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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Linx
TECHNOLOGIES

**HumRC™ Series
Master Development System
User´s Guide**

Wireless made simple®

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HumRC™ Master Development System

User´s Guide

Figure 1: HumRC™ Series Master Development System

Introduction

The Linx HumRC™ Series Remote Control Transceiver modules offer a simple, efficient and cost-effective method of adding remote control capabilities to any product. The Master Development System provides a designer with all the tools necessary to correctly and legally incorporate the module into an end product. The boards serve several important functions:

- Rapid Module Evaluation: The boards allow the performance of the Linx HumRC™ Series modules to be evaluated quickly in a user's environment. The development boards can be used to evaluate the range performance of the modules.

- Application Development: A prototyping board allows the development of custom circuits directly on the board. All signal lines are available on headers for easy access.

- Software Development: A programming dock with a PC interface allows development and testing of custom software applications for control of the module.

- Design Benchmark: The boards provide a known benchmark against which the performance of a custom design may be judged.

The Master Development System includes 2 Carrier Boards, 2 RC Demo Boards, 2 Programming Dock Boards, 2 Prototype Boards 4 HumRC™ Series transceivers*, antennas, batteries and full documentation.

* One part is soldered to each Carrier Board

Ordering Information

Ordering Information	
Part Number	**Description**
EVAL-***-RC	HumRC™ Series Basic Evaluation Kit
MDEV-***-RC	HumRC™ Series Master Development System
HUM-***-RC	HumRC™ Series Remote Control Transceiver
HUM-900-RC-UFL	HumRC™ Series Remote Control Transceiver, Certified, UFL Connector
HUM-900-RC-CAS	HumRC™ Series Remote Control Transceiver, Certified, Castellation Connection
EVM-***-RC	HumRC™ Series Carrier Board
EVM-900-RC-UFL	HumRC™ Series Carrier Board with Certified module, UFL Connector
EVM-900-RC-CAS	HumRC™ Series Carrier Board with Certified module, Castellation Connection
MDEV-DEMO-RC-A	Development System Remote Control Demo Board, Type A
MDEV-DEMO-RC-B	Development System Remote Control Demo Board, Type B
MDEV-PGDOCK	Development System Programming Dock
MDEV-PROTO	Development System Prototype Board
CON-SOC-EVM	EVM Module Socket Kit
*** = Frequency; 900MHz, 2.4GHz	

Figure 2: Ordering Information

HumRC™ Series Transceiver Carrier Board

Figure 3: HumRC™ Series Transceiver Carrier Board

HumRC™ Series Transceiver Carrier Board Objects

1. HumRC™ Series Transceiver
2. MMCX RF Connector
3. Dual Row Header
4. Single Row Header

HumRC™ Series Transceiver Carrier Board Pin Assignments
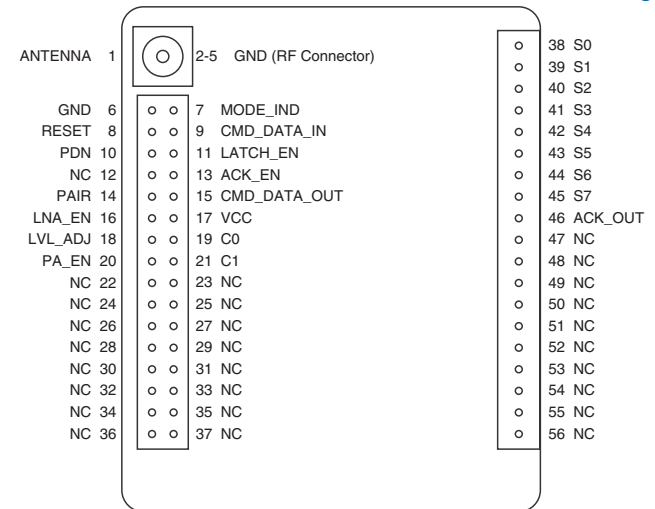
Figure 4: HumRC™ Series Transceiver Carrier Board Pin Assignments (Top View)

Programming Dock
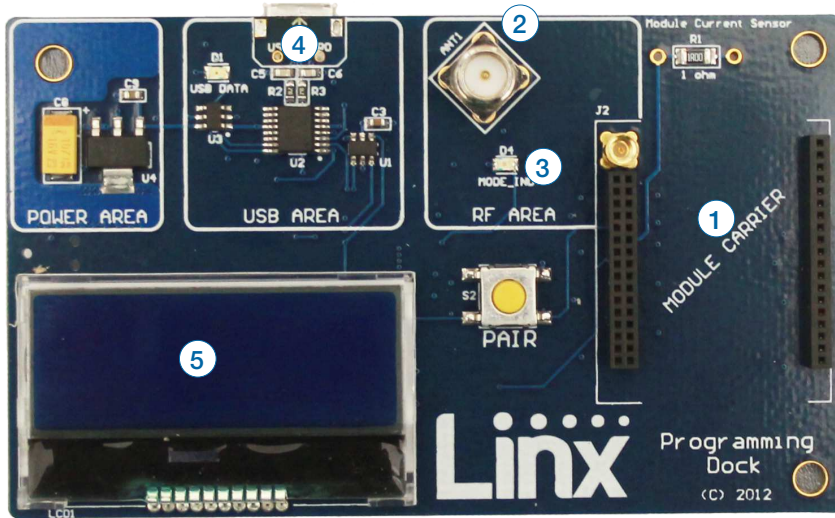
Figure 5: Programming Dock

Programming Dock Objects

1. Carrier Board Socket
2. RP-SMA Antenna Connector
3. MODE_IND LED
4. Micro USB Connector
5. LCD Display

Remote Control Demo Board
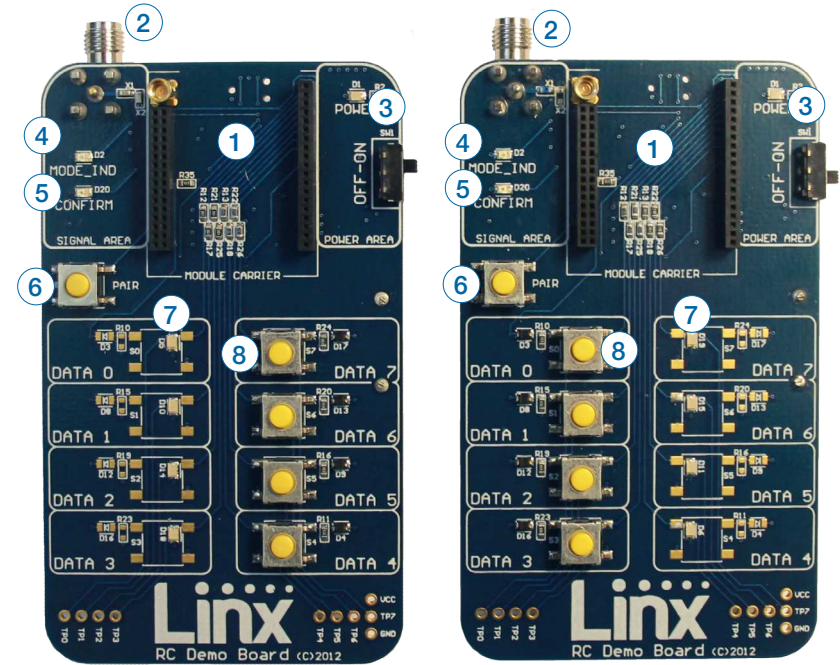
Board A   Board B

Figure 6: Remote Control Demo Board

Remote Control Demo Board Objects

1. Carrier Board Socket
2. RP-SMA Antenna Connector
3. Power Switch
4. MODE_IND LED
5. CONFIRM LED
6. PAIR button
7. Status Line Output LEDs
8. Status Line Input Buttons
9. 4 AAA Batteries (Not shown, on the back of the boards)

