Analysis and research on data transmission interference of telemetry monitoring equipment of navigation beacon under electromagnetic noise source environment

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Abstract

In the process of data transmission, the telemetry information monitoring equipment of navigational AIDS will be interfered by electromagnetic noise sources, which leads to the derivative problems of telemetry interference of navigational AIDS, that is, the regional, periodic and multiple time-out alarm problems of telemetry data of navigational AIDS in navigational AIDS information monitoring system. In order to solve the interference caused by environmental noise sources and further improve the anti-jamming and interference identification ability of telemetry information monitoring equipment of navigational markers in the jurisdiction area, this paper aims to analyze and study the electromagnetic interference problems of telemetry terminal module of navigational markers based on the actual daily management and maintenance work of navigational markers in the jurisdiction area. This paper tries to provide relevant help and countermeasures for the optimization of anti-interference ability of PLC integrated module of telemetry and remote control equipment of navigational AIDS and to improve the reliability, accuracy and timeliness of navigational AIDS information monitoring and supervision data.

Key words: navigation mark ,elemetry electromagnetic interference problem ,interference identification analysis research ,help and countermeasures

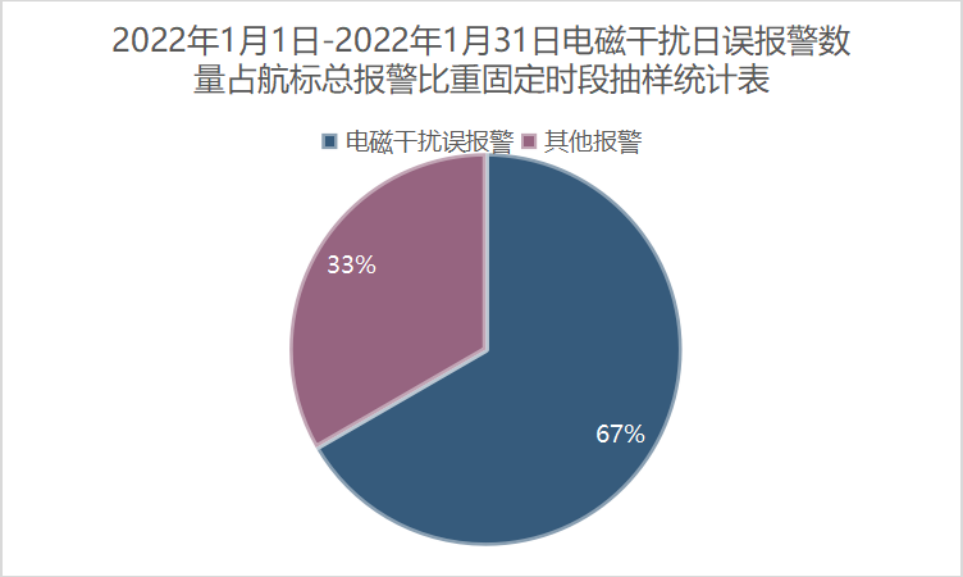
1. Study the significance of electromagnetic interference to navigation beacon information management

AIDS to navigation information management, with the help of information technology, beacons actual operation situation of the whole process of management, through the form of data collection for dynamic monitoring and monitoring of AIDS to navigation efficacy, and monitoring data is the important basis and measure whether the running state of the beacon continued effect evaluation of AIDS to navigation, give full play to the important means, therefore, Improving the reliability, accuracy and timeliness of the data transmission process of telemetry information equipment for navigational AIDS is an important basis and guarantee for reducing the operation risk of navigational AIDS and giving full play to the safety supervision efficiency. Because of the convenience and efficiency caused by AIDS to navigation information management, AIDS to navigation information monitoring facilities of widespread use become the inevitable trend, suffers from the co-existence of however a series of signal transmission interference problems, affects the AIDS to

