CEN/CLC/JTC 22/WG 3 "Quantum Computing and Simulation"
WG Secretariat: **AFNOR**
Convenor: **Lefebvre Catherine Mrs**

PWI_CryogenicSolidStateQC_V03

Document type	Related content	Document date	Expected action
Meeting / Other	Meeting: VIRTUAL 31 Aug 2023	2023-09-04	**INFO**

Preliminary New Work Item	
* to be attached to the CIB	
CEN/CENELEC JTC 22 – Quantum Technologies	
Secretariat: DIN	Proposal documented in N xx
Date of circulation:	Closing date for voting:
Decision reference:	Decision date:

Proposal

0. This proposal relates to

☐ the adoption of a New Work Item in the committee's work programme (stage 10.99)
☒ the adoption of a Preliminary Work Item in the committee's work programme (stage 00.60)
☐ the activation of a Preliminary Work Item in the committee's work programme (stage 10.99): PWI *XXXXX*

1. Deliverable

☐ European Standard (EN)
☐ Technical Specification (TS)
☒ Technical Report (TR)

2. This item corresponds to

☒ A new project
☐ An amendment to the EN *XXX*
☐ The revision of EN *XXX*
☐ The conversion of TS *XXX* into an EN *XXX*
☐ The revision of TS *XXX*
☐ The revision of TR *XXX*

2.1 - Only for WIs of CEN/TCs (not applicable to CEN-CLC/JTCs WIs): if this item corresponds to an amendment/revision of an EN indicate if:

☐ the scope will change (weighted vote required - select the right option in the CIB)
☐ the scope will not change (simple majority vote required - select the right option in the CIB)

3. Explain the purpose and give a justification for this proposal (max 4000 characters). This text should provide information on technical topics to be discussed.

One of the quantum computing hardware architectures that has been identified in the Roadmap document of FGQT is “Cryogenic Solid State Quantum Computing”. These architectures include solutions based on superconducting qubits (like Transmons and Flux Qubits), semiconductor spin-qubits, topological qubits, artificial atoms in solids, etc.

The commercial interest in this kind of quantum computer architecture is growing rapidly, and a supply chain of associated products from different vendors is growing as well. This justifies the need for a document that offers associated functional descriptions and functional requirements.

The proposal is to create a first Technical Report (TR) about cryogenic solid state quantum computing. This first part is to be restricted to functional descriptions and functional requirements only. It could have initial descriptions on low-level benchmarking of the involved hardware as well (high-level benchmarking based on algorithms are out of scope of this TR). It is expected that in future multiple TR’s will deal with this topic, where other (future) parts are concentrated on further details and even technical specifications.

Contribution CEN-CLC-JTC 22_N14 offers a good description of scope and objective of this first part. It shows how it fits in the present layer model of quantum computing and offers a Table of Content. It was inspired by a Annex B of the Roadmap document from FGQT that offers a predecessor of the aimed document. That annex also contains example text about a particular layer (control highway), which illustrates how functional descriptions and functional requirements may look like.

Starting this TR is important to support the industry in collecting functional requirements from customers and users, and to start with hardware (and software) experiments on how modules from different origin can interwork with each other through what interfaces.

4. Titles

English title: Cryogenic Sold-State Quantum Computing;
Part 1: Descriptions and functional requirements of modules

French title:
(*Optional*)

German title:
(*Optional*)

5. Scope of the proposed work item (max 4000 characters)

This document specifies the functional requirements for modules for use in cryogenic solid-state quantum computers and describes their functionality. This includes the hardware layers and control software for cryogenic solid-state quantum computers, as shown in figure 1 of the annex in this WI proposal. This is an architecture family of which all members make use of a cryogenic fridge. The quantum device(s) within the fridge are usually controlled from outside by room-temperature control electronics, through a (huge) number of I/O channels.

Examples of members within this architecture family are solutions based on superconducting transmons, superconducting flux qubits, semiconductor spin qubits, topological qubits and artificial atoms in solids.

This document does not specify specific values, only functional requirements, and offers informative examples that have been proven in practice.

6. Digital aspects

☒ The deliverable is intended to be developed using the Online Collaborative Authoring platform

☐ The deliverable is intended to include non-Word/PDF content, e.g. audio files, XML schemas, machine-readable formats or software.
Please provide details of the non-Word/PDF content:

☐ None of the above.