Prototype Board
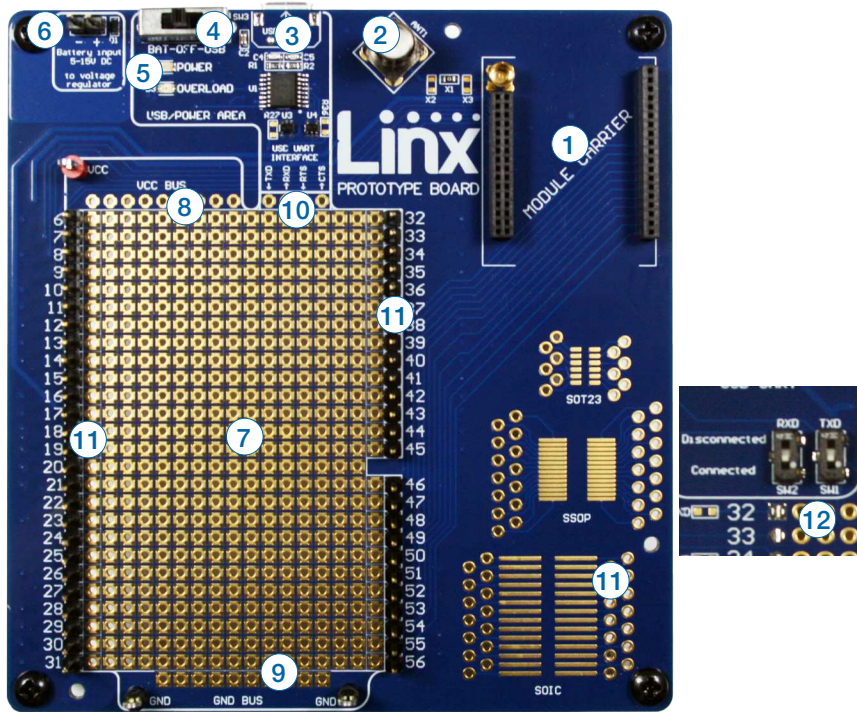
Figure 7: Prototype Board

Prototype Board Objects

1. Carrier Board Socket
2. RP-SMA Antenna Connector
3. Micro USB Connector
4. Power Switch
5. Power LED
6. External Battery Connection
7. Prototyping Area
8. 3.3V Supply Bus
9. Ground Bus
10. USB Interface Lines
11. Module Interface Headers
12. Command Data Interface Routing Switches (on back)

Initial Setup

There are several boards that are included with the Development System. The Carrier Boards have a HumRC™ Series transceiver on a daughter board with headers. These boards snap into sockets on the other boards, enabling the modules to be easily moved among the test boards.

There are two Programming Docks that have a socket for a Carrier Board and a USB interface for connection to a PC. This is used with the demonstration software included with the kit to configure the module through its Command Data Interface.

There are two Remote Control Demo Boards that are populated differently. Board A has the buttons on the right column and board B has them on the left column. These accept the Carrier Boards and are used to demonstrate the remote control functionality of the HumRC™ Series. They can also be used for range testing. These boards use hardware configuration, so if any changes have been made to the modules using the software then they may not operate correctly. A restore to default configuration can be used to reset the modules.

There are two Prototype Boards that have a socket for a Carrier Board, a USB interface and a large area of plated through holes that can be used to develop custom circuitry. The board can be powered either from the USB connection or an external battery.

> ⚠ **Warning:** Installing or removing a Carrier Board while power is applied could cause permanent damage to the module. Either turn off power to the board or unplug the USB cable before installing or removing a Carrier Board

The development software supports Windows 7 and 10; with Java 1.6 or later.

Using the Programming Dock

Snap a Carrier Board onto the socket on the Programming Dock as shown in Figure 8.
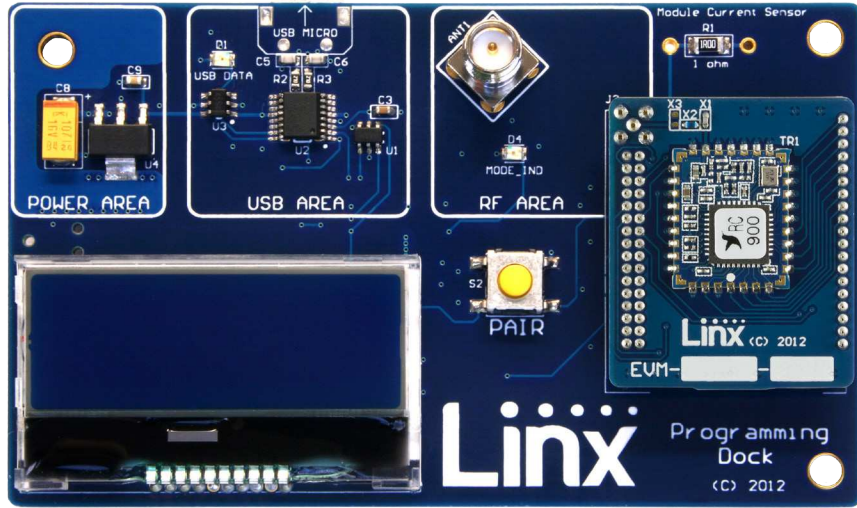

Figure 8: Programming Dock with a Carrier Board

Connect a micro USB cable into the connector at the top of the board. Plug the other end into a PC. The board is powered by the USB bus. The demonstration software included with the kit or custom application software can be used to configure the module through its Command Data Interface. The LCD is used to display information about the module. This includes the module's local address and a custom nickname. The nickname is entered using the development kit software and can be any name that helps distinguish the modules from one another. This is convenient when multiple programming docks are connected to the same computer. Please see the development kit software section for more information on the nicknames.

The HumRC™ Series transceiver has a serial Command Data Interface that offers the option to configure and control the transceiver through software instead of through hardware. This interface consists of a standard UART with a serial command set. This allows for fewer connections in applications controlled by a microcontroller as well as for more control and advanced features than can be offered through hardware pins alone.

Using the Remote Control Demo Board

Snap a Carrier Board onto the socket on each Remote Control Demo Board as shown in Figure 9.
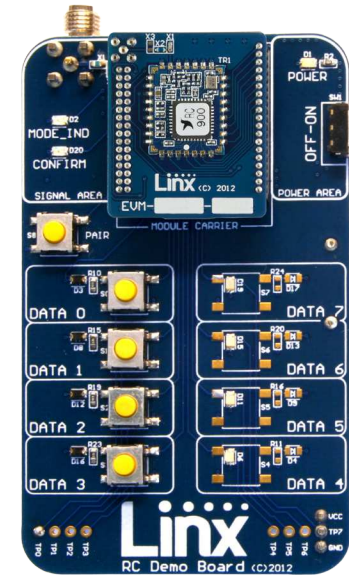
Figure 9: Remote Control Demo Board with a Carrier Board

Insert 4 AAA batteries into the holders on the back of each board, connect antennas and turn on power.

The modules come paired out of the box, but to Pair additional modules, press the PAIR button on both boards. The MODE_IND LEDs flash to indicate that the modules are searching for each other and exchanging addresses. The MODE_IND has a quick flash while searching (100ms on, 900ms off) and a longer flash once Pairing is complete (400ms on, 100ms off). This process only takes a few seconds. The pairing process takes the status line input / output directions into account. If these are changed then the modules should be paired again.

Once complete, pressing a button on one board (the Initiating Unit or IU) causes an LED to light up on the other board (the Responding Unit or RU). The RU sends an acknowledgement message to the IU. If the message is valid, the IU turns on the CONFIRM LED.

> **Note:** To restore the default configuration, push the PAIR button four times and hold it down on the fifth press. The MODE_IND LED flashes when it has reset.

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 modules in the intended operational environment.

Range testing can be performed with the Remote Control Demo Boards. To prepare the board for range testing, simply turn it on by switching the power switch to the ON position. Pressing a status line button on one board (the IU) activates an LED on the other board (the RU). The RU then sends an acknowledgement back to the IU, which turns on the CONFIRM LED. This indicates good bi-directional RF communications and lets the user set one board down and walk with the other board.

As the maximum range of the link in the test area is approached, it is not uncommon for the signal to cut in and out as the radio moves. This is normal and can result from other interfering sources or fluctuating signal levels due to multipath effects. This 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 farther usually restores the signal. If the signal is not restored, then the maximum range of the link has been reached.

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. High RSSI readings while the transmitter off indicate there is interference. If this fails to resolve the issue, please contact Linx technical support.

> **Note:** The Remote Control Demo boards are designed for hardware configuration. If the modules are changed through software configuration then the boards may not operate as expected. A restore to default configuration can be used to reset the modules.

Using the Prototype Board

Snap a Carrier Board onto the socket on the Prototype Board as shown in Figure 10.