navigation information supervision data transmission quality constantly, a problem in information management system of AIDS to navigation and challenges: This is because with the further promotion and application of electrical automation technology, a large number of electrical control work in the field of manufacturing equipment and communication transmission related equipment gradually put into use, around the beacon telemetry information monitoring equipment to form a strong electromagnetic frequency interference, the beacon telemetry data transmission process of information monitoring terminal equipment caused great disturbance. Therefore, the analysis and study AIDS to navigation telemetry terminal module interference problem, the beacon telemetry equipment deal with anti-jamming performance optimization of electromagnetic noise source environment, increase the feasibility of the anti-interference measures, relative economic and reasonable anti-interference measures are taken, thus improving the quality of AIDS to navigation telemetry data supervision information system, AIDS to navigation information supervision for management efficiency fully effective play.

2. Current situation of electromagnetic interference in telemetry of navigation AIDS

In lianyungang beacons in lianyun beacon station district as an example, based on the jurisdiction navigation beacon telemetry alarm number of regular hours daily sampling capture statistics, combining research offline, affected by electromagnetic interference lead to AIDS to navigation telemetry terminal data timeout error alarm beacon number (timeout is greater than 6 h) of all beacons alarm screenshots sampling statistics of major as shown below, Take January 1, 2022 -- January 31, 2022 as an example:



According to the sampling statistics of the number of daily telemetry alarms of navigational markers in the jurisdiction area at fixed time, electromagnetic interference leads to the proportion of telemetry alarms of navigational markers as high as two-thirds, which has become the main interference source affecting the data transmission quality of telemetry monitoring equipment of navigational markers. Among them, the most affected by electromagnetic interference is the external terminal of navigation beacon. Therefore, solving the electromagnetic interference problem plays a certain role in improving the fault identification of online navigational AIDS and giving full play to the efficiency of navigational AIDS information management.

3.A major source of electromagnetic interference problems.

According to the combination of online analysis and offline mapping, systematically check the electromagnetic interference sources within the jurisdiction area, analyze and summarize their working frequency band, timeout causes, area and coverage area online, and check and test the operation of navigation equipment and related performance parameters offline. The surrounding environment and the facilities and equipment that may cause signal interference are carefully surveyed. At present, the electromagnetic interference sources with large influence degree and scope in the area can be divided into the following two types:

3.1 Narrowband adjacent frequency interference of 5G RF communication

By visiting 5G communication service providers to understand their 5G working frequency bands (China Mobile (2515-2675mhz), China Telecom (3400-3500mhz), China Unicom (3500-3600mhz)) and working principles, Among them, the 5G working frequency band of China Telecom and China Unicom is adjacent to the Beidou working frequency band (3400-4200mhz). As the working frequency spectrum is basically the same, saturation interference of power amplifier is generated.

3.2 Broadband interference of electromagnetic wave in the operation of mechanical and electrical equipment

In the operation process of mechanical and electrical equipment, the motor is the main one, which may produce wide band interference and certain interference to the terminal working condition. This is because the rotor windings inside the motor produce variable magnetic field, and then lead to discharge between the steering gear and the brush, resulting in noise source. This mainly includes spark discharge between the steering gear and the brush to cause high-frequency noise source interference, resulting in terminal.

Produce a large range of interference, there are some electromagnetic distortion caused by other factors of the motor, there are rich in high harmonics, as well as electrical and mechanical equipment leakage tape to the high frequency high voltage electromagnetic pulse, these will affect the normal operation of electromagnetic equipment.

