Design of shock-resistant miniaturized shipborne radar confluence ring

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Abstract. In order to reduce the overall size of the shipborne radar and improve the reliability of signal transmission, a miniaturized design has been carried out on the shipboard radar confluence ring. The miniaturized confluence ring adopted the electric contact form that the brush wires and the conductive ring are matched. The brush wires and the conductive ring coating used high-performance noble metal electrical contact materials, and the contact force was designed to be 0.1N to ensure the reliable and effective electrical contact. In addition, the dynamic design analysis method (DDAM) was used to analyze the shock resistance of the confluence ring. The test results showed that the size of the confluence ring had been reduced, all performance indicators met the requirements, and reliable transmission of various signals could be realized; the calculation results showed that the maximum impact stress of the confluence ring was less than the yield strength of the shell material, which met the requirements of the ship equipment shock resistance design requirements. The design method and analysis results have reference value and guiding significance for the miniaturization design and shock assessment of shipborne radar confluence ring.

1. Introduction

The confluence ring is the connecting device between the fixed part and the rotating part of the radar. It is a key component of the radar. Its main function is to transmit the power signal, control signal and network signal of each cabinet under the turntable to the top of the rotating antenna turntable [1]. According to different transmission signals, the confluence ring is divided into power ring, control ring, network ring and so on. When applied to shipborne radar, the confluence ring has a harsh working environment, high performance requirements, long trouble-free working time and long service life [2]. At the same time, the structure size and weight are also strictly limited. Therefore, the demand for miniaturization of the confluence ring of shipborne radars is increasing day by day.

The shock resistance of ship equipment is an important index to evaluate the survivability of ships, and the confluence ring is an indispensable equipment on shipborne radar, so the confluence ring of shipborne radar must meet the shock resistance requirements. At present, the anti-shock design analysis methods mainly include the equivalent static method, the dynamic design analysis method (DDAM) and the time domain simulation method. Among them, DDAM has the advantages of fast calculation speed and low resource requirements, and is widely used in the shock assessment of shipboard equipment [3].

Aiming at the requirements and characteristics of shipborne radar signal transmission, this paper adopted the electric contact technology of precious metal brush wire and conductive ring to design a miniaturized confluence ring for shipborne radar, and it used DDAM to simulate its shock resistance.
Not only the reliable transmission of various signals was realized, but also the shock resistance performance of the miniaturized confluence ring was obtained, which provided a reference for the design of the shock resistant miniaturized confluence ring.

2. Miniaturization design

The key to miniaturization of the confluence ring lies in the change of the electrical contact structure. The electrical contact structure of the confluence ring mainly includes piston structure, cantilever structure, and metal brush bundle or brush wire structure. Among them, the metal brush bundle or brush wire structure can significantly reduce the overall size of the confluence ring [4]. Compared with the brush bundle, the combination of the brush wire and the conductive ring can reduce the thickness of the conductive ring, thereby further reducing the size of the confluence ring. The confluence ring mainly relies on the electrical contact friction pair to realize the transmission of electrical signals, so the performance of the electrical contact material directly determines the reliability, stability and service life of the confluence ring transmission [5]. Therefore, a high-performance noble metal electrical contact material and an electrical contact structure in which the brush wire and the conductive ring are matched has been used to realize the miniaturization design of the confluence ring.

2.1. Overall design

The confluence ring adopted a column-type laminated structure, which was mainly composed of ring core components, brush wire components, bearings, shells, outer covers and other parts. The ring core and the shell of the confluence ring were connected by two sets of upper and lower bearings, and the rotor and the stator were respectively installed with sockets. The overall structure diagram of the confluence ring is shown in Figure 1, and the specific performance index requirements are shown in Table 1.

![Figure 1. Schematic diagram of the confluence ring structure.](image)

| Type of rings   | Ampacity (A) | Rated voltage (V) | Withstand voltage (V) | Insulation resistance (MΩ) | Contact resistance (mΩ) | Contact resistance change (mΩ) | Network speed (Mbps) |
|----------------|--------------|-------------------|-----------------------|----------------------------|-------------------------|-------------------------------|---------------------|
| Power rings    | ≥12          | AC230             | ≥1500 (AC)            | >500                       | <20                     | <10                           |                     |
| Signal rings   | ≥2           | DC120             | ≥1000 (DC)            | >500                       | <30                     | <5                            |                     |
| Network rings  |              |                   | ≥500 (DC)             | >500                       | <30                     | <10                           | 1000                |

Table 1. Performance index requirements of the confluence ring.
The confluence ring was used for shipborne radar, and considering the working environment of ship equipment, it needed to meet the sealing level of IP67. Therefore, the confluence ring was designed as a full seal, in which the dynamic seal adopted rotating shaft lip seal rings with secondary lip inner skeleton type, and the static seal adopted O-rings.

