LT test station

Tester of laser range finders

Fig. 1. Photo of the LT test system

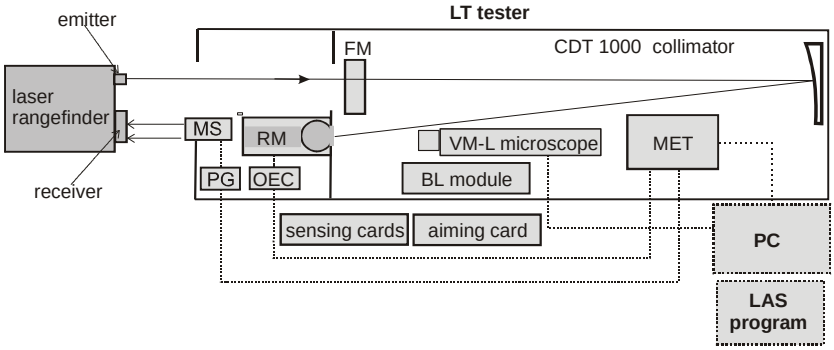

Fig.2. Block diagram of the LT test system

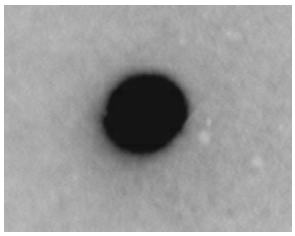

Fig.3. Image of laser beam

BASIC INFORMATION:

The LT test station is a modular measuring set that enables measurement of all important parameters of laser systems (laser range finders, laser designators, laser illuminators, laser pointers).

General concept of testing laser range finders is based on an idea to collimate the emitted laser pulse; measure energetic, temporal and spatial parameters of the pulse; and emit with a regulated temporal delay an optical pulse (a series of pulses) into the receiver module of the laser range finder. When testing laser designators, laser illuminators and laser pointers LT station works only in passive mode.

Basically the LT test station is built from three main blocks: LT tester, PC (with frame grabber), LAS software.

The LT test station enables measurement of the following parameters of laser range finders: pulse energy, pulse power, pulse width, pulse frequency, beam divergence, receiver sensitivity, accuracy of distance measurement (single target), accuracy of distance measurement (case of multiply reflections), bore-sighting of the laser emitter (in reference to optical axis of an internal optical sight, or external visible imager/thermal imager) and aligning of receiver (in reference to the emitter).

Due to some new modern features (very wide pulse energy range, simulation of multiply reflections, ability to test high frequency laser range finders, wide range of regulation of receiver sensitivity level) the LT test stations significantly exceed other commercially available stations for testing laser systems.

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Versions of LT test station

LT test stations are basically offered in two different types of slightly different design: LT-X and LT-Y.

LT-X station is developed to enable typical extended tests of LRFs. This means it is assumed that the user wants to measure all parameters of LRF presented typically in specifications (pulse energy, pulse time, PRF, accuracy, receiver sensitivity), and additionally to test LRF "intelligence" (how it works in case of multiply reflections) and to check aligning of both the emitter and the receiver in comparison to some reference axis (optical sight, TV camera or thermal imager).

LT-Y station was originally developed for simplified tests of LRFs and for bore-sighting applications to be carried out at depot/field conditions. Next, it was assumed that for true checking of performance of laser range finders at field conditions knowledge of peak power of the optical pulse is more important that knowledge of pulse energy. Therefore electronics of the LT-Y station was more simple than in case of LT-X but at the same time it was more reliable and more resistible to environmental conditions. However, later measurement capabilities of LT-Y were extended and nowadays both types enable extended tests of laser range finders.

Parameters of both types of LT station are presented in **Tab. 1**. As we see there are two main difference between two

1. LT-X optimised for tests at laboratory conditions, LT-Y – optimised for tests at depot/field conditions.
2. LT-X measure directly pulse energy, indirectly – peak pulse power. LT-Y – measure directly pulse energy, indirectly – peak pulse power.
3. LT-X can simulate up to five reflections, LT-Y – only a single reflection.
4. LT-Y is characterized by wide working temperature region.