Figure 10: Prototype Board with a Carrier Board
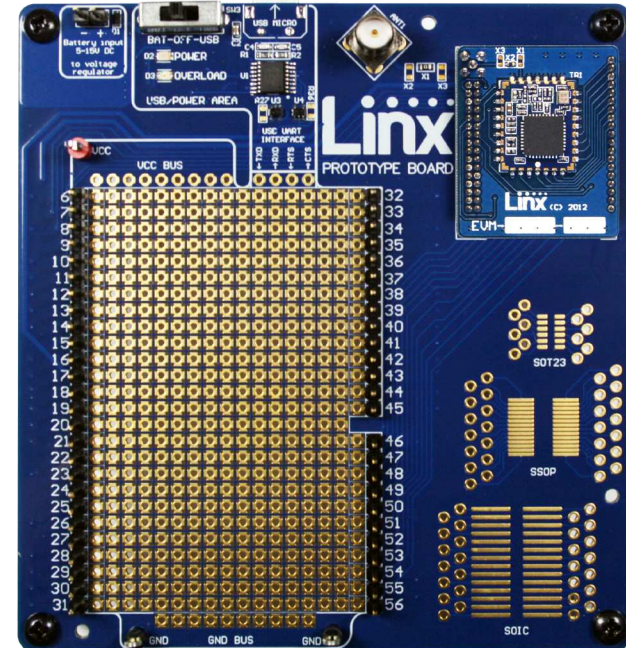
Place the power switch into the "USB" position then connect a micro USB cable into the connector at the top of the board. Plug the other end into a PC or any USB charger. The board is powered by the USB bus. This board features a prototyping area to facilitate the addition of application-specific circuitry. The prototyping area contains a large area of plated through-holes so that external circuitry can be placed on the board. The holes are set at 0.100" on center with a 0.040" diameter, accommodating most industry-standard SIP and DIP packages.

At the top of the prototyping area is a row connected to the 3.3V power supply and at the bottom is a row connected to ground. External circuitry can be interfaced to the transceiver through the breakout headers. The numbers next to the headers correspond to the pin numbers on the Carrier Board. Figure 4 shows the pin assignments for the Carrier Board.

The OVERLOAD LED indicates that that too much current is being pulled from the USB bus. This is used to prevent damage to the parts or the bus. The overload condition is reset once the excess current draw is removed.

Supply for the module is connected through R17. This can be removed and replaced by another supply or used to measure the current consumption of the module.

> **Note:** The onboard 3.3-volt regulator has approximately 400mA available for additional circuitry when plugged into a PC. If more current is required, the user must power the board from an external supply or a USB charger with more current capabilities, up to 1A.

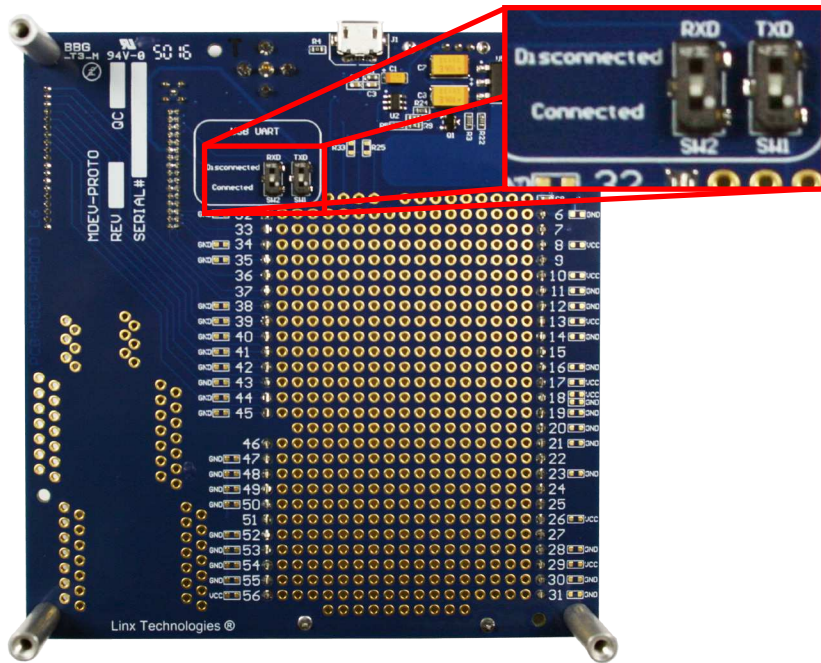Figure 11 shows the bottom of the board.

Figure 11: Prototype Board Bottom Side

SW1 and SW2 connect the USB interface to the Command Data Interface lines on the module. This allows the prototype board to be used with the development kit software or a custom application. When in the "USB Connected position", the module is connected to the USB interface. The "Header Only" position connects the module to the header.

Footprints for 0603 size resistors are on most lines so that pull-ups or pull-downs can easily be added to the lines. The pads are connected to V_{CC} or GND based on the most common configuration for the module. The schematic at the end of this document shows how each line is connected.

The LADJ line has pads for both a pull up and pull down resistor. This can be populated based on the needs of the specific module that is connected to the prototype board. The HumRC™ Series uses both resistors to create a voltage divider that determines the output power level. Please see the HumRC™ data guide for more details on this.

Figure 12 shows a convenient cross reference showing which lines on the module connect to which lines on the prototype board.

Module to Prototype Board Pin Number Cross Reference		
Pin Name	Module Pin Number	Prototype Board Pin Number
MODE_IND	30	7
RESET	22	8
CMD_DATA_IN	27	9
POWER_DOWN	12	10
LATCH_EN	13	11
ACK_EN	28	13
PAIR	29	14
CMD_DATA_OUT	26	15
VCC	21	17
LVL_ADJ	32	18
C0	10	19
C1	11	21
S0	8	38
S1	7	39
S2	6	40
S3	5	41
S4	4	42
S5	3	43
S6	2	44
S7	1	45
ACK_OUT	31	46

Figure 12: Module to Prototype Board Pin Number Cross Reference

The Development Kit Demonstration Software

The development kit includes software that is used to configure and control the module through the Programming Dock. The software defaults to the Demo & EZConfiguration tab when opened (Figure 13). This window offers basic configuration and demonstration of the module's functionality with the current configuration.
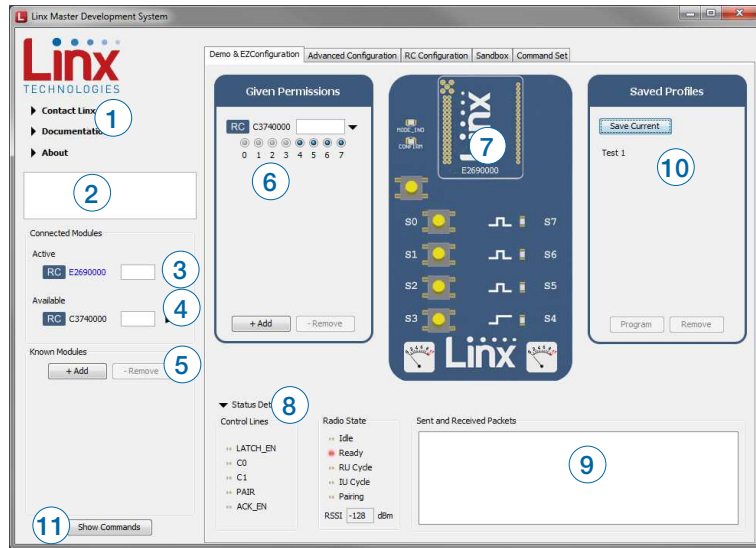

Figure 13: The Master Development System Software Demo and EZConfiguration Tab

1. Clicking the Contact Linx, Documentation and About labels on the left side expands them to show additional information and links to the latest documentation. This is shown in Figure 15.

2. The Help window shows tips and comments about the software.

3. The active module is connected to the PC and being configured by the software.

4. Available modules are connected to the PC but are not currently being configured or controlled by the PC

5. Known Modules are not currently connected to the PC, but have either been connected to the software in the past or have been manually entered.

6. The Given Permissions window shows the list of modules that are paired with the active module and the Permissions Mask for each one.

7. The demo area replicates a remote control device. The appearance changes with the programmed configurations.

8. The Status Details section shows the module's control line states, radio state and RSSI level.

9. The Sent and Received Packets window shows the commands sent to the module and the responses from the module. This aids in debugging custom software.

10. Once a module has been configured, the configurations can be saved into a profile that can be recalled and programmed into other modules. The Saved Profiles list shows all of the profiles that have been saved into the software.

