

Statement of Work

For

Lock-in Amplifier

Title: Lock-in Amplifier

Document Date: 7/27/2026.

1. Background: There are many challenges facing the implementation of quantum information systems that are affordable, portable, and robust. While there are numerous candidates for the stationary qubits found in quantum computers, the most likely candidate for transmitted or “flying” qubits is the photon. Therefore, the ability to store photons reliably for extended periods of time is necessary for the processing of photonic qubits and the establishment of entanglement between distant nodes in a quantum network. However, the process of storage will by its nature distort the retrieved photonic states and thus distort the information encoded by the photons.

The Coherent Atomic Transfer (CAT) function is a framework developed for storing light pulses in a Λ -type atomic system using the phenomenon of electromagnetically induced transparency (EIT). The specific goal of this proposal is to build an experimental setup for the storage of light using EIT, which includes setting up the experiment, characterizing the alkali cells spectroscopically, and inducing EIT using a targeted set of atomic energy transitions and appropriately tuned lasers.

The product to be purchased is a commercial off-the-shelf lock-in amplifier device for the purpose of modulating photodetector output with a chopper wheel in order to suppress noise from overhead lights, allowing for accurate characterization of an alkali cell. The lock-in device will then be used to sync photodetectors to an electro-optic modulator and waveform generator for EIT laser input and output pulses. This experimental setup will also be used in the Quantum Optics Summer Lab for the purposes of exploration of sensing quantum coherence, as well as likely integration in the AFIT-OSU quantum network as a storage node for qubits over fiber. Stored light pulses will then be de-convoluted using the CAT function.

2. Scope: The vendor should provide a lock-in amplification capable device. The system must be capable of modulating and sampling fast enough to pull and resolve short pulse durations.

The research objectives outlined above satisfy the following requirements outlined in Section 101 of H.R.6227 "National Quantum Initiative Act", the Air Force science and technology strategy document for 2030 and beyond, and the Department of Energy's "Blueprint for a Quantum Internet.

3. Requirements/Salient Characteristics: The following specification lists the minimum requirements for a lock-in amplifier. Objective requirements are also highlighted when available.

A lock-in amplifier is crucial for separating laser photodetector outputs from noise that may otherwise drown out the signal. Therefore, this lock-in component is necessary for meeting mission requirements.

3.1. The lock-in amplifier shall meet the following technical requirements:

- 3.1.1.** Demodulation capability for DC up to 600 megahertz or higher reference signals
- 3.1.2.** At least two analog BNC inputs
- 3.1.3.** At least two analog BNC outputs
- 3.1.4.** Analog to digital input conversion capability included, along with the inverse of digital to analog output conversion
- 3.1.5.** Minimum sampling rate for input data of 1.25 giga-samples per second (GSa/s)
- 3.1.6.** USB 2.0 or USB-C interface is supported
- 3.1.7.** PC software interface included
- 3.1.8.** Coding support for either Python or MATLAB languages
 - 3.1.8.1.** API for supported language must be given
- 3.1.9.** Come with a manufacturer's warranty of at least 1 year
- 3.1.10.** Signal output must support digital to analog conversion of at least 1.25 giga-samples per second
- 3.1.11.** An included oscilloscope capability on device or PC software interface

4. Delivery:

SHIP TO:

Air Force Institute of Technology (AFIT/ENP)
ATTN: Greg Smith
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765

5. Lead time:

The contractor shall deliver ordered systems no later than 24 weeks after contract award.

6. Warranty:

Must provide 1 year warranty from that of acceptance.

7. Delivery Procedures – Commercial Vehicles:

- a. The company shall properly ship the system to the Air Force Institute of Technology at WPAFB, OH. All shipping costs to include insurance will be included in contractor's proposal. Great care using standard, approved packaging methods shall be taken.
- b. All vehicles larger than a large pick-up truck are required to be inspected by the Wright-Patterson Air Force Base Commercial Vehicle Delivery Gate (CVDG) prior to entering the installation. Vehicles to be inspected include, but are not limited to, the following:
 - 1. Step van/panel truck
 - 2. Tractor/trailer, box and flatbed containing cargo
 - 3. Tanker trucks
 - 4. Box trucks
 - 5. Tour buses
 - 6. Garbage/recycled waste trucks
 - 7. Concrete trucks/mixers, dump trucks
 - 8. Cranes, recreational vehicles, petroleum tanker

This inspection will be conducted at Gate 26A located off State Route 235.

- c. The following are exemptions to vehicles utilizing the CVDG:
1. If the vehicle has the product inside (concrete and asphalt trucks) and timely delivery is necessary due to product deterioration it does not need to enter the CVDG. To bypass the CVDG, the contractor shall submit a list containing drivers' names, social security numbers and the state in which the driver's license is held for those drivers who will be entering the base. This shall be accomplished 24 hours prior to requested entry time. If entry is requested on Monday, this list must be submitted by Friday at 1630 hours. All lists shall be submitted to the 88th ABW/CE Directorate contract inspector. The only gates that may be used under this exemption shall be 15A, 26A, 38A, and gate 1B. If the driver's name is not on the list, he/she will not be allowed access to the installation through these gates and the base will not assume liability for denied access.
 2. If a delivery vehicle must exit, and then re-enter the base to complete its route, the vehicle shall be resealed upon exiting the base. After initially passing through the commercial vehicle delivery gate, trucks shall be resealed at Gates 15A, 38A and 22B. The resealing of the trucks will allow them to continue to any other area of the installation (Areas A, B, or Kittyhawk) without reprocessing through the CVDG. To receive resealing assistance, the drivers shall physically stop at one of the three authorized gates and request the installation entry controller to reseal their truck and provide the next location of their delivery. The controller will reseal the truck and give the delivery driver a pre-clearance form. The driver shall present the pre-clearance form to the entry controller at the next point of installation entry. This reentry can be through any base gate.
- d. Vehicles may be subject to an inspection at any of installation entry control points during a directed random antiterrorism measure (RAM.) Any commercial vehicle, regardless of size, can be directed to the CVDG at the discretion of the installation entry controller.