



***BiStar***

**USA Frequency Hopping**



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## 1 General description.

The goal of the reader random generator is:

- To insure that each reader has its own random channel select pattern within the allowed frequency band.
- To provide a channel select method which is random in the short term but which has an even distribution of the channel usage over the longer term.
- To provide a channel dwell time of less than 400ms in any 20 second period.
- To operate over the frequency range of 902.2MHz up to 927.8MHz.
- Provide a channel spacing of 200kHz to allow for a selection of 128 different channels.

### 1.1. Random generator.

Considering the above, the MR-101 uses a Dual Random Generator configuration.

The first random generator is an 8-Bit Binary Feedback Shift Register. Figure 1 shows a hardware implementation of this random generator. This Random Generator will select unique channels randomly between channels 1 to channel 128. These 128 channels are stored in the reader non-volatile memory. (The channel spacing is 200kHz and the frequency is between 902.2 and 927.8MHz). The initial value in the shift register or seed is the reader unique electronic identification number.

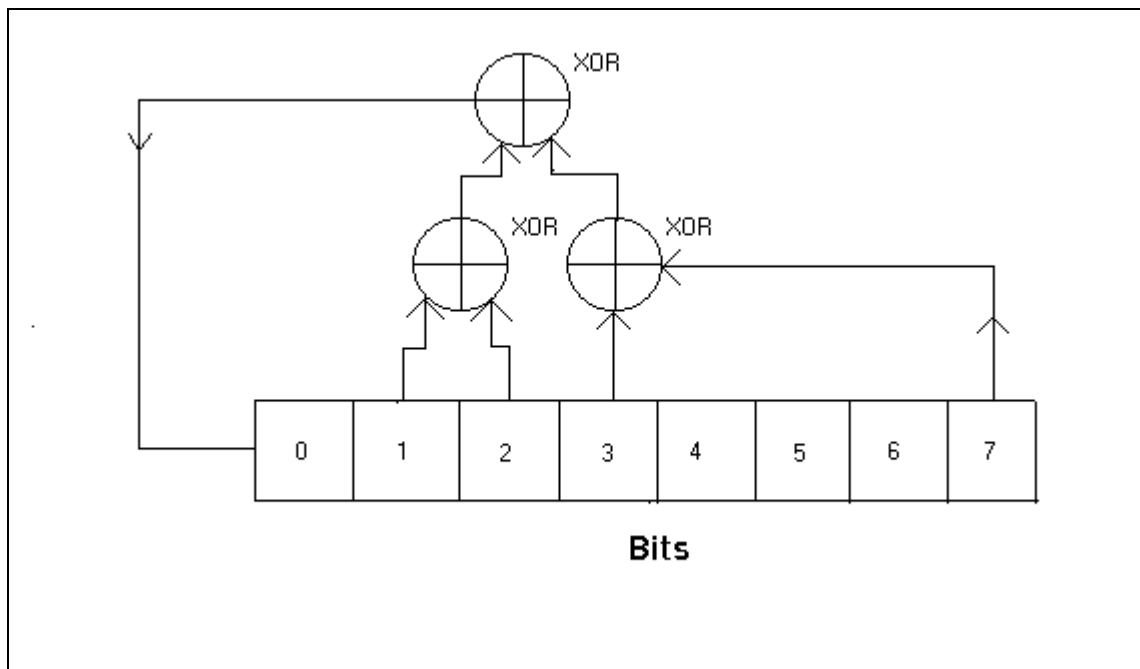


Figure 1



The second random generator is a Linear Congruential Generator with a mathematical expression of:

Seed = (Seed x 13) + 229. (8-Bit binary number).

Where seed is the reader unique electronic identification number that is converted to an 8-Bit binary number.

If seed is bigger than 255 then-

Seed = Seed – 255.

This Random Generator gives 255 unique random numbers. This random number is used as an address to point to the memory where the random numbers of the first Random Generator are stored. Only the values between 1 and 128 are used the rest are discarded.

## 1.2. Examples.

The following table gives the first ten channels selected by ten readers with an incremental seed value 1 to 10.

| Reader<br>Seed =<br>Reader<br>number | 1<br>Channel<br>Select | 2<br>Channel<br>Select | 3<br>Channel<br>Select | 4<br>Channel<br>Select | 5<br>Channel<br>Select | 6<br>Channel<br>Select | 7<br>Channel<br>Select | 8<br>Channel<br>Select | 9<br>Channel<br>Select | 10<br>Channel<br>Select |
|--------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|-------------------------|
| 1                                    | 92                     | 113                    | 95                     | 117                    | 105                    | 73                     | 96                     | 69                     | 98                     | 112                     |
| 2                                    | 1                      | 69                     | 53                     | 21                     | 9                      | 38                     | 44                     | 74                     | 122                    | 68                      |
| 3                                    | 29                     | 15                     | 55                     | 67                     | 22                     | 57                     | 114                    | 45                     | 7                      | 61                      |
| 4                                    | 117                    | 6                      | 109                    | 67                     | 9                      | 63                     | 53                     | 127                    | 46                     | 114                     |
| 5                                    | 107                    | 83                     | 6                      | 75                     | 45                     | 1                      | 69                     | 53                     | 21                     | 9                       |
| 6                                    | 10                     | 34                     | 35                     | 112                    | 84                     | 53                     | 79                     | 128                    | 5                      | 19                      |
| 7                                    | 113                    | 68                     | 25                     | 109                    | 44                     | 15                     | 105                    | 31                     | 119                    | 54                      |
| 8                                    | 114                    | 99                     | 123                    | 24                     | 98                     | 41                     | 59                     | 97                     | 47                     | 117                     |
| 9                                    | 76                     | 14                     | 10                     | 8                      | 121                    | 116                    | 38                     | 95                     | 13                     | 25                      |
| 10                                   | 27                     | 90                     | 32                     | 102                    | 100                    | 11                     | 121                    | 84                     | 128                    | 49                      |
|                                      |                        |                        |                        |                        |                        |                        |                        |                        |                        |                         |

The next example shows all 128 channels with the seed value set to 1. (Reader 1 in the table above).

