The design and implementation of Virtual Automatic Direction Finding (ADF) Based on LABVIEV

Program and principle brief introduction

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ADF brief introduction

When an aircraft is flying in the air, it is necessary to determine its own direction. Some people think that since the radio wave can propagate at high speed in all directions, it is possible to establish a radio beacon station to send radio waves to the outside world through the antenna, and then install a receiver on the aircraft, and use the receiving equipment to determine the relative angle between the longitudinal axis of the aircraft and the beacon station, so as to determine the direction of the aircraft.

So people set up a non directional radio beacon (NDB), which has a large antenna that can transmit radio waves of a specific frequency to all directions.

ADF principle formula

Antenna signal simulation

Sinusoidal loop antenna to receive terrestrial station signal: $V1 = A \sin x \cos \omega_c t$

Cosine loop antenna to receive terrestrial station signal: $V2 = A \cos x \cos \omega_c t$

A----The amplitude of the signal voltage X----The relative azimuth angle of the aircraft and the ground station

ω_c----Carrier angular frequency of receiving terrestrial station signal

The two balanced modulators are respectively modulated by low-frequency ωm (such as 96Hz) sine and cosine modulation numbers, and the output signals after modulation are V3 and V4:

$$V3=V1\sin \omega m\ t = A\sin\theta \cos \omega ct \sin \omega m\ t$$

$$V4=V2\cos\omega m\ t = A\cos\theta \cos \omega ct \cos \omega m\ t$$

Combine V3 and V4 to obtain a combined modulation signal V5:

$$\begin{aligned} V5 &= V3+V4 \\ &= A\cos \omega ct\ (A\sin\theta \sin\omega m\ t + \cos\theta \cos \omega m\ t) \\ &= A\cos \omega ct \cos (\omega m\ t-\theta) \end{aligned}$$

V5 is a function containing the relative azimuth angle θ. The signal received by the vertical antenna and the output signal after the phase shift is 90 degrees are V6 and V7:

$$V6= B \sin\omega ct \qquad V7= B \cos\omega ct$$

The phase-shifted vertical antenna signal V7 and the combined modulation signal V5 are superimposed to obtain V8:

$$\begin{aligned} V8 &= V7+V5= B \cos \omega ct + A\cos \omega ct \cos (\omega m\ t-\theta) \\ &= B \cos \omega ct\ [1+A/B \cos (\omega m\ t-\theta)] \end{aligned}$$

V8 is a heart-shaped directional map with θ angle as a function.

ADF principle formula

$$V_{10} = K\cos(\omega_m t - \theta)$$

V_{10} is added to the two phase detectors, the two low-frequency sine ($\sin\omega_m t$) and cosine ($\cos\omega_m t$) signals from the modulator are also added to the two phase detectors respectively, and after phase detection, V'_{11} and V'_{12} are obtained:

