



FreeWave Technologies, Inc.

**1.47 – 1.432 GHz
User Manual Addendum
(LRS-140CSU)**

FreeWave Technologies, Inc. products may be subject to control by the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR). Export, re-export, or transfer of these products without required authorization from the U.S. Department of Commerce, Bureau of Industry and Security, or the U.S. Department of State, Directorate of Defense Trade Controls, as applicable, is prohibited. Any party exporting, re-exporting or transferring FreeWave products is responsible for obtaining all necessary U.S. government authorizations required to ensure compliance with these and other applicable U.S. laws. Consult with your legal counsel for further guidance.

Safety Information



Warning! Do not remove or insert diagnostics cable while circuit is live.

Warranty

FreeWave Technologies, Inc. warrants your FreeWave® Wireless Data Transceiver against defects in materials and manufacturing for a period of two years from the date of shipment, depend on model number. In the event of a Product failure due to materials or workmanship, FreeWave will, at its discretion, repair or replace the Product. For evaluation of Warranty coverage, return the Product to FreeWave upon receiving a Return Material Authorization (RMA) for evaluation of Warranty Coverage.

In no event will FreeWave Technologies, Inc., its suppliers, or its licensors be liable for any damages arising from the use of or inability to use this Product. This includes business interruption, loss of business information, or other loss which may arise from the use of this Product. OEM customer's warranty periods can vary.

Warranty Policy will **not apply** in the following circumstances:

1. If Product repair, adjustments, or parts replacements are required due to accident, neglect, or undue physical, electrical, or electromagnetic stress.
2. If Product is used outside of FreeWave specifications as stated in the Product's data sheet.
3. If Product has been modified, repaired, or altered by Customer unless FreeWave specifically authorized such alterations in each instance in writing. This includes the addition of conformal coating.

Restricted Rights

Any product names mentioned in this manual may be trademarks or registered trademarks of their respective companies and are hereby acknowledged.

This manual is for use by purchasers and other authorized users of FreeWave products.

No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, or for any purpose without the express written permission of FreeWave Technologies, Inc. FreeWave reserves the right to make changes to this manual without notice. FreeWave assumes no responsibility or liability for the use of this manual or the infringement of any copyright or other proprietary right.

FreeWave products are designed and manufactured in the United States of America.

FreeWave Technologies, Inc.

Boulder, CO

Phone: 303.381.9200

Toll Free: 866.923.6168

Fax: 303.786.9948

www.FreeWave.com

Printed in the United States of America.

Copyright © 2012 by FreeWave Technologies, Inc. All rights reserved

The FreeWave Technologies LRS Family 1.427–1.432 GHz Licensed Radios operate in substantially the same manner as the 900 MHz and 2.4 GHz transceivers. They can be used in point to point and multipoint modes, with essentially the same parameter options.

UL Certification

LRS-140CSU:

“This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.”

“Warning – Explosion Hazard – Substitution of components may impair suitability for Class I, Division 2.”

The diagnostics port and cable do not have a latching connector and cannot be used in a hazardous location.

GENERAL:

The device covered by this Report is a wireless data transceiver. It must be installed in a suitable enclosure.

RATINGS:

Model LRS-140CSU is supplied by a NEC Class 2 Power Supply.
6 V dc to 30 V dc at 500 mA (Avg) @ 115.2K bd max.
The ambient rating is -20°C to 40°C.

Conditions of Acceptability – When installed in the end use equipment, the following considerations are to be examined:

1. The transceivers shall be mounted within an enclosure which is suitable for the intended application. The enclosure shall also have provisions for Division 2 wiring methods as specified in the National Electrical Code or Canadian Electrical Code, as applicable.
2. The transceivers must be used within their Recognized ratings and transmission rate.
3. Installations and use should be in accordance with the National Electrical Code or Canadian Electrical Code, as applicable.
4. The end product shall be marked with a warning for the end user indicating that changes to the baud rate may impair the safety characteristics for Class I, Division 2 Hazardous Locations.

5. The suitability of field wiring connections shall be determined in the end use application.
6. The devices were evaluated for use in 40°C ambient, use of these devices above 40°C may require additional testing.
7. The diagnostics port and cable do not have a latching connector and cannot be used in a hazardous location.

Quick Start on a Point-to-Multipoint System

The following is a quick start guide for setting up two transceivers in Point-to-Multipoint mode. This mode allows for a Master to communicate with several Slaves simultaneously. In addition to the Quick Start Guide, detailed instructions on how to set up the frequency and min and max packet sizes are also provided.

