An IQ amplitude-phase imbalance correction algorithm in IF receiver

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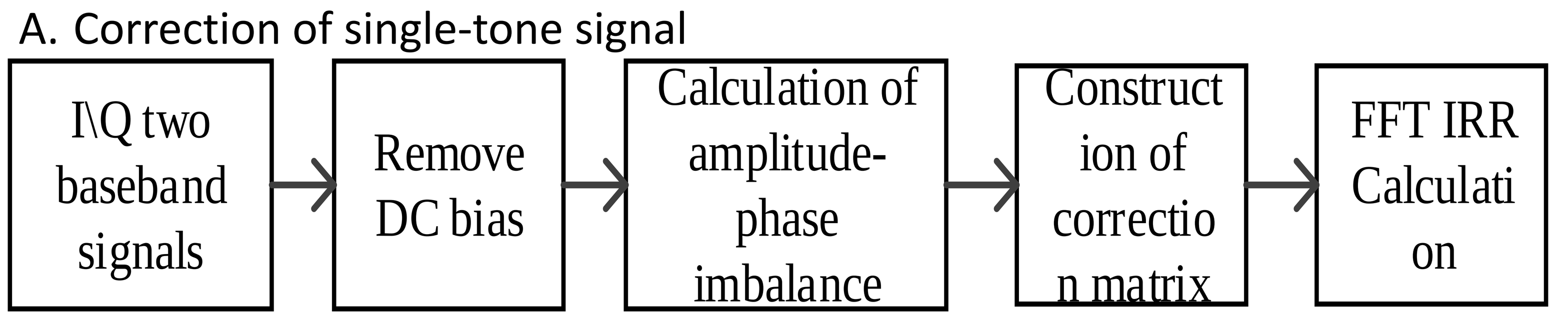
ABSTRACT

We propose a correction algorithm for I/Q amplitude and phase imbalance in IF receiver, which can solve the problem of image frequency caused by I/Q amplitude and phase imbalance. The test results show that in 25MHz bandwidth, 10MHz bandwidth and 1MHz bandwidth, the IRR before and after correction has been significantly improved. These test results show that most of the corrected image frequencies are submerged in spurious noise, and the image frequency suppression ratio is improved.

THEORY

A. Correction of single-tone signal



For ordinary single-tone signals, the amplitude-phase inconsistency of I/Q is independent of frequency, so the compensation matrix can be directly constructed for compensation. Analog baseband signal sampled by ADC to obtain discrete baseband signal, and are used to represent the sampled discrete I-road and Q-roadbed signal, respectively. The sampling depth is N. The phase imbalance and amplitude imbalance of the orthogonal component and the in-phase component can be expressed as :

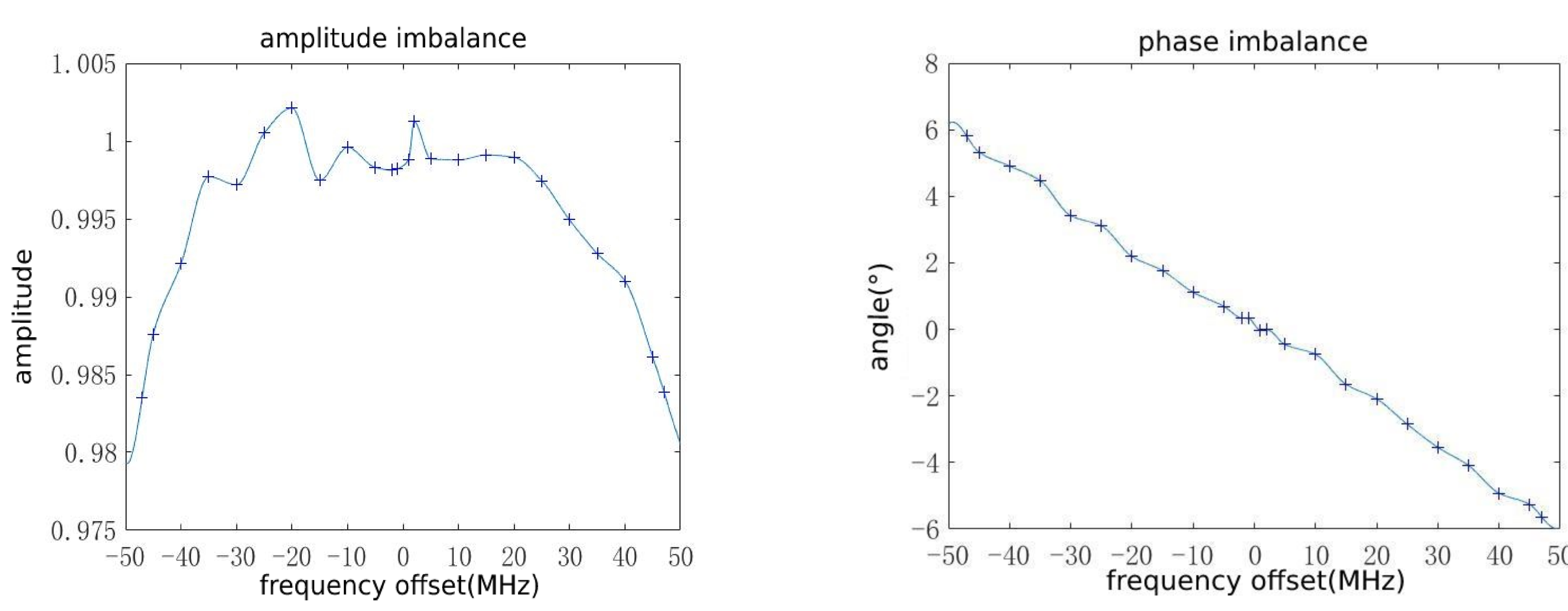
$$\beta = \sqrt{\frac{\sum_{n=1}^{N}\{x_Q^2[n]\}}{\sum_{n=1}^{N}\{x_I^2[n]\}}} \qquad \alpha = -\arcsin\frac{\sum_{n=1}^{N}\{x_Q[n]x_I[n]\}}{\sqrt{\sum_{n=1}^{N}\{x_Q^2[n]\}\sum_{n=1}^{N}\{x_I^2[n]\}}}$$

