**CLAIMS:**

1. A method for a Near Field Communication (NFC) card for use in asynchronous NFC card emulation mode transmission comprising:

estimating a carrier frequency offset (CFO) between a carrier frequency of a NFC reader and a carrier frequency of the NFC card comprising:

obtaining an in-phase component (I) and a quadrature phase component (Q) for a plurality of samples of an input signal from an Analogue to Digital Converter (ADC) of the NFC card comprising:

down-converting the input signal at an intermediate frequency into a complex signal centered at zero frequency comprising:

multiplying the input signal with cos(2π fc/fs n) to obtain in-phase component (I);

multiplying the input signal with sin(2π fc/fs n) to obtain quadrature phase component (Q), wherein fc is the carrier frequency, fs is an ADC sampling frequency, and n is a sample number;

applying a low pass filter for the complex signal to filter harmonics components from the complex signal;

computing a phase for each sample;

computing phase differences between a plurality of adjacent samples from the input signal;

averaging the phase differences to obtain the estimated carrier frequency offset;

storing the estimated carrier frequency offset in a memory in the NFC card;

adjusting digital baseband sampling of a baseband sample output at a NFC card emulation mode transmitter in the NFC card based on the estimated carrier frequency offset to obtain an adjusted baseband sample output; and

modulating a radio frequency (RF) transmitter in the NFC card emulation mode transmitter based on the adjusted baseband sample output.

2. The method according to claim 1, wherein the step of estimating the carrier frequency offset is triggered upon detecting a RF magnetic field from the NFC reader.

~~3. The method according to claim 1, wherein the step of estimating the carrier frequency offset comprises:~~

~~obtaining an in-phase component (I) and a quadrature phase component (Q) for a plurality of samples of an input signal from an Analogue to Digital Converter (ADC) of the~~

~~NFC card;~~

~~computing a phase for each sample;~~

~~computing phase differences between a plurality of adjacent samples from the input signal;~~

~~averaging the phase differences to obtain the estimated carrier frequency offset; and~~

~~storing the estimated carrier frequency offset in a memory in the NFC card.~~

~~4. The method according to claim 3, wherein the step of obtaining the set of in-phase component (I) and quadrature phase component (Q) for the signal from the Analogue to Digital Converter (ADC) comprises:~~

~~down-converting the input signal at an intermediate frequency into a complex signal centered at zero frequency; and~~

~~applying a low pass filter for the complex signal to filter harmonics components from the complex signal.~~

~~5. The method according to claim 4, wherein the step of down-converting the input signal at the intermediate frequency into the complex signal centered at zero frequency comprises:~~

~~multiplying the input signal with cos(2π fc/fs n) to obtain in-phase component (I); and~~

~~multiplying the input signal with sin(2π fc/fs n) to obtain quadrature phase component (Q), wherein fc is the carrier frequency, fs is an ADC sampling frequency, and n is a sample number.~~

~~6~~3. The method according to claim 1~~3~~, wherein the phase for each sample is computed with the following expression: $\tan^{-1}(Q/I)$.

~~7~~4. The method according to any one of claims 1 to 3~~6~~, wherein the step of adjusting the digital baseband sampling of the baseband sample output at the NFC card emulation mode transmitter based on the estimated carrier frequency offset comprises:

receiving input sample stream from a subcarrier generator;

setting n, k and Acc to zero;

retrieving the estimated CFO from the memory;

adding the absolute of the estimated CFO to Acc;

determining if the Acc is more than the input sampling frequency of the NFC card;

outputting the input sample stream with the following expression output[k]=input[n], in response to the Acc being determined to be less than the input sampling frequency;

determining if there is any more input sample stream; and

incrementing n and k by 1 and repeating from the step of adding the absolute of the estimated CFO to Acc in response to determining that there is more input sample stream, wherein n and k are variables, output[k] is an output sample number, input[n] is an input sample number, and Acc is an accumulation of estimated CFO.