4. Analysis of main modes of electromagnetic interference

In practical navigation telemetry terminal equipment signal transmission quality stability of two main interference modes are common mode interference and differential mode interference:

4.1 Common mode interference

"Common-mode interference refers to the interference voltage signal in the signal lines and back online (commonly referred to as signal ground) formed by the same voltage amplitude, the voltage to any nearby objects (including the land, the metal battery box, and ground plate, etc.) as a reference potential, under the influence of interfering voltage, wire is relative to the reference object constitute the current loop. Under normal circumstances, the common mode current is mainly caused by the following reasons: first, the induced voltage generated by the external electromagnetic field of the equipment on the circuit wire (voltage to the ground is equal amplitude and in phase) produces the induced current; Second, the voltage difference between the two ends of the device connection position is different at both ends of the circuit, forming an induced current at the ground line; Third, there is a potential difference between the conductor on the device and the earth, forming a common mode induced current on the conductor. Common mode interference does not directly affect the device, but affects the device by converting to differential mode voltage." Quote [2] Common mode interference has a high working frequency. For the telemetry remote control terminal of navigation beacon, its working frequency is beidou operating frequency band (3400-4200mhz). If the common mode interference is strong, it will be converted into differential mode current when the circuit is unbalanced, which will cause great interference to the data transmission quality of the telemetry terminal. At present, common mode coil and filter can be used to

restrain the interference of common mode signal in a certain frequency band.

4.2 Differential mode interference

Differential mode interference refers to the interference voltage between the signal line and the loop (commonly known as ground wire), and the interference current loop is the current that forms the loop between the wire and the reference object. Space electromagnetic field in the signal which is formed by the coupling between the induction voltage and unbalanced circuit switching common-mode interference and form of voltage, can cause interference to the telemetry and telecontrol module control signal beacon, cause the system module is blocked, the process of signal transmission to a certain extent reduces the telemetry signals transmission quality, the stability of telemetry and telecontrol terminal beacon signal transmission quality problems. The main ways to eliminate differential mode interference can be through differential mode coil, filtering and so on.

5. Main path construction for accurate identification of electromagnetic interference noise sources.

Due to electromagnetic interference sources has spatial frequency difference is bigger, dense widely distributed, the working frequency and generation mechanism is complicated, a variety of external factors interweave and have the features of space more noise source, therefore how in the limited time and condition, the minimum economic and human cost, but also the space interference sources and the effective identification of interference pattern accurately, In order to better docking the follow-up relatively reasonable, economic, suitable anti-interference measures to choose. At present, the identification of electromagnetic interference sources in the area can be divided into the following two methods: online identification and on-site identification:

5.1 Main path construction for online identification

Online identification can mainly carry out online data collection and analysis of telemetry terminals with the help of navigational telemetry and remote control information management system. Through establishing index model and big data analysis method for data analysis during interference period, relevant data analysis can be carried out on the interfered situation of online telemetry data. Through the analysis of interference time, the length of data transmission time interval of telemetry terminal equipment is reflected, which is embodied in the discrete degree of point set of data transmission time interval, which can reflect the intensity of interference degree of telemetry terminal equipment to a certain extent.

This paper is a simple analysis and statistics of the telemetry interference period of online navigational AIDS in the form of charts:

Statistical rule: Data update interval of telemetry terminal is set to be updated every hour, and the part of statistical telemetry not updated in time (telemetry data is not updated after the update period exceeds 3h) is mainly used as the judgment basis and standard of timeout caused by interference. The definition of interference period is the distribution period of unupdated data of telemetry terminal of navigation beacon affected by interference for more than 3h, which is used as one of the basis to identify the intensity of interference in this paper.

According to the online analysis and row, the stage statistics of telemetry data as follows (to market lane guide light pile as an example), where the telemetry data update interval is greater than 3h approximately period as shown in the following. ⭕ means that there is no telemetry data update over 3h period on that day) :

5.1.1 Interference identification of electromagnetic wave noise sources generated during the operation of electromechanical equipment

Front guide area (mainly interference from electromagnetic wave noise source generated by the operation of electromechanical equipment engine)

