LTE

Tester of laser range finders

Fig. 1. Photo of LTE test station

Basic information:

LTE test station enables expanded tests of laser range finders at laboratory conditions without necessity of frequent costly and time consuming field tests. The station enables measurement of both design parameters, final performance parameters and checking boresight errors. The first group includes such parameters like pulse energy, pulse peak power, pulse time width, pulse frequency, beam divergence, receiver sensitivity. The second group includes such parameters like accuracy of distance measurement, distance discrimination, extinction ratio (ER). Boresight errors are understood as angles between optical axis of transmitter and aiming axis; and between receiver axis and aiming axis.

LTE test station is an optimal choice for teams that need ability to measure design parameters of laser range finders (to support production line or R&D works), and to determine final performance parameters.

Why and how to test?

Laser range finders are important sensor in many surveillance systems. Proper distance determination is critical for system performance and long operational range of LRF is very imortant. At the same time performance of LRF depends on a set of parameters that can deteriorate in short time. Therefore testing of LRF is needed to assure that this device will produce proper distance measurement result in required distance zone.

Testing laser range finders appears to be very simple. It is enough to shoot a LRF to a target of known distance and check if LRF generates accurate distance measurement result. Therefore it is a common belief that testing LRF is to determine accuracy of distance measurement to a large reference target. However, practically in case of medium/long range LRF used in surveillance aplications it is not important if distance measurement to is for example 4000m or 4005 m. Another common misconcept is that measurements of design parameters is mostly limited to measurement of pulse energy of its transmitter. Practically pulse energy is important but it is only one of many parameters.

The aim of final performance tests to verify that LRF can measure distance to small targets of interest within required distance zone. LTE station makes possible to achieve this task. The station enables simulation of field tests where LRF shoots into direction of a target of regulated angular size located at regulated distance and seen via a medium of regulated attenuation. Such simulation makes possible to carry our indirect performance tests. LTE station enables also measurement of a long series of design parameters needed to evaluate proper design of laser range finders.

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How it works

LTE sttaion can work in two modes: electronic mode and fiber optics mode. In both modes the station simulates a target of regulated angular size located at some distance (regulated in electronic mode and fixed in fiber optics mode) and seen via a medium of regulated attenuation. The user can see image of the target and shoots to it like to real target. The target size can be regulated. In both modes The LRF is located in position to have situation when optics of LTE station overlaps optics of tested LRF.

- Electronic mode: In this mode LTF station measures parameters of pulse (pulses) emitted by transmitter of tested LRF and generates with some temporal delay optical pulse of regulated properties directed into receiver of tested LRF. In this mode a long series of parameters can be measured like: pulse energy, pulse peak power, pulse time width, pulse frequency, beam divergence, receiver sensitivity, accuracy of distance measurement, distance discrimination, and extinction ratio (ER). Boresight errors can be checked, too.
- Fiber mode: In this mode LTF station transmits a light pulse generated by the transmmitter through a long fiber optics line and finally generates this light pulse into direction of receiver of tested LRF. Attenuation of the fiber optics loop can be regulated. Maximal attenuation of fiber loop is good indicator how good LRF is. In this mode ER extinction ratio is measured of this mode is used for simple comparions tests.

Features

1. Two modes of simulation of targets located at different distances: 1) variable distance, variable signal electronic simulation, 2) fixed distance, variable signal fiber optics simulation. Advantages of both methods are achieved:
   - Electronic simulation: measurement of parameters of pulses emitted laser transmitters, simulation of variable distance targets, simulation of multiply targets, regulation of pulses of variable amplitude,
   - Fiber optics simulation: resemble conditions during field measurements of ER, ulra high reliability due to simple design.
2. Ultra expanded test range:
   - electronic mode: pulse energy, pulse peak power, pulse time width, pulse repetition frequency, missing pulse, pulse coding, distance measurement accuracy (test for both single target or multiply targets), distance discrimination, receiver sensitivity
   - fiber mode: extinction ratio ER, distance measurement accuracy, distance discrimination (option)
   - checking of boresight errors and divergence angle at both modes.
3. Ability to test both monopulse LRFs and multipulse LRFs
4. LRFs working at all typical wavelengths can be tested: 905/910 nm, 1060nm, 1540nm, 1550nm, 1570nm.
5. Ability to simulate six targets of different angular size (from 0.25 mrad to 4 mrad).
6. Fully computerized test system. Distance target-LRF, target size, system attenuation can be controlled from PC. The incoming pulses are digitally recorded and analyzed.
7. LTE simulates real field tests conditions. User sees a small target and shoots to it. Distance measurement indication only when laser beams hits the target.
8. Ability to test laser range finder equipped with night vision channel.
9. Enable testing typical dual channel LRFs with internal aiming channel or external aiming channel located close to receiver/transmitter. Other types of LRFs can be optionally tested, too.

