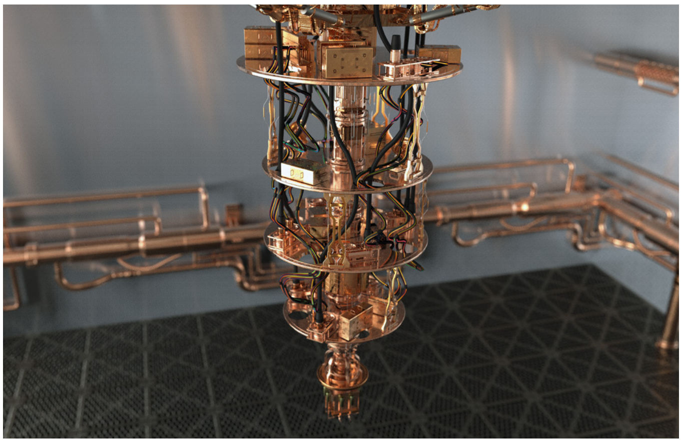
Initialising Quantum Computers

Application note



Overview

Quantum mechanics is a theory in physics that describes nature at the atomic and subatomic level. Quantum computers use this theory to create effects in the macroscopic world - our world. Quantum computers effectively harness the power of superposition, which is a system that has two different states that can define it and it's possible for it to exist in both.

Qubits

While normal computers use binary digits, i.e. bits characterized as 0 or 1, a quantum bit (qubit), can be a coherent superposition of both states. In other words, a qubits value might be somewhere in the middle. While it is in superposition, the quantum computer and specially built software algorithms harness the power of both these states. As a result of this, quantum computers can solve problems much faster than any classical computer and also have the potential to solve problems classical computers can not.

Challenge

Storing a quantum state – i.e. particles in superposition – is the biggest challenge in quantum computing. Any interaction with the universe will disrupt it and cause errors. The slightest bit of ambient noise can damage the computation process, rendering the computer useless. Therefore quantum computers are shielded electromagnetically and cooled down to almost absolute zero to minimize this effect.

Fine-tune magnetic field

In superconducting circuits of a quantum computer, the qubits are built up from the so-called Josephson junctions, which consist of superconductor- normal metal-superconductor sequences. The non-linear Josephson junction element, when integrated in a closed loop, is highly sensitive to small changes in the external magnetic field passing through the loop. One of the challenges is to finely tune the magnetic field so that the quantized energy levels can be smoothly transformed.

Recommended Solution

To fine-tune the magnetic field, which is an inevitable requirement for initializing a quantum computer, a nanometer-size wire in the proximity of the super-conducting loop is used to produce magnetic field and consequently tune the qubit energies. To generate the stable and small current a GS200 DC voltage and current source is used that offers an extremely low noise floor.

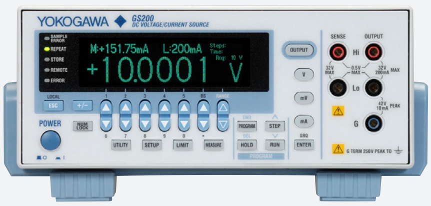
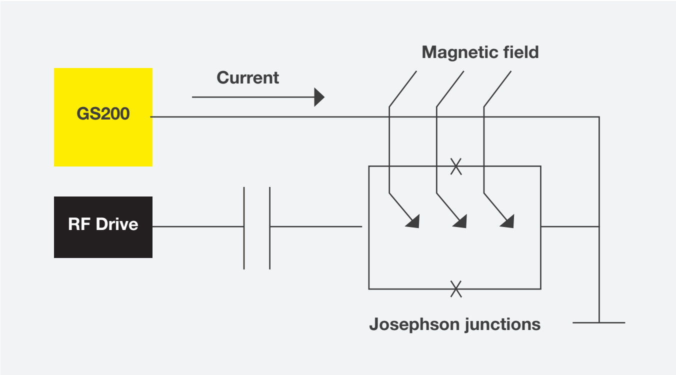


Fig. 1. The highly stable GS200's outstanding Low-noise performance delivers extremely low noise DC signals used in a wide range of design processes.

Measurement setup

As an example, in a measurement setup, the small applied current (~10 mA) produces the magnetic field to initalize a quantum bit.



Why choose the GS200?

Performance – The GS200's outstanding performance delivers extremely low noise DC signals used in a wide range of design processes.

Versatility – The GS200 can act not only as a source but also as a constant - load. Its monitoring feature delivers data logging capability.

Usability – Individual up/down digit keys enable dynamic and fast change of output. The high-resolution display provides a comprehensive view.

About the GS200

The GS200 is widely used in various state-of-the-art academic research and next-generation equipment development because it provides a very low noise (in the order of μV) and very stable DC voltage and current output. The combination of a minimum output resolution of 100 nV and its low noise performance enable engineers to make extremely small changes to the signal level. Moreover, it features superb linearity over all the ranges.
The GS200 offers:

- Voltage/current source up to ±32 V / ±200 mA
- Output resolution : 5 1/2-digit, ±120000-count
- Low Noise
  - 100 uVp-p (10 V range, DC to 10 kHz)
  - 3 uAp-p (100 mA range, DC to 10 kHz)
- High Stability (specified out to 90 days)
  - +/- 0.001% of setting + 20 uV (at 10 V range for one day)
  - +/- 0.004% of setting + 3 uA (at 100 mA range for one day)
- Programmable output: up to 10000 points
- Channel expansion / synchronized operation

How can GS200 support your application?

Visit the product page on **tmi.yokogawa.com** for more information or to download a product brochure. Or contact us directly via **tce@nl.Yokogawa.com** to discuss your applications measurement requirements.

Related products

Lasers shape the world of quantum technologies. Narrow-linewidth tunable diode lasers, amplified and frequency-doubled laser systems, frequency combs, and wavelength meters enable many quantum technologies.

Optical Spectrum Analyzer
Across the six models in the precise and sensitive AQ6370 series, Yokogawa covers a broad wavelength range. From the visible light spectrum measured by the AQ6373B, to the mid-wavelength infrared region in which the AQ6377 operates.

Electrical Power Analysis
In order to measure and analyze the power consumption of quantum computers please explore our portfolio of power analyzers.

For more information about these products visit **tmi.yokogawa.com**