket, which allows the use of two different PC interface modules. The first is a USB interface module that uses a standard USB cable to connect to a PC's USB port or a USB hub. The second type of module is a RS-232 interface module that can be connected to a standard serial COM port on a PC using a straight-through 9-pin extension cable (not included). The evaluation board is considered a DCE device and as such is designed to be connected using a straight-thru serial extension cable. Do not use a null-modem cable as the boards will not function.

To install, select the module to be used and then line up the pins on the module with the headers on the board. Verify that the pin one polarity marks on the board and on the Host Interface Module match. The USB jack or the D-sub connector should face away from the board. Press firmly on the module so that it slides fully into the header.

The development system may be prepared for host operation with the supplied Linx software by setting the jumpers on the header as shown in the adjacent figure. This routes the module's data lines to the Host Interface Module. Despite being electrically interfaced, appropriate protocol must be employed to ensure reliable and error-free data transfer since the ES Series modules do not encode or packetize the data in any manner. It is important to understand that the development boards are transparent; that is, the user's software is entirely responsible for controlling the timing and error correction aspects of the link. The evaluation boards have no provision to check or qualify the incoming data. When designing a protocol to transfer data across a wireless link, it is very important to remember that interference is inevitable. The protocol must

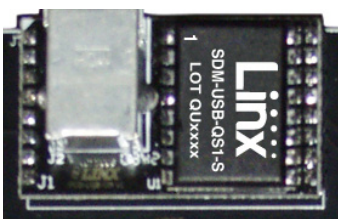


Figure 7: USB Interface Module

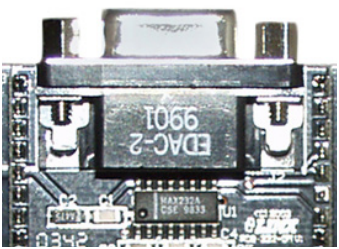


Figure 8: RS-232 Interface Module

TS1	TS2
<div><div></div>PDN ENC</div> <div><div></div>TX PDN</div> <div><div></div>PDN RS232</div> <div><div></div>TX RS232</div> <div><div></div>TX DATA</div> <div><div></div>TX ENCODER</div> <div><div></div>/CLK</div> <div><div></div>/CLK SEL</div> <div><div></div>LO V DET</div> <div><div></div>NC</div> <div><div></div>GND</div>	<div><div></div>SQ. DATA</div> <div><div></div>NC</div> <div><div></div>AUDIO REF</div> <div><div></div>AUDIO</div> <div><div></div>RSSI</div> <div><div></div>RX DATA</div> <div><div></div>RX DECODER</div> <div><div></div>RX PDN</div>
TX	RX

Figure 9: Jumper Configuration

support error detection and correction if it is to be successful. A correctly designed protocol will provide optimum performance and throughput for product specific applications while taking into account the timing and data-rate requirements of the module. For further information on protocol considerations please refer to Application Note AN-00160.

If the designer needs to develop protocols using a physical implementation other than an RS-232 or USB interface, the designer can build the custom interface circuitry in the prototyping area and route the module's data signals from the header to the prototyping area.

Master Development Software

The development system is supplied with Windows-based software that facilitates communication with the development boards through the Host Interface Module. This software allows for testing and illustrates basic implementation of the modules as a wireless serial link. The user selects either a USB or RS-232 connection and whether the connected board is the transmitter or receiver. The user can then send text, ASCII characters, and even a picture. Documentation for the software may be found by going to the 'Help' menu then 'Help File'.

Terminal emulation programs, such as HyperTerminal, do not provide error correction; therefore, bit errors or data line hashing are displayed as random characters. Some form of error detection should be employed when developing a protocol for wireless environments (please see Application Note AN-00160).

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.

Using the Boards as a Design Reference

The master development 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 will suppress 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 ES Series data guide or the calculator available on our website for details on microstrip calculations.

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 or call +1 541 471 6256 between 8AM and 4PM Pacific Time to speak with an application engineer.