$$V'_{11} = V_{10}\cos\omega_m t$$

$$= \frac{K}{2}[\cos\theta + \cos(2\omega_m t - \theta)]$$

$$V'_{12} = V_{10}\sin\omega_m t$$

$$= \frac{K}{2}[\sin\theta + \sin(2\omega_m t - \theta)$$

After filtering by the low-pass filter, the output of the phase detector is

$$V_{11} = K'\cos\theta$$

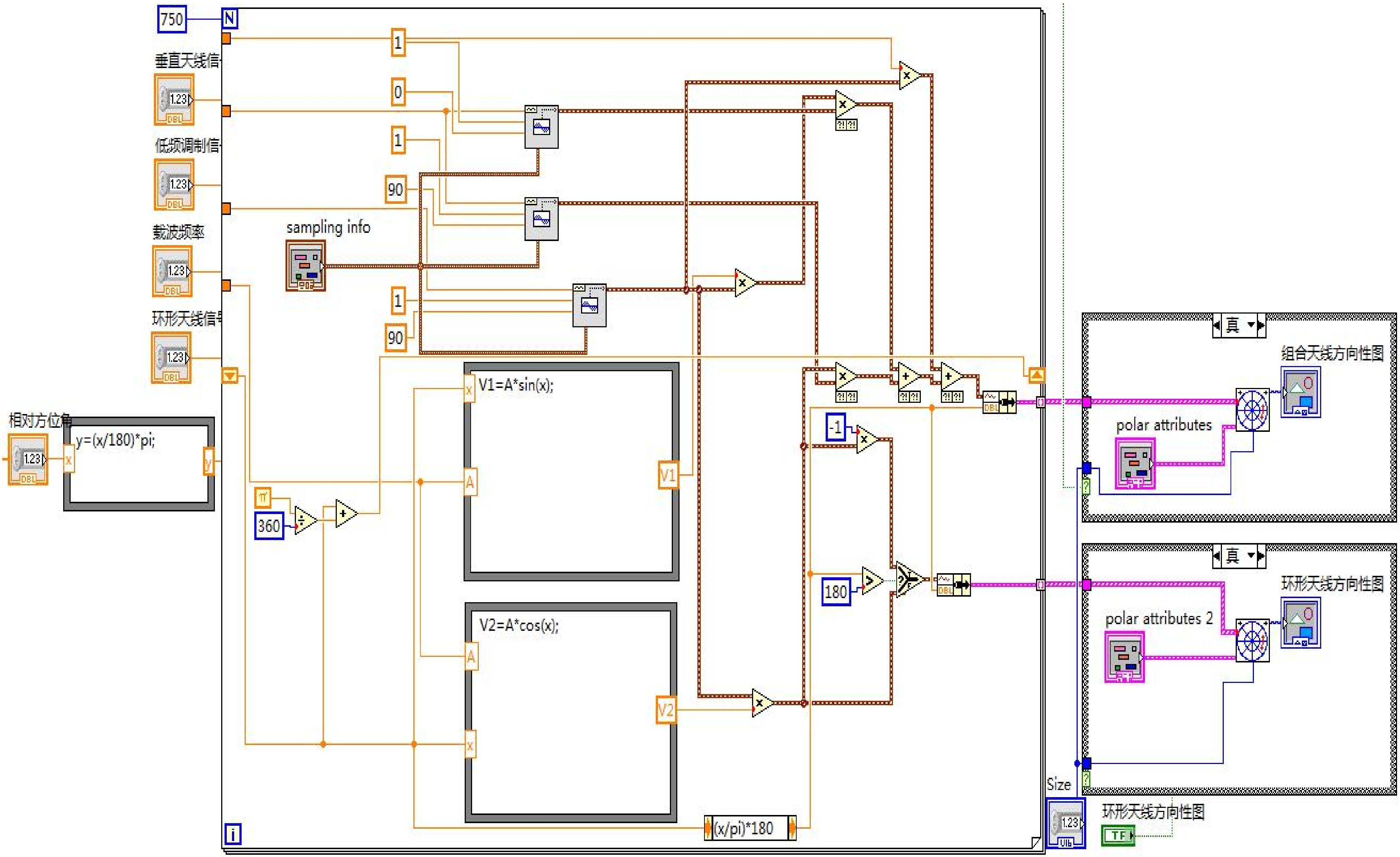
$$V_{12} = K'\sin\theta$$

Finally obtain the relative azimuth