2.2. Structural design

The signal transmission in the confluence ring was realized by the electric contact friction pair formed by the relative movement of the brush wire and the conductive ring. The conductive ring was in the ring core assembly, and the brush wire was in the brush wire assembly. Therefore, the structural design of the confluence ring focused on the design of the ring core assembly and the brush wire assembly.

2.2.1. Ring core assembly. The ring core assembly included a bottom tube, power rings, signal rings, network rings and shielding rings. Among them, the power rings, the signal rings and the network rings were used to transmit the power signal, control signal and network signal between the fixed part and the rotating part of the radar system respectively, and the shielding rings were used to reduce electromagnetic interference during network data transmission. The conductive rings of the power rings and the signal rings were isolated by insulating rings. The conductive rings of the network rings were isolated by insulating rings, and the groups of the network rings were isolated by shielding rings.

The base material of the conductive ring was brass, and the surface was coated with gold and its alloy. The slideway of the conductive ring was designed to be semi-circular. So that in actual work, the brush wire is not easy to slip off the slideway of the conductive ring, the electrical contact area is large after running, and the dust is not easy to accumulate, which can effectively improve the reliability of contact.

The safe operating voltage of the conductive ring was mainly related to the creepage distance. The rated working voltage of the power ring was AC230V. Considering the 10% bias value, the maximum working voltage of the power ring was 253V. And the rated working voltage of the signal ring was DC120V. According to the standard GB 7251.1-2013 [6], the pollution level was taken as 2. When the voltage is 320V and 125V, the minimum creepage distance of the long-term withstand voltage was 3.2mm and 1.5mm respectively. Under normal conditions, the creepage distances of the power ring and signal ring were 6mm and 5mm. Considering the extreme situation that the worn dust fills the end face of the insulating ring under the conductive ring, as shown in Figure 2, the minimum creepage distances of the power ring and the signal ring were 4mm and 3mm respectively, which were greater than the minimum creepage distance of the long-term voltage, so they met the requirements of the safe use of the rated voltage.

![Figure 2. Schematic diagram of minimum creepage distance of power ring and signal ring.](image)

Commonly used insulating ring materials included polytetrafluoroethylene and epoxy resin. Considering that polytetrafluoroethylene was low in hardness, difficult to process, and had strong electrostatic adsorption, the insulating ring of the confluence ring used epoxy resin insulating materials. The rated working voltage of the epoxy material was about 10kV·mm⁻¹, and the insulation thickness
between the power ring, signal ring and network ring were 2mm, 1mm and 1mm respectively, and the rated working voltage was 20kV, 10kV and 10kV respectively. The AC and DC withstand voltage values were 2 to 4 times the rated working voltage, which was far greater than the power ring withstand voltage $\geq 1.5kV$ (AC), the signal ring withstand voltage $\geq 1kV$ (DC), and the network ring withstand voltage $\geq 0.5kV$ (DC).

The insulation resistance between the ring and the ring was related to the design of the insulation ring. The calculation formula of the insulation resistance is as follows:

$$R_I = \frac{R_V \cdot R_S}{R_V + R_S}$$  \hspace{1cm} (1)

In the formula: $R_I$ is the insulation resistance; $R_V$ is the volume resistance; $R_S$ is the surface resistance. The calculation formulas of volume resistance and surface resistance are as follows:

$$R_V = \frac{\rho_V L}{S}$$  \hspace{1cm} (2)

$$R_S = \frac{\rho_S T}{C}$$  \hspace{1cm} (3)

In the formula, $\rho_V$ is the volume resistivity; $L$ is the thinnest wall thickness; $S$ is the cross-sectional area corresponding to the thinnest wall thickness; $\rho_S$ is the surface resistivity; $T$ is the creepage distance between conductive rings; $C$ is the outer circumference of the conductor ring.