NOTE: The following is a step by step procedure for radio setup through HyperTerminal. The device may also be setup via EZConfig. When using EZConfig, please reference the tables in this procedure for proper radio configuration.

1. Connect the transceiver to the serial port of a computer either through a data cable (9 pin serial) or via the diagnostics cable.
2. Open up a HyperTerminal session.
 - Use the following settings in connecting with HyperTerminal
 - Connect to COMx (the COM port to which the cable is connected)
 - Set; Bits per second to **19200**, Data bits- **8**, Parity- **None**, Stop bits- **1**, Flow control- **None**.
3. Press the **setup** button next to the serial port on the radio. If the diagnostics cable is being used, press Shift-U (capital U).
 - The three lights on the board should all turn green, indicating Setup mode.
 - The main menu will appear on the screen.
4. Press **0** to get into the Operation Mode menu.
 - Press **2** to set the radio as a point to **Multipoint Master**.
 - Press **3** to set the radio as a point to **Multipoint Slave**.
 - Press **Esc** to get back to Main menu.
5. Press **1** in the main menu to change the Baud Rate.
 - The baud rate in setup mode will default to 19200.
 - The baud rate must be changed to match the baud rate of the device that the radio is attached to.
6. At the Main Menu, press **3**.
 - All of the following settings must be the same on all radios throughout the network.
 - FreqKey- This setting is discussed later in this manual.

- Max Packet Size-This setting is discussed later in this manual.
 - Min Packet Size- This setting is discussed later in this manual.
 - RF Data Rate- The LRS Licensed Radio can be configured to operate at one of two available throughputs. To adjust this setting, enter 4, RF Data Rate, in the Radio Parameters Menu. (Available settings are 2 or 3.)
 - For Maximum Throughput of **9.6 Kbps** at 2 Level GFSK, RF Data Rate= **3**.
 - For Maximum Throughput of **19.2 Kbps** at 4 Level GFSK, RF Data Rate=**2**.
7. At the Main Menu, press **5**.
- Number Repeaters should be set to **0**.
 - Set the Network ID value to any value between 1 and 4095, except 255.
 - Make sure this value is the same on every radio in the network.

Operation in Single Frequency Mode

Note: It is imperative that all transceivers used in a network are set to identical frequency parameters.

To set the frequency to be used, enter the Radio Parameters section of the transceiver setup from the Main Menu, as shown below:

```
(Esc) Exit to Main Menu
Enter Choice 0
Enter New Frequency Key (0-E) (F for more)0
                                RADIO PARAMETERS
WARNING: Do not change parameters without reading manual
(0) FreqKey           0
(1) Max Packet Size  8
(2) Min Packet Size  4
(3) Xmit Rate        1
(4) RF Data Rate     3
(5) RF Xmit Power    0
(6) Slave Security   1
(7) RTS to CTS       0
(8) Retry Time Out  255
(9) Lowpower Mode    0
(A) High Noise       0
(B) MCU Speed        2
(C) RemoteLED        0
(Esc) Exit to Main Menu
Enter Choice _
```

Editing the Hop Table

Enter 0 in the Radio Parameters section of the menu, corresponding to Frequency Key.

Next, enter F for more options.

1. Enter 0 to edit Hop Table.
2. Choose the Channel # to edit (0-63). The Channel # is the entry # in the Table for the value that represents the frequency being edited.
3. Choose the desired frequency from the table below, then enter the value associated with that frequency (4320-5280).

NOTE: If the desired frequency is not listed in the table below, use the following formula to determine the value to enter for that frequency:

Value= (Desired Frequency in MHz – 1400 MHz) / 0.00625

Example: To determine the Value for the frequency 1.427.0125 MHz:

Value= (1427.0125 MHz – 1400 MHz) / 0.00625

Value= 27.0125 / 0.00625

Value= 4322

Enter the value 4322 to use the frequency 1.4270125 GHz

1.427-1.432 GHz Frequency Table

VALUE	FREQ MHz	FREQ GHz	VALUE	FREQ MHz	FREQ GHz
4320	1427.000	1.427000	4356	1427.225	1.427225
4324	1427.025	1.427025	4360	1427.250	1.427250
4328	1427.050	1.427050	4364	1427.275	1.427275
4332	1427.075	1.427075	4368	1427.300	1.427300
4336	1427.100	1.427100	4372	1427.325	1.427325
4340	1427.125	1.427125	4376	1427.350	1.427350
4344	1427.150	1.427150	4380	1427.375	1.427375
4348	1427.175	1.427175	4384	1427.400	1.427400
4352	1427.200	1.427200	4388	1427.425	1.427425

