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Ultra-low temperature and ultra-low noise platform for superconducting quantum computing

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents". Drafting. Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents. This document was proposed

and is under the jurisdiction of the National Technical Committee on Standardization of Quantum Computing and Measurement (SAC/TC578). This document was drafted by: Hefei National Laboratory, University of Science and Technology of China, Jinan Institute of Quantum Technology, and QuantumCTek Co., Ltd. Limited Liability Company, Tsinghua University, Nanjing University, the Eighth Research Institute of China Electronics Technology Group Corporation, and Origin Quantum Computing Technology (Hefei) Co., Ltd. Limited Company, Shanghai Liangxi Technology Co., Ltd., the 16th Research Institute of China Electronics Technology Group Corporation, Institute of Physics of the Chinese Academy of Sciences, China Science and Technology Institute of Physics and Chemistry, Enthalpy-Gathering Scientific Instruments (Suzhou) Co., Ltd., Shenzhen International Quantum Research Institute, Hefei Zhileng Cryogenic Technology Co., Ltd. Company, China Great Wall Technology Group Corporation, CSSC Pengli (Nanjing) Cryogenic Technology Co., Ltd., and Gewu Cold Control (Suzhou) Scientific Instruments Limited Liability Company, Shandong New Generation Standardization Research Institute Co., Ltd., Beijing Feisike Technology Co., Ltd., and the Cyberspace Department of the Chinese People's Liberation Army Team Information Engineering University, Aucma Co., Ltd. The main drafters of this document are. Wu Gang, Li Junyun, Wang Minglei, Li Xu, Sun Luyan, Yu Yang, Zheng Mingrui, Lu Zhaohui, Zhang Junfeng, Wu Ming, and Luo Gaoqiao. Xu Yang, Fan Jie, Gong Ming, Dai Wei, Dong Jing, Pan Changzhao, Wang Shaoliang, Yu Chunlin, Chao Wei, Zhang Lei, Guo Kai, Huang Shesong, Ji Zhongqing, Wu Jiajie, Wang Weilong He Haoran, Li Dongdong, Wang Jing, Wang Chaofan, Shen Fuzhi.

Ultra-low temperature and ultra-low noise systems are key supporting devices for superconducting quantum computing, providing the necessary conditions for the stable operation of superconducting quantum processors. The required extremely low temperature environment and high-fidelity measurement and control conditions are crucial. Currently, the core trend in the development of superconducting quantum computing technology is shifting from the tens of qubits level... The demonstrated "quantum supremacy" stage is progressing towards the goal of "universal quantum computing" at the megabit level. In this evolution, quantum processing... The core requirements for instruments to operate in extremely low-temperature and extremely low-noise environments, and for corresponding measurement and control technologies, remain persistent and are becoming increasingly stringent. Among these, a 50-bit scale is considered... The typical threshold for achieving "quantum supremacy" is that the industry has initially established the foundation for developing and applying superconducting quantum processors with 50 qubits or more. This capability makes this node a crucial support for technological advancement and standardization. To standardize the key technical indicators and application boundaries of ultra-low temperature and ultra-low noise systems for superconducting quantum computing, and to ensure the performance of systems with 50 qubits and above... This document is specifically formulated to meet the measurement and control requirements of superconducting quantum processors. Ultra-low temperature and ultra-low noise system for

superconducting quantum computing

1 Scope

GB/T 47176-2026 is the Chinese national standard covering the dilution refrigerator and its wiring around a superconducting quantum processor - a few millikelvin, filtered and attenuated lines, magnetic and vibration isolation, because the qubit is destroyed by any of the noise a normal laboratory is full of. First edition, in force since 1 September 2026, with the quantum computing benchmarking and service platform standards of this batch. It was issued on 27 February 2026 and has been in force since 1 September 2026, as a first edition. The document is under the responsibility of the Standardization Administration of China. This page is published from the official record of the 2026 edition; the clause text of a standard this recent is not yet in circulation, and the figures, limits and tables it contains are those of the document itself, delivered in full with the English translation.

This document defines the terminology and definition of ultra-low temperature, ultra-low noise systems for superconducting quantum computing (hereinafter referred to as ultra-low temperature, ultra-low noise systems). The definition specifies the system structure, technical requirements, and describes the corresponding testing methods. This document applies to the design, fabrication, and performance of cryogenic and ultra-low noise systems running 50-qubit or higher superconducting quantum computing processors. test.

2 Normative references

The contents of the following documents, through normative references within the text, constitute essential provisions of this document. Dated citations are not included. For references to documents, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies. This document.

GB/T 25915.1-2021 Cleanrooms and related controlled environments - Part

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1 Infrastructure integration that provides the ultra-low temperature and ultra-low noise environment required for superconducting quantum processors. Note

1.It generally consists of a dilution refrigeration unit, a low-temperature monitoring and control circuit, a vibration damping device, and a magnetic shielding device.

Note 2: A typical configuration of a 50-qubit superconducting quantum computing system with extremely low temperature and noise is shown in Appendix A.

3.2 dilution refrigerator A method utilizes the phase separation of a helium-3 and helium-4

mixture at extremely low temperatures, and absorbs the helium-3 by continuously "diluting" it into a helium-4 enriched phase. A continuous-cycle refrigeration system that generates heat to obtain and maintain extremely low temperatures at the milliKelvin (mK) level.

3.3 noise In the context of superconducting quantum computing, all factors that could interfere with the normal operation of the superconducting quantum processor, disrupt quantum state coherence, or affect measurement and control signals... Non-target physical disturbances that affect the accuracy of the signal.

Note. The noise contained in superconducting quantum computing systems generally includes vibration noise, electromagnetic noise, and thermal noise.

3.4 minimum temperature base temperature In superconducting quantum computing systems, the quantum processor chip can achieve and maintain a stable mounting position under static, unloaded conditions. Lower limit of temperature.

4 Shock Response Spectrum Analysis

GB/T 40661-2021 Calibration Specification for Power Frequency Magnetic Field Measuring Instruments