Typle /Date	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
XuGou guiding light pile right front (Telemetry of fujian Postal service）	·✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Hour:8-14	Hour:8-13	Hour:11-13	Hour:7-12	Hour:7-18	Hour:7-13and17-20	Hour:9-13	Hour:9-13and14-17	Hour:8-13	Hour:9-13	Hour:9-13	Hour:9-17	Hour:8-13and14-17	Hour:8-14	Hour:8-13
XuGou guiding light pile in front (Keyton high current telemetry)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Hour:6-the next day3	Hour:5-13 and 18-24	Hour:6-24	Hour:7-24	Hour:7-16 and 21-the next day3	Hour:4-18and19-the next day2	Hour:4-the next day3	Hour:5-18and 19-the next day1	Hour:5-the next day1	Hour:1-12and 15-the next day1	Hour:12-the next day2	Hour:2-the next day3	Hour:9-the next day3	Hour:3-the next day3	Hour:4-the next day3
XuGou guiding light pile	✔	✔_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Hour:8-	Hour:7-15 and	Hour:8-23	Hour:8-11and	Hour:8-21	Hour:7-24	Hour:8-24	Hour:8-23	Hour:8-19	Hour:8-13an	Hour:8-13	Hour:7-21	Hour:7-the	Hour:7-the	Hour:7-24

left front (Telemetry of Fujian Postal Service)	24	17-24		15-24						d 21-24	and 15-24		next day1	next day1	

Table 1: Timeout situation before replacing anti-jamming telemetry terminal (simplified statistical table of telemetry data updating over 3h roughly period)

Typle /Date	3.06	3.07	3.08	3.09	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17	3.18	3.19	3.20
XuGou guiding slight pile right front (Anti-jamming telemetry of FUJIAN Postal Service)	⭕	⭕	⭕	⭕	⭕	⭕	⭕	⭕	✔ Hour: 1-3	⭕	✔ Hour:17-20	⭕	⭕	⭕	⭕
XuGou	⭕	⭕	⭕	⭕	⭕	⭕	⭕	⭕	✔	⭕	✔	⭕	⭕	⭕	⭕

guiding light pile in front (Anti-jamming telemetry of FUJIAN Postal Service)									Hour: 1-4		Hour:17-20				
XuGou guiding light pile left front (Anti-interference telemetry in Langfang)	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Table 2: Timeout situation after the replacement of anti-jamming telemetry terminal (there is a comparison table for the approximate time period of telemetry data updating over 3h)

Carry out online interference identification analysis for the pre-guide area, as shown in Table 1: Without anti-interference telemetry, the period distribution of unupdated data over 3h was counted and preliminarily defined as the interference period, which was used as one of the basis for identifying the intensity of interference in this paper. As the control group of this experiment, Table 2 objectively reflects the interference time range after installing the anti-jamming telemetry terminal. The control group and experimental group on the space in

the same area, the experimental group and control group in time, in the control group after one month, therefore, assumes that the same area on the space interference intensity within a month won't have too big change, so, by adding variable namely after adding anti-interference telemetry, the distribution of the interference period intensity can reflect the strength of the anti-interference ability.

For the three telemetry terminals in the same area in Table 1, from top to bottom, they are the right front of market lane guide light pile, middle front of XuGou guide light pile and left front of XuGou guide light pile. Through the horizontal comparison of the data collected in 15 days, the interference periods of the same terminal on different days generally coincide, which reflects the periodicity of interference. The telemetry terminals located in the same area will cause interference, which reflects the regional characteristics of interference. By longitudinal comparison, the interference period between the three so-called XuGou has overlapping, and not consistent with each other, XuGou guide light pile middle front > XuGou guide light pile left front > XuGou lead light pile right front, reflects that even in the same space area, the orientation and distance of the interference source will affect the size of the interference period.

In contrast with Table 1, Table 2 more truly reflects the significant changes in the interference period after the replacement of the external anti-interference terminal. The interference period is greatly reduced, which shows that the anti-interference performance of telemetry terminal module of navigation beacon has been optimized to a certain extent.