Legal Notice: All Linx kits and modules are designed in keeping with high engineering standards; however, it is the responsibility of the user to ensure that the products are operated in a legal and appropriate manner. The purchaser understands that legal operation may require additional permits, approvals, or certifications prior to use, depending on the country of operation.

USB Host Interface Board Schematic

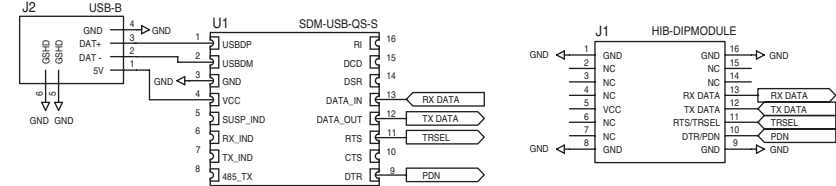


Figure 10: USB Host Interface Board Schematic

RS232 Host Interface Board Schematic

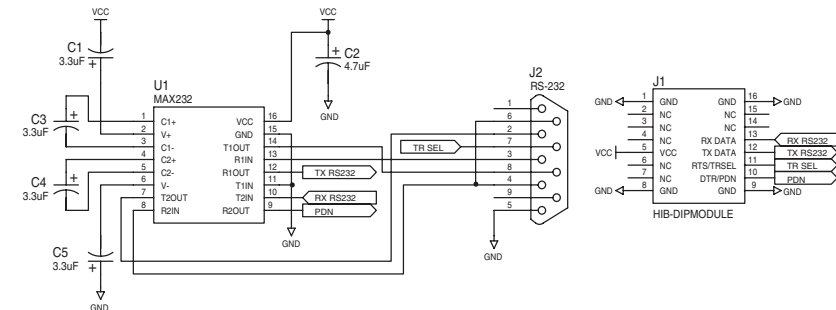


Figure 11: RS232 Host Interface Board Schematic