Taking the volume resistivity of epoxy resin $1\times10^{15}\Omega\cdot cm$ and the surface resistivity of $1\times10^{15}\Omega\cdot cm$, taking the signal ring with the smallest insulation thickness as an example, the insulation resistance $R_I = 1.15\times10^5M\Omega$ could be calculated. Therefore, all the insulation resistance of the ring was not less than $1.15\times10^5M\Omega$, which met the requirement of insulation resistance $>500M\Omega$.

2.2.2. Brush wire assembly. The brush wire assembly was composed of a printed circuit board and brush wires, and the brush wire material was made of gold-nickel alloy. Each power ring had 2 semi-circular slides, and each slide was crimped with 4 brush wires. The cross-sectional area of the brush wire was about 0.5mm$^2$, and the current density was 10A·mm$^{-2}$. Considering the extreme case, only half of the brush wires were in contact with the conductive ring, the current that the ring could pass was at least 20A, which met the requirement of power ring current $\geq 12A$. Each signal ring had a semi-circular slide. Similarly, each channel could pass a current of at least 10A, which met the requirement of signal ring current $\geq 2A$.

The contact surface of the electric contact friction pair produced contact resistance. The contact resistance and its change were important indicators to measure the contact state of the conductive ring and the brush wire and the stability of electrical signal transmission. Contact resistance included shrinkage resistance and film resistance. Shrinkage resistance referred to the resistance due to the reduction of the effective conductive area of the contact point, and the film resistance referred to the resistance generated by the oxidation of the contact surface to generate an oxide film. The calculation formula for the contact resistance of each contact point between the conductive ring and the brush wire is as follows [7]:

$$R_c = R_{s1} + R_{s2} + R_I = \frac{\rho_1 + \rho_2}{4\alpha} + R_I$$  \hspace{1cm} (4)

In the formula, $R_c$ is the contact resistance; $R_{s1}$ and $R_{s2}$ are the contraction resistance of the conductive ring and the brush filament; $R_I$ is the film resistance; $\rho_1$, $\rho_2$ are the resistivity of the conductive ring and the brush filament, and $\alpha$ is the equivalent radius of the contact point.

Considering the hardness and contact force, the calculation formula of contact resistance is as follows:
In the formula, \( H \) is the softer hardness of the conductive ring and the brush wire; \( F \) is the contact force between the conductive ring and the brush wire.

It can be seen from the Formula (5) that the contact resistance is related to the resistivity, hardness and contact force. The greater the contact force, the smaller the contact resistance, but it will also increase the wear of the contact surface, thereby affecting the life of the electrical contact friction pair. In order to ensure the stability, reliability and service life of the confluence ring transmission, combined with engineering experience, the contact force \( F = 0.1 \text{N} \) was selected. The schematic diagram of the structure of the electrical contact friction pair is shown in Figure 3.

\[
R_c = \frac{\rho_l + \rho_2}{4} \sqrt{\frac{\pi H}{F}} + R_i
\]  

(5)

\[ R_c = \frac{\rho_l + \rho_2}{4} \sqrt{\frac{\pi H}{F}} + R_i \]

In addition, the contact resistance was also related to the water vapor and dust that may be generated between the conductive ring and the brush wire. The confluence ring adopted a fully sealed structure, so water vapor and dust could not enter. Therefore, the contact resistance and its change value were correspondingly small.

3. Shock resistant design

As an important part of the shipborne radar, the confluence ring must be analyzed for its anti-shock capability during the development process. In this paper, DDAM was used to calculate the shock resistance of the designed miniaturized confluence ring.

3.1. DDAM theoretical analysis

DDAM is based on the main modal theory. First, the equipment is simplified into a spring mass system, and the modal analysis is performed on it to obtain the modal shape, modal frequency and quality of each mode; then according to the national military standard GJB 1060.1-91 regulations for the calculation of the impact load of equipment in different installation areas [8], deduced the modal displacement and stress of each mode under the impact input spectrum; finally, in accordance with navy regulations, the NRL synthesis method is used to calculate the displacement and stress of the equipment under the impact of the input spectrum [9].

For a confluence ring with multiple degrees of freedom, the differential equation of motion when it is subjected to basic acceleration is [10]:

\[
[m]\dddot{x} + [k]{x} = -[m]{f} \ddot{z}(t)
\]

(6)

In the formula, \([m]\) is the mass matrix; \([k]\) is the stiffness matrix; \({x}\) is the displacement vector; \({\dddot{x}}\) is the acceleration vector; \({f}\) is the n-th order unit vector; \(\ddot{z}(t)\) is the basic acceleration.

