system design of a Wireless Tin Can Telephone

**Zhidong Guo**

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**System design methodology**

|  |  |
| --- | --- |
|  | A top-down design approach is used to design this wireless system as follows.  Problem definition  System specification  System requirements  System architecture |

# Specifications and requirements

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The system specifications are based on 4MHz of central frequency and bandwith is 20kHz.   |  |  |  | | --- | --- | --- | | System Specification | System Requirements | System Architecture | | Audio wireless | Analog processing | Amplitude modulation | | Low power | Pdc=1W | Direct conversion | | Simple design | Fc=4 MHz | Half-duplex | | Noisy environment | SNRout>=70 dB | Differential circuit | |  |

## **System Architecture**

Diagram

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Figure 1 Block diagram of wireless system of can tin telephone

**.Transmitter**

The microphone gets the audio and translates it into electrical signal, that is then amplified by the media frequency amplifier and mixed up with the local oscillator by the mixer. The output of the mixer generates many signals. Band pass filter (BPF) filters out the undesired one. The 4-megahertz signal for instance, with 20 kilohertz around, and then it's amplified by the power amplifier(PA) to drive the antenna. See figure 2.

A picture containing text, clock

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Figure 2 Block diagram of transmitter system

**.Receiver**

Chart

Description automatically generatedThe signal will get attenuated in a very noisy environment from antenna when it gets to the receiver side. The signal has to be filtered.  Any of the undesired blockers or interferes are filtered out by the band pass filter (BPF). Then, amplified by the low noise amplifier (LNA) that it's important to have a high gain and low noise, so it limits the overall noise of the receiver. It is then converted by the mixer (Mixer) using the local oscillator (LO), the output of the mixer. Then the low pass filter (LPF) filters out those undesired and leaves only the base band signal. It's finally amplified by the intermediate frequency IF amplifier. So it can be driven into the speaker.

Figure 3 Block diagram of receiver system

# link budget and reference table

Diagram

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Figure 4 The factors should be considered in design.

**.System analysis**

Table

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Formula:

Noise Floor(dBm)=10\*LOG10(Boltzmann(J-K-1)\*Temperature(K)\*Bandwidth(Hz)/0.001)

**.Transmitter analysis**

Table

Description automatically generated

Formula:

TX Signal Pin(dBm)=10\*LOG10(((TX Vin(Vp)/SQRT(2))^2)/(Impedance(Ω)\*0.001))

TX Signal Vout(Vp)= SQRT((10^((TX Pout(dBm)-30)/10))\*Impedance(Ω)\*SQRT(2)

Conditioning TX Gain(dB)= TX Pout(dBm)-TX Pin(dBm)-TX Antenna Gain(dB)

Conditioning Noise Floor(dBm)= System Noise Floor(dBm)

Conditioning TX SNR Out(dB)= =TX Pout(dBm)-TX Noise Floor(dBm)

**.Channel Analysis**

Table

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Formula:

Interference Signal Power(dBm)= 10\*LOG10(Interf Signal Power(W)/0.001)

Interference Voltage (Vp) =SQRT(Interf Signal Power(W)\*Impedance(Ω)\*SQRT(2)

**.Load (Speaker) Analysis**

Table

Description automatically generated

Formula:

Audio Signal Minimum Required Load Power(dBm)

=30 - 20\*LOG10((10^(Speaker Sensitivity(dB)/20))/(10^(SPL Min(dB)/20))) + 20\*LOG10(Target Distance(m))

Audio Signal Maximum Required Load Power(dBm)

=30 - 20\*LOG10((10^(Speaker Sensitivity(dB)/20))/(10^(SPL Max(dB)/20))) + 20\*LOG10(Target Distance(m)) + Power Margin(dB)

**. Receiver analysis**

Table

Description automatically generated

Formula:

RX Signal Pin Min (dBm)=TX Pout(dBm)-Path Loss(dB)

Vin Min (Vp)=SQRT((10^((RX Pin Min(dBm)-30)/10))\*Impedance(Ω))\*SQRT(2)

Pin Max (dBm)=Interf Signal Power(dBm)-RX Filter Loss\_OB(dB)

Vin Max (Vp)=SQRT((10^((RX Pin Max(dBm)-30)/10))\*Impedance(Ω)\*SQRT(2)

Pout Min (dBm) =Load Power Min(dB)

Vout Min (Vp) =SQRT((10^((RX Pout Min(dBm)-30)/10))\*Load Impedance(Ω)\*SQRT(2)

Vout Max (Vp) =SQRT((10^((RX Pout Max(dBm)-30)/10))\*Load Impedance(Ω)\*SQRT(2)

RX Gain Min (dB) =MIN(RX Pout Min(dBm)-RX Pin Min(dBm)-RX Antenna Gain(dB),RX Pout Max dBm-RX Pin Max(dBm)-RX Antenna Gain(dB)

RX Gain Max (dB) =RX Pout Max(dBm)-RX Pin Min(dBm)-RX Antenna Gain(dB)

RX DR Out (dB) =RX Pout Max(dBm)-RX Pout Min(dBm)

Noise Floor (dBm) =Man Made Noise(dB)+System Noise Floor(dBm)-Noise Margin(dB)

RX SNR In (dB) =RX Pin Min(dBm)-RX Noise Floor(dBm)+RX Antenna Gain(dB)

Noise Figure (dB) =RX SNR In(dB)-RX SNR Out(dB)