The correction matrix is :

$$\begin{bmatrix} y_I[n] \\ y_Q[n] \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\sin\alpha & \frac{1}{\beta\cdot\cos\alpha} \end{bmatrix} \cdot \begin{bmatrix} x_I[n] \\ x_Q[n] \end{bmatrix}$$

B. Single-tone signal correction at different frequencies

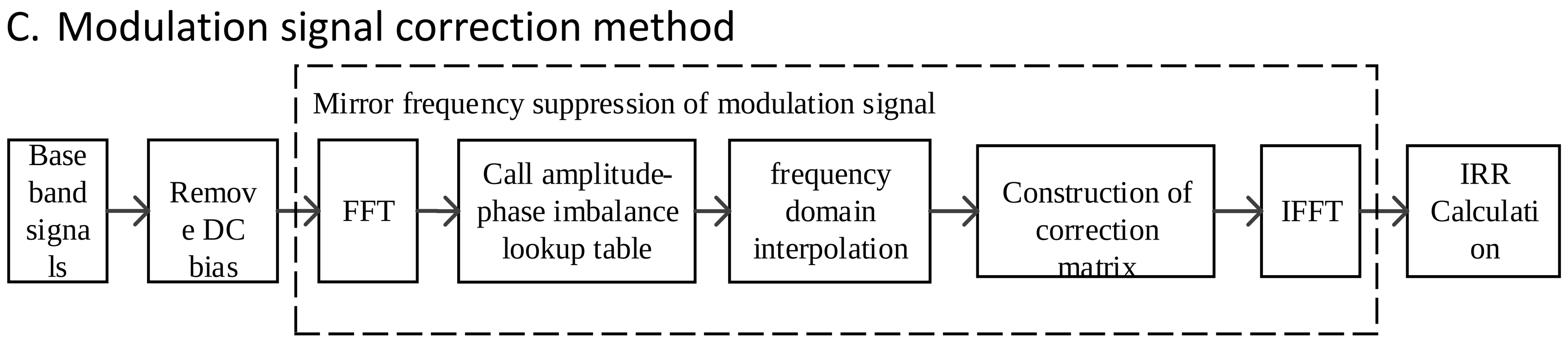
The frequency offset between single-tone signal and DC is -50MHz to 50MHz, and the sampling interval is 5MHz.



(a) (b)

