Amonics Nano-second Pulsed Fiber for LiDAR Application

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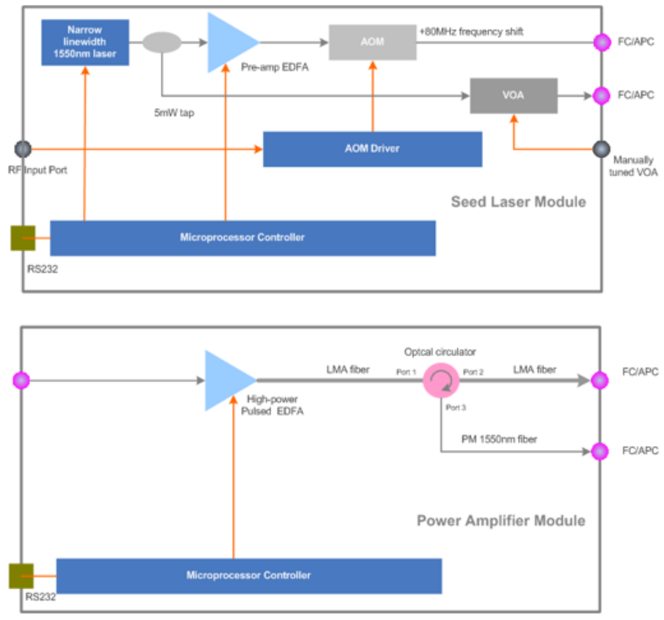
Amonics ALIDAR-150-M-FA, 150uJ Nano-second Pulsed Laser Appearance

Overview

Until recently, the most widespread implementation of a coherent lidar transmitter is a high energy (milli Joules) and low repetition rate (~ few Hz) solid state laser. The high energy requirement is necessary to further detection range and alleviate requirements on the receiver. The low repetition rate is however not particularly desirable due to possible fluctuations of the laser and the atmospheric conditions from pulse to pulse, yielding inaccurate measurements. Moreover, the lower repetition rate requires longer overall measurement time for a full-field lidar scan. On the other hand, a higher repetition rate enables faster time-resolved measurements, and provides capability for averaging the measurements to smooth out speckle and other distortions. It also implies the pulse energy can be reduced for Lidar scan of the same range.

As the repetition rate of the solid state is confined by thermal problems, Amonics now addresses the above limitations and offers the new all fiber optic based coherent Lidar transmitters which provide up to tens of kHz repetition rates. With the fiber optic technology, the resulting Lidar transmitter is smaller and lighter, and thus more robust and flexible for installation and integration.

Leveraging from the telecom applications, the fiber based pulsed laser is more reliable (no moving parts, long life span) and low cost, which is perfect tool for remote sensing applications, including wind speed measurement, range finding, 3D mapping and hard target characterisation.



Amonics ALIDAR-150-M-FA Functional Diagram

Key Features

- High pulse energy, up to 150 μJ @ 200ns pulse duration & 10kHz repetition rate
- Eye-safe 1550nm operation wavelength
- Linear polarization emission
- 100 dB pulse extinction ratio
- 15kHz narrow laser linewidth
- Wide operation temperature range from -10ºC to +65ºC
- Adjustable pulse duration from 100 to 1,000 ns
- Adjustable pulse repetition rate from 10 to 20 kHz

Applications

- Wind speed measurement
- Range finding
- 3D mapping
- Target characterisation
- Atmospheric pollutant detection

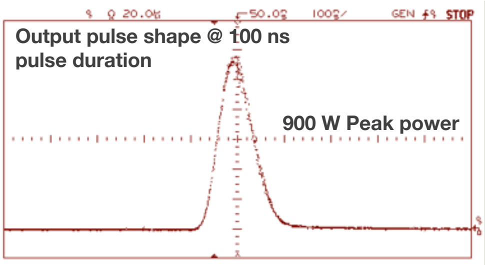
System Configuration

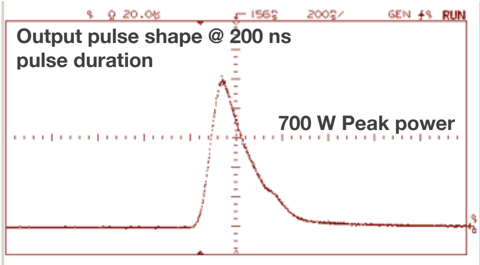
Amonics' all polarization maintaining fiber based nano-second pulsed laser is based on the master oscillator power amplifier (MOPA) design. The laser system consists of two compact modules, Seed Laser Module and Power Amplifier Module.

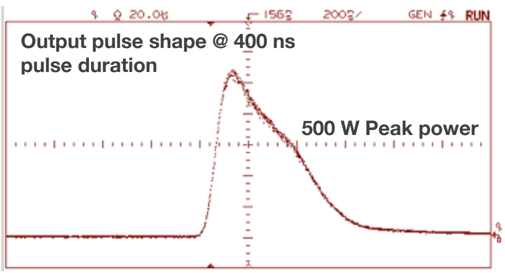
In the ***Seed Laser Module***, a continuous-wave 15 kHz (2kHz is available) narrow linewidth, low noise single mode diode laser with eye-safe 1550 nm emission is chosen as the seed laser. This enables a very long coherence length (> 20 km) for Lidar measurement. The seed laser is split by an optical coupler, tapping 1mW output power to a FC/APC receptacle as a local oscillator (LO), while the seed laser from the other arm of the optical coupler is connected to an acoustic optical modulator (AOM) to generate a pulse train with 100 to 1,000 ns pulse width at 10 to 20 kHz repetition rate. The AOM serves two purposes: one as an ultra high extinction ratio (>100 dB) optical pulse generator, and second as the frequency shifter (+80MHz) for Doppler detection. A pre-amp polarization maintaining fiber amplifier is used to compensate AOM insertion loss and boost up the pulse energy.

