2. General Information

2.1 Product Description

The ITVERS Corporation Model ITV-R01T (referred to as the EUT in this report) is used to remote controller which has a function of nRF24XX. The product specification described herein was obtained from product data sheet or user's manual.

Equipment Name	RF 2.4GHz Wireless Remote
Operating Frequency	2402 MHz ~ 2478 MHz
RF Output Power	-1.33 dBm
Number of Channel	39 Channels
Mode of Operation	Duplex (Tx/RX)
Modulation Type	GFSK
Antenna Type / Gain	PCB Pattern Antenna /1.70dBi(Max)TX, -0.8dBi(Max)RX
List of Each OSC. Or Crystal. Freq.	16 MHz Crystal Oscillator
Rated Supply Voltage	DC 3.0 V

3. EUT MODIFICATION

- NONE.

4. Information about the FHSS characteristics

4.1 Pseudo Random Frequency hopping sequence

Nordic has developed Gazell, an RF protocol designed for efficiency, low power consumption and minimum latency. Gazell incorporates frequency agility technology; this employs a simplified frequency hopping scheme where the transmitting and receiving pair establish communication on a particular frequency and then only hop to a different frequency should interference be experienced.

The channel on which the interference was experienced is marked and not reused during that particular communication cycle

➔Frequency hopping in Gazell

In Gazell, the frequency hopping as seen on the air is completely determined by the Devices. The Host will for any frequency hopping policy on a Device still listen on all channels in turn, rotating through the complete channel table. The Host is configured in the same way for all Device modes, and does not even know a Device's synchronization mode or hopping policy.

A Device can select which channels to use and how often to use them. Different Devices can choose different channel hopping policies if wanted. The available channel selection policies are different for the asynchronous and semi-synchronous modes:

Channel selection policies in asynchronous mode

A Gazell Device in asynchronous mode can be set up with two channel selection policies:

-Frequency agility (FA)
-Frequency hopping spread spectrum (FHSS)

For the "frequency agility" policy, we first try the previous successful channel, assuming that this channel is still good. This is the channel that was used by the last acknowledged packet.
We will stay on this channel as long as it is good. In a quiet environment we will then very seldom change channel. If we do not succeed transmitting on the previous good channel, a pseudo-random channel is selected from the channel table.
For the "frequency hopping" policy we select a new pseudo-random channel from the channel

table each time. This gives us frequency hopping spread spectrum behavior. The transmitted radio power is then spread evenly among all channels in the channel table. This behavior is required by some radio regulations when transmitting at high power, as when using a power amplifier. If we do not succeed on the first random channel, a new pseudo-random channel is selected from the channel table.

Channel selection policies in semi-synchronous mode

A Gazell Device in semi-synchronous mode can be set up with three channel selection policies:

-Frequency agility (FA)

-Frequency hopping spread spectrum (FHSS)

-Low latency frequency hopping spread spectrum (smart FHSS)

For the first two policies the selection of the first channel to try is the same as in asynchronous mode. The difference lies in how the secondary channel choice is made.

In asynchronous mode, if the first channel choice in FA or FHSS mode fails, a pseudo-random channel will be tried. In synchronous mode, if the first channel choice in FA or FHSS mode fails, the estimated Host channel will be used instead. We have sync, so the Device knows the channel rotation at the Host, and just waits until the time slot for this channel comes up a the Host, before attempting to transmit. Details of Device channel selection and transmit operation are shown in the figure below.

The third policy - low latency frequency hopping, or smart FHSS - is only meaningful for a synchronized Device. With this policy the Device immediately starts transmitting at the channel that the Host is listening on. If the Device is still in sync with the Host, we will hit the correct timer the first time, reducing latency and saving power.

Frequency hopping spread spectrum is defined in the 2.4 GHz band and operates in around 39 frequencies ranging from 2.402 GHz to 2.478 GHz.
Every frequency is GFSK modulated with channel width of 2MHz and rates defined as 2 Mbps.

The frequency hopping code hops between 39 channels (channel 1 to channel 39) pseudo-randomly distributed in a 256-bytes constant table embedded in the code. The hopping functions as follows. Each time the transmitter sends a packet on a channel it starts waiting for an acknowledge packet (ACK) on the same channel.

If the ACK is received within a predefined time-out (3ms in this example) the transmitter selects the next channel in the hopping table and sends the next packet on the newly selected channel.

If an ACK is not received within the time-out period the packet is re-transmitted on the same channel. If this does not result in a valid ACK the transmitter hops to the next channel and repeats the procedure above.

This process is repeated until an ACK is received or a time-out (3 seconds in the demo applications) is reached and if the time-out is reached the function returns with an error.

For the Hop pattern of 2412MHz, 2414MHz, 2402MHz, 2406MHz ,24014MHz,
The sequential hops are +2MHz, -12MHz, +12MHz, +4MHz, +14MHz

You can use a channel number and it might look like channel 2,4,19,3,7,32,2,15,etc,etc.
These represent Channel numbers.

4.2 Equal Hopping Frequency Use

In normal operation, the initial pseudorandom list of frequency hopping locations is volatile in terms of the number of hopping frequencies in use and the sequence of which they occur. These elements combined result in an unpredictable hopping sequence with pseudorandom properties.

Hopping positions are used equally on average with even noise distribution in the band.