5.1.2 Interference identification of radio frequency communication electromagnetic wave noise source of communication base station

Rear pilot area (mainly radio frequency communication interference of communication base station equipment)

Typle /Date	3.06	3.07	3.08	3.09	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17	3.18	3.19	3.20
XuGou guiding light piles on the right side (Telemetry of Fujian Postal	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Hour: 9-19	Hour:10-19	Hour:8-20	Hour: 9-18	Hour: 9-19	Hour:9-20	Hour:8-16	Hour: 8-20	Hour: 9-19	Hour:Hour: 9-1	Hour:9-20	Hour: 8-19	Hour: 9-19	Hour: 8-19	Hour: 9-19

Service)															
XuGou guiding light pile left after (Telemetry of Fujian Postal Service)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Hour:7-23	Hour:7-20	Hour:6-24	Hour:7-23	Hour:7-23	Hour:8-24	Hour:6-21	Hour:7-24	Hour:6-24	Hour:5-the next day 1	Hour:7-24	Hour:7-the next day 2	Hour:6-the next day 1	Hour:7-the next day 1时	Hour:7-18

Table 3: Timeout of post-guide installation of common telemetry terminal (there is a comparison table for the approximate time period of telemetry data updating over 3h)

Typle/Date	3.06	3.07	3.08	3.09	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17	3.18	3.19	3.20
XuGou	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

guiding light pile after (Anti-jamming telemetry of FUJIAN Postal Service)															

Table 4: Timeout after anti-jamming telemetry terminal is installed in the rear guide (there is a comparison table for the approximate time period of telemetry data updating over 3h)

Analyzing the upper area to carry out the online identification, as shown in table 3 and 4: table 3 and table 4 is located in the same area, at the same time, in table 3 XuGou guiding light right after, XuGou guiding light did not add anti-jamming telemetry terminal before pile on the left, by contrast, XuGou guiding light after the pile, the anti-interference telemetry terminal is equipped with the interference period was decreased greatly. Compared with the former guide, the same terminal overlapped in different interference periods by horizontal comparison of data collected in 15 days. The telemetry terminals in Table 3 are compared longitudinally, and the interference time range between them is also different to some extent.

Therefore, according to the statistical analysis of online data, the navigational AIDS with high timeout alarm frequency of telemetry and remote control terminal mainly have regional and periodic characteristics. However, compared with the electromagnetic interference of electromechanical equipment, the interference time distribution of 5G narrowband interference is more concentrated in a relatively fixed time period, while the electromagnetic interference of electromechanical equipment is relatively random.

5.2 Main path construction for field identification

Of electromagnetic interference sources in the scene recognition, mainly by using electromagnetic noise measurement tool of the scene more noise source of the source, among them, the jurisdiction of beacon telemetry

terminal equipment the main electromagnetic interference noise source pathways mainly has two forms, a form of transmission noise source in the air, another for underground transmission noise source, therefore, to accurately locate the noise source location and distance, Construct an offline interference source identification model.

5.2.1 Determination model of multi-point noise source in air by sound pressure method

Using the method of sound pressure can be divided into a single point in the air, determination of noise source and noise source more by M * N microphone array to construct sound pressure signal effective value vector P and Q = | using formula ⟨ P, E ⟩ | Max / | | P v and Pij2 = (Q1 / r1) 2 + 2 (Q2 / r2) valuation iteration of multipoint noise source of the paper studies the strength and location of sound source signal. On single point noise source of the main working principle of the main according to the formula of P = Q/r (Q as the intensity of the sound source, r to accept to acoustic source), through a set of M * N microphone array, and the sound source signal of S1 to measure the propagation distance of acoustic pressure signal and the effective value P and available source intensity: Q = | ⟨ P, e ⟩ | | | P/v Max. Similarly, the identification of multi-point noise sources in air by sound pressure method is based on the principle of single-point sound source identification, and the acoustic intensity of S2 position in air noise source is further estimated: For S1 and S2 sound source intensity Q1>Q2, the spatial coordinates of the sound source are (X1,Y1,Z1) and (X2,Y2,Z2), respectively. The microphones adopt dimension equal spacing M×N array. According to the principle of superposition of sound waves from unrelated sound sources, the effective value Pij of the sound pressure signal everywhere at the array measuring point Mij can be obtained by the formula: Pij2 =(Q1/ R1) 2+ (Q2/ R2) 2, where R1 and R2 are the distances from sound source S1 and S2 to the measuring point Mij respectively. Take the square of effective values of sound intensity S1 and S2 to form vectors P1 and P2 and measure the vector P' formed by sound pressure Pij2 through M×N array: P '= P1 + P2, S1 was measured according to the single point noise source, and then the position and sound strength of S2 was obtained through estimation iteration.

