



Model: T7406 Cordless Phone

Technical Specification

Specifications
Circuit Diagrams
Technical Description

PROPRIETARY INFORMATION
NO DISSEMINATION OR USE ALLOWED
WITHOUT PRIOR WRITTEN PERMISSION

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I. Introduction

The T7406 Cordless Telephone is a frequency hopped spread spectrum transmitter to be compliance with US (FCC Part 15.247) and Canadian (RSS-210) regulations for license free use in the 902-928MHz ISM band. It can connect with most Nortel KSU to make the KSU has wireless capability.

The T7406 Cordless Telephone operates in the ISM (Industrial Scientific and Medical) band (903.479 ~ 925.421 MHz). The 20dB bandwidth of the hopping channels used in T7406 is greater than 250 KHz. And the number of hopping channels used in T7406 is 25. It complies with FCC part 15.247(a)(1)(i). The T7406 is a frequency hopper, it uses the full available frequencies in the ISM band for operation and can make it difficult for other 900MHz devices to operate correctly.

The 20dB bandwidth of the hopping channels is about 450 KHz and any two consecutive channels are separated by a bandwidth greater than 450 KHz. It complies with FCC part 15.247(a)(1).

The maximum power used in T7406 base station and handset are 130 mW and 20 mW respectively. It complies with FCC part 15.247(b)(2).

Each T7406 base station supports up to three handsets and uses Time Division Duplex to distinguish the three handsets.

II. Specifications

Operating Frequency Range:	903.479 ~ 925.421 MHz
Number of Used Channels:	25
RF Output Power:	20mW (Handset) / 130mW (Base)
Range:	110m/750m (In Door/Out Door)
Type of Spread Spectrum:	Frequency Hopped Spread Spectrum
Bandwidth of Channel:	≤ 500 KHz (It is 480 KHz.)
Channel Separation:	≥ 450 KHz (It is 620 KHz.)
Duplexing:	Time Division Duplex
Power Supply:	3.6 VDC (Handset) / 120VAC Adapter (Base)

III. Technical Description

1. General

The T7406 Cordless Telephone is a frequency hopped spread spectrum transmitter to be compliance with US (FCC Part 15.247) and Canadian (RSS-210) regulations for license free use in the 902-928MHz ISM band. The T7406 is a multiple-handset, single-base cordless telephone system, which provides a full-integrated mobility solution for your business. The T7406 handset allows you to freely move around your working space while on a call, and still maintain access to all your telephone system features.

The T7406 telephone uses advanced digital frequency hopping spread spectrum (FHSS) technology to provide a quality audio path over a 900MHz radio link. Establishing a call over a radio link is comparable to a wire line communication.