$$\theta = \mathrm{arctg}\frac{\sin\vartheta}{\cos\theta}$$

LabVIEW program

Drawing of directional graph



Modulation and demodulation of signals

$$V_{10} = K\cos(\omega_m t - \theta)$$

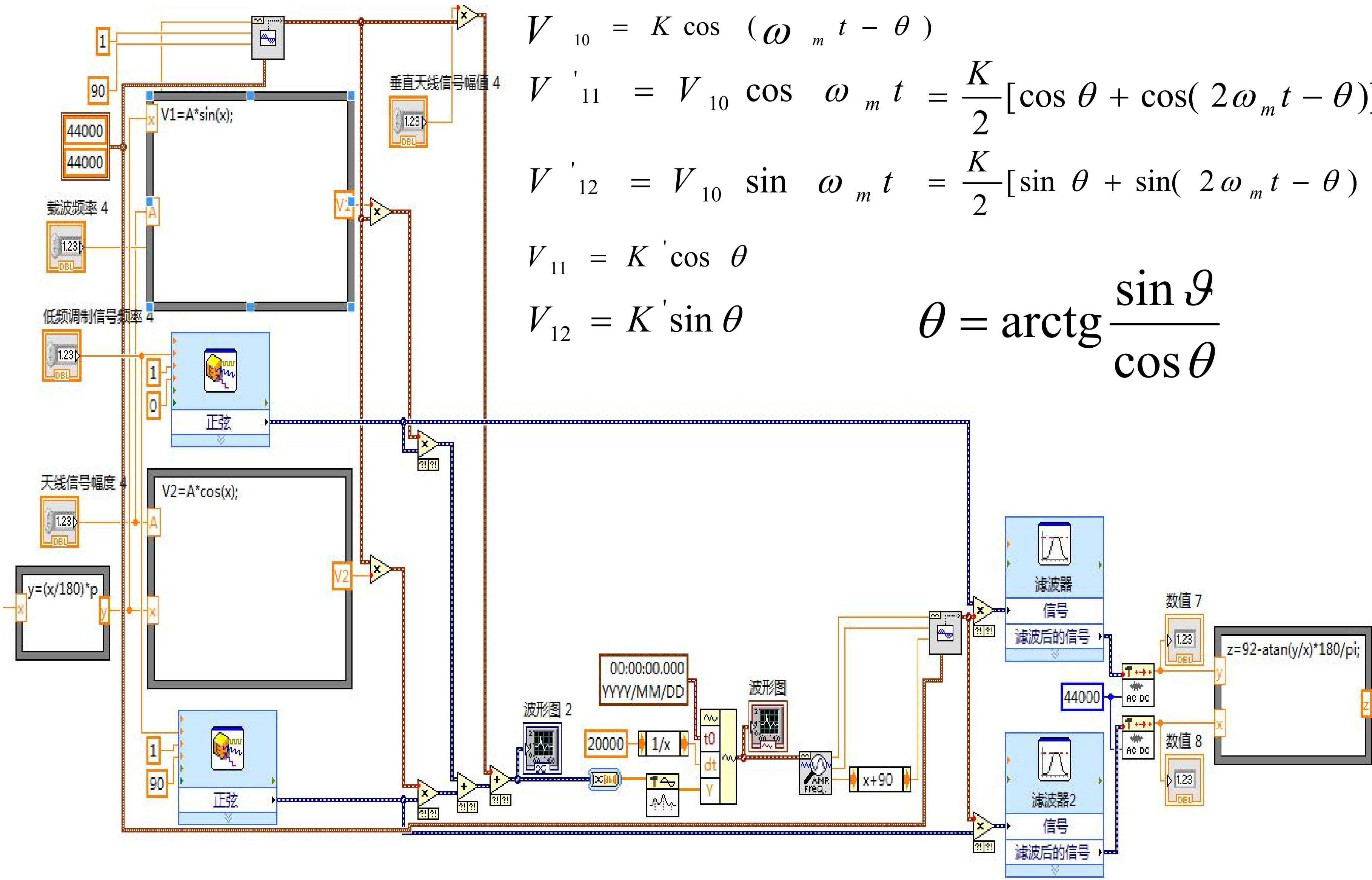
$$V'_{11} = V_{10}\cos\omega_m t = \frac{K}{2}[\cos\theta + \cos(2\omega_m t - \theta)]$$

$$V'_{12} = V_{10}\sin\omega_m t = \frac{K}{2}[\sin\theta + \sin(2\omega_m t - \theta)]$$