11. The Show Commands button opens a larger window to view the serial commands sent to and received from the module.

The modules are shown with three identifiers as shown in Figure 14.
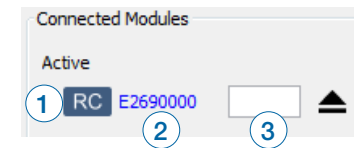

Figure 14: The Master Development System Software Module Identifiers

1. The type of module (HumRC™ Series)

2. The module's local address.

3. A custom name that can be given to the module. Type a name into the box and press Enter to apply it. This name is shown on the LCD display on the programming dock.
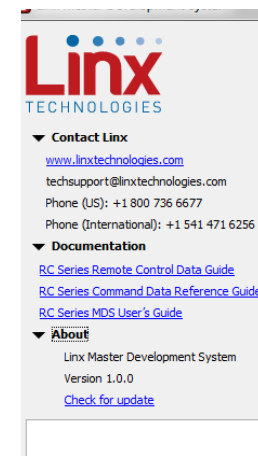

Figure 15: The Master Development System Software Additional Information

The Advanced Configuration tab (Figure 16) offers more detailed configuration options for the active module.
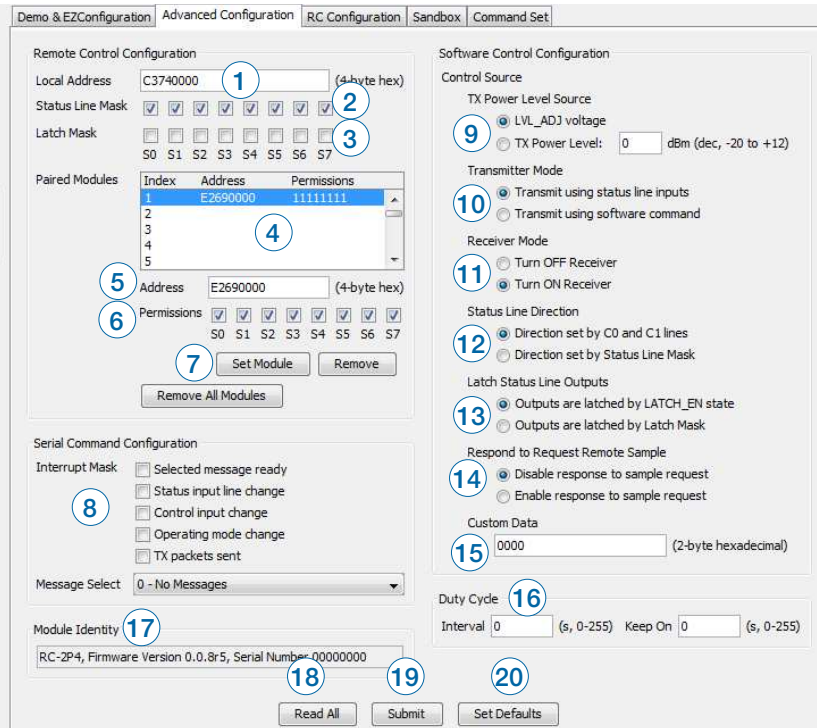

Figure 16: The Master Development System Software Advanced Configuration Tab

1. The Local Address box shows the module's local address in hexadecimal format. This can be changed by typing a new hex value.

2. The Status Line Mask sets the status lines as either inputs or outputs. If the box is checked then the line is an input.

3. The Latch Mask determines if the status line outputs are latched or momentary. If the box is checked then the output is latched. This setting has no effect on lines that are configured as inputs.

4. The Paired Modules Window lists all of the modules that are paired with the active module and their Permissions Mask.

5. The Address box enables manual pairing of a module. Enter an address into this box and press the Set Module button to add the address to the list.

6. The Permissions Mask determines whether a specific module is authorized to control a specific status line output. If the box is checked then the module is authorized to control that line.

7. The Set Module button adds the address and Permissions Mask to the list. If a current module is selected, then the Permissions can be updated. The Remove module button removes the selected module from the list. The Remove All Modules button removes all of the modules from the list.

8. The Interrupt Mask sets the conditions under which an interrupt is to be generated on the CMD_DATA_OUT line. The Message Select menu sets the type of message that triggers the interrupt when the Selected Message Ready box is checked.

9. The TX Power Level Source configures how the transmitter output power is set. It uses either the voltage on the LVL_ADJ line or the value in the box. The accepted range of values is -20 to +12.

10. The Transmitter Mode selection sets whether the module transmits command messages when a status line input is asserted or when it receives a software command.

11. The Receiver Mode selection turns the receiver on or off for power savings. If the module is set as an Initiating Unit only with all status lines as inputs, then the receiver is disabled by default.

12. The Status Line Direction selection sets how the status lines are configured as inputs and outputs. Either the C0 and C1 hardware lines are used to set them in groups of 4 or the Status Line Mask is used to set them individually.

13. The Latch Status Outputs selection configures how the latched or momentary operation for each status line output is set. Either the LATCH_EN hardware line is used to set all of the lines the same way or the Latch Mask is used to set the lines individually.

14. If the Respond to Request Remote Sample is enabled, the module automatically responds to the request with a packet than contains the values determined by the MType field in the received packet.

15. The Custom Data box enables a custom 2-byte value to be loaded into the module to be transmitted with each control message or Acknowledge with Data packet.

16. The Duty Cycle configuration sets the interval and Keep on times for automatically cycling power to the receiver.

17. The Module Identity box displays the module type, firmware version and serial number of the active module.

18. The Read All button reads all of the current configurations from the active module.

19. The Submit button writes all changes to the active module.
20. The Set Defaults button restores the active module to factory default conditions.

The Command Set tab (Figure 17) allows specific commands to be written to the module.
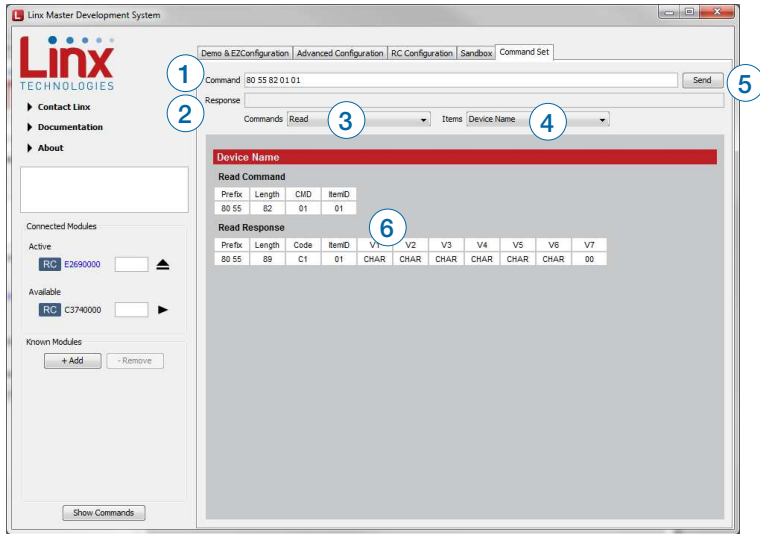

Figure 17: The Master Development System Software Command Set Tab

1. The Command box shows the hexadecimal values that are written to the module. Values can be typed into the box or a command can be selected from the Commands menu.
2. The Response box shows the hexadecimal values that are returned from the module in response to a command.
3. The Commands drop-down menu shows all of the commands that are available for the active module (Figure 18). Selecting one of the commands from this menu automatically fills in the Command box. The values can be adjusted by typing in the box.
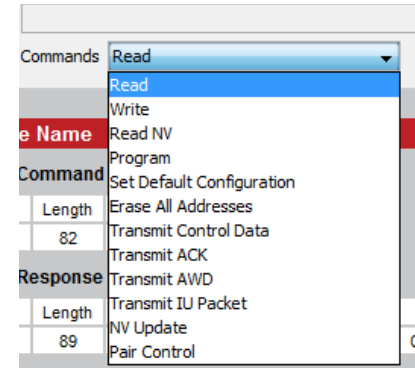

Figure 18: The Master Development System Software Demo Command Set Tab Commands Menu

4. The Items drop down menu displays all of the items that are available for the active module (Figure 19). Selecting one of the items from this menu automatically fills in the Command box. The values can be adjusted by typing in the box.
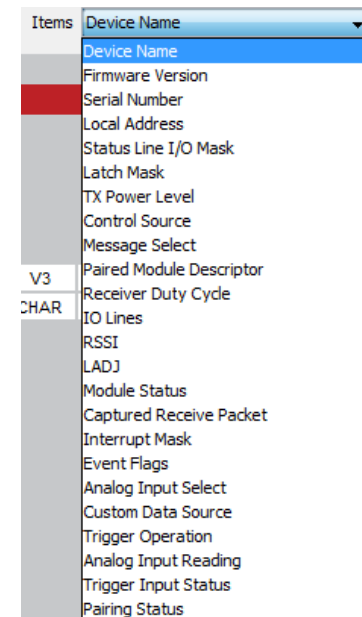

Figure 19: The Master Development System Software Demo Command Set Tab Items Menu

5. Clicking the Send button writes the values in the Command box to the module.
6. The structure of the selected command and its response is shown in the main window. Please see the HumRC™ Series Transceiver Command Data Interface Reference Guide for definitions of each value.