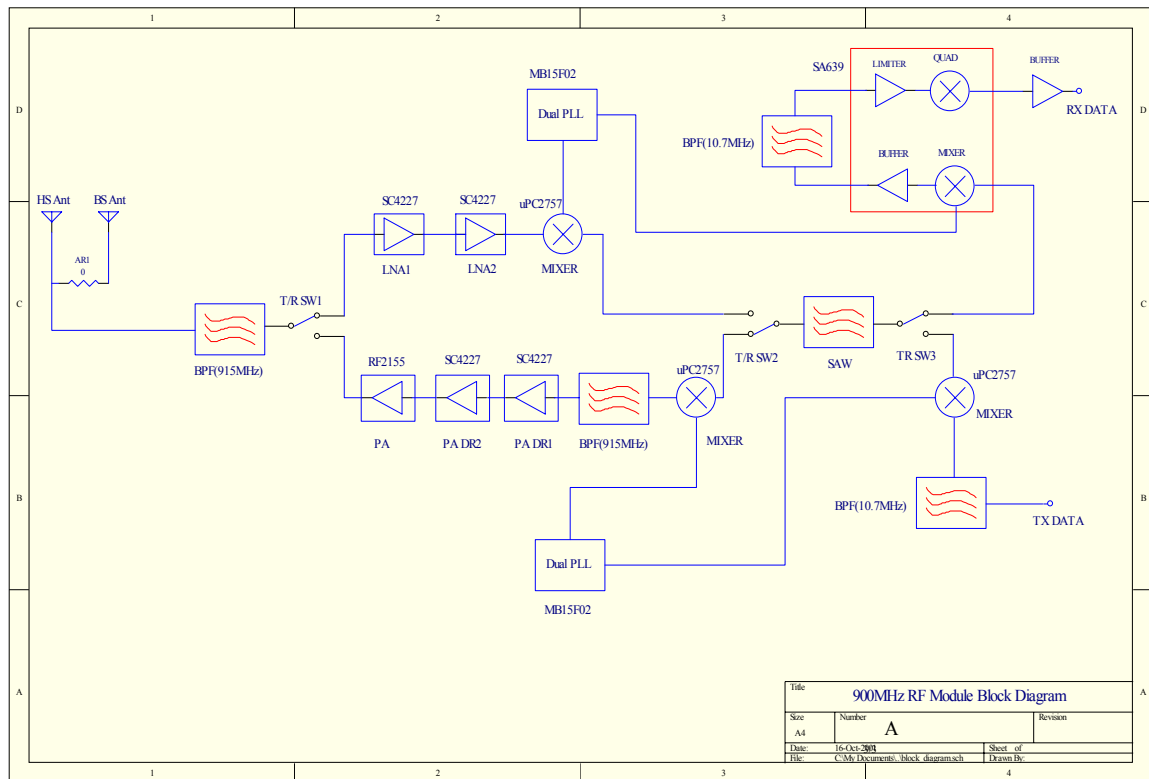
The frequency band is divided into 25 channels in T7406. And 25 channels are used for each T7406 base and handset. Each message from T7406 base to handset is four frames in length. That is the message from T7406 base to handset hops on four different channels. The T7406 handset receiver gets the message from four different hopping channels.

The message from T7406 handset to base is six frames in length. That is the message from T7406 handset to base hops on six different channels. The T7406 base receiver receives the message from six different hopping channels. It complies with FCC part 15.247(g).

T7406 base and handset use same algorithm to control the hopping sequence. The key of the hopping sequence bases on the "System Security Code". When T7406 base chooses a System Security Code, it will hop in a sequence calculated from the algorithm accordingly. T7406 handset hops using the same sequence and tries to synchronize to T7406 base. That is the hopping sequence selected within T7406 is controlled by the base station and is not coordinated in any way with devices outside of T7406. It complies with FCC part 15.247(h).

Each base station has a unique security code. All three handsets registered to the base station must share the same security code. Each of the three handsets assigned to a base station must also have a unique identification. Each base station provides three independent time compression multiplexing (TCM) line connections to the telephone system.

2. Block Diagram of RF Module



3. Functional Description

3.1. Radio Section

The radio uses FSK modulation at 320k bits per second, and utilizes channels of 480KHz bandwidth. All transmissions are hopped over 25 channels chosen from a pseudo-random table, with equal transmission time on all channels. Transmissions are typically of 4.5 ms duration on a given channel, and never exceed 400 ms in 10 seconds period. The radio is half-duplex; meaning it is either receiving or transmitting at any given time. These comply with FCC 15.247(a).

3.1.1. Antenna

The antenna used is a vertical mono-pole antenna that protrudes from the top of the handset unit. Because of its small size and the limited size of the “ground plane” in the antenna system, the gain of this antenna configuration is 0dBi.

3.1.2. Tunable Local Oscillator

3.1.2.1. 19.2 MHz Crystal circuit

A crystal circuit at 19.2 MHz with 19.2MHz crystal is used as the reference frequency for the phase-lock loop and direct digital synthesizer. This reference oscillator is specified to be accurate to within ± 10 ppm over the temperature range of 0 to +50° C.