If yes to either of these questions, CCMC will contact you for feasibility and organizational aspects.

7. Stakeholder categories immediately affected by the proposal

☒ Industry and commerce	☐ Societal consumer groups	☒ Standards application
☒ SMEs	☐ Labour	☐ Non-governmental organization (NGO)
☒ Government	☒ Academic and research bodies	☐ Environmental stakeholders
☐ Consumers		

☐ None of the above categories

8. How will these Stakeholders benefit from or be impacted by the proposed deliverable?

The market for modules and components on cryogenic solid-state quantum computing is growing rapidly. Many academic research teams as well as big-tech companies are acting as customers for hardware and software modules to enable their research and development of those (experimental) quantum computing systems. It has generated a growing industry on all kinds of quantum computing modules, ranging from start-ups, SME's to big enterprises offering all kinds of dedicated modules. The majority of the European industry is more focused on modules and less focussed to complete stand-alone quantum computing systems. They all will benefit from a global market where products from different origin can interwork with each other.
Standardisation should keep pace with that development, but is still in its infancy. The next step beyond a layer model is a TR about functional descriptions and functional requirements for those architectures, collected by both industry, academia and other customers. All stakeholders will benefit from this since customers can communicate their requirements on the modules they need while the industry can provide modules that can interwork with others and meet those requirements. It stimulates a global market, which is beneficial for everybody, while this does not hold for multiple local markets.

9. Document developed in drafting body

☒ Existing drafting body *(please give name and title)*:
CEN-CENELEC JTC22 on Quantum Technologies – WG3 on Quantum Computing.

☐ New drafting body *(please give name and title)*:

10. Proposed Project Leader (including contact details) - *Optional*

Rob F.M. van den Brink – Netherlands – Rob.vandenBrink@Delft-Circuits.com

11. United Nations Sustainable Development Goals (SDGs)

Please select any United Nations Sustainable Development Goals (SDGs) that this document will support. For more information, please visit the SDG section of the CEN website (currently under development).

☐ **GOAL 1:** No Poverty
☐ **GOAL 2:** Zero Hunger
☐ **GOAL 3:** Good Health and Well-being
☐ **GOAL 4:** Quality Education
☐ **GOAL 5:** Gender Equality
☐ **GOAL 6:** Clean Water and Sanitation
☐ **GOAL 7:** Affordable and Clean Energy
☐ **GOAL 8:** Decent Work and Economic Growth
☒ **GOAL 9:** Industry, Innovation and Infrastructure
☐ **GOAL 10:** Reduced Inequality
☐ **GOAL 11:** Sustainable Cities and Communities
☐ **GOAL 12:** Responsible Consumption and Production
☐ **GOAL 13:** Climate Action
☐ **GOAL 14:** Life Below Water
☐ **GOAL 15:** Life on Land
☐ **GOAL 16:** Peace and Justice Strong Institutions
(N/A **GOAL 17:** Partnerships to achieve the Goal)
☐ None of the above

Proposed rationale for the selected SDG(s)- (optional):

12. Accessibility aspects

See CEN-CENELEC Guide 6:2014 'Guide for addressing accessibility in standard'

☐ Accessibility aspects are relevant for this NWI *(please indicate which ones):*
See the 'protocol' to help you decide when accessibility following a Design for All approach is relevant:
https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/accessibility/design-for-all/

☒ Accessibility aspects are not relevant for this NWI
Please provide a written explanation detailing why accessibility aspects do not apply to the current proposed WI:

The deliverable itself is a TR, developed in an accessible way like any other CEN-CENELEC TR. The content of the TR will not affect any accessibility aspects (i.e. 24x "no" to the questions from "The Protocol Form")

13. Environmental aspects

☐ Discharges to soil	☐ Discharges to water	☐ Emission to air
☐ Heat	☐ Noise/Vibration	☐ Use of land
☐ Radiation	☒ Use of energy	☐ Other effects on biodiversity
☒ Use of material	☐ Use of water	☐ Waste
☐ Risk to the environment from accidents/misuse		☐ Chemicals

☐ Other:

☐ None of the above.
Please provide a written explanation detailing why these environmental aspects do not apply to the current proposed WI:

14. How do you plan to address these environmental aspects?

☐ Bring in environmental expertise to the WG

☐ Contact EHD for help/support (cen.ehd@cencenelec.eu) and/or use examples from Environmental Framework

https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/environment-and-sustainability/environmental-helpdesk-and-trainings/
☐ Use of environmental checklist and guides (please visit the dedicated section in the CEN website

☒ Other**:**

Environment aspects are included as part of the analysis, e.g. energy use.