Tab. 1. Comparison of measurement capabilities of two types of LT station

Parameter	***LT-X***	***LT-Y***
Pulse energy	Yes	Yes (indirect measurement as product of pulse power and pulse width)
Peak pulse power	Yes (indirect measurement as ratio of pulse power and pulse width)	Yes
Pulse width	Yes	Yes
Pulse Repetition Frequency	Yes	Yes
Missing pulses	Yes	Yes
Divergence angle	Yes	Yes
Distance measurement accuracy	Yes (with up to five reflections)	Yes (for only one reflection)
Receiver sensitivity tests	Yes	Yes
Aligning of the laser emitter with internal optical sight/TV camera/thermal camera	Yes	Yes
Aligning of the laser receiver with the laser emitter	Yes	Yes
Testing laser illuminators and laser pointers	Option	Option
Sensitivity spectral range	0.9-1.6μm	0.9-1.6μm
Measurement pulse energy range	0.002-180 mJ	
Peak pulse power		100W-10 MW
Pulse width range	4 - 100 nsec	4 - 100 nsec
Resolution of pulse width measurement	±1ns	±2ns
Pulse Repetition Frequency	0.1 Hz – 1kHz	0.1 Hz – 1kHz
Optical aperture of tested laser range finder	140 mm	140 mm (option: 190 mm)
Measured divergence angle range	0.2 to 4 mrad	0.2 to 4 mrad
Divergence angle resolution	0.05 mrad	0.05 mrad
Source of simulated reflected pulses	Three exchangeable sources (1.55, 1.06 and 0.9μm sources)	Three exchangeable sources (1.55, 1.06 and 0.9μm sources)
Number of simulated targets	up to 5	1

Receiver sensitivity regulation range	500:1	1000:1
Range simulation	300-30000m	300-30000m
Resolution of range simulation	5 m	5 m
Bore-sighting target	visual and thermal	visual and thermal
Working temperature:	from 10ºC to 35ºC	from 3ºC to 40ºC
Humidity	up to 90% (non condensing)	up to 95% (non condensing)
PC	Processor: AMD ATHLON 64 X2 3800; main board: GIGABYTE GA-MA69VM-S2; Memory:1Gb RAM DDRAM; Hard disk 80 Mb; monitor: resolution 1280×1024.	
Software	LAS-X program: • Communication and control of MET module, MS module and VM-L microscope (the communication is done using RS232 and USB ports). • Analysis of data got from MET module and calculation and presentation of Pulse energy, pulse width, PRF parameters of the tested laser • Analysis of data got from VM-L microscope and calculation and presentation of beam divergence parameter of the tested laser • Regulation of parameters (simulated distance, amplitude) of impulses generated by MS module to test laser range finder distance measurement accuracy and sensitivity • Generation of test report and storing the test result	
Dimensions	1290x330x 350mm	
Mass	29 kg	

Structure of both versions is very similar and presented in table below.

Tab. 2. Components of LT stations

LT-X	**LT-Y**
LT-X tester (LT-X base module, set of sensing cards, aiming card, set of pulse sources, PC, frame grabber, LAS-X software)	LT-Y tester (LT-Y base module, set of sensing cards, aiming card, set of pulse sources, PC, frame grabber, LAS-Y software)

Both types of LT test stations can be delivered in different versions of different design and significantly different measurement capabilities. Combinations of nine digits are used to compose codes that describe different available versions of LT test system. LT- X-1111-11111-1 describe basic version of LT test system. Definitions of the codes are shown in Tab. 3. As we see in this table changing digit 1 to digit 2 increase test capabilities of LT test system but also increase its cost.

Please check the code of the ordered station and find the measurement capability in the table presented below. Combinations of eight digits are used to compose codes that describe different available versions of LT test system.