3.1.2.2. Voltage Controlled Oscillator

The local oscillator signal originates in the voltage controlled oscillator, which is tuned between 1146.97 and 1171.20 MHz at a constant 243.95 MHz offset from the receiving or transmission frequencies in the 903.479 to 925.421 MHz range.

3.1.2.3. Phase Lock Loop

The phase-lock loop integrated circuit tunes the voltage-controlled oscillator to a given channel based on the control words received from the microprocessor. Tuning is achieved in 600 μ s.

3.1.3. Receiver

The receiver architecture is dual down-conversion, with intermediate frequencies of 243.95 MHz and 10.7 MHz. The first conversion is performed in the RF front-end circuit, the second conversion is performed in the IF integrated circuit, which generates its own LO signal using a 19.2 MHz crystal oscillator. The bandwidth of the receiving channel is 480 KHz and the channel separation is 620 KHz.

3.1.3.1. 902-928 MHz Ceramic Band-pass Filter

A ceramic band-pass filter has been used at the antenna port of the radio receiver front-end. Note that this filter also appears in the transmission signal path. The selected filter has excellent out-of-band rejection to eliminate undesired signals received at the antenna, and to reduce emissions other than the desired RF output during transmission.

3.1.3.2. Transmit/Receive Switch

Two PIN diodes are used to switch the antenna between transmit and receive functions. The unit does not transmit and receive simultaneously.

3.1.3.3. SAW Band-pass Filter

The IF circuit utilizes an external surface-acoustic-wave (SAW) band-pass filter between its IF IC and mixer to reduce image noise and further reduce the receiver's susceptibility to out-of-band signals.

3.1.4. Transmitter

In a manner quite analogous to the receiver, the transmitter uses a dual up-conversion architecture. The signal is converted to 10.7 MHz and finally to the desired RF frequency in the 903.479 to 925.421 MHz range. Transmit power is typically 12dBm for Handset and 20dBm for Base at the antenna port with the antenna gain is 0dBi.

3.1.4.1. First Up-conversion Mixer

In the first integrated circuit up-conversion mixer, the signal is mixed with the local oscillator signal at 233.75 MHz that is produced by the dual synthesizer IC. The result is an FSK

modulated signal centered at 243.95 MHz.

3.1.4.2. Second Up-conversion Mixer

A second integrated circuit mixer is used to convert the transmit signal to the final RF frequency in the 903.479 to 925.421 MHz range. The tunable LO signal is used to select the exact channel that is used for any transmission.

3.1.4.3. 902-928 MHz Ceramic Band-pass Filter

To reduce the levels of the local oscillator and image signals produced in the second up-conversion mixer, a band-pass filter is used between the mixer and the PA driver.

3.1.4.4. PA Driver

Two stages of amplifiers, designed by the NPN transistor, are to amplify the signal from the band-pass filter to 0dBm radio output power.

3.1.4.5. Power Amplifier

An integrated circuit power amplifier boost the transmission signal level to nominal 14dBm for Handset and 22dBm for Base at the radio output port. The power gain is controlled by the control pins of this device. Thus, the output power can be controlled.

3.1.4.6. 902-928 MHz Ceramic Band-pass Filter

As mentioned above in the receiver section, this final filter in the transmission chain is also shared with the receive chain. The selected filter has excellent out-of-band rejection to reduce undesired emissions.

3.2. Digital Section

A baseband modem, an audio modem and a controller are all integrated onto the ASIC. The ASIC perform all of the protocol, data formatting, spread spectrum and audio processing in conformance with United States FCC regulation Part 15.247.

The microprocessor portion of the digital section is composed of an 8-bit single-chip microprocessor, a 60k x 8 FLASH non-volatile memory, a 1024-byte internal high-speed RAM and a 1024-byte internal expansion RAM. The functions performed include control of the radio section (frequency tuning and transmit/receive control), receive data decoding, transmit data generation, and control of ADPCM, LED indicator, ringing signal and key scanning.