VALUE	FREQ MHz	FREQ GHz	VALUE	FREQ MHz	FREQ GHz
4392	1427.450	1.427450	4584	1428.650	1.428650
4396	1427.475	1.427475	4588	1428.675	1.428675
4400	1427.500	1.427500	4592	1428.700	1.428700
4404	1427.525	1.427525	4596	1428.725	1.428725
4408	1427.550	1.427550	4600	1428.750	1.428750
4412	1427.575	1.427575	4604	1428.775	1.428775
4416	1427.600	1.427600	4608	1428.800	1.428800
4420	1427.625	1.427625	4612	1428.825	1.428825
4424	1427.650	1.427650	4616	1428.850	1.428850
4428	1427.675	1.427675	4620	1428.875	1.428875
4432	1427.700	1.427700	4624	1428.900	1.428900
4436	1427.725	1.427725	4628	1428.925	1.428925
4440	1427.750	1.427750	4632	1428.950	1.428950
4444	1427.775	1.427775	4636	1428.975	1.428975
4448	1427.800	1.427800	4640	1429.000	1.429000
4452	1427.825	1.427825	4644	1429.025	1.429025
4456	1427.850	1.427850	4648	1429.050	1.429050
4460	1427.875	1.427875	4652	1429.075	1.429075
4464	1427.900	1.427900	4656	1429.100	1.429100
4468	1427.925	1.427925	4660	1429.125	1.429125
4472	1427.950	1.427950	4664	1429.150	1.429150
4476	1427.975	1.427975	4668	1429.175	1.429175
4480	1428.000	1.428000	4672	1429.200	1.429200
4484	1428.025	1.428025	4676	1429.225	1.429225
4488	1428.050	1.428050	4680	1429.250	1.429250
4492	1428.075	1.428075	4684	1429.275	1.429275
4496	1428.100	1.428100	4688	1429.300	1.429300
4500	1428.125	1.428125	4692	1429.325	1.429325
4504	1428.150	1.428150	4696	1429.350	1.429350
4508	1428.175	1.428175	4700	1429.375	1.429375
4512	1428.200	1.428200	4704	1429.400	1.429400
4516	1428.225	1.428225	4708	1429.425	1.429425
4520	1428.250	1.428250	4712	1429.450	1.429450
4524	1428.275	1.428275	4716	1429.475	1.429475
4528	1428.300	1.428300	4720	1429.500	1.429500
4532	1428.325	1.428325	4724	1429.525	1.429525
4536	1428.350	1.428350	4728	1429.550	1.429550
4540	1428.375	1.428375	4732	1429.575	1.429575
4544	1428.400	1.428400	4736	1429.600	1.429600
4548	1428.425	1.428425	4740	1429.625	1.429625
4552	1428.450	1.428450	4744	1429.650	1.429650
4556	1428.475	1.428475	4748	1429.675	1.429675
4560	1428.500	1.428500	4752	1429.700	1.429700
4564	1428.525	1.428525	4756	1429.725	1.429725
4568	1428.550	1.428550	4760	1429.750	1.429750
4572	1428.575	1.428575	4764	1429.775	1.429775
4576	1428.600	1.428600	4768	1429.800	1.429800
4580	1428.625	1.428625	4772	1429.825	1.429825

