Dear reviewer,

Thank you very much for taking the time to review our manuscript entitled "Research on clock synchronization method of marine controlled source electromagnetic transmitter base on coaxial cable". We greatly appreciate your valuable comments, which have helped us improve the quality of our paper.

First and foremost, we would like to express our sincere apologies for the delay in responding to your valuable comments. Since September 9th, our team has been engaged in crucial fieldwork at sea, which unfortunately limited our ability to respond until today. We deeply appreciate your patience and understanding.

Below, we provide detailed responses to each of your comments.

**Reviewer Comment 1:** Several aspects are rather trivial, like e.g. the description of coaxial cables.

**Response:** Thank you for your feedback on several trivial aspects. This has helped us improve the manuscript's conciseness. The description of the coaxial cable was indeed overly trivial. Additionally, we also found some descriptions in other sections to be either trivial or irrelevant to manuscript.

● In Chapter 2 , we have removed some well-known industry information "Fig.1 illustrates …… protective sheath" (Page 2, line 68-70 on the original manuscript) and Fig.1, but retained content relevant to the manuscript's theme.
● We have removed the unnecessary description "utilizing a differential chaos shift keying coding scheme" (Page 2, line 66 on the original manuscript). We also have removed the redundant and repetitive sentence "The 400 Hz AC output from the power supply is synchronized with the 400 Hz square wave" (Page 3, line 97-98 on the original manuscript).
● We replaced the sentence "The deck monitoring terminal contains a signal follower that receive 400 Hz square wave from the GPS and transmits it to the ship-borne high-power supply" (Page 3, line 96-97 on the original manuscript) with new ones "The 400 Hz square wave is transmitted to the deck's high-power supply through the deck terminal as a synchronization signal".

● In Chapter 3.2, we removed the phrase "synchronization signal access" (Page 4, line 122 on the original manuscript) and the sentence "It outputs a synchronized sinusoidal signal aligned with the externally connected synchronization signal" (Page 4, line 123-124 on the original manuscript).
● We replaced the sentence "Another TIMEPULSE pin on the GPS" (Page 4, line 127 on the original manuscript) with new ones " The TIMEPULSE pin on another GPS" to make the descriptions more accurate.

**Reviewer Comment 2:** There is no long term evaluation of the synchronization. How did you address/evaluate offset and drift problems?

**Response:** Thank you for your comment on offset and drift on our manuscript. This will help us better articulate our synchronization scheme.
The sinusoidal wave output from the high power supply is synchronized in real-time with GPS. The 1 Hz synchronization signal shows no significant deviation (500-600 ns) from the PPS. The internal clock signal of the circuit is calibrated every minute, preventing large cumulative offset over time. Naturally, the clock signal in use will experience drift within that minute. The extent of this drift depends on the crystal oscillator used. Our tests indicate that the 1 Hz internal clock signal drifts approximately 5 μs relative to the PPS signal each minute. However, at the end of each minute, the clock signal is re-calibrated by the 1 Hz synchronization signal. The circuit calibrates the clock signal only after detecting three consecutive rising edges at 1 s intervals. This repeated calibration ensures that significant drift does not occur.

**Reviewer Comment 3:** What happens if there is a short GPS outage?

**Response:** Thank you for raising concerns about potential issues caused by short GPS outages. Such outages can possibly occur and lead to various problems.
If there is a short GPS outage, the sinusoidal wave output from the high power supply will shift, and the 1Hz synchronization signal will also be affected. Therefore, we used a GPS time server with timing keeping functions. This time server can maintain PPS output during short GPS signal outages, ensuring the 1Hz synchronization signal remains accurate. Based on our sea trial experience, the absence of tall buildings and trees at sea ensures that GPS signals remain effective throughout the operation.

**Reviewer Comment 4:** How does the signal jitter? How does the distribution look-like? From the small number of presented measurements no such information can be reasonably obtained.