3.3. Frequency Plan

The transmitter can be set to operate on any one of 25 frequency channels in the 902 ~ 928MHz ISM band. Each frequency is used equally by the spread spectrum transmitter in a pseudorandom sequence. At any time only one channel will be used by T7406 during each transmission. It complies with FCC part 15.247(g). The frequency plan is in the following table.

Hop Channel No.	Frequency (MHz)
1	903.479
2	904.393
3	905.307
4	906.221
5	907.136
6	908.050
7	908.964
8	909.879
9	910.793
10	911.707
11	912.621
12	913.536
13	914.450
14	915.364
15	916.279
16	917.193
17	918.107
18	919.021
9	919.936
20	920.850
21	921.764
22	922.679
23	923.593
24	924.507
25	925.421

3.4. Hopping Sequence

The hopping sequence used in T7406 is calculated from a special formula. First, the Seed is generated from the three-byte System Security Code. Then the formula generates the hopping sequence from the Seed. Totally, there are up to 256 different combinations. The formula is:

```
(1) Seed = SSC_HI + SSC_MID * 2 + SSC_LO;
(2) for (i=0; i<25; i++)
    ChanBuf[i]=i+1;
(3) for (i=24; i>=0; i--)
{
    TempSeed = Seed * 7 + 11;
    Ch = (TempSeed % 25);
    TempCh = ChanBuf[Ch];
    ChanBuf[Ch] = ChanBuf[i];
    ChanBuf[i] = TempCh;

    Seed = (unsigned char)(TempSeed & 0xFF); // Get lower 8 bits
}
```

The hopping sequence table is lists in the following.

Sequence Seed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1.	11	24	22	17	09	12	10	18	06	05	01	08	19	14	16	23	07	02	25	13	03	04	21	20	15
2.	18	06	22	15	19	03	25	07	14	16	11	12	20	23	10	24	09	17	08	04	02	01	21	13	05
3.	06	12	25	16	01	13	11	05	20	08	03	17	07	02	15	21	23	04	24	09	22	18	14	19	10
4.	01	10	07	14	25	04	21	05	06	13	02	08	23	11	22	16	03	15	12	24	18	20	17	09	19
5.	14	08	06	21	10	12	13	23	09	03	16	25	02	01	20	05	24	15	17	22	11	04	07	19	18
6.	20	04	13	21	09	03	05	25	18	08	19	11	16	02	22	10	24	12	23	14	17	06	01	07	15
7.	18	17	20	08	23	19	13	06	10	24	25	03	11	21	05	07	12	14	22	15	16	02	09	01	04
8.	04	14	07	10	22	12	08	20	09	24	16	01	02	19	15	18	06	25	23	13	17	21	05	03	11