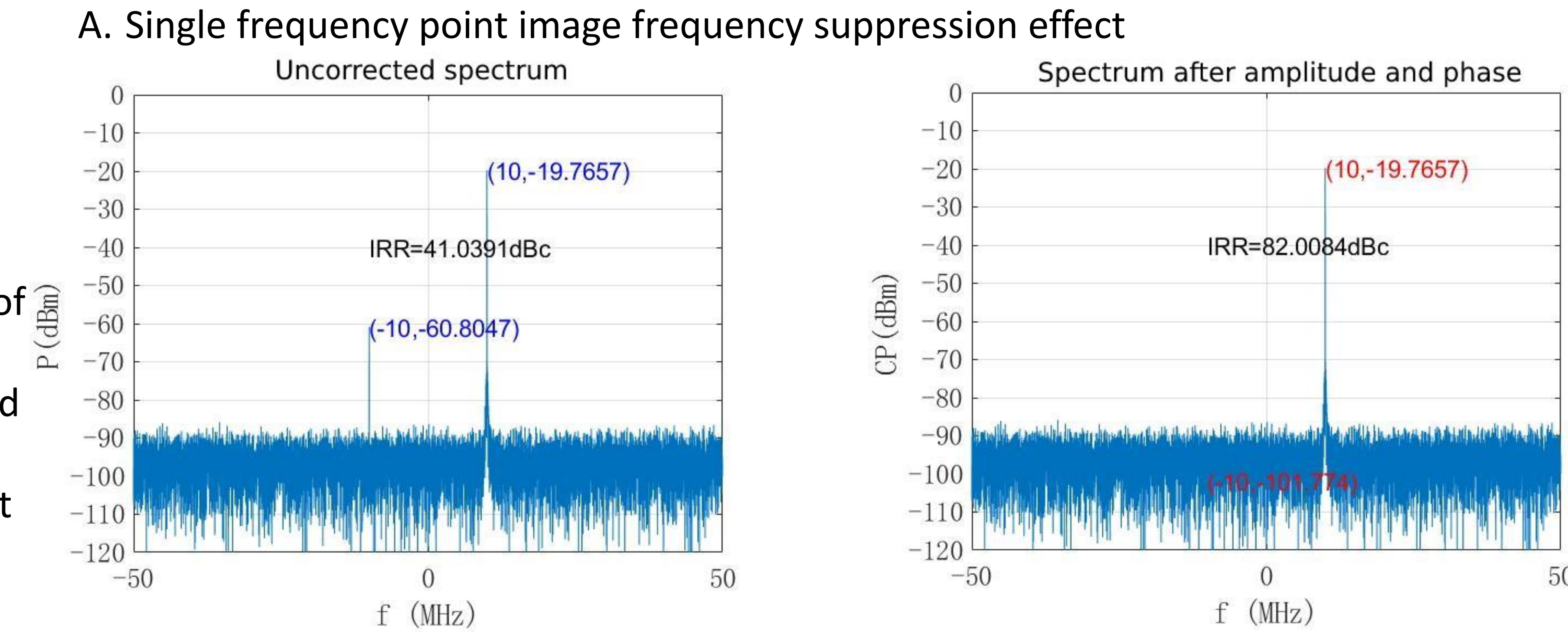
(a) The variation of amplitude imbalance with frequency offset of single-tone signal. (b) The variation of phase imbalance with frequency offset of single-tone signal.

C. Modulation signal correction method



TEST RESULTS

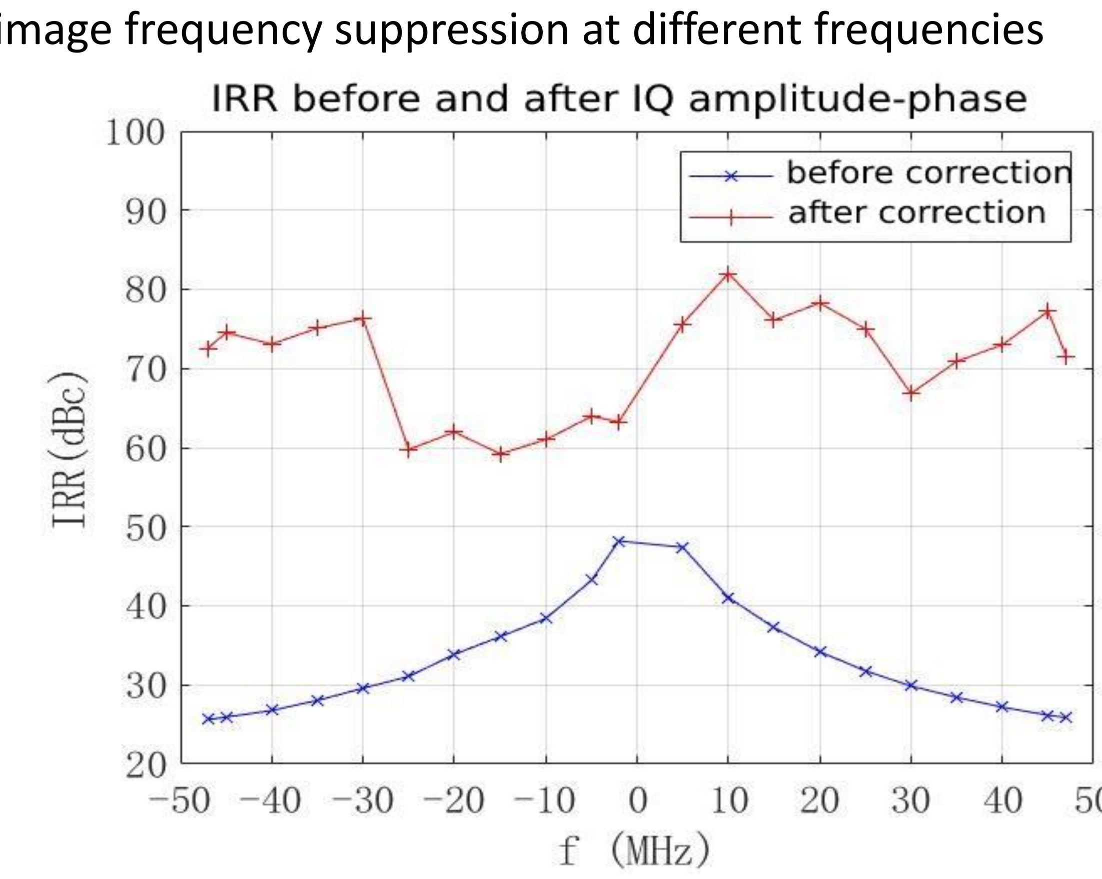
A. Single frequency point image frequency suppression effect