6. Assessment of countermeasures against electromagnetic interference

In order to solve the practical interference problems of telemetry terminal of navigation beacon, the electromagnetic noise sources in the environment can be suppressed by suppressing electromagnetic interference sources, cutting off the coupling path of electromagnetic interference (including conduction interference and radiation interference) and reducing the sensitivity of electromagnetic devices. Based on the analysis of the telemetry interference time of online navigation beacon, field visits and on-site platoon, and the analysis and investigation of the key interference frequency band of the potential external interference environment, the main electromagnetic interference sources that affect the stability of signal transmission are preliminaries: Electromechanical equipment produced by the engine to run the electromagnetic noise source interfere with communication, communication base station equipment, wireless radio frequency interference and external power grid operation system in the process of the passive and electromagnetic interference, therefore, the interference suppression method is mainly through the combination of the above three ways to reduce environmental noise source to the influence of beacons telemetry data transmission terminal.

6.1 Suppression of narrowband adjacent frequency interference of RF communication

Narrow band of radio frequency communication main frequency interference is to suppress electromagnetic interference sources, to cut off the electromagnetic interference coupling way of conducted interference to suppress interference, 5 g base station radio frequency interference, for example, because of its working frequency range is relatively dense, through on-the-spot investigation, and found that the channel coverage within 100 m of beacon telemetry terminal will be a strong signal interference, As for the telemetry data in Table

3, there are 5G base stations around them, and their interference periods are generally the same, mostly concentrated in the time period when 5G signals are frequently used in the daytime. Therefore, in view of the influence of 5G noise source, a large number of telemetry terminals in the region are affected by its interference. On the one hand, it can coordinate and contact 5G communication providers to conduct frequency modulation processing for 5G base station transmitting equipment and stagger its working frequency with telemetry terminals to reduce the telemetry interference degree to terminal equipment. In this paper, from the Angle of cutting off the conduction interference of the electromagnetic interference coupling path, the optimization of PCB set module is discussed to improve the anti-noise and anti-interference ability of the circuit board. At present, the main optimization measures for nB-IOT adjacent frequency conduction interference are as follows:

① Add narrowband bandpass filter to filter, modify the power amplifier of the equipment, stagger the working frequency range with 5G signal, and reduce the impact of environmental noise sources.

② Through the optimization of communication module, adaptive feedforward control spread spectrum technology is used to adjust the resistance value of internal PLC communication module and baseband chip algorithm to realize the algorithm compensation of short message signal and 5G interference suppression, and improve the anti-noise and anti-interference ability of external 5G coverage environment.

According to the analysis of interference period of telemetry terminal in Table 4, optimization measures (1) and (2) are mainly taken for it. Compared with the navigation telemetry and remote control system module that is not optimized by the integrated module against interference in Table 3, its anti-interference ability has been significantly improved.

6.2 Broadband interference suppression for electromagnetic noise sources of electromechanical equipment

Work for mechanical and electrical equipment operation of broadband electromagnetic interference suppression, due to the electrical equipment distribution is more dispersed, comparatively broad spectrum and complex, and there may be more noise source, causing interference to its, main is taken to cut off the electromagnetic interference coupling way of conducted interference way for interference suppression, the main optimization measures were as follows:

① Through the optimization of communication module, adaptive feedforward control fH technology is used to adjust the resistance value of internal PLC communication module and baseband chip algorithm to realize the algorithm compensation of B short message signal and the suppression of electromagnetic interference, so as to improve the anti-noise and anti-interference ability of external 5G coverage environment.