The pulse train then goes to the second module, ***Power Amplifier Module***. It consists of a multi-stage amplifier, at each amplification stage, fibers with increasing mode-field diameter are used to minimise nonlinear effects. The largest nonlinear effect for the laser system is identified as Stimulated Brillouin Scattering (SBS), which arises from the interaction between optical field and acoustic photons in the fiber. The SBS generation not only limits the maximum output power, but also poses threat to the laser system. Strong backward SBS generation can damage the laser components on its path, therefore it is very important to suppress the SBS generation.

Having applied Amonics proprietary SBS suppression techniques, the Amonics ***ALiDAR-150-M-FA*** pulsed laser achieves over 150 μJ at 200 ns pulse duration and 10kHz repetition rate. The pulse energy can be further increased to 200 μJ by broadening the pulse width to 400 ns.







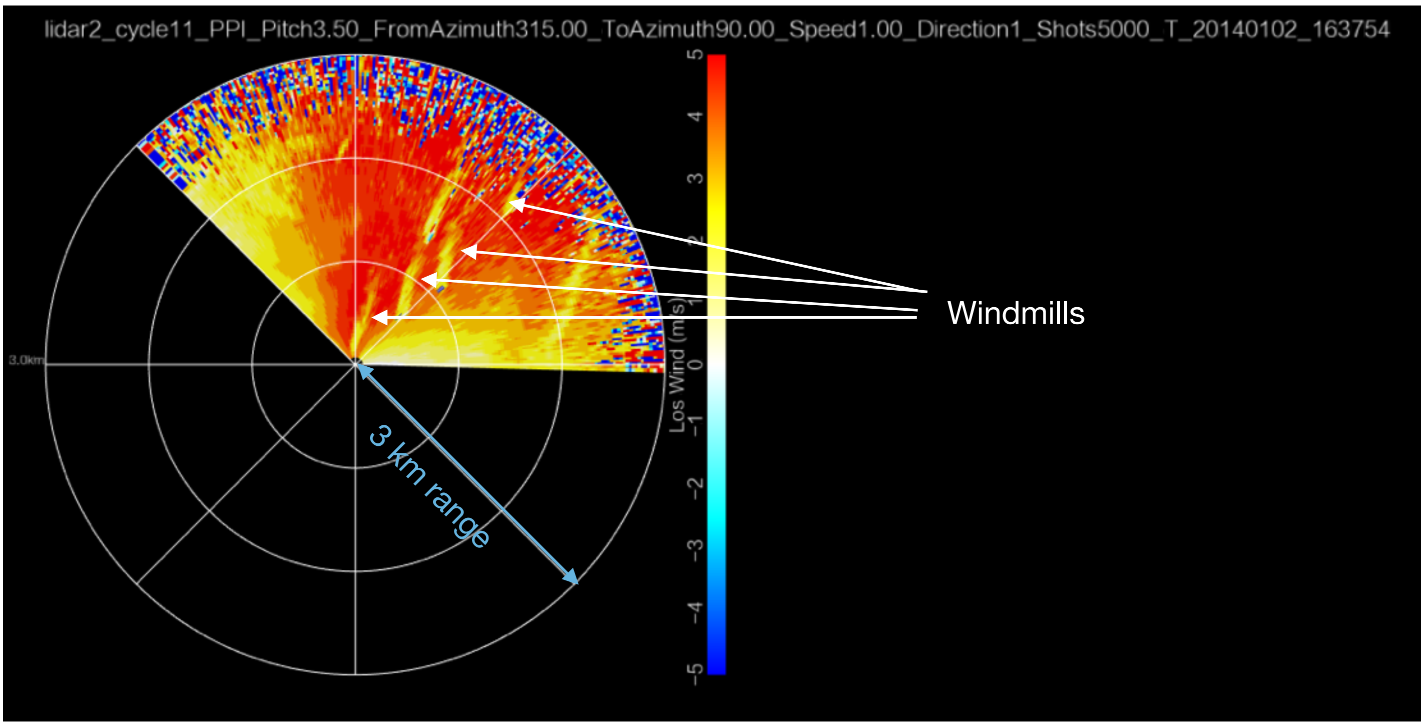
In a typical Lidar application, the modulated and amplified signal from the Amonics ***ALiDAR-150-M-FA*** pulsed laser is transmitted into atmosphere through an optical telescope. The return signal is scattered off atmosphere and Doppler shifted before taking a return path from the telescope through an optical circulator. The return signal then beats against the LO. The resulting RF signal is forwarded to a signal processor to extract information on frequency shift and signal strength as a function of time delay.

The performance of the Lidar system including range and velocity resolution is governed by the optimisation of the transmitted pulse duration and pulse peak power. In ***AiDAR-150-M-FA***, the peak power is 900 W, 700 W and 500W at 100 ns, 200 ns and 400ns respectively.

Wind Velocity Measurement

Wind velocity measurement is one the of the most popular applications of Lidar systems. To facilitate this application, the output pulse from Amonics ***ALiDAR-150-M-FA*** pulsed laser is expanded by a telescope and radiated into atmosphere through a hemispherical scanner. The received signal will be beat with the LO at the balanced receiver to generate a heterodyne beat signal. The detectable wind velocity ranges between -30 m/s to +30 m/s, and the detectable range is 30 m to 3,000m.

Below is an example of the wind velocity measurement taken in a real-life wind electric power plant.



Wind velocity measurement