# FreeWave Technologies Inc.
# 1.427 – 1.432 GHz User Manual Addendum
# (LRS-140CSU)

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 | | | |

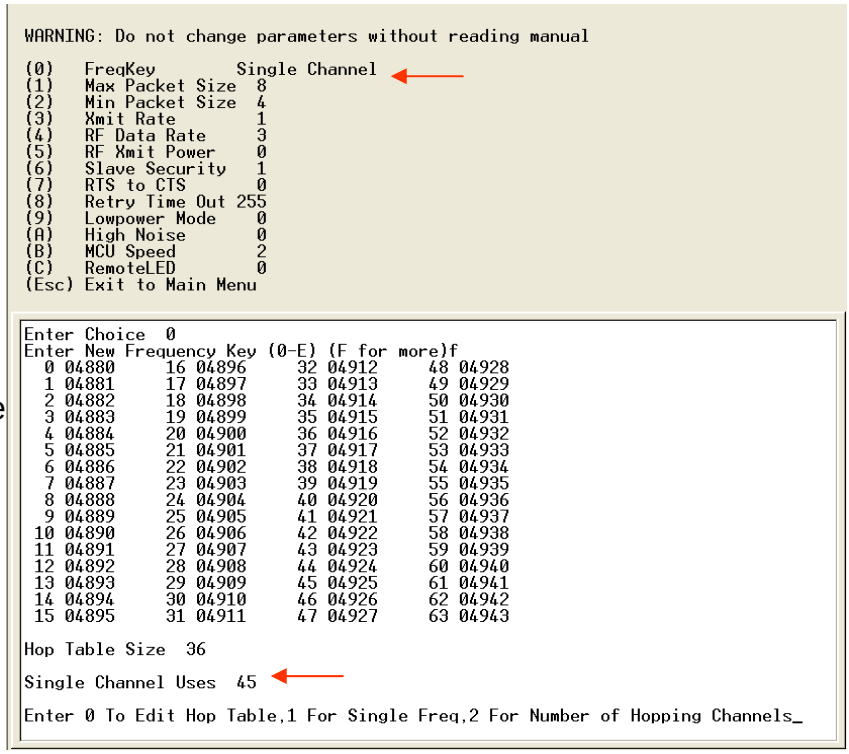
## Programming Single Frequency Mode

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 GHz.




## 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