The Sandbox tab shows the interaction of all of the connected modules on one screen. Figure 20 shows two modules on the screen, but up to 8 modules can fit at one time.

Figure 20: The Master Development System Software Sandbox Tab

Clicking a button on one device causes the module to transmit control messages. Paired modules with appropriate Permissions Mask settings activate and their status is updated in the software. Paired modules that are not connected to the PC can activate a module that is connected and the connected module's status is reflected in the software.

The Sandbox is a convenient place to show the interaction of multiple units in one location, but it is a reflection of actual module operation. It is not a simulation.

The RC Configuration tab (Figure 21) allows configuration of the module's advanced remote control features.
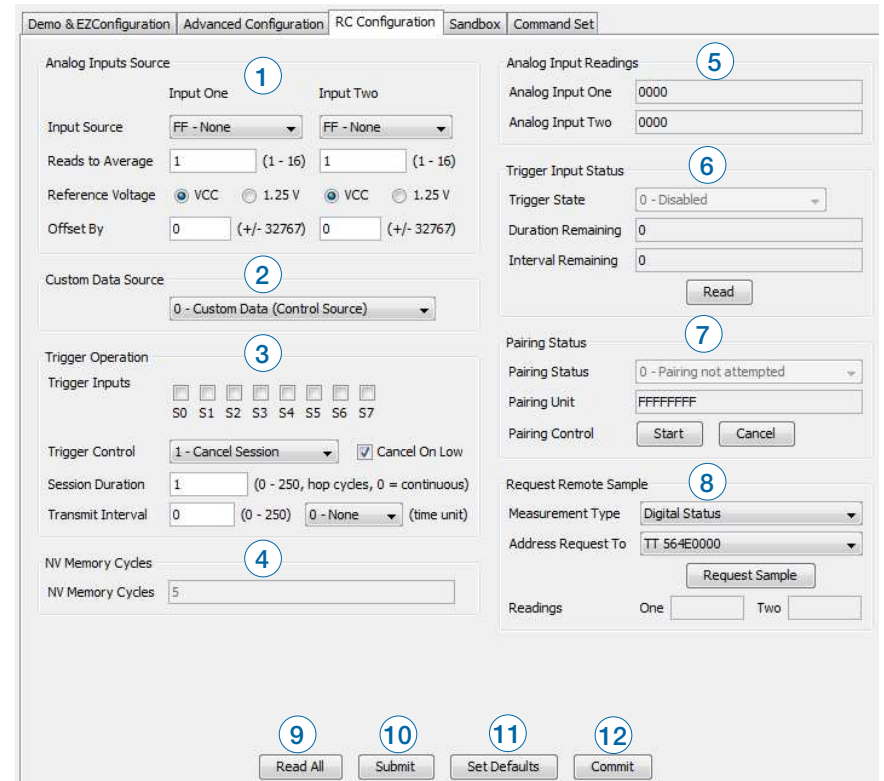

Figure 21: The Master Development System Software RC Configuration Tab

1.   The Analog Inputs Source area configures which lines are analog inputs, the number of readings to average, the reference voltage and the offset for each channel.
2.   The Custom Data Source menu sets the source of custom data transmitted with each IU message.
3.   The Trigger Operation area configures which lines are triggered inputs, their type of control, session duration and transmit interval.
4.   The NV Memory Cycles show how many times data has been written to the module's non-volatile memory. The module is capable of approximately 1,000 writes to NV memory before it wears out. This count gives an indication of how many more times the module can be written.
5.   The Analog Input Readings show the current analog measurements.
6.   The Trigger Input Status shows the current states of the trigger lines.

7. The Pairing Status area shows the current status of any pairing operations.

8. The request Remote Sample configures the module to request a response from a remote unit. This area configures the type of sample that should be in the response and the address of the unit that should respond.

9. The Read All button reads all of the current configurations from the active module.

10. The Submit button writes all changes to the active module.

11. The Set Defaults button restores the active module to factory default conditions.

12. The Commit button writes any changed configurations to non-volatile memory. The changes should be written to the module using the Submit button first, then the Commit button is used to make the changes permanent.

Development Kit Demonstration Software Example

This example shows how to configure two modules to work with each other. The software defaults to the Demo & EZConfiguration tab when opened (Figure 22).
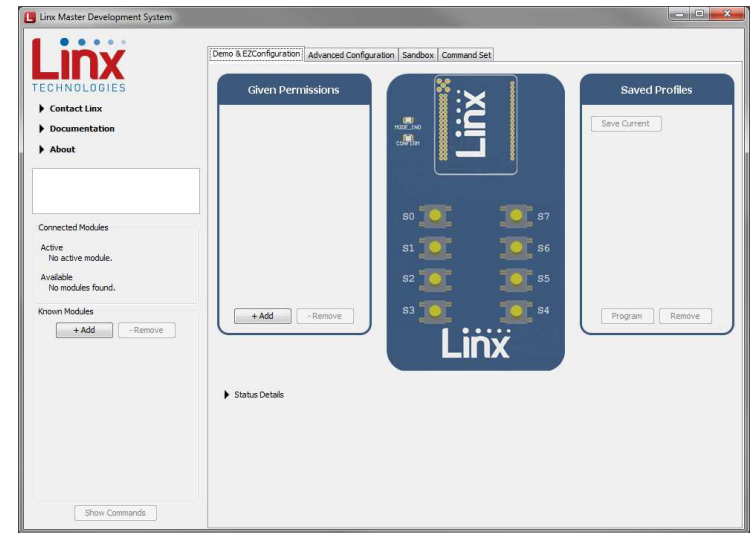

Figure 22: The Master Development System Software Demo and EZConfiguration Tab

Install Carrier Boards onto the Programming Docks and plug a USB cable between the Programming Docks and the PC. The software automatically detects attached devices. The first module that is identified appears under the Active label. This is the module that is actively controlled by the software. Subsequent modules are listed under the Available label as shown in Figure 23.
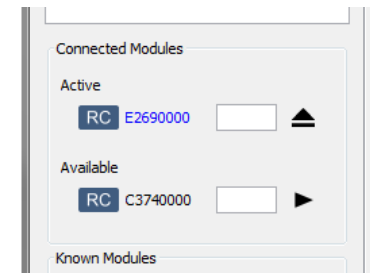

Figure 23: The Master Development System Software Connected Modules

Modules must be paired with the active device. This is accomplished by dragging modules from the Available or Known Modules lists to the Given Permissions window as shown in Figure 24.

Figure 24: The Master Development System Software Pairing Modules

Once the module is dropped into the Given Permissions window it is written to the active module's memory. Clicking on the down arrow displays the paired module's Permissions Mask. This configures which output lines the paired module is authorized to control. In Figure 25 the Permissions are inactive since the active module only has inputs and no outputs to control.