92,113,95,117,105,73,96,69,98,112,3,114,50,7,65,66,79,36,22,77,15,78,13,16,10,33,119,128,54,29,9,104,75,81,86,18,59,37,63,87,116,107,71,124,14,32,46,68,24,51,122,67,53,88,64,49,90,82,60,39,41,48,28,76,4,108,72,56,111,19,45,115,44,100,102,126,120,27,103,110,40,21,20,2,26,62,106,61,101,70,97,38,99,80,47,84,8,94,109,93,57,52,121,30,31,55,42,89,118,85,17,58,12,1,35,91,11,5,83,43,125,34,25,127,23,123,6.

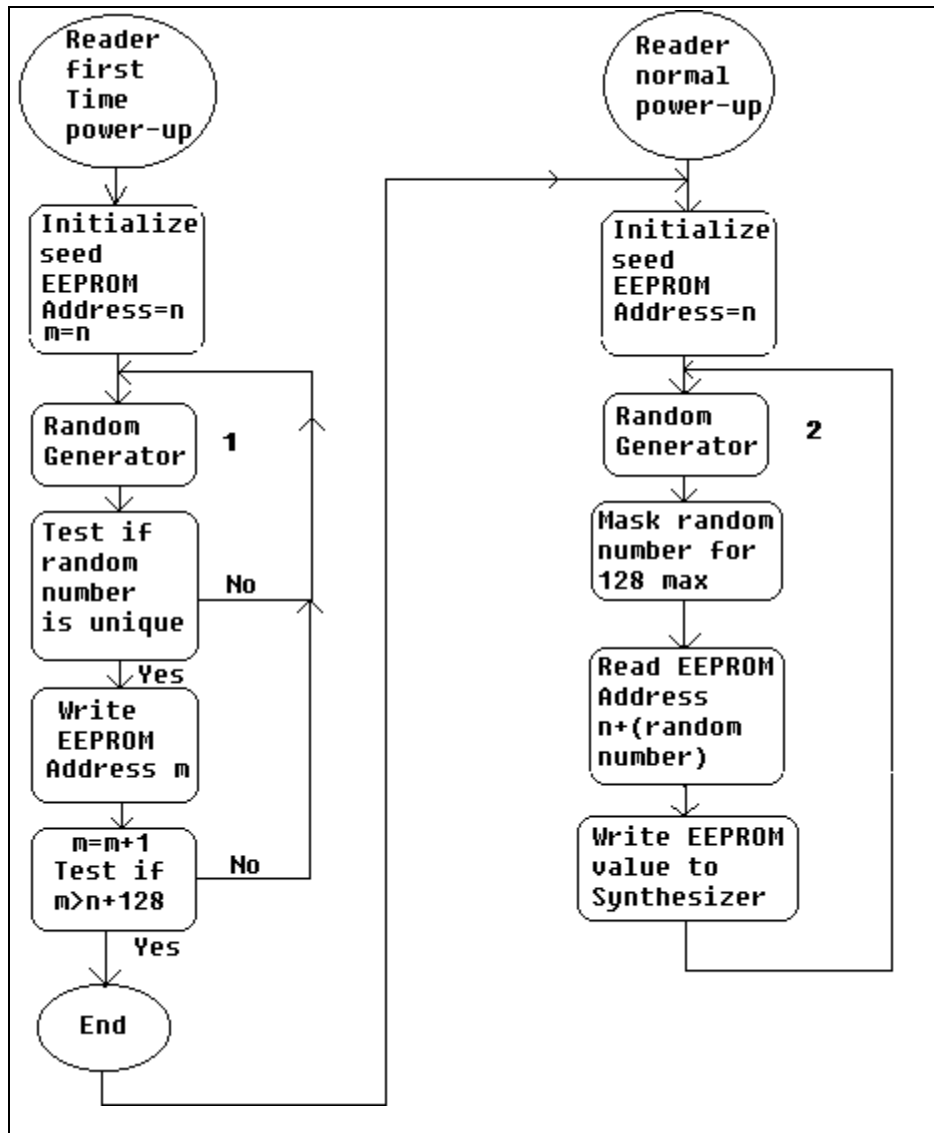


## 2 Flow diagram.

Below is a flow diagram of the random frequency hopping sequence.

**Random Generator 1** is an 8-Bit Binary Feedback Shift Register.

**Random Generator 2** is a Linear Congruential Generator.





### 3 Conclusion.

The random generator in the method above causes a unique random pattern for each reader with a unique seed value. The channel selection of each reader is random over the short term but because of the sequence being repeated in each reader, the channel distribution by any one reader has an equal distribution over the 128 channels.

The dwell on each channel is 0.38 Seconds with a re-visit interval of  $\pm 45$  Seconds.

The method above will provide 127 different random patterns for a seed value of 1 to 127.

If it is found that parts of the frequency band are un-usable or congested to the extent where it is undesirable to operate on those channels, then the number of hops may be reduced to any number more than 56 while retaining the desired spreading characteristics and while meeting the regulatory requirements.

End.