VALUE	FREQ MHz	FREQ GHz	VALUE	FREQ MHz	FREQ GHz
4776	1429.850	1.429850	4968	1431.050	1.431050
4780	1429.875	1.429875	4972	1431.075	1.431075
4784	1429.900	1.429900	4976	1431.100	1.431100
4788	1429.925	1.429925	4980	1431.125	1.431125
4792	1429.950	1.429950	4984	1431.150	1.431150
4796	1429.975	1.429975	4988	1431.175	1.431175
4800	1430.000	1.430000	4992	1431.200	1.431200
4804	1430.025	1.430025	4996	1431.225	1.431225
4808	1430.050	1.430050	5000	1431.250	1.431250
4812	1430.075	1.430075	5004	1431.275	1.431275
4816	1430.100	1.430100	5008	1431.300	1.431300
4820	1430.125	1.430125	5012	1431.325	1.431325
4824	1430.150	1.430150	5016	1431.350	1.431350
4828	1430.175	1.430175	5020	1431.375	1.431375
4832	1430.200	1.430200	5024	1431.400	1.431400
4836	1430.225	1.430225	5028	1431.425	1.431425
4840	1430.250	1.430250	5032	1431.450	1.431450
4844	1430.275	1.430275	5036	1431.475	1.431475
4848	1430.300	1.430300	5040	1431.500	1.431500
4852	1430.325	1.430325	5044	1431.525	1.431525
4856	1430.350	1.430350	5048	1431.550	1.431550
4860	1430.375	1.430375	5052	1431.575	1.431575
4864	1430.400	1.430400	5056	1431.600	1.431600
4868	1430.425	1.430425	5060	1431.625	1.431625
4872	1430.450	1.430450	5064	1431.650	1.431650
4876	1430.475	1.430475	5068	1431.675	1.431675
4880	1430.500	1.430500	5072	1431.700	1.431700
4884	1430.525	1.430525	5076	1431.725	1.431725
4888	1430.550	1.430550	5080	1431.750	1.431750
4892	1430.575	1.430575	5084	1431.775	1.431775
4896	1430.600	1.430600	5088	1431.800	1.431800
4900	1430.625	1.430625	5092	1431.825	1.431825
4904	1430.650	1.430650	5096	1431.850	1.431850
4908	1430.675	1.430675	5100	1431.875	1.431875
4912	1430.700	1.430700	5104	1431.900	1.431900
4916	1430.725	1.430725	5108	1431.925	1.431925
4920	1430.750	1.430750	5112	1431.950	1.431950
4924	1430.775	1.430775	5116	1431.975	1.431975
4928	1430.800	1.430800	5120	1432.000	1.432000
4932	1430.825	1.430825			
4936	1430.850	1.430850			
4940	1430.875	1.430875			
4944	1430.900	1.430900			
4948	1430.925	1.430925			
4952	1430.950	1.430950			
4956	1430.975	1.430975			
4960	1431.000	1.431000			
4964	1431.025	1.431025			

Programming Single Frequency Mode

To operate the transceiver in single frequency mode enter a 0 in the Radio Parameters section of the menu, corresponding to Frequency Key.

Next, enter F for more.

1. Enter 1 to program the transceiver to operate in single frequency mode.
2. When prompted enter the number of the frequency to be used:
Enter New Frequency Channel (0-63).
3. Once the single frequency has been entered it will appear at the bottom of the table as the Single Channel being used. In addition, the FreqKey in the Radio Parameters menu will now be programmed as Single Channel. As shown below.

In this example, the radio is programmed to transmit and receive at Frequency 1.430781 GHz. This is understood because the Single Channel being used is 45. Channel 45 has a value of 4925. $4925 = 1.430781 \text{ GHz}$.

```

WARNING: Do not change parameters without reading manual
(0) FreqKey          Single Channel ←
(1) Max Packet Size 8
(2) Min Packet Size 4
(3) Xmit Rate       1
(4) RF Data Rate    3
(5) RF Xmit Power   0
(6) Slave Security  1
(7) RTS to CTS     0
(8) Retry Time Out 255
(9) Lowpower Mode   0
(A) High Noise      0
(B) MCU Speed       2
(C) RemoteLED      0
(Esc) Exit to Main Menu

Enter Choice 0
Enter New Frequency Key (0-E) (F for more)f
 0 04880 16 04896 32 04912 48 04928
 1 04881 17 04897 33 04913 49 04929
 2 04882 18 04898 34 04914 50 04930
 3 04883 19 04899 35 04915 51 04931
 4 04884 20 04900 36 04916 52 04932
 5 04885 21 04901 37 04917 53 04933
 6 04886 22 04902 38 04918 54 04934
 7 04887 23 04903 39 04919 55 04935
 8 04888 24 04904 40 04920 56 04936
 9 04889 25 04905 41 04921 57 04937
10 04890 26 04906 42 04922 58 04938
11 04891 27 04907 43 04923 59 04939
12 04892 28 04908 44 04924 60 04940
13 04893 29 04909 45 04925 61 04941
14 04894 30 04910 46 04926 62 04942
15 04895 31 04911 47 04927 63 04943

Hop Table Size 36
Single Channel Uses 45 ←
Enter 0 To Edit Hop Table,1 For Single Freq,2 For Number of Hopping Channels_

```

Min/Max Packet Sizes

Min/Max Packet Sizes allow the user to designate the size in bytes of the packets used by the transceiver in its communication link. This may be of particular value when using FreeWave with different communications software packages. In addition, packet sizes should be changed for every network, especially when overlapping or adjacent networks are installed.