9.	15	11	05	08	25	04	07	21	06	22	24	09	20	14	10	01	17	03	12	16	02	13	23	19	18
10.	22	03	21	14	17	15	04	13	19	07	20	02	11	06	24	23	05	10	12	18	08	01	09	16	25
11.	21	25	20	06	05	16	09	02	01	12	13	22	11	14	17	03	07	24	19	08	10	18	04	23	15
12.	25	05	12	14	17	18	01	24	11	06	19	23	02	15	07	04	10	09	13	20	03	08	22	21	16
13.	16	21	24	23	06	05	11	19	15	07	20	22	08	04	09	14	03	17	25	01	18	12	10	02	13
14.	03	09	15	11	02	08	24	23	07	19	16	04	05	13	22	17	14	06	21	10	18	12	25	01	20
15.	19	12	08	13	01	06	22	04	23	09	07	11	18	20	17	10	03	02	25	21	05	15	14	16	24
16.	04	08	12	13	10	11	14	05	03	02	06	19	01	20	09	22	15	07	23	18	16	25	21	24	17
17.	25	13	03	21	11	10	06	17	22	04	15	05	07	14	12	19	02	09	18	08	20	01	16	23	24
18.	18	06	01	17	20	11	24	19	04	15	16	09	13	22	07	08	05	25	21	10	14	03	12	23	02
19.	25	09	12	06	16	13	03	19	07	04	22	11	14	24	20	15	10	18	08	05	23	02	01	21	17
20.	24	25	02	17	03	08	20	04	21	18	07	22	01	15	11	14	16	09	12	06	05	13	19	10	23
21.	06	19	01	22	07	04	13	15	09	11	05	10	20	12	24	03	23	17	25	08	21	16	14	18	02
22.	23	15	13	24	16	01	18	14	07	12	25	03	10	06	22	09	08	04	05	17	21	20	02	11	19
23.	25	03	09	05	23	02	10	19	07	24	13	14	01	20	18	11	12	08	15	04	16	21	06	17	22
24.	11	19	04	17	23	02	13	21	24	05	12	03	07	10	20	01	06	08	22	18	09	15	16	25	14
25.	08	19	21	01	12	04	11	13	15	10	20	03	23	05	22	07	02	25	18	06	16	24	17	09	14
26.	02	20	14	04	01	15	08	22	19	09	12	03	23	07	11	24	16	05	13	10	21	06	18	25	17
27.	11	03	10	02	01	07	09	13	19	05	24	20	21	15	16	17	12	06	08	04	18	14	22	25	13
28.	14	19	04	01	06	12	02	13	05	20	16	03	24	08	22	11	21	18	25	15	17	07	10	09	23
29.	11	09	12	22	10	16	01	18	21	25	24	03	08	19	02	14	17	05	23	13	15	06	04	07	20
30.	22	20	03	04	15	17	02	12	01	06	18	13	16	09	08	11	14	24	19	21	07	23	25	10	05
31.	15	10	18	02	24	23	12	05	14	13	01	03	07	08	21	25	11	04	22	06	20	17	16	09	19
32.	01	11	21	04	13	03	07	10	02	24	16	09	18	06	25	05	08	23	20	12	14	22	19	17	15
33.	06	01	07	02	15	10	04	13	05	23	03	11	17	19	22	16	08	25	14	12	18	21	24	09	20
34.	11	17	23	01	06	04	15	08	14	07	10	19	18	03	21	09	22	16	25	12	24	02	20	05	13