15. Vienna Agreement (parallel procedure)

☒ No or Vienna Agreement with CEN lead proposed

The project focusses on the European perspective. There does not exist a parallel ISO activity on this particular topic/scope of the project.

☐ Yes – Vienna Agreement Parallel with ISO Lead
ISO project reference:
ISO project ID:
ISO/TC:

16. The project is based on

☒ No document from another organization
It is a natural follow-up from the "Standardization Roadmap on Quantum Technologies" written by the CEN-CENELEC Focus Group on Quantum Technologies (FGQT) during 2021-2023

☐ An ISO or ISO/IEC document (not covered by a parallel procedure)
☐ Identical
☐ Non-identical
ISO/IEC project reference:
ISO/IEC project ID:
Publication date:

☐ A document from another organization than ISO or ISO /IEC:
Note: Please explain the purpose and give a justification for this proposal in Section 3.

☒ The project will make reference to relevant standards from ISO/IEC, ITU-T, ETSI, NIST and other.

17. Please indicate whether the proposed project is linked to a specific European Research and Innovation Project

☐ **No**

☒ **Yes**

Research and/or Innovation project code:
Research and/or Innovation project acronym: QUCATS
Research and/or Innovation project title:

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Research and/or Innovation project title:

To do: plenty of Europeans projects working on Quantum Computing.

18. Track

☐ Enquiry + Formal Vote (for EN)

☒ Vote on TS or TR by correspondence

19. Please provide the target dates for the below key stages.

19.1 – For ENs

N/A

19.2 – For TSs and TRs

Project start date (10.99)	**Dispatch of 1st WD (20.60)**	**Dispatch of draft for Vote (30.99)**
2023-06-30	2023-10-30	2025-03-31

20. Related standardization request(s) (formerly mandate):

☒ No

☐ Yes *(please specify)*:

21. Related directive(s)/regulation(s)

☒ No

	Directive/ Regulation reference	Candidate for citation in Official Journal?
☐ Yes		☐ No ☐ Yes
		☐ No ☐ Yes

22. Relation to other legislation or established public policy.

☒ No

☐ Yes

Please specify which legislation or established public policy is/are in relation with the proposed project:

23. Is the proposed project covered by Intellectual Property Rights (IPR)?

Please indicate whether there is any knowledge of items covered by IPR(s), for instance patents, copyright, trademark, etc.

☒ No

☐ Yes

Please provide full information about these items and the identified IPR(s):

24. Commitment This section applies only to *CEN-CLC/JTC* T*o be completed for NWI request to be approved by CEN and CENELEC BTs.*

The following members (at least five) are committed to participate in the development of the project:

1) Netherlands (contact: Rob.vandenBrink@Delft-Circuits.com)
2)
3)
4)
5)

ANNEX : Proposed Table of Content

Cryogenic solid state quantum computing

Part 1: Descriptions and functional requirements of modules

1. Scope and objectives

The scope of this document comprises the hardware layers and control software dedicated to cryogenic solid state quantum computing, as shown in figure 1. This is an architecture family of which all members make use of a cryogenic fridge. The quantum device(s) within the fridge are controlled from outside by room-temperature control electronics, through a (huge) number of I/O channels. Examples of members within this architecture family are superconducting transmons, superconducting flux qubits, semiconductor spin qubits, topological qubits and artificial atoms in solids.