The combination of Max and Min Packet Size settings determines the allocation of the communication link from the Master to the Slave and vice versa. With a given Max Packet Setting the Master will transmit up to that number of bytes on every hop.

If fewer than that number of bytes is transmitted the balance is allocated to the Slave's transmission, in addition to the quantity in the Min Packet Size Setting.

Packet size is determined by a combination of the settings entered by the user and RF Data Rate. The following tables provide the packet sizes for each different combination of settings.

In the Radio Parameters menu, enter the Min Packet size (0-F), Max Packet size (0-F), and the RF Data Rate (2 or 3). Please see the following tables to determine min and max packet sizes and RF Data Rate to be used based on the number of bytes of data being transmitted.

PLEASE NOTE: the invalid settings as indicated by "xxxx" on the tables.

For example, if the Minimum Packet Size is set to 7, Maximum Packet Size to 6, and the RF Data Rate to 3, the radio would be transmitting 110 bytes per hop. Refer to Table 1; a Min Packet size of 7 and RF Data Rate of 3 shows a minimum packet size of 38 bytes per slot. Next, refer to Table 3. A Max Packet size of 6 and RF Data Rate of 3, shows a maximum 72 bytes per slot. This gives a total of 110 bytes per slot.

The following lists the Min Packet size settings by bytes when the RF Data Rate equals 2 and 3.

Setting	Min Packet Size RF Data Rate= 2	Min Packet Size RF Data Rate= 3
0	36	18
1	41	20
2	47	23
3	53	26
4	59	29
5	64	32
6	70	35
7	76	38
8	81	40
9	87	43
A	93	46
B	98	49
C	104	52
D	110	55
E	115	57
F	121	60

Table 1

The following lists the Max Packet size settings by bytes when the RF Data Rate equals 2. RF data rate of 2 is currently not supported.

Max Packet Size											
Min Packet Size	0	1	2	3	4	5	6	7	8	9	A
0	36	47	59	70	81	93	104	115	127	138	XXXX
1	41	53	64	76	87	98	110	121	132	144	XXXX
2	47	59	70	81	93	104	115	127	138	XXXX	XXXX
3	53	64	76	87	98	110	121	132	144	XXXX	XXXX
4	59	70	81	93	104	115	127	138	XXXX	XXXX	XXXX
5	64	76	87	98	110	121	132	144	XXXX	XXXX	XXXX
6	70	81	93	104	115	127	138	XXXX	XXXX	XXXX	XXXX
7	76	87	98	110	121	132	144	XXXX	XXXX	XXXX	XXXX
8	81	93	104	115	127	138	XXXX	XXXX	XXXX	XXXX	XXXX
9	87	98	110	121	132	144	XXXX	XXXX	XXXX	XXXX	XXXX
A	93	104	115	127	138	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
B	98	110	121	132	144	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
C	104	115	127	138	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
D	110	121	132	144	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
E	115	127	138	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
F	121	132	144	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Table 2

The following lists the Max Packet size settings by bytes when the RF Data equals 3.

Max Packet Size											
Min Packet Size	0	1	2	3	4	5	6	7	8	9	A
0	18	23	29	35	40	46	52	57	63	69	XXXX
1	20	26	32	38	43	49	55	60	66	72	XXXX
2	23	29	35	40	46	52	57	63	69	XXXX	XXXX
3	26	32	38	43	49	55	60	66	72	XXXX	XXXX
4	29	35	40	46	52	57	63	69	XXXX	XXXX	XXXX
5	32	38	43	49	55	60	66	72	XXXX	XXXX	XXXX
6	35	40	46	52	57	63	69	XXXX	XXXX	XXXX	XXXX
7	38	43	49	55	60	66	72	XXXX	XXXX	XXXX	XXXX
8	40	46	52	57	63	69	XXXX	XXXX	XXXX	XXXX	XXXX
9	43	49	55	60	66	72	XXXX	XXXX	XXXX	XXXX	XXXX
A	46	52	57	63	69	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
B	49	55	60	66	72	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
C	52	57	63	69	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
D	55	60	66	72	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
E	57	63	69	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX
F	60	66	72	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX

Table 3

Firmware Errata Notes:

- **Version 9.36C**
 - Point to Point repeaters not currently supported
 - Point to Multipoint repeaters not currently supported
 - Low Power mode not currently supported
 - RF Data Rate of 2 not currently supported