The formula for calculating the mode participation factor \(P_n\) of the nth mode is:
The formula for calculating the modal mass $M_n$ of the $n$th mode is:

$$M_n = \sum_i m_i x_{ni}$$

(8)

The formula for calculating synthetic stress using NRL method is:

$$\sigma_{\text{shock}} = |\sigma_{n(\text{max})}| + \sqrt{\sum_n \sigma_n^2 - (\sigma_{n(\text{max})})^2}$$

(9)

In the formula, $\sigma_n$ is the maximum value of the $n$th mode Von Mises dynamic stress at a certain point of the confluence ring; $\sigma_{n(\text{max})}$ is the maximum value of the Von Mises dynamic stress of all modes at a certain point of the confluence ring; $\sigma\text{\text{shock}}$ is the effective impact dynamic stress at a point of the confluence ring.

The effective impact stress of the confluence ring should be integrated with the working stress caused by the continuous rotation of the confluence ring. The stress caused by the gravity of the confluence ring, the pre-tightening force caused by the fastening of the housing mounting screws and the stress caused by the non-continuous operation of the confluence ring should be ignored during the stress synthesis [11]. Then the calculation formula of the total stress is:

$$\sigma_{\text{total}} = |\sigma_{\text{shock}}| + |\sigma_{\text{work}}|$$

(10)

In the formula, $\sigma_{\text{total}}$ is the total stress under the impact environment of the confluence ring; $\sigma_{\text{work}}$ is the Von Mises continuous working stress at a certain point of the confluence ring.

Comparing the total stress of the confluence ring under the ship-borne impact environment calculated by the above method and the yield strength of its material could be used to evaluate the shock resistance of the confluence ring structure.

3.2. Establishment of finite element model

The material of the bottom tube and the outer cover of the ring core assembly of the confluence ring was steel, and the material of the outer shell was aluminum alloy. Compared with the bottom tube and the outer cover, the yield strength of the confluence ring shell material was lower, so impact analysis of the shell was required. The bottom tube and the outer cover were fixed by bolts and replaced by equivalent mass points. In order to improve the quality of meshing, the small features such as holes, fillets, chamfers, grooves, and step surfaces in the model were simplified without affecting the accuracy of the calculation results. After processing, tetrahedral elements were used to mesh the confluence ring. The finite element model is shown in Figure 4, with a total of 152764 elements and 287611 nodes.

Figure 4. Finite element model of the confluence ring.
3.3. Modal analysis

The first 20 modes of the confluence ring were solved and calculated, and the modal shapes and modal quality corresponding to the modal sequence 1 to 20 could be obtained. Among them, the first 6 modes of the confluence ring are shown in Figure 5. In the modal calculation of the confluence ring, the screw holes on the bottom mounting surface were fixed. The first-order modal frequency of the confluence ring was 184.89 Hz, which was greater than the highest frequency of 50Hz in the ship environmental swept sinusoidal vibration test, indicating that the confluence ring had good rigidity.

(a) 1st-order mode shape diagram                      (b) 2nd-order mode shape diagram

(c) 3rd-order mode shape diagram                      (d) 4th-order mode shape diagram

(e) 5th-order mode shape diagram                      (f) 6th-order mode shape diagram

Figure 5. Vibration shape diagram of the first 6 modes of the confluence ring.
3.4. Design shock spectrum calculation

The confluence ring is installed on the deck of the ship. From GJB 1060.1-91, the impact input spectrum of the confluence ring elastic design can be obtained, as shown in Table 2. The vertical, transversal and longitudinal directions correspond to the Y, Z, and X directions in Figure 4 respectively.

| Installation position | Impact direction | Isoacceleration spectrum (m·s⁻²) | Isovelocity spectrum (m·s⁻¹) |
|-----------------------|------------------|----------------------------------|-------------------------------|
| Deck position         | Vertical         | 1.0A₀                           | 0.5A₀                        |
|                       | Transversal      | 0.4A₀                           | 0.2A₀                        |
|                       | Longitudinal     | 0.2A₀                           | 0.2A₀                        |

For the confluence ring installed on the deck, the following is the calculation formula of $A₀$ and $V₀$ in Table 2:

$$A₀ = 98.1 \times \frac{19.05 + M_n}{2.72 + M_n}$$

(11)

$$V₀ = 1.52 \times \frac{5.44 + M_n}{2.72 + M_n}$$

(12)

In the formula: $M_n$ is the modal mass of the confluence ring, the unit is t; $A₀$ is the nominal acceleration spectrum, the unit is m·s⁻²; $V₀$ is the nominal velocity spectrum, the unit is m·s⁻¹.