RF Section Schematic

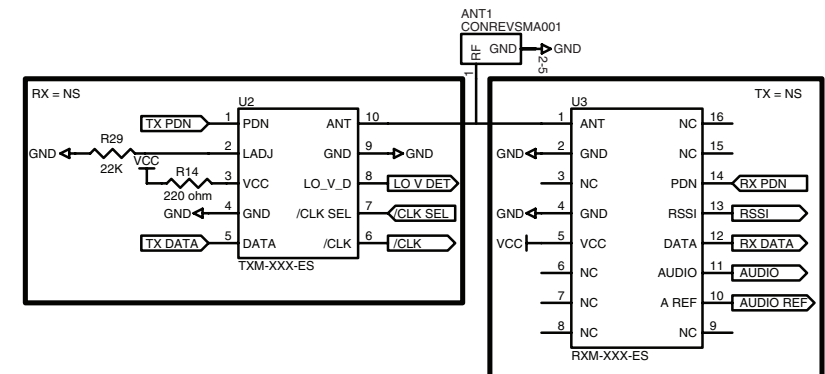


Figure 12: RF Section Schematic

Header Section Schematic

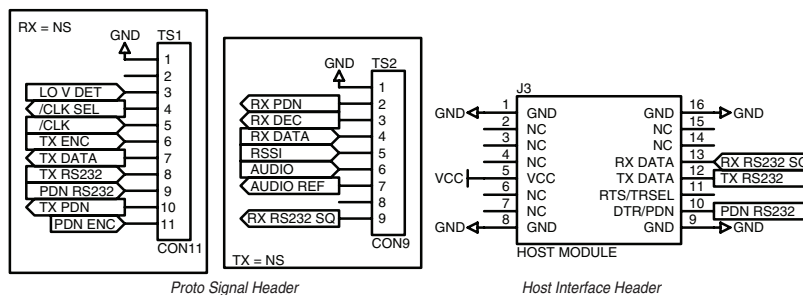


Figure 13: Header Section Schematic

Squelch Circuit Schematic

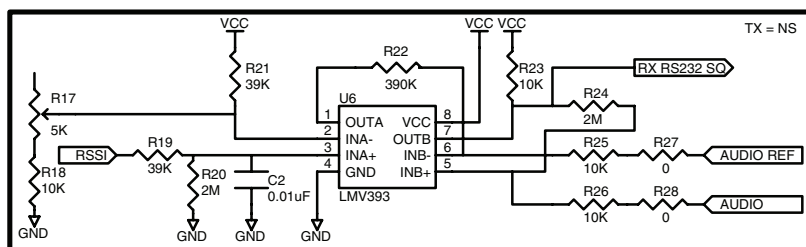


Figure 14: Squelch Circuit Schematic

Power Supply Section Schematic

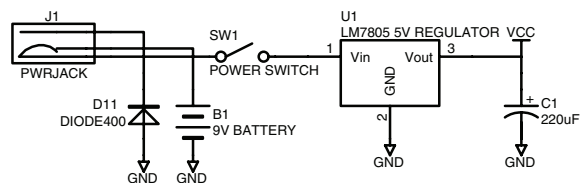


Figure 15: Power Supply Section Schematic

Encoder/Decoder Section Schematic

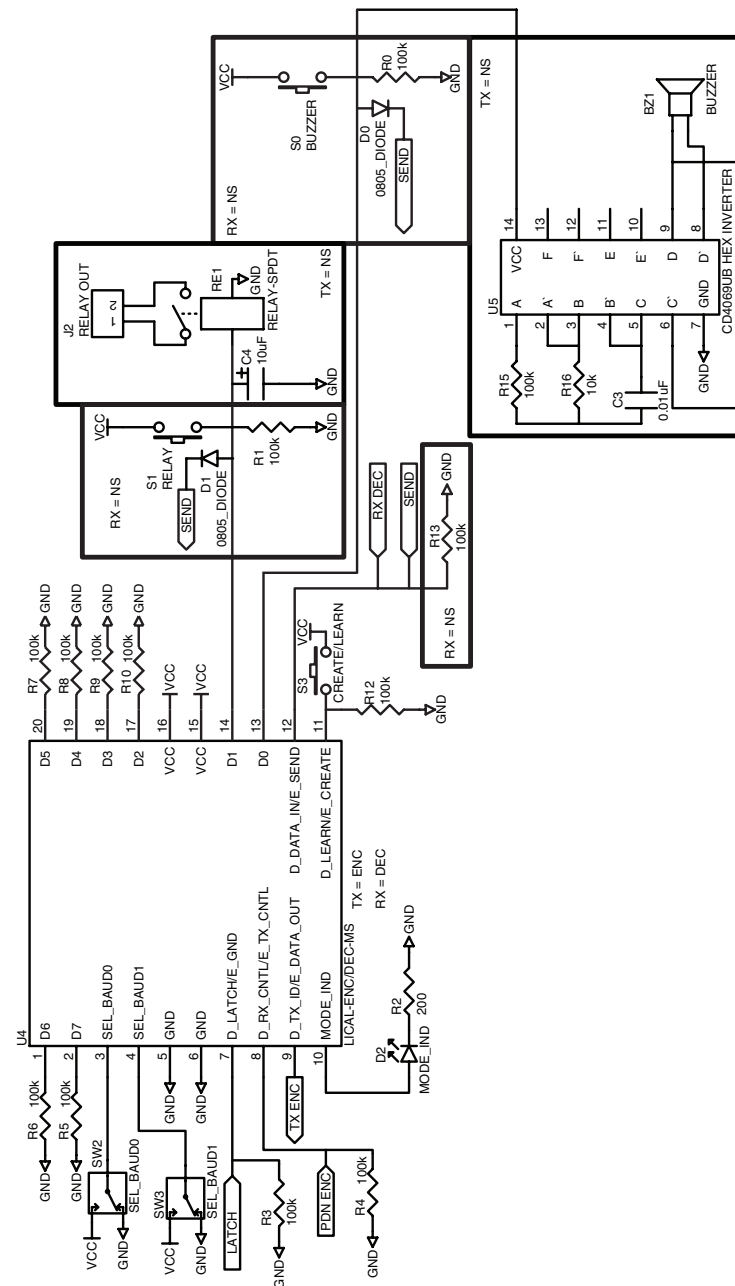


Figure 16: Encoder/Decoder Section Schematic



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