Figure 25: The Master Development System Software Paired Modules

Changing the active module is accomplished by dragging a module from the Available list to the Active spot, as shown in Figure 26.
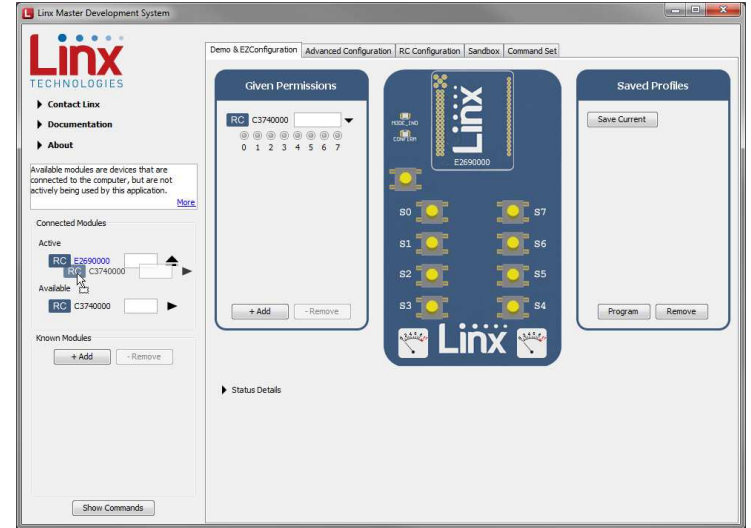

Figure 26: The Master Development System Software Changing the Active Module

With the new module active, drag the original module to the Given Permissions window. Click on the Advanced Configuration tab (Figure 27).
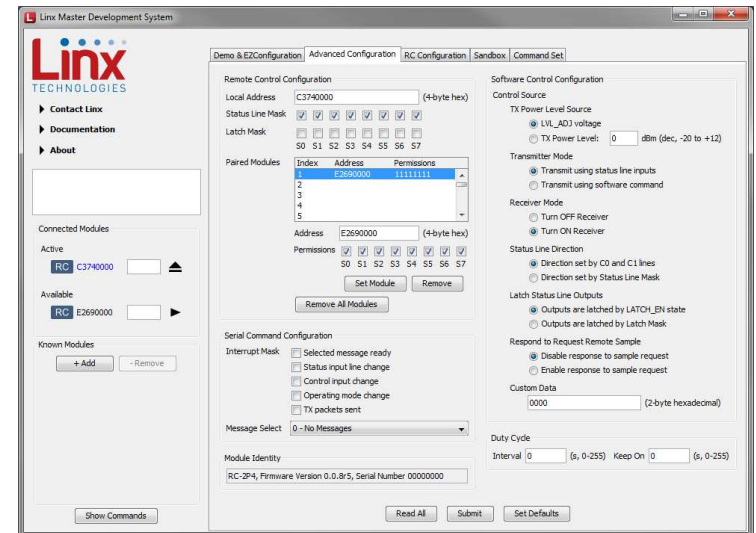

Figure 27: The Master Development System Software Advanced Configuration

This tab shows the advanced configurations enabled by the module's Command Data Interface. Any changes are highlighted in red. In the example in Figure 28 the output mask has been changed to all inputs, S0 is latched, the Paired module is given full permissions, the status line direction is set by the mask and the outputs are latched by the Latch Mask. Clicking the Set Module button sets the updated Permissions Mask. Clicking the Submit button writes all of the changes to the module's memory.
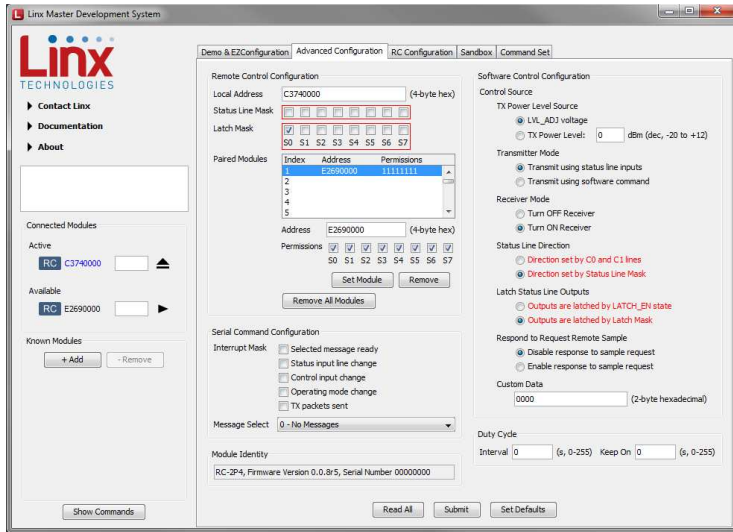

Figure 28: The Master Development System Software Advanced Configuration with Changes

This configuration changes the module to have all outputs. This is shown by clicking on the Demo & EZConfiguration tab Figure 29.
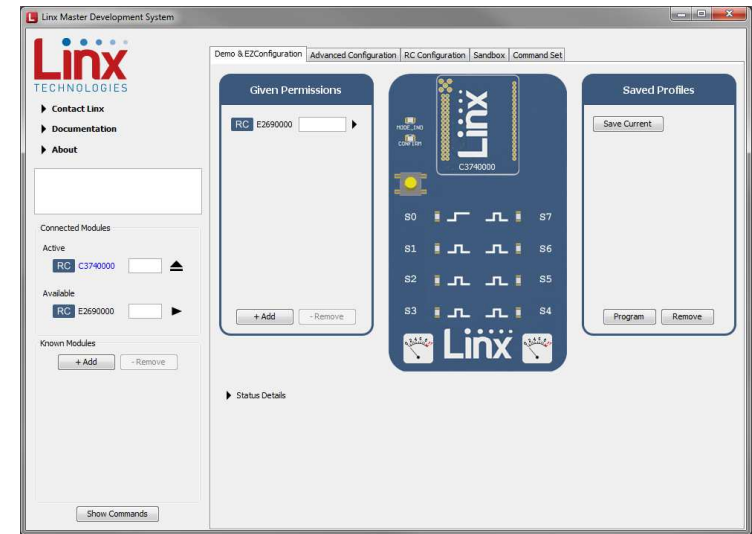

Figure 29: The Master Development System Software Demo and EZConfiguration Tab with Changes

The buttons have all changed to LEDs. The symbol next to each LED indicates if it is latching or momentary (Figure 30). S0 is latching, the rest are momentary.

Figure 30: The Master Development System Software Latching (1) and Momentary (2) Symbols

Now that the modules are configured their use can be demonstrated. Clicking a button on the transmitter module activates an LED on the receiving module. Figure 31 shows the transmitter, Figure 32 shows the receiver.

Figure 31: The Master Development System Software Transmitting Module

Figure 32: The Master Development System Software Receiving Module

Full system operation is demonstrated by clicking on the Sandbox tab (Figure 33).

Figure 33: The Master Development System Software Sandbox

These configurations can be saved as a profile for recalling or programming into other modules. The Demo & EZConfiguration tab has the profile window (Figure 34).
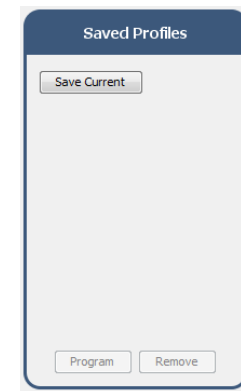

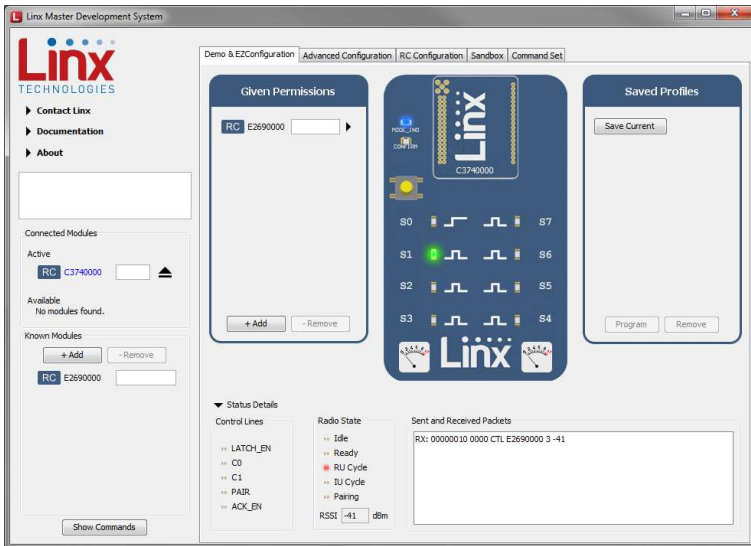Figure 34: The Master Development System Software Saved Profiles Window

Clicking the Save Current button brings up a prompt asking for a name of the profile (Figure 35).

Figure 35: The Master Development System Software Save Profile
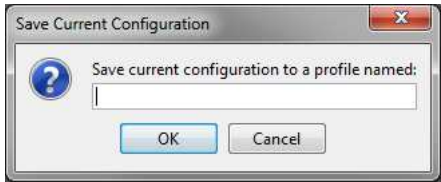
Once saved, the profile appears in the window, as shown in Figure 36.

Figure 36: The Master Development System Software with a Saved Profile

To apply a profile, select it from a list and click the Program button. Clicking the Remove button removes it from the list.