~~8~~5. The method according to claim 4~~7~~, wherein the step of adjusting the digital baseband sampling of the baseband sample output at the NFC card emulation mode transmitter based on the estimated carrier frequency offset further comprises:

determining if the estimated CFO is greater than zero;

skipping a sample in response to determining the estimated CFO is less than zero;

adding a sample in response to determining the estimated CFO is greater than zero; and

deducting the Acc by the input sampling frequency.

~~9~~6. The method according to claim 5~~8~~, wherein the step of skipping a sample comprises:

incrementing n by 1; and

outputting the input sample stream with the following expression output[k]=input[n].

~~10~~7. The method according to claim 5~~8~~, wherein the step of adding a sample comprises:

outputting the input sample stream with the following expression output[k]=input[n];

increment k by 1; and

outputting the input sample stream with the following expression output[k]=input[n].

~~11~~8. The method according to any one of claims 1 to 3~~6~~, wherein the step of adjusting the digital baseband sampling of the baseband sample output at the NFC card emulation mode transmitter based on the estimated carrier frequency offset comprises:

receiving encoded bit stream from an encoder;

setting Acc to zero;

retrieving the estimated CFO from the memory;

adding the absolute of the estimated CFO to Acc;

determining if the Acc is more than a data-rate,

establishing the number of samples for each encoded bit, N, which is equal to number of samples per information bit, Bit_Len, in response to the Acc being less than the data-rate;

generating the digital baseband sample for 1 bit duration based on a value of N;

determining if there is any more input sample stream; and

repeating from the step of adding the absolute of the estimated CFO to the Acc in

response to determining that there is more input sample stream, wherein the data-rate is equal to a sampling frequency divided by Bit_Len, and Acc is the accumulation of estimated CFO.

~~12~~9. The method according to claim 8~~11~~ where the step of adjusting the digital baseband sampling of the baseband sample output at the NFC card emulation mode transmitter based on the estimated carrier frequency offset further comprises:

deducting the Acc by the data-rate in response to the Acc being determined to be more than the data-rate;

determining if the estimated offset frequency is greater than zero;

establishing N is equal to Bit_Len+1 in response to the estimated CFO is greater than zero; and

establishing N is equal to Bit_Len-1 in response to the estimated CFO is less than zero.

10~~3~~. A Near Field Communication (NFC) card comprising:

a clock frequency offset (CFO) estimation module configured to estimate a carrier frequency offset between a carrier frequency of a NFC reader and a carrier frequency of the NFC card, the CFO estimation module is further configured to:

obtain an in-phase component (I) and a quadrature phase component (Q) for a plurality of samples of an input signal from an Analogue to Digital Converter (ADC) of the NFC card by:

down-converting the input signal at an intermediate frequency into a complex signal centered at zero frequency by:

multiplying the input signal with cos(2π fc/fs n) to obtain in-phase component (I);

multiplying the input signal with sin(2π fc/fs n) to obtain quadrature phase component (Q) wherein fc is the carrier frequency, fs is an ADC sampling frequency, and n is a sample number;

applying a low pass filter for the complex signal to filter harmonics components from the complex signal;

compute a phase for each sample;

compute phase differences between a plurality of adjacent samples from the input signal;

average the phase differences to obtain the estimated carrier frequency offset;

store the estimated carrier frequency offset in a memory in the NFC card;

a sample adjustment module configured to adjust digital baseband sampling of a

baseband sample output at a transmitter of the NFC card based on the estimated carrier frequency offset to obtain an adjusted baseband sample output; and

an analogue transmission module configured to modulate a radio frequency (RF) transmitter in the NFC card based on the adjusted baseband sample output.

11~~4~~. The NFC card according to claim 10~~3~~, wherein the CFO estimation module is triggered to estimate the carrier frequency offset upon detecting a RF magnetic field from the NFC reader.