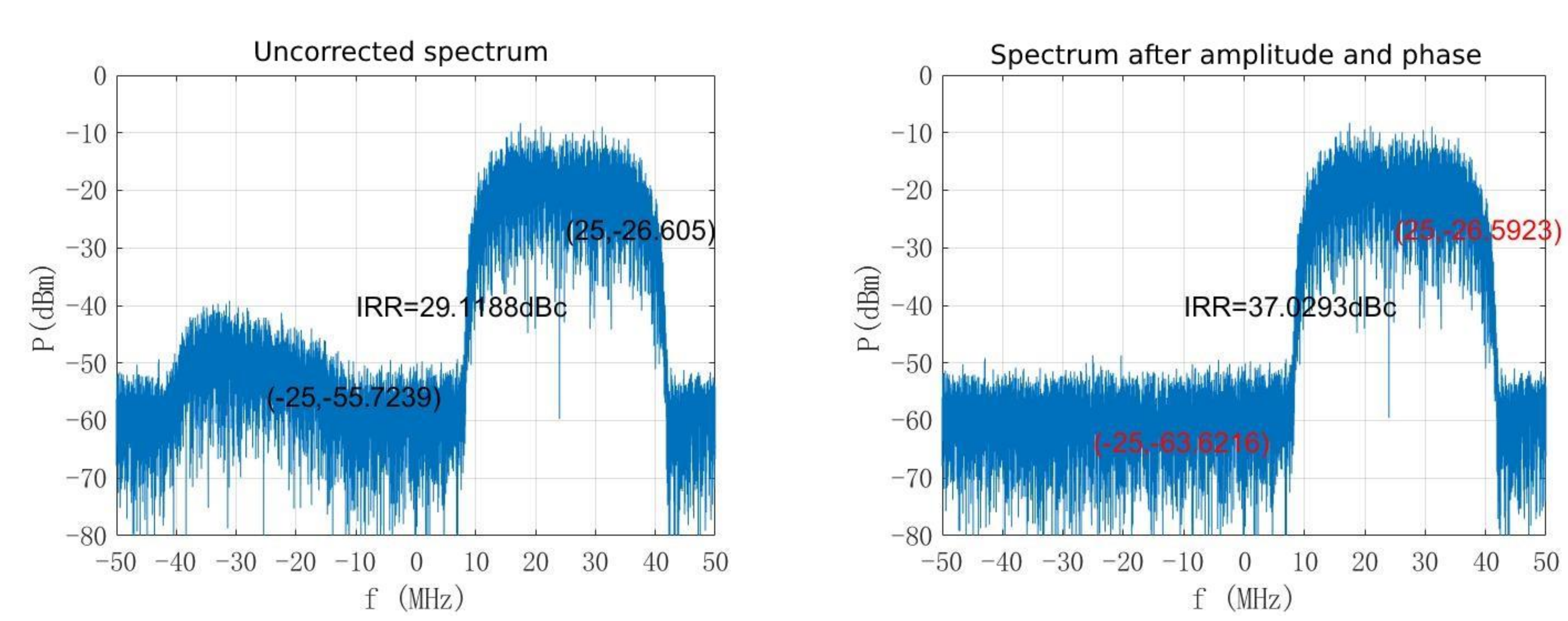
(a) (b)

(a)Spectrum before specular frequency suppression of 10MHz single-tone signal. (b) Spectrum after specular frequency suppression of 10MHz single-tone signal.

B. Effect of image frequency suppression at different frequencies



C. Image frequency suppression effect of modulation signal



(a) (b)

(a) Uncorrected spectrum with 25MHz bandwidth. (b) Spectrum after 25MHz bandwidth correction.

CONCLUSION

We propose a correction algorithm for I/Q amplitude-phase imbalance used in the receiver. This algorithm can be applied to the correction of I/Q amplitude-phase imbalance of single-tone signal and I/Q amplitude-phase imbalance of modulated signal. The test results show that this correction algorithm can effectively improve the image frequency rejection ratio of the receiver.

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