35.	16	25	03	09	14	22	24	18	01	17	08	23	06	02	07	12	21	15	04	10	20	19	13	05	11
36.	06	09	03	02	16	15	13	01	05	12	10	25	14	07	08	21	04	23	11	24	17	22	20	19	18
37.	18	11	06	05	07	15	13	08	09	16	25	17	23	04	19	03	24	01	20	22	21	12	10	02	14
38.	13	10	04	08	18	05	21	22	12	16	11	17	07	24	02	03	19	01	09	20	25	14	06	15	23
39.	02	18	15	11	21	25	14	07	13	09	06	12	22	05	10	08	04	03	17	16	20	24	01	19	23
40.	03	02	11	07	22	08	05	20	24	09	01	15	10	25	14	17	04	12	13	18	16	21	23	06	19
41.	02	14	22	09	08	25	06	05	23	12	20	24	17	15	04	01	21	07	10	11	03	16	19	18	13
42.	07	15	13	25	23	08	03	24	05	18	12	10	02	06	04	21	22	11	16	19	01	09	17	14	20
43.	01	19	14	11	12	24	09	03	06	07	20	21	08	25	05	04	22	23	16	13	02	10	18	15	17
44.	18	12	16	08	14	10	03	21	24	07	09	02	23	25	01	19	11	06	20	15	05	04	17	22	13
45.	03	17	22	14	04	06	02	01	11	25	13	12	07	23	05	09	10	08	24	21	15	18	16	19	20
46.	25	11	23	13	12	17	04	07	02	10	14	05	08	09	18	03	01	21	06	16	20	19	24	22	15
47.	12	20	08	24	17	25	06	01	23	13	15	19	11	22	04	09	10	18	02	05	21	07	03	14	16
48.	11	22	02	23	03	15	10	19	04	17	05	12	24	09	14	20	01	08	07	06	18	25	21	16	13
49.	08	21	22	23	25	02	04	13	18	11	15	12	06	05	10	07	20	03	16	17	09	01	14	24	19
50.	01	02	13	15	07	14	25	10	03	05	19	21	17	12	06	23	04	24	18	11	09	20	22	16	08
51.	14	19	01	02	18	17	09	05	06	13	04	25	15	11	24	23	07	10	20	08	16	03	12	22	21
52.	07	19	24	17	02	25	21	18	10	03	14	22	20	06	04	01	09	16	11	23	15	12	08	13	05
53.	01	15	03	08	13	02	12	10	09	05	06	22	18	20	17	11	19	21	25	24	07	04	16	14	23
54.	23	24	18	13	01	11	15	20	06	17	12	04	19	14	09	03	07	05	22	16	25	21	10	02	08
55.	08	11	10	25	01	03	07	16	24	20	06	04	15	18	02	12	17	09	22	23	14	19	05	21	13
56.	02	23	15	10	07	12	19	13	05	03	01	04	06	21	16	25	24	11	08	09	18	14	20	17	22
57.	25	18	14	08	20	21	13	17	22	07	19	03	12	02	15	10	05	11	24	01	06	16	09	23	04
58.	10	07	09	21	12	20	16	01	06	19	15	04	03	08	22	24	14	13	11	18	23	02	17	25	05
59.	25	18	20	03	02	14	08	09	04	21	22	16	01	19	11	13	10	07	17	05	06	23	24	15	12
60.	12	10	18	07	06	20	01	14	03	15	24	04	19	05	22	11	13	16	23	17	02	08	09	21	25
61.	25	12	11	02	15	10	21	09	16	19	08	22	03	01	20	05	04	06	13	23	14	17	18	24	07
62.	08	07	03	09	11	20	06	14	04	23	21	19	24	10	01	12	13	18	25	02	15	16	22	05	17
63.	13	01	02	03	09	23	22	08	07	04	21	05	06	20	16	24	14	25	10	18	12	17	15	19	11
64.	24	02	09	16	11	04	06	08	01	07	23	17	12	10	05	14	15	21	22	25	13	19	18	20	03
65.	21	02	24	08	15	16	03	14	20	17	07	09	04	25	01	11	06	13	12	23	22	19	05	18	10
66.	04	15	16	03	05	06	21	22	25	18	09	17	07	01	11	08	23	02	10	20	12	14	19	13	24
67.	14	09	10	23	03	16	24	22	11	02	01	08	15	07	13	05	19	25	18	04	21	20	12	06	17
68.	14	01	12	15	17	19	11	07	22	16	18	21	13	24	08	10	02	09	23	05	03	04	25	20	06
69.	19	22	09	14	17	02	25	16	03	08	23	01	13	07	15	24	10	11	20	18	12	05	06	04	21
70.	11	04	14	21	08	23	22	05	24	03	10	07	06	15	19	02	01	09	17	25	12	16	18	13	20
71.	20	25	23	14	12	11	09	08	04	02	10	06	05	13	01	19	03	15	07	16	22	18	17	24	21