Carrier Board Schematic
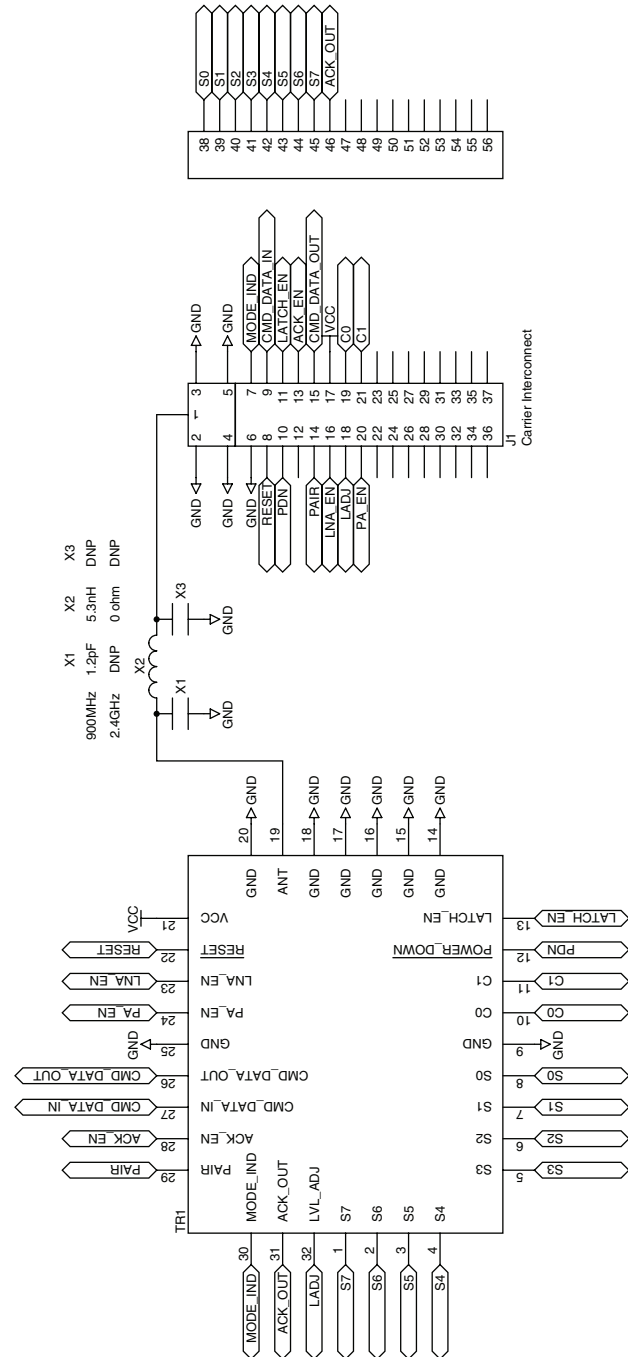
Figure 37: HumRC™ Series Transceiver Carrier Board Module Schematic

Remote Control Demo Board Schematic

> **Note:** The Remote Control Demo boards are designed to accept carrier boards for multiple module families. Some circuitry is not applicable for some modules.
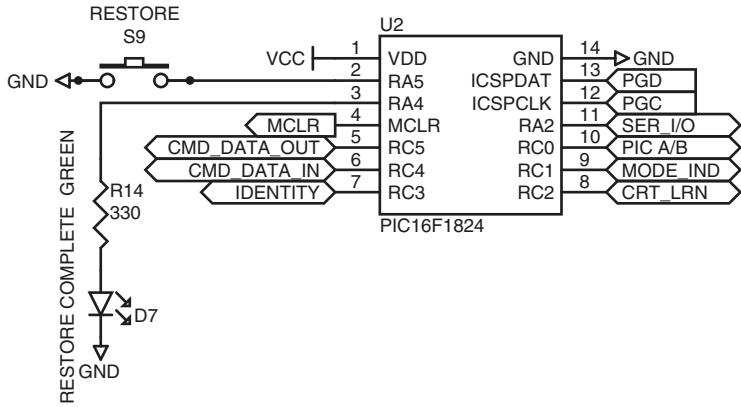
Figure 38: Remote Control Demo Board Microcontroller Area Schematic

Figure 39: Remote Control Demo Board Power Supply Area Schematic

Figure 40: Remote Control Demo Board RF Carrier Area Schematic

Figure 41: Remote Control Demo Board Remote Control Area Schematic

Figure 42: Remote Control Demo Board Miscellaneous Circuits Schematic

Programming Dock Board Schematic
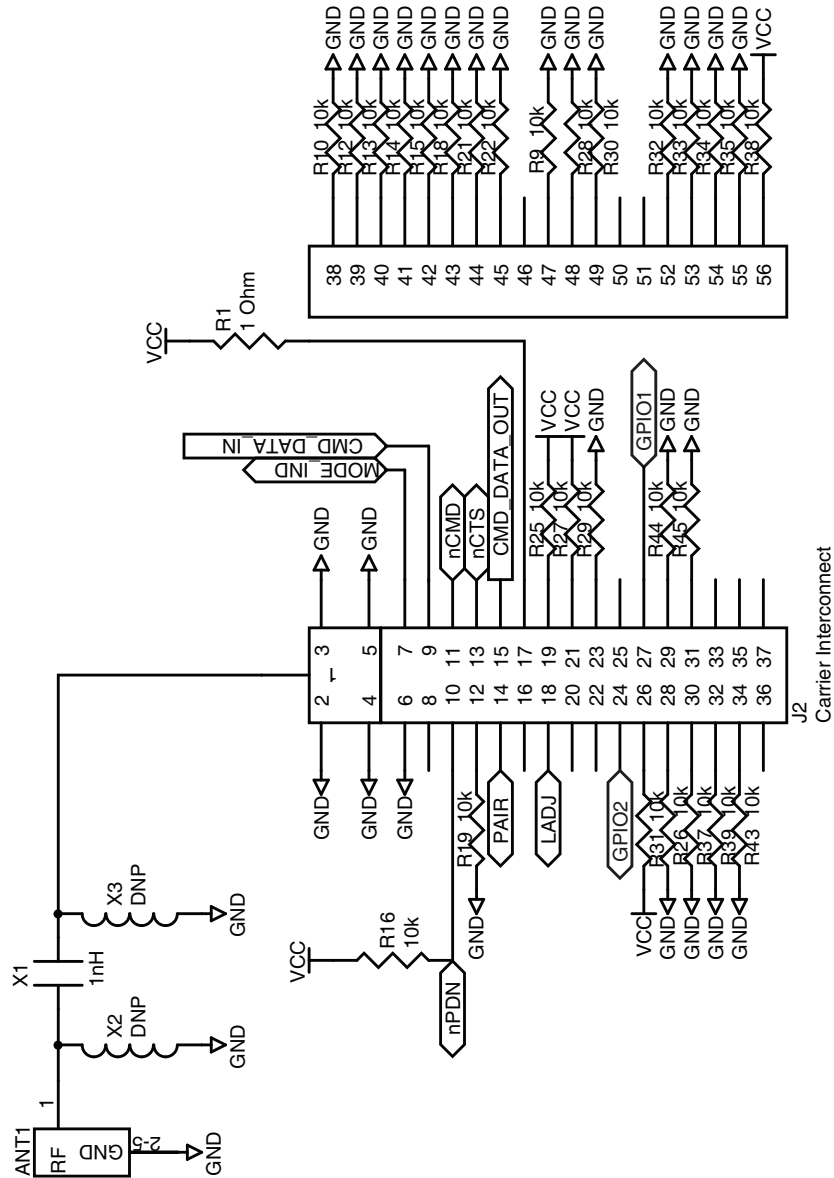
Figure 43: Programming Dock Board RF Carrier Area Schematic