Requirements on tested LRFs

From the point of optics the laser range finders can be divided onto several groups:

A) Dual channel LRFs with integrated aiming (two separate optical channels and aiming system integrated with transmitter or receiver. The channels are located at very short distance from one to another.
B) Three channel LRFs having channels at short distance from each other. Aiming device is a separate optical channel.
C) Dual channel LRFs with additional aiming channels (optical sight/video camera) located at significant distance from LRF optics,
D) Single channel LRFs built using using coaxial optics solution (receiver is integrated with transmitter (and sometimes also with a video camera as aiming device) in one optical system)
E) LRFs using an external thermal imager as an aiming device.

Typical LTE test station is built using two separate optical channels. Diameter of optics in both optical channels is 70mm. It is typically required that optics of the LTE station should at least partially overlap the optics of the tested LRF (Fig.2). It means that situation shown in Fig 2a is preferable but situation shown in Fig.2 is still acceptable.

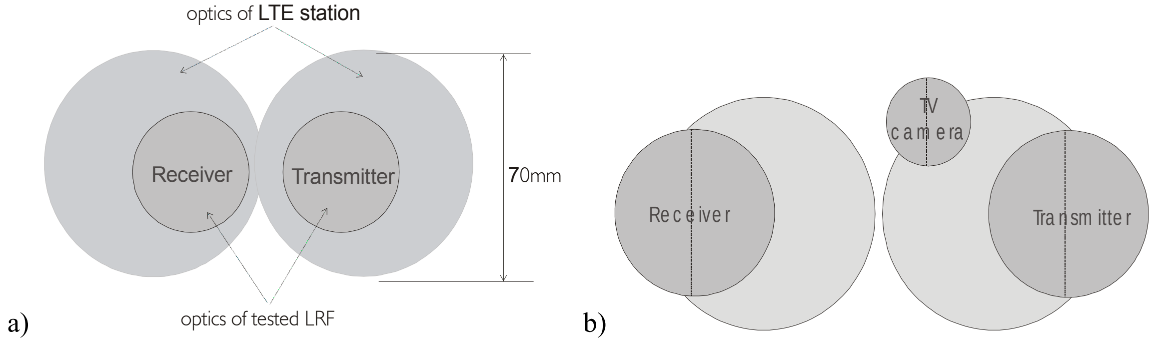

Fig. 2. Optics of tested LRF relative to optics of LTE test station a)optics of LTE test station fully overlaps optics of LTE test station overlaps only partially optics of tested LRF

Design of LTE station is optimized for testing of LRFs from groups A and B. Such LRFs represent at least 99% of all hi-tech LRFs.
LRFs from group C can be optionally tested using a special version of LTE station with third additional channel.
LRFs from group D can be optionally tested using a special version equipped with additional adapters. Detail information about active aperture of coaxial optics is needed.
LRFs from group E cannot be tested at all because optics of LTE station is non transparent for thermal imagers.

Technical parameters

Parameter	Value
Types of tested LRF	Both mono-pulse LRF and multi-pulse LRFs can be tested. Optimized for testing dual channel LRFs with integrated aiming and three channel LRFs having channels at short distance from each other. Other types optional.
Spectral wavelength of tested LRFs	910 nm, 1060 nm, 1540 nm, 1550 nm, 1570 nm (other wavelengths optional)
Optics of LTE test station	Two circles of 70 mm diameter
Mode of work	two manually switched modes: electronic simulation and fiber optics simulation
Location of LRF relative to test station	LTE optics must overlap at least 50% of optics of tested LRF
Regulation of target size	Step regulation, six values: 0.25; 0.5; 0.75; 1.0; 1.5; 2.0; 4.0 mrad
Electronic mode	
List of measured parameters	pulse energy, pulse peak power, pulse time width, pulse repetition frequency, missing pulses, pulse coding, distance measurement accuracy (test for both single target or multiply targets), distance discrimination, receiver sensitivity, ER
Optical detector type	ultrafast, calibrated InGaAs photodiode
Pulse energy range	10nJ to 200 mJ (option 500mJ)
Peak pulse power	1W to 10 MW
Pulse width	4-600ns (option 2-800ns)
Resolution of pulse width measurement	±1ns
Pulse Repetition Frequency	from 0.1 Hz to 20kHz
Simulated distance	At least from 200m to 40 km (can be extended up to 98km)
Resolution of simulated distance	2 m
Number of simulated reflections of single shot	up to 3 (can be increased up to 6)
Missing pulses	Yes
Coding	Yes (customer is expected to define type of coding used)
Central wavelength of pulsed light	905nm, 1060 nm, 1540 nm, 1550 nm, 1570 nm (the sources are to be