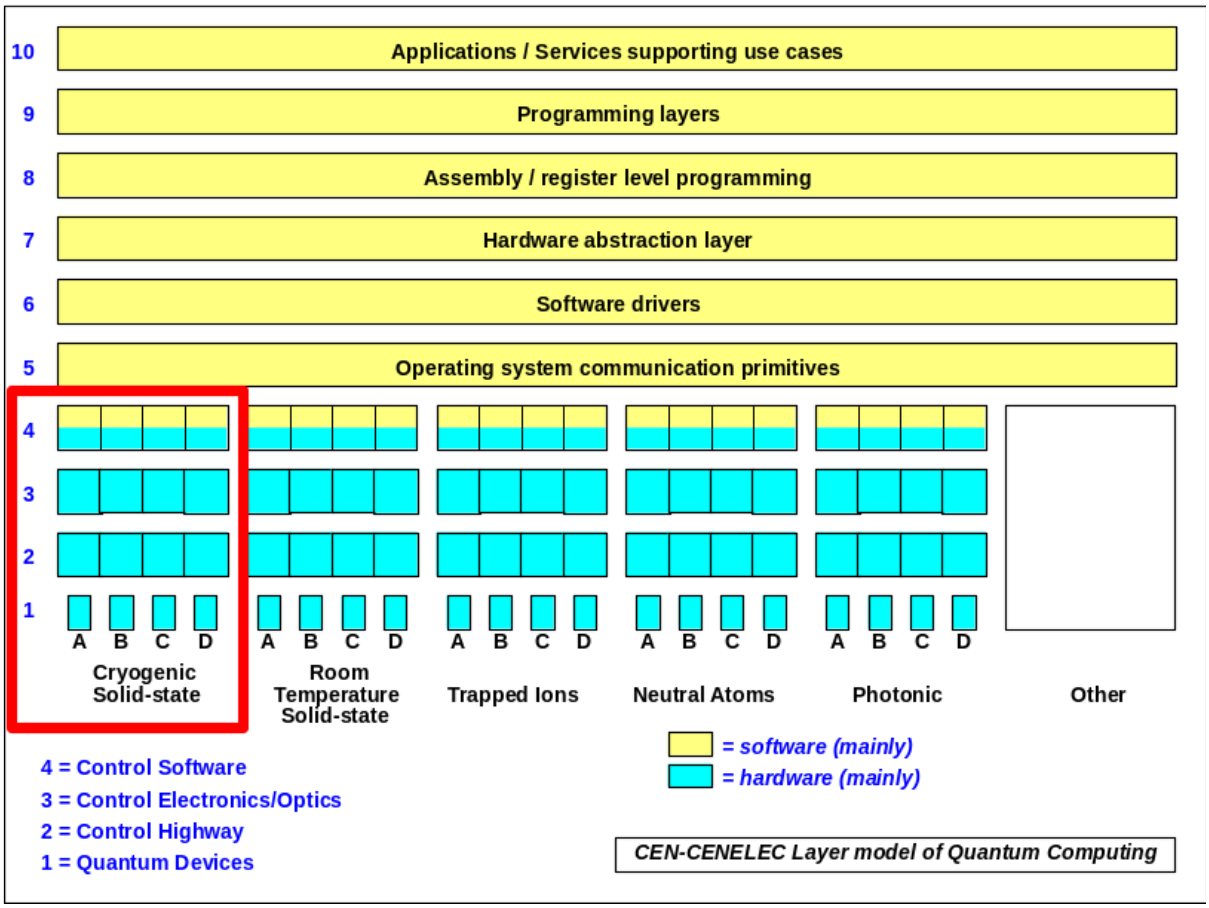

Figure 1*: The scope comprises hardware layers and control software dedicated to cryogenic solid state quantum computing,*

The objectives of this first part from a series of documents are functional descriptions and functional requirements of the involved layers. The specification of limiting requirements and associated values is reserved for future parts. Descriptions of multiple best-practices on implementations are within scope as long as their description does not exclude similar other solutions.

2. Normative references

- [1] <a first reference>
- [2] <more references as needed>

3. Terminology and abbreviations

4. Overall functional description

5. Layer 1: Quantum Devices

5.1 Functional descriptions

- Superconducting qubits
  - Transmons
  - Flux Qubits
- Semiconductor spin qubits
- Topological qubits
- Artificial atoms in solids

5.2 Functional requirements

6. Layer 2: Control Highway

6.1 Functional descriptions

6.2 Functional requirements

7. Layer 3: Control Electronics

7.1 Functional descriptions

7.2 Functional requirements

8 Layer 4: Control Software

8.1 Functional descriptions

8.2 Functional requirements

9 Benchmarking (low level)

End of proposal