Tab. 3. Definition of the eight digit code (abcdfgh) used to describe versions of LT test system

		Values of the digits used to define code	
Code Column	**Parameter**	**1**	**2**
a	Sensitivity range	0.9-1.6μm (for 1.06 and 1.55μm lasers)	0.6-1.6μm (for 0.8/0.9μm , 1.06μm and and 1.55μm lasers)
b	Energy range	0.2-300mJ	0.002[1]-300mJ (when both long range and short range laser range finders to be tested)
c	Source of simulated reflected pulses	one source (1.55 or 1.06μm) (if only 1.06 or 1.55μm tested)	three exchangeable sources (1.55, 1.06 and 0.9/0.8μm)
d	PRF	0.1 Hz – 20Hz (when only mono-pulse LRF are tested)	0.1 Hz – 20kHz (when both mono-pulse and laser diode LRFs are tested)
e	Bore-sighting target	Visual	visual and thermal (useful to align the laser with a thermal imager)
f	Optical aperture of the tested laser range finder	140 mm (for small stand alone laser range finder)	190 mm (bigger stand alone laser range finders or multi-spectral imaging systems)
g	Aligning of the laser receiver with the laser emitter	No	Yes (useful feature for manufacturer)
h	Testing laser illuminators, laser pointers, laser designators	No	Yes
i	Number of reflected pulses	1	Up to 5

Tab. 4. Description of two exemplary versions of LT station

Code	Description
LT-X 1111-1111-1	LT-X station of 0.9-1.6μm sensitivity range, energy range 0.2-300mJ, having one emitter light source, PRF of the tested laser not higher than 20Hz, equipped with only visual target for boresighting, recommended aperture of the laser range finder below 140mm, no abilities for aligning of the laser emitter and receiver, no ability for testing laser illuminators, only single reflection is simulated
LT-Y 2222-2221-2	LT-Y station of 0.9-1.6μm sensitivity range, energy range 0.002-300mJ, having three emitter light sources, PRF of the tested laser not higher than 2kHz, equipped with both visual target and thermal target for boresighting, recommended aperture of the laser range finder below 190mm, abilities for aligning of the laser emitter and receiver, no ability for testing laser illuminators; multiply reflections are simulated.

Comparison of LT and other laser range finders test systems

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 high speed oscilloscope at price

[1] Low energy values can be measured only for short laser pulses.

level about 7 000 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 measurement 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 measurement range and measurement accuracy we need a test station capable not only to measure two mentioned above parameters but additionally capable to:

1. Simulate radiation reflected by the targets (best scenario is to simulate complex scenarios as several reflections at different distances of regulated amplitude)
2. To check angular divergence of the emitted beam
3. To check aligning of the laser emitter with reference optical axis
4. To check aligning of the laser receiver with the laser emitter
5. To check aligning of laser emitter with thermal imager (or TV camera)

LT test stations are the systems needed for expanded tests of laser range finders that enable tests that give precise information about possible performance of tested laser range finder at real field conditions. LT test stations do not compete with simple measuring tools that could be used for measurement of some parameters of laser range finders but with other systems for testing laser range finders.

There are other commercially available test stations that can be used for testing laser range finders. Here we will present advantages of the LT test system in comparison to other commercially available test systems.

- LT test system is the first commercially available test system equipped with a sensing module capable to measure both energy and temporal parameters. Other systems use typically in one channel – an energy meter, and in the second channel – a temporal parameters meter.
- Versatile measuring tool for testing any type of laser range finders of laser illuminators:
  - Enable testing of all three typical types of LRF present on the market: 1.54/1.57μm, 1.06μm or 0.9μm. Typical test system enable only to test a single type of LRF
  - Exceptional wide rage of pulse frequency up to 20 kHz (other commercially available test stations cannot test laser emitters of PRF higher than about 20Hz eliminating testing of most short range laser range finders)
  - Exceptional wide range of measured energy (from 0.002mJ to 300mJ). Typical test stations can measure energies only over 1 mJ.
- Continuous regulation of receiver sensitivity level. Typical systems can carry out only step regulation and Go/No test.
- Modular design. Depending on application can be delivered in different configuration optimised for different laser range finders.
- High temporal resolution of pulse width measurement: 1ns.
- Continuous regulation of simulated distance up to 30km. Typical test systems can simulate only a fixed single distance.
- Ability to test performance of laser range finders under real field conditions (case of multiply reflections). Typical test systems can simulate only a single reflection.
- LT can be used to align both emitter and the receiver of the tested LRF. Typical systems does not enable such capabilities.
- LT test system can be used for aligning laser range finder with an external thermal camera or a TV camera.

CONTACT:

Tel: +48 604061817 Fax: +48 22 3987244 Email: info@inframet.com