$$V_{11} = K'\cos\theta$$

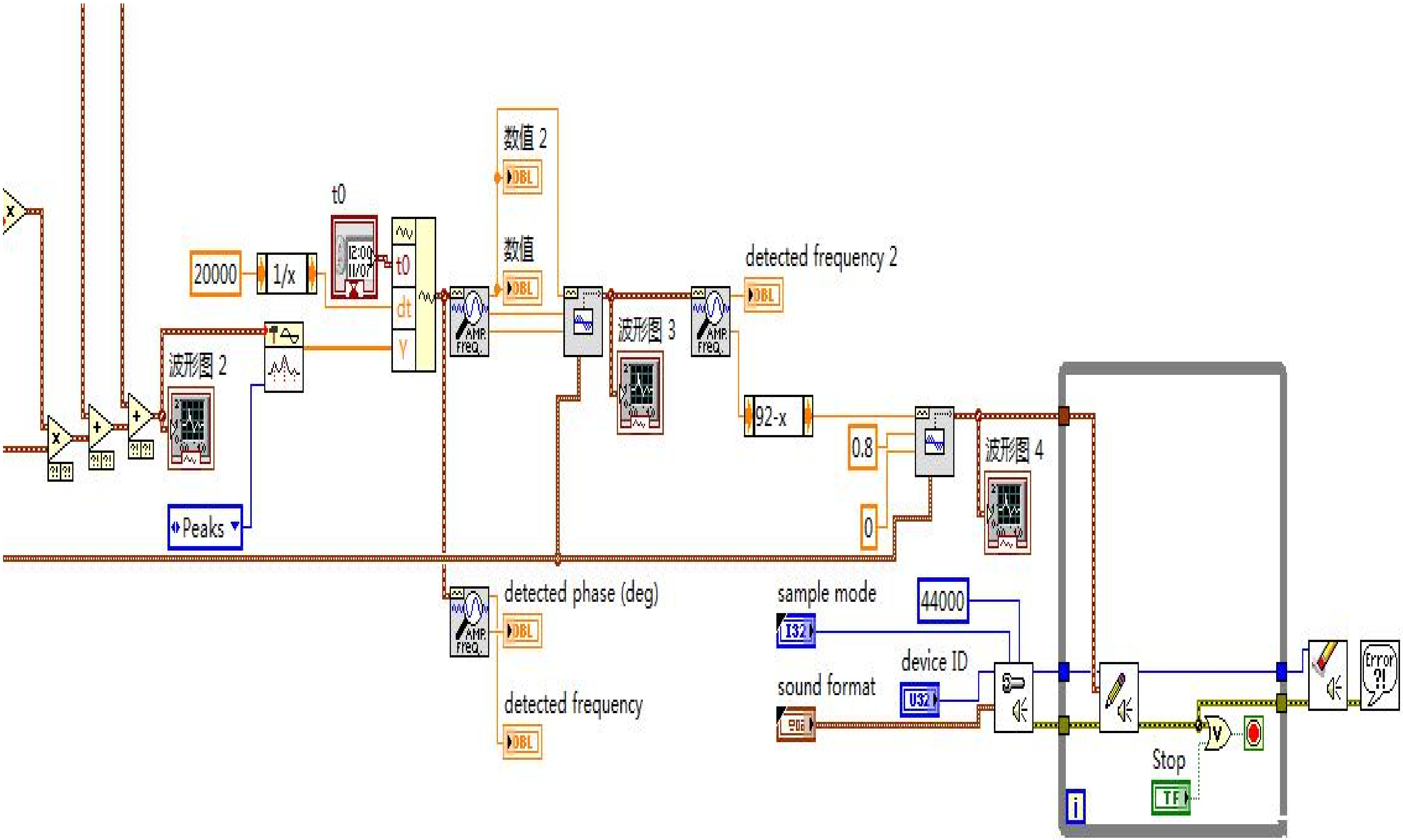
$$V_{12} = K'\sin\theta$$

$$\theta = \mathrm{arctg}\frac{\sin\vartheta}{\cos\theta}$$

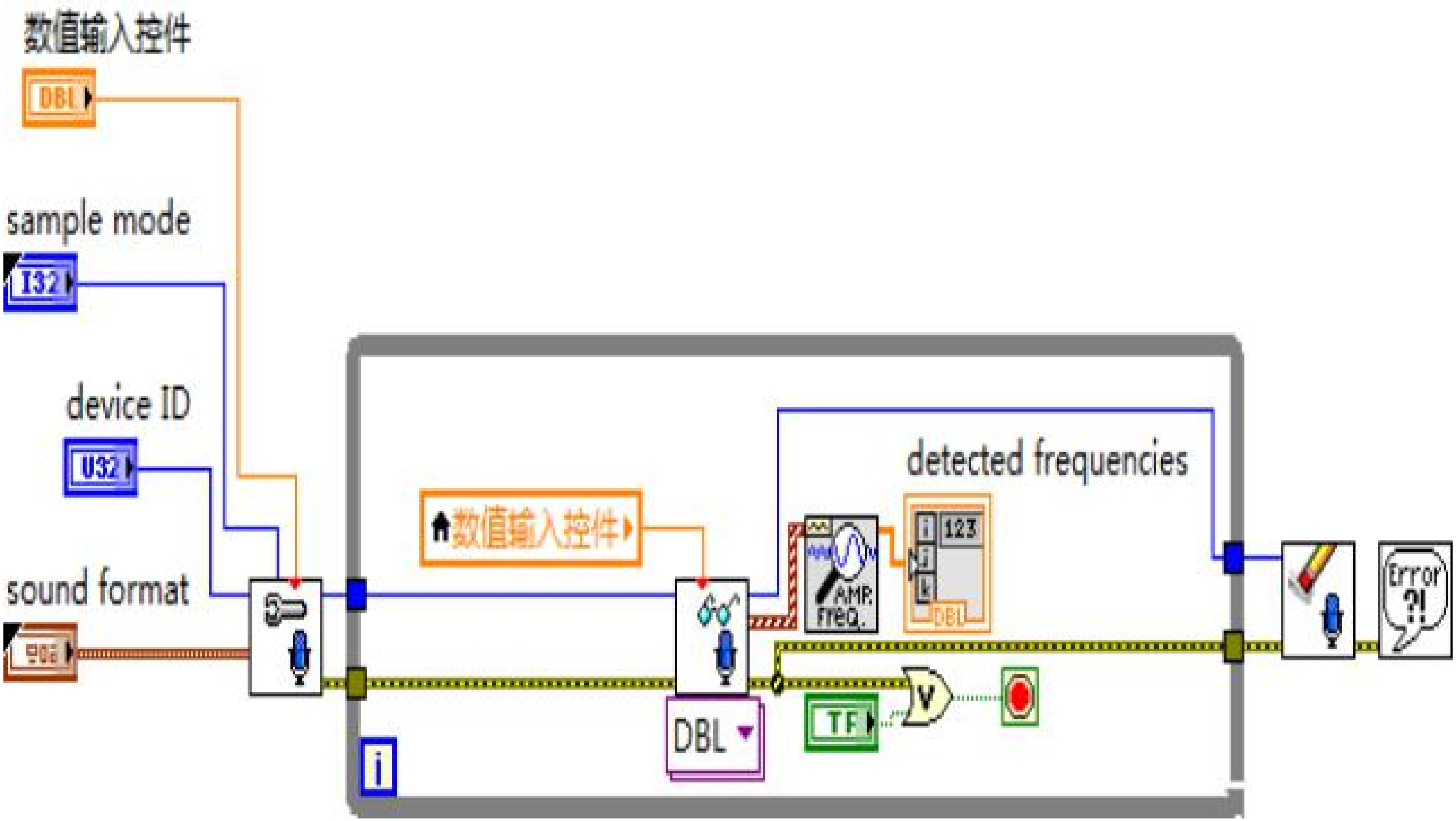