**Response:** Thank you for your attention to signal jitter and distribution. This has prompted us to think more deeply about synchronization schemes.
The 1 Hz synchronization signal is generated based on the sinusoidal wave transmitted underwater. The sinusoidal wave output from the high power supply is stepped down to 0~24 V. When the level of the sinusoidal wave is detected to exceed 3.5 V, the 1 Hz synchronization signal is set high (3.3 V); otherwise, the 1Hz synchronization signal is set low (0 V). Due to the jitter of the sinusoidal wave, the position of 3.5 V of the sinusoidal wave also has jitter, which leads to jitter in the rising edge of the 1Hz synchronization signal.
We have continuously observed the relative position with PPS for 5 hours. The 1Hz synchronization signal jitters around a position 500 ns later than PPS, mostly between 500-570 ns after PPS, and occasionally between 490-500 ns.

**Reviewer Comment 5:** Language wise, the paper is readable to some extent, has, however some issues like missing conjunctions or repeated words ("the the", "power power" etc).

**Response:** Thank you for your constructive feedback on the language quality of our manuscript. We appreciate your attention to detail and understand the importance of clarity and precision in scientific communication. We have revised some details of the manuscript to improve readability.

We have taken immediate action to address the problem of repeated words, which have now been corrected throughout the document. We have removed repeated "the" (Page 3, line 83 on the original manuscript) and "power" (Page 4, line 115 on the original manuscript).

Additionally, we found no space between some numbers and their units. We have reviewed all numbers and units in the manuscript to ensure that there is a space between them.

Furthermore, we will continue to revise the manuscript to improve its linguistic clarity and precision.

**Reviewer Comment 6:** What is an "attitude module" that measures safety-related parameters?

**Response:** Thank you for attention to the attitude module. Your comment has provided us with the opportunity to further elaborate on the details of our transmitter, which we believe is crucial for a comprehensive understanding of our MCSEM transmitter.

We installed an attitude module on the transmitter to measure the pitch, roll and heading of the transmitter underwater. Given that our transmitter can be towed at a depth of 4000 meters near the seabed, its attitude is crucial. If the attitude changes drastically, the transmitter may be damaged and we will consider halting operations. In addition to the attitude module, the transmitter is equipped with a crucial module-the altimeter. The altimeter measures the height of the transmitter above the seabed and the depth of the seawater. The transmitter is also equipped with a USBL beacon, allowing for observation of its underwater position, which can be cross-referenced with depth readings. Typically, we require the transmitter to operate at a height of 50 meters above the seabed. If the transmitter is too high, the effectiveness of MCSEM will diminish; if it is too low, the transmitter may touch the seabed, compromising its safety. Throughout the towing operation, we continuously adjust the ship's speed and the length of the tow cable based on real-time changes in the transmitter's height above the seabed.

**Reviewer Comment 7:** One image shows GPS coupled to the control chamber and one not (Fig. 2 and Fig. 8). Is it really so that GPS is coupled to the control chamber temporarily before it is submerged? What do you do when there is a short outage when everything is submerged, do you need to pull-in everything that is submerged to restart anew?

**Response:** Thank you for your attention to the figures in our manuscript. Your feedback has made us realize that the figures may not be sufficiently clear.

Fig.2 illustrates the schematic diagram of the MCSEM operation. Fig.8 shows our test connection diagram. The GPS in Fig.2 is included within the communication module in Fig.8. The communication module and modem in Fig. 8 are located in the instrument control room shown in Fig.2. This GPS is used to synchronize the output of the high-power supply. Additionally, we use another GPS (temporarily referred to as GPS2). Before the transmitter is submerged, GPS2 provides time and the rising edge of the integer second for the control circuits inside the control chamber. once the transmitter is ready for submersion, GPS2 will be removed. We have removed the GPS in Fig.8 to avoid any potential misunderstanding.

If there is a short outage when everything is submerged, we don't need to pull-in everything that is submerged to restart anew. The control cabin is equipped with batteries to ensure circuit operation. If the outage occurs, the 1 Hz synchronization signal will temporarily disappear, causing a drift in the internal clock signal of the control circuit. Upon power restoration, a new 1 Hz synchronization signal will be generated to calibrate the clock signal. Typically, if power is restored promptly after an interruption, the drift will not be significant. We strive to avoid such outages. Before MCSEM operations, we continuously monitor all equipment to ensure proper functioning.

Once again, we sincerely apologize for the delay in our response and thank you for your thoughtful and constructive feedback. Your insights have greatly contributed to improving our manuscript. We look forward to any further feedback you may have.

Your Sincerely,

Zhibin Ren
rzb@email.cugb.edu.cn