sources	manually exchanged)
Receiver sensitivity tests	Yes
Absolute receiver sensitivity range	At least 0.1 nW/cm² to 1µW/cm²(depends on wavelength)
Fiber optics mode	
List of measured parameters	ER (extinction ratio), distance measurement accuracy (single distance), receiver sensitivity, estimated range of LRF, distance discrimination (optional)
Test conditions for ER	LTE is calibrated for the following conditions: distance 500m, target reflectance = 0.4; target type: diffusive, Lambertian surface; visibility 20km, probability of proper indication: 90%
ER measurement range	At least 60 dB (limit vary on wavelength of tested LRF)
Simulated distance	About 1200 m (at distances over 1km all LRFs are working in maximal gain mode)
Conditions for range calculations	Software calculates the ranges on the basis of measured ER values and atmosphere attenuation data determined experimentally by Inframet – Attention: it is estimation of real operational range.
Distance discrimination	fiber circuit simulating up to 3 distances can be optionally delivered (typical version: single distance)
Both modes	
Divergence angle	Rough measurement using six step targets
Checking aligning of laser transmitter with internal optical sight/TV camera	Yes (it is checking how well LRF is aligned not measurement of absolute value)
Aligning of the laser receiver with the laser transmitter	Yes (it is checking how well LRF is aligned not measurement of absolute value)
Ability to test aligning of LRF with night vision sight	Yes
PC	typical modern laptop, Windows 7 operating system
Software	Set of computer programs: Pulse Browser, LE Control, LF Control, MET Control. Pulse Browser: to support acquisition and analysis of temporal profiles of pulses emitted by laser transmitter LE Control: to enable PC control of attenuators and target sliders working in electronic mode LF Control: to enable PC control of attenuators and target sliders working in fiber mode MET Control: program to enable control of pulse generator module (distance simulation in electronic mode)
PC communication	USB 2.0
Working temperature	+5ºC to 35ºC
Storage temperature	-5ºC to 50ºC
Humidity	up to 95% (non condensing)
Dimensions	(H x L x W) 350 mm x 1500 mm x 445 mm (base module + platform)
Mass	59 kg (base module + platform) + 10 kg additional parts + PC

Version of LTE station

LTE station is offered in two main versions:

1. LTF-A test station
2. LTE-B test station.

The LTE-A station has only electronic simulation block (no fiber optics block). LTE-B is a station having both electronic and fiber optics channels.

Options

A) Third optical channel to enable testing dual channel LRFs with additional external aiming channel (optical sight/video camera) located at significant distance from LRF optics,

B) Additional adapters to enable testing single channel LRFs built using using coaxial optics solution

C) Additional mechanical platform for tested LRFs to allow precision angular positioning of tested LRF
D) Additional camera to replace human operator and increase accuracy of angular positioning of tested LRF.

Why LTE station?

Some important parameters of laser range finders can be accurately measured using typical measuring instruments: pulse energy using optical energy meters, or pulse width using high speed oscilloscopes. These measuring tools are not cheap but still they are not very expensive. Having a set of optical energy meter and a hiigh speed oscilloscope at price level about 5 000 Eur we can measure accurately pulse energy and pulse width of all laser range finders present on the market. However knowledge about pulse energy and pulse width is not enough to evaluate performance of laser range finders at real conditions. The users of laser range finders are not specially interested in what are values of pulse energy and pulse width but what is operational range and accuracy of their laser range finders at real life conditions. We must keep in mind that performance of LRF characterized by the same pulse energy can differ a lot.

In order to evaluate fully laser range finders we need a test station capable not only to measure two mentioned above parameters but capable to:

1. Measure a long set of design parameters of LRFs: pulse energy, pulse peak power, pulse time width, pulse repetition frequency, missing pulses, pulse coding, distance measurement accuracy (test for both single target or multiply targets), distance discrimination, receiver sensitivity
2. Measure final quality parameters like extinction ratio (directly related to operational range)
3. Simulate targets of different angular sizes,
4. Simulate case of multiply reflection targets
5. To check angular divergence of the emitted beam
6. To check aligning of the laser emitter with aiming device or other reference optical axis,
7. To check aligning of the laser receiver with aiming device or other reference optical axis.

There are several commercially available stations for testing laser range finders available on world market. These stations use relatively simple mechanisms for electronic simulation or fiber optic simulation. LTE test station proposes to its users advance electronic simulation (ability to simulate reflected pulses for all LRFs present on market) and fiber optic simulation (hi tech fiber attenuators). LTE is the first commercially available test station that enables both possibility to measure all design parameters of LRFs, final quality parameters and checking of boresight errors.

Version 5.6

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