② Adjust the inclination Angle of antenna installation to make the orientation Angle of built-in antenna installation consistent with the direction of signal receiving base station, and improve the signal transmission coverage capacity.

According to table 2, XuGou guiding light piles on the right side of the front and XuGou guiding light main optimization measures (1) the pile top, the XuGou guiding light left before using optimization measures (2), the relative specific optimization measures (1) is suitable for the target under the interference spectrum interference, if the interference spectrum, anti-interference ability will decline, such as time, 3.14, 3.16, the interference Optimization measure 2 is suitable for spatial noise sources in different interference frequency bands, but the installation requirements are relatively high. It is necessary to keep the antenna direction Angle consistent with the beidou signal receiving base station, and there should be no noise source in front of the antenna direction Angle, which may decrease the anti-interference ability in places with dense noise sources.

7. Prospect of practical application

The study of electromagnetic interference is of great benefit to solving the interference caused by

environmental noise sources and further improving the anti-jamming and interference identification ability of telemetry information monitoring equipment of navigation beacon in the jurisdiction. In the study of electromagnetic interference problem in the process of accurate identification of the emi noise source is the important premise and foundation of interference and effective disposal, in this process, need further online data analysis model is established, through the application of the large data analysis methods, realize the management of master data module unit, for the processing of unstructured data management, Through the integration and management of telemetry information data of navigational AIDS, the whole process and whole life cycle of monitoring and supervision of telemetry information data of navigational AIDS can be realized, so as to reduce the operation risk of navigational AIDS, improve the quality of data management and give full play to the efficiency of data management. In view of different electromagnetic interference sources, put forward effective anti-interference measures, using relatively reasonable, relatively economic and relatively applicable anti-interference measures, to solve the interference problem will be twice the result with half the effort. For narrowband adjacent frequency interference, on the one hand, narrowband filter can be added to reduce the SNR of adjacent frequency band; On the other hand, the antenna installation Angle can be adjusted to keep consistent with the base station to reduce the influence of interference sources and improve the applicability of the terminal in dealing with electromagnetic interference environment. Interference from intermediate noise sources should be avoided, but it has universal applicability to the interference in different working bands. At the same time, spread spectrum technology can be used for frequency modulation processing of the equipment, stagger or increase the working frequency of the interference band, to achieve the suppression of interference. In view of the electromagnetic wave broadband noise source interference, the noise source has a wider impact, and the method of adjusting the antenna tilt Angle is more universal applicability, relatively more economic and cost, but the suppression degree of multi-point noise source is lower. At this point, we can choose the adaptive anti-jamming technology, through the optimization of communication module, Adaptive feedforward control fH technology is used to adjust the resistance value of internal PLC communication module and baseband chip algorithm to realize the algorithm compensation of short message signal and the suppression of electromagnetic interference, and improve the anti-noise and anti-interference ability of external 5G coverage environment. Therefore, this puts forward higher requirements for the further optimization and upgrading of the control module of telemetry terminal and the combined application of new technology and new material research and development. At the same time, in this process, we should fully analyze and demonstrate, further reduce the actual application cost of the module through the improvement of technology, and improve the actual mass production capacity of the anti-interference terminal module.

reference

[1] tao y h. research and practice on anti-jamming reconstruction of satellite antenna 5G [J]. Modern information science and technology,2020,4(24):63-66. DOI:10.19850/j.cnki.2096-4706.2020.24.017.

[2] huang chuanyu. Interference type and source analysis of PLC operation [J]. Mechanical and electrical engineering technology,2019,48(12):51-52,108. DOI:10.3969/j.issn.1009-9492.2019.12.017.

[3] LUO Hanbo, ZHAO Xiaodan, ZHOU Haichuan, et al. Identification of white noise source using sound pressure RMS information [J]. China Measurement & Testing,202,48(1):40-45,52. DOI:10.11857/j.issn.1674-5124.2020120124.

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