Substituting the modal mass $M_n$ of the confluence ring into the formula can obtain $A₀$ and $V₀$, and then from Table 2 can calculate the corresponding $A_n$ and $V_n$ in the vertical, transversal and longitudinal impact directions of the confluence ring. Take the smaller value of $A_n$ and $V_n$ as the input acceleration of the confluence ring shock design, where $ω_n$ is the circular frequency corresponding to the modal mass $M_n$ of the confluence ring.

The impact design acceleration of the confluence ring in the vertical, transversal and longitudinal impact directions are shown in Tables 3, 4 and 5 respectively.

### Table 3. Vertical impact design acceleration of the confluence ring.

| Modal order | Frequency (Hz) | $M_n$ (t) | Percentage (%) | $A_n$ (m·s⁻²) | $V_n$ (m·s⁻¹) |
|-------------|----------------|-----------|----------------|---------------|---------------|
| 3           | 581.16         | 0.0299    | 91.06          | 680.66        | 1.512         |
| 8           | 1078.25        | 0.000035  | 0.11           | 687.05        | 1.52          |
| 9           | 1173.3         | 0.000053  | 0.16           | 687.05        | 1.52          |
| 13          | 1269.25        | 0.000337  | 1.02           | 686.99        | 1.52          |
| 18          | 1907.76        | 0.00106   | 3.21           | 686.83        | 1.52          |
| 20          | 2053.24        | 0.000036  | 0.11           | 687.05        | 1.52          |

### Table 4. Transversal impact design acceleration of the confluence ring.

| Modal order | Frequency (Hz) | $M_n$ (t) | Percentage (%) | $A_n$ (m·s⁻²) | $V_n$ (m·s⁻¹) |
|-------------|----------------|-----------|----------------|---------------|---------------|
| 1           | 184.89         | 0.027085  | 82.4           | 272.5         | 0.605         |
| 6           | 1012.4         | 0.000201  | 0.61           | 274.81        | 0.608         |
| 8           | 1078.25        | 0.000275  | 0.84           | 274.8         | 0.608         |
| 20          | 2053.24        | 0.000034  | 0.11           | 274.82        | 0.608         |
Table 5. Longitudinal impact design acceleration of the confluence ring.

| Modal order | Frequency (Hz) | $M_n$ (t) | Percentage (%) | $A_n$ (m·s$^{-2}$) | $V_n$ (m·s$^{-1}$) |
|-------------|----------------|-----------|----------------|-------------------|-----------------|
| 2           | 189.63         | 0.0268    | 81.59          | 136.26            | 0.605           |
| 4           | 870.91         | 0.000299  | 0.91           | 137.4             | 0.608           |
| 5           | 902.39         | 0.00129   | 0.39           | 137.41            | 0.608           |
| 7           | 1015.69        | 0.000271  | 0.83           | 137.4             | 0.608           |
| 10          | 1176.02        | 0.000064  | 0.2            | 137.41            | 0.608           |
| 14          | 1565           | 0.000051  | 0.15           | 137.41            | 0.608           |
| 17          | 1719.81        | 0.000976  | 3              | 137.37            | 0.608           |

It can be seen from the tables that the sum of the percentages of the total mass of the selected modes in the three directions is 95.8%, 84%, 87.1%, which are all greater than 80%. Therefore, the modal quality obtained by extracting the first 20 steps of the confluence ring met the impact resistance design requirements of the National Military Standard GJB 1060.1-91. In addition, it can be seen from the table that the maximum impact input of the confluence ring comes from the vertical direction, followed by the transversal direction, and the longitudinal direction is the smallest.

4. Results and analysis

4.1. Test results and analysis

This brush wire type confluence ring includes 16 power rings, 50 signal rings and 16 network rings, with a total length of 538.5mm; a piston type brush block type confluence ring includes 10 power rings and 55 signal rings, with a total length of 700mm; a brush bundle type confluence ring includes 15 power loops and 64 signal loops, with a total length of 661mm. It can be seen that, compared with the piston type and brush block type confluence ring, the size of the brush wire type confluence ring is greatly reduced; compared with the brush bundle type confluence ring, the size of the brush wire type confluence ring is also reduced. Therefore, the use of the electrical contact structure in which the brush wire and the conductive ring are matched can effectively reduce the axial size of the confluence ring and realize the miniaturization of the confluence ring.