LabVIEW program

Transmission of dual computer communication

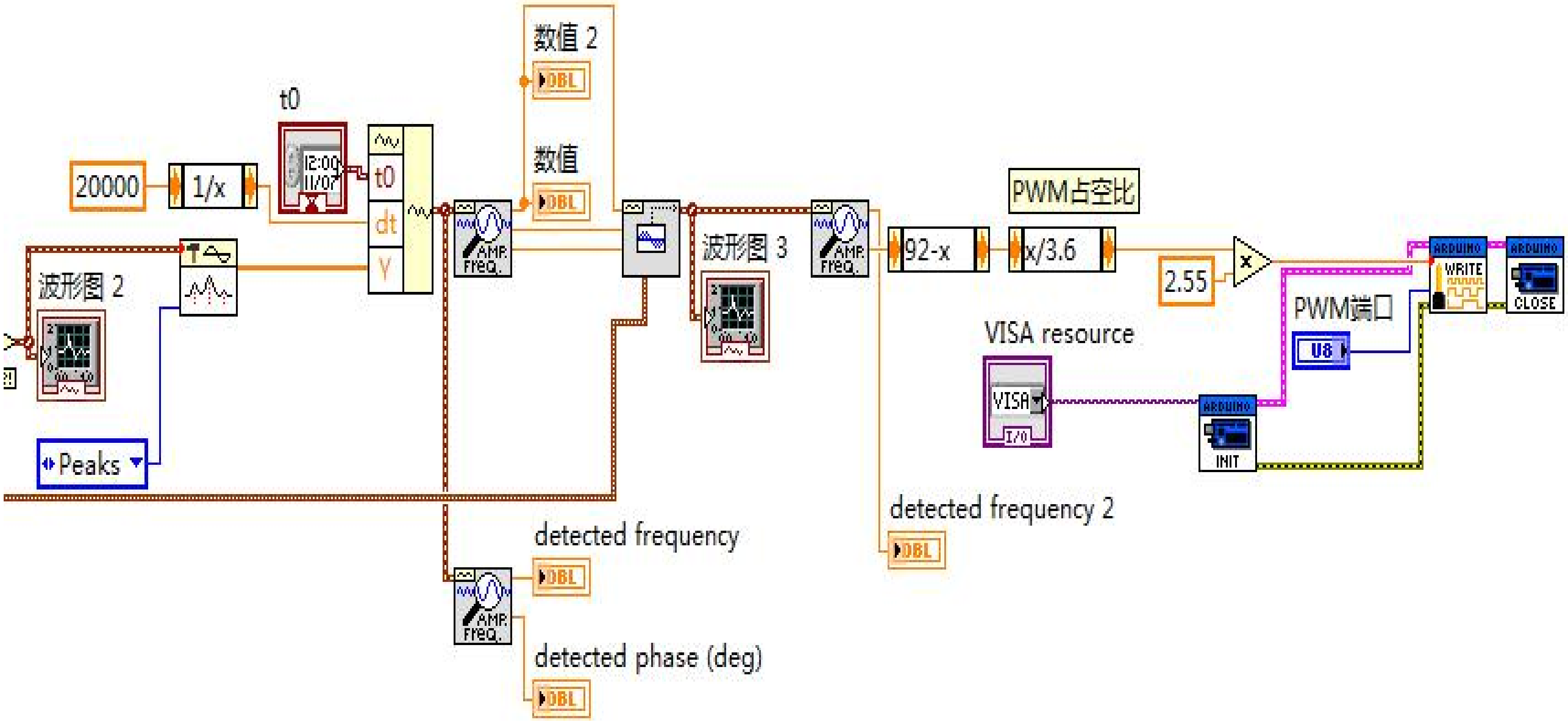


Reception of dual computer communication



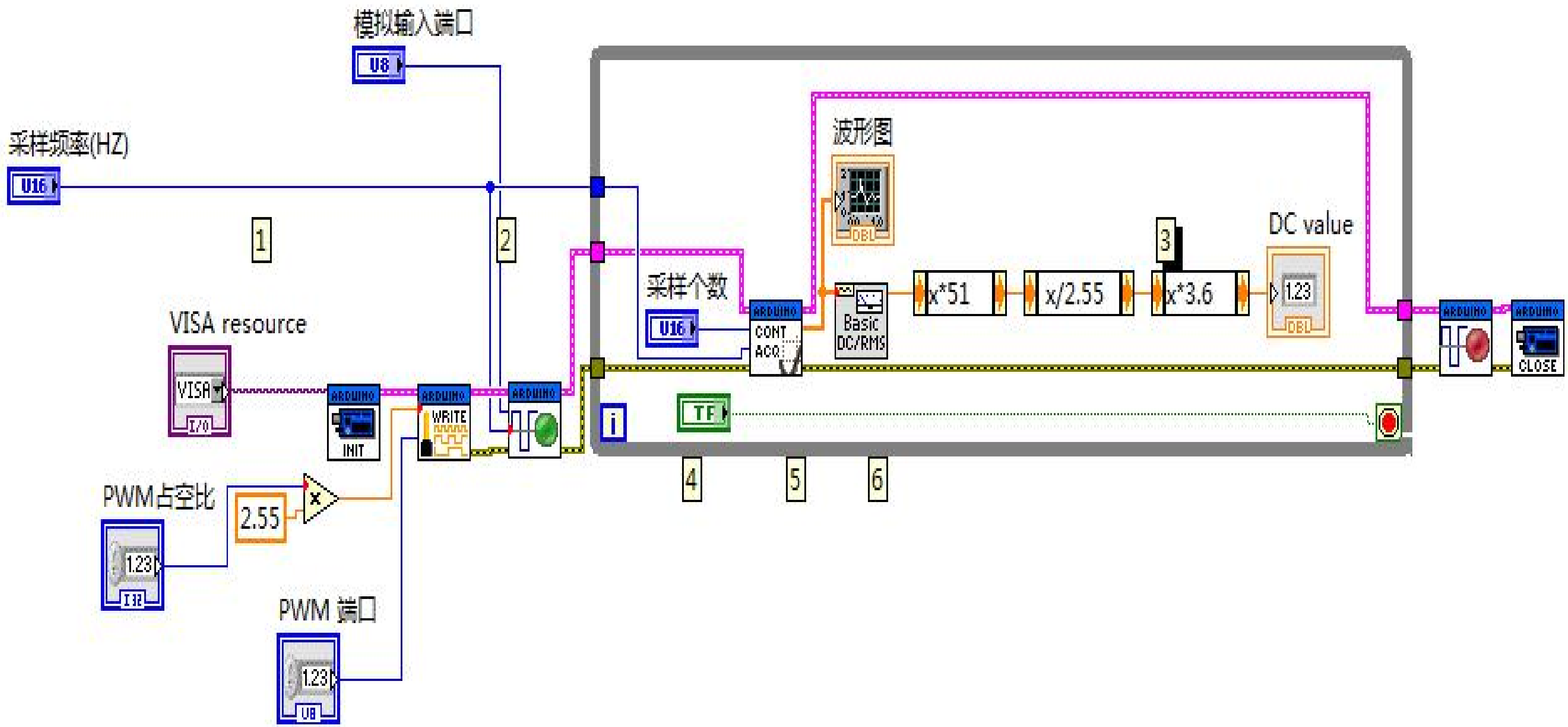
LabVIEW program

Transmitter



LabVIEW program

Receiver



Conclusion

Thank you for reading.

The entire program and principle of ADF are relatively complicated, and I want to introduce you to the results of this project in a simple form as possible. Because of the Chinese version of LabVIEW, there are some Chinese in the program. I apologize for the trouble it may cause you. Hope to gain your understanding. Thank you very much.