72.	23	18	10	15	12	09	06	03	07	24	02	22	13	16	11	25	04	17	01	14	05	08	21	19	20
73.	24	11	17	03	04	12	05	06	16	18	07	08	15	10	01	22	13	09	23	14	02	19	21	25	20
74.	12	08	19	16	05	24	02	01	06	18	20	13	10	25	03	23	07	15	11	21	09	17	04	22	14
75.	05	08	23	16	10	17	21	04	20	15	11	03	12	07	22	25	24	06	13	14	18	02	19	09	01
76.	22	16	08	23	20	18	25	05	19	09	03	12	01	21	11	02	07	04	06	24	17	14	15	10	13
77.	20	22	19	04	03	25	15	02	01	07	10	06	12	24	13	14	16	21	08	11	23	09	18	17	05
78.	09	13	14	02	12	11	07	18	03	24	05	20	21	16	08	04	01	10	22	06	19	15	25	23	17
79.	12	14	16	19	11	08	04	06	17	20	23	07	15	21	03	01	09	13	05	22	10	18	24	02	25
80.	14	24	05	06	02	04	03	08	12	11	21	01	22	20	16	18	10	07	09	23	17	19	25	13	15
81.	08	17	14	13	10	01	23	11	19	18	04	05	12	06	07	20	22	15	02	16	25	03	21	09	24
82.	08	09	21	13	04	25	12	10	02	01	22	07	20	23	05	18	03	15	14	17	11	19	06	24	16
83.	02	19	03	05	24	17	01	23	25	12	15	22	09	14	11	04	18	20	10	06	08	16	07	21	13
84.	16	12	25	04	01	08	18	21	10	19	06	05	11	22	17	09	24	14	02	15	03	13	07	20	23
85.	21	22	09	08	02	03	10	04	23	25	13	05	12	20	24	16	06	11	19	07	15	17	18	01	14
86.	19	07	16	01	06	24	12	23	25	20	14	05	21	10	22	17	09	13	11	04	03	08	18	15	02
87.	10	15	05	23	14	24	20	02	01	09	25	17	19	04	03	18	08	16	22	06	07	11	21	13	12
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242.	21	07	25	01	05	24	02	09	18	22	04	10	20	13	08	17	06	14	12	23	15	16	03	11	19
243.	18	03	07	08	19	20	04	17	22	24	15	10	11	06	23	12	21	09	16	13	05	01	02	25	14
244.	20	15	08	12	22	10	23	06	25	24	03	21	01	07	14	19	16	04	09	05	11	18	02	17	13
245.	02	01	04	23	19	17	13	10	14	08	12	05	16	22	25	11	20	15	03	07	24	09	21	18	06
246.	10	21	17	18	09	11	19	01	08	04	02	07	06	12	13	03	20	16	24	05	15	25	14	23	22
247.	13	14	15	23	20	21	10	03	04	02	25	06	12	17	08	18	11	05	24	22	01	19	07	16	09
248.	13	05	18	16	14	09	04	11	12	15	20	24	08	06	03	21	01	02	17	25	22	19	07	10	23
249.	04	02	12	09	01	22	08	07	23	11	05	19	14	13	18	03	16	24	06	20	17	21	15	25	10
250.	02	22	05	03	10	12	16	20	18	11	09	23	01	06	08	14	07	15	25	17	21	24	19	13	04
251.	17	15	16	11	23	03	06	05	12	02	18	10	01	09	04	21	13	08	20	07	14	22	24	25	19
252.	23	15	25	11	18	07	03	22	19	20	17	02	13	24	08	16	06	14	21	01	12	10	05	04	09
253.	19	07	10	23	14	21	01	25	03	12	24	02	16	04	09	08	06	05	13	15	17	18	22	20	11
254.	02	23	06	19	20	25	07	12	04	15	14	13	05	24	17	10	18	11	21	01	03	22	16	09	08
255.	20	05	18	19	22	16	12	10	17	11	21	02	24	13	14	25	23	04	01	03	07	06	09	08	15
256.	10	14	20	15	22	19	03	07	25	08	16	02	18	13	05	12	06	24	21	23	11	09	01	04	17

4. Precautions Taken to Avoid Interference

4.1. RF Filtering

The transmit signal passes through a SAW bandpass and a three-section ceramic bandpass filter before reaching the output port. These filters greatly reduce spurious signals, harmonics, and out-of-band transmitter phase noise.

4.2. Shielding

The circuit boards are contained in a shielded enclosure formed by the coated plastic housing, which also provides the antenna ground plane.