The performance indicators of the confluence ring have been tested, and the specific results are as follows:

Power on the power ring and signal ring at 12A and 2A for 10 minutes, without overheating or short circuit; power on the power ring, signal ring, and network ring at 1500V, 1000V, 500V alternating current for 1 minute, without creepage or breakdown; under normal temperature and after the environmental test, the insulation resistance of the confluence ring exceeds 2000MΩ, which meets the requirement of insulation resistance greater than 500MΩ. Therefore, the current, withstand voltage and insulation performance of the confluence ring meet the requirements.

Table 6. Contact resistance and its variation of confluence ring.

| Type of rings     | Maximum contact resistance (mΩ) | Minimum contact resistance (mΩ) | Average contact resistance (mΩ) | Maximum contact resistance change (mΩ) | Minimum contact resistance change (mΩ) | Average contact resistance change (mΩ) |
|-------------------|---------------------------------|---------------------------------|---------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| Power rings       | 9.5                             | 5                               | 7.97                            | 1.5                                    | 0.5                                    | 0.94                                   |
| Signal rings      | 26.5                            | 16                              | 19.93                           | 4.5                                    | 1                                      | 2.06                                   |
| Network rings     | 27                              | 18                              | 22.56                           | 4                                      | 1.5                                    | 2.63                                   |

The test results of the contact resistance of the confluence ring and its variation are shown in Table 6. The maximum contact resistances of the power rings, signal rings, and network rings are 9.5mΩ, 26.5mΩ, 27mΩ respectively, which meet the requirements of power ring contact resistance < 20mΩ.
signal ring contact resistance $<30\,\text{m}\Omega$, network ring contact resistance $<30\,\text{m}\Omega$ performance indicators; the maximum contact resistance changes of power ring, signal ring, and network ring are 1.5mΩ, 4.5mΩ, 4mΩ, which also meet the requirements of power ring contact resistance change $<10\,\text{m}\Omega$, signal ring contact resistance change $<5\,\text{m}\Omega$, network ring contact resistance change $<10\,\text{m}\Omega$.

In the ring scan mode and fan scan mode, the network speed of the network ring has been tested respectively. The minimum values are 849.11Mbps and 827.59Mbps, which meet the requirements of the gigabit network speed.

In summary, the performance indicators of the power rings, signal rings, and network rings in the confluence ring all meet the requirements for use.

4.2. Calculation results and analysis

Through the DDAM calculation, the impact stress cloud diagrams of the confluence ring in the vertical, transversal and longitudinal directions have been obtained, as shown in Figure 6.

![Impact stress diagrams](image)

(a) Vertical impact stress diagram

(b) Transversal impact stress diagram

(c) Longitudinal impact stress diagram

**Figure 6.** Impact stress diagram of the confluence ring.
It can be seen from Figure 6 that the stress values of the bottom mounting surface and the side wall area of the confluence ring in the three impact directions of vertical, transversal and longitudinal are relatively large, and the maximum stress is located on the screw holes on the bottom mounting surface. The stress values are 79.5 MPa, 115 MPa, and 52.6 MPa, which are all less than the yield strength of 165 MPa of the aluminum alloy shell material of the confluence ring. It means that the confluence ring has not undergone plastic deformation and meets the requirements of elastic design. Due to the high center of gravity of the confluence ring, the maximum impact stress in the transverse direction is higher than the maximum impact stress in the vertical direction.

To sum up, the structure design of the confluence ring is reasonable, which meets the strength requirements of the anti-shock design of ship equipment.

5. Conclusions
Based on the high-performance electrical contact material and the electrical contact structure of the brush wire and the conductive ring, a miniaturized confluence ring was designed to realize the reliable transmission of power signal, control signal and network signal. In addition, DDAM was used to analyze the shock resistance of the confluence ring. The results showed that the confluence ring has the largest impact stress in the transversal impact direction, and the maximum stress value was less than the yield strength of its material, which met the requirements of shock resistance design. The design method in this paper provides a technical approach for the design of the anti-shock miniaturized confluence ring. It also has certain reference significance for the evaluation of the anti-shock performance of shipborne radar confluence ring, and has provided a certain theoretical basis for its wider engineering application.

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