~~15. The NFC card according to claim 14, wherein the CFO estimation module is configured to:~~

~~obtain an in-phase component (I) and a quadrature phase component (Q) for a plurality of samples of an input signal from an Analogue to Digital Converter (ADC) of the NFC card;~~

~~compute a phase for each sample;~~

~~compute phase differences between a plurality of adjacent samples from the input signal;~~

~~average the phase differences to obtain the estimated carrier frequency offset; and~~

~~store the estimated carrier frequency offset in a memory in the NFC card.~~

~~16. The NFC card according to claim 15, wherein the CFO estimation module is further configured to:~~

~~down-convert the input signal at an intermediate frequency into a complex signal centered at zero frequency; and~~

~~apply a low pass filter for the complex signal to filter harmonics components from the complex signal.~~

~~17. The NFC card according to claim 16 wherein the CFO estimation module is further configured to:~~

~~multiply the input signal with cos(2π fc/fs n) to obtain in-phase component (I); and~~

~~multiply the input signal with sin(2π fc/fs n) to obtain quadrature phase component (Q) wherein fc is the carrier frequency, fs is an ADC sampling frequency, and n is a sample number.~~

12~~8~~. The NFC card according to claim 10~~5~~ wherein the phase for each sample is computed with the following expression: $\tan^{-1}(Q/I)$.

13~~9~~. The NFC card according to any one of claims 10~~3~~ to 12~~8~~ wherein the sample adjustment module is configured to:

receive input sample stream from a subcarrier generator;

set n, k and Acc to zero;

retrieve the estimated CFO from the memory;

add the absolute of the estimated CFO to Acc;

determine if the Acc is more than the input sampling frequency of the NFC card;

output the input sample stream with the following expression output[k]=input[n], in response to the Acc being determined to be less than the input sampling frequency;

determine if there is any more input sample stream; and

increment n and k by 1 and repeat from the step of adding the absolute of the estimated CFO to Acc in response to determining that there is more input sample stream, wherein n and k are variables, output[k] is an output sample number, input[n] is an input sample number, and Acc is an accumulation of estimated CFO.

14~~20~~. The NFC card according to claim 13~~19~~ wherein the sample adjustment module is further configured to:

determine if the estimated CFO is greater than zero;

skip a sample in response to determining the estimated CFO is less than zero;

add a sample in response to determining the estimated CFO is greater than zero; and

deduct the Acc by the input sampling frequency.

15~~21~~. The NFC card according to claim 14~~20~~ wherein the sample adjustment module is further configured to skip a sample by:

incrementing n by 1; and

outputting the input sample stream with the following expression output[k]=input[n].

16~~22~~. The NFC card according to claim 14~~20~~ wherein the sample adjustment module is further configured to add a sample by:

outputting the input sample stream with the following expression output[k]=input[n];

incrementing k by 1; and

outputting the input sample stream with the following expression output[k]=input[n].

17~~23~~. The NFC card according to any one of claims 10~~3~~ to 12~~8~~ wherein the sample adjustment module is configured to:

receive encoded bit stream from an encoder;

set Acc to zero;

retrieve estimated CFO from the memory;

add the absolute of the estimated CFO to Acc;

determine if the Acc is more than a data-rate,

establish the number of samples for each encoded bit, N, is equal to number of samples per information bit, Bit_Len, in response to Acc being less than the data-rate;

generate the digital baseband sample for 1 bit duration based on value of N;

determine if there is any more input sample stream; and

repeat from the step of adding the absolute of the estimated CFO to the Acc in response to determining that there is more input sample stream, wherein data-rate is equal to sampling frequency divided by Bit_Len.

18~~24~~. The NFC card according to claim 17~~23~~ where the sample adjustment module is further configured to:

deduct the Acc by data-rate in response to the Acc being determined to be more than data-rate;

determine if the estimated offset frequency is greater than zero;

establish N is equal to Bit_Len+1 in response to the estimated CFO is greater than zero; and

establish N is equal to Bit_Len-1 in response to the estimated CFO is less than zero.