Figure 44: Programming Dock Board Power Supply Area Schematic

Figure 45: Programming Dock Board Signal Routing Schematic

Figure 47: Programming Dock Board Microcontroller Area Schematic

Figure 46: Programming Dock Board USB Area Schematic

Prototype Board Schematic
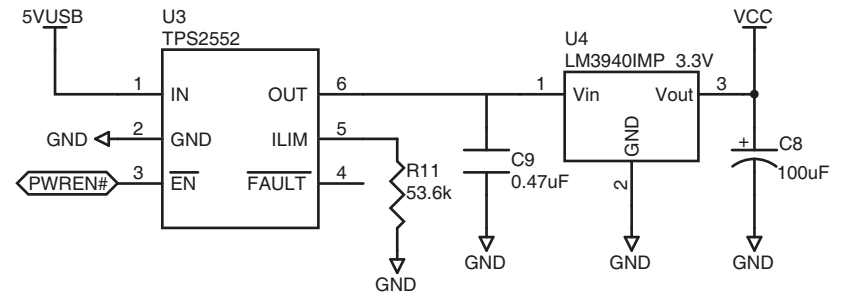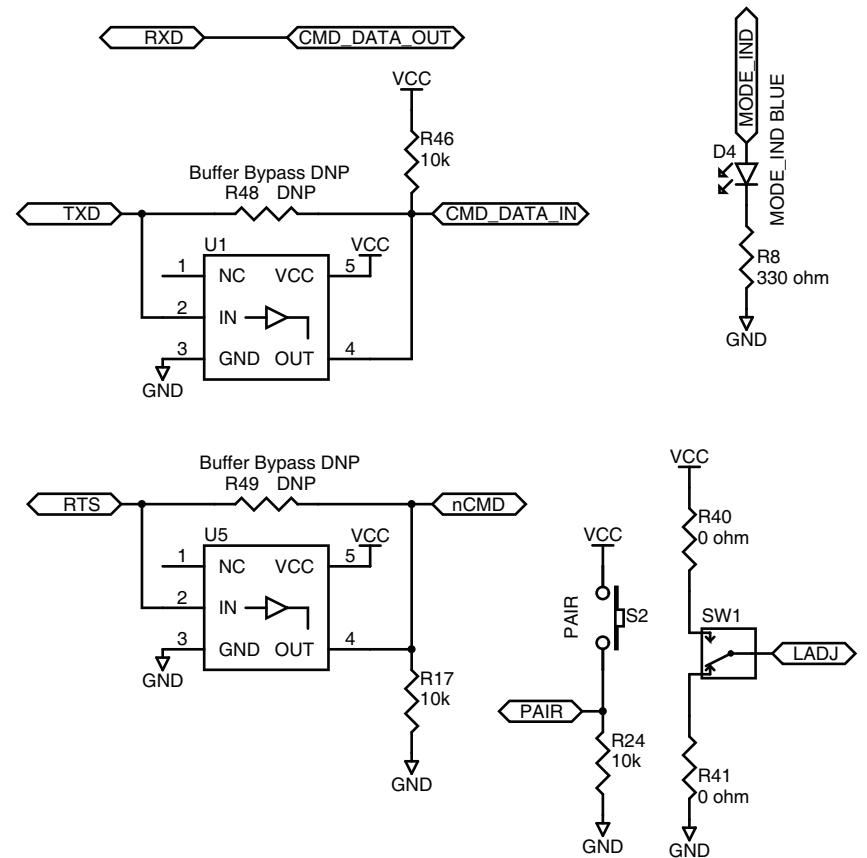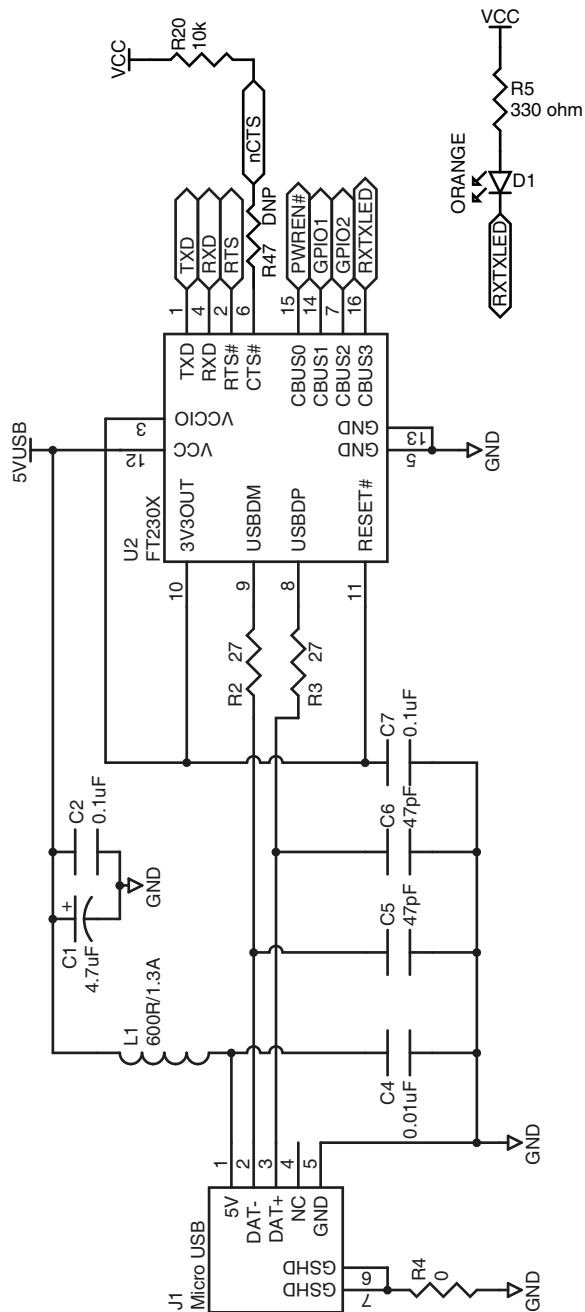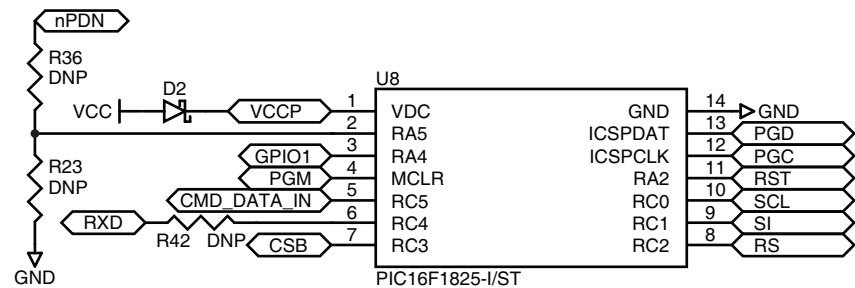
Figure 48: Prototype Board Power Supply Area Schematic

Figure 49: Prototype Board RF Carrier Area Schematic

Figure 50: Prototype Board USB Area Schematic

VCC

C9
0.1uF
→GND

TXD RXD RTS CTS

TP1
VCC BUS
1 2 3 4

J4
100mil Header

J6
100mil Header

PROTOTYPE
AREA

J5
100mil Header

GND ◄ R6 DNP
VCC ├ R8 DNP
VCC ├ R10 DNP
GND ◄ R11 DNP
GND ◄ R12 DNP
VCC ├ R13 DNP
GND ◄ R14 DNP

VCC
R15
DNP

R18
DNP

GND

GND ◄ R16 DNP
VCC ├ R17 0 ohm

GND ◄ R19 DNP
GND ◄ R20 DNP
GND ◄ R21 DNP

GND ◄ R23 DNP

VCC ├ R26 DNP

GND ◄ R28 DNP
VCC ├ R29 DNP
GND ◄ R30 DNP
GND ◄ R31 DNP

J5 pins	
6	1
7	2
8	3
9	4
10	5
11	6
12	7
13	8
14	9
15	10
16	11
17	12
18	13
19	14
20	15
21	16
22	17
23	18
24	19
25	20
26	21
27	22
28	23
29	24
30	25
31	26

J4	
1	32
2	33
3	34
4	35
5	36
6	37
7	38
8	39
9	40
10	41
11	42
12	43
13	44
14	45

R32 DNP →GND
R34 DNP →GND
R35 DNP →GND
R38 DNP →GND
R39 DNP →GND
R40 DNP →GND
R41 DNP →GND
R42 DNP →GND
R43 DNP →GND
R44 DNP →GND
R45 DNP →GND

J7
100mil Header

J7	
1	46
2	47
3	48
4	49
5	50
6	51
7	52
8	53
9	54
10	55
11	56

R47 DNP →GND
R48 DNP →GND
R49 DNP →GND
R50 DNP →GND
R52 DNP →GND
R53 DNP →GND
R54 DNP →GND
R55 DNP →GND
R56 DNP ├VCC

GND ◄ TP2 1   GND BUS   1 →GND TP3

Notes

Linx Technologies
159 Ort Lane
Merlin, OR, US 97532

Phone: +1 541 471 6256
Fax: +1 541 471 6251

www.linxtechnologies.com

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