L64 test system

Tester of laser receivers

Fig. 1.Photo of the L64 test system

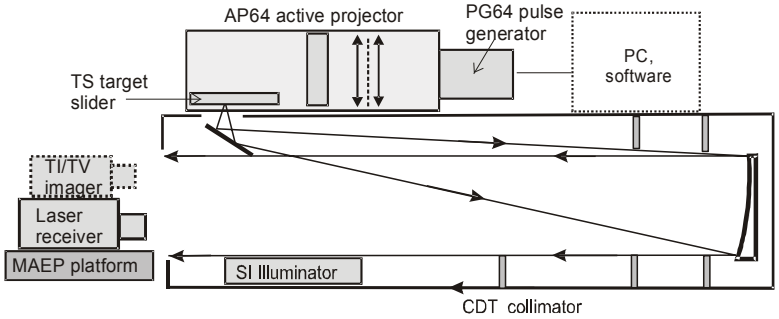

Fig. 2.. Block diagram of L64 test system

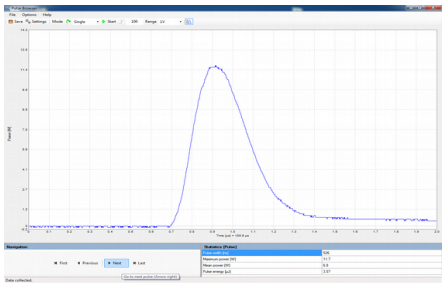

Fig. 3.. Laser pulse emitted by L64 system

BASIC INFORMATION:

Receivers of pulse laser radiation have found a series of applications like optical communication systems, laser seekers, laser trackers, LIDARs and laser range finders. Task of laser receivers in all these groups of laser systems is to detect pulse/modulated laser radiation emitted by small size sources. Wavelength, peak power, pulse width time, pulse repetition frequency, pulse interval time, and angular size of light source can vary significantly during real work conditions and application type. Next, laser receivers are often combined with other electro-optical sensors (laser transmitters, optical sights, thermal imagers or VIS-NIR cameras). Aligning of the laser receiver with the latter reference sensors sensor (or to a reference mechanical axis) is needed for proper work of the multi-sensor systems.

1064nm wavelength is characterized by excellent spectral transmittance of atmosphere at most geographic conditions. Therefore receivers of pulsed 1064nm radiation have found application in both long range optical communication systems, long range laser range finders, laser seekers, laser trackers or LIDARs.

L64 test system is a laser spot projector that simulate to the tested laser receiver a spot emitting/reflecting pulsed laser radiation at 1064nm wavelength. Peak power, temporal parameters of laser pulses, angular spot size of simulated laser spot can be regulated in wide range.

In basic version of L64 system, user can use ultra precision regulation of pulse repetition frequency (PRF mode). In advanced version L64 can work on two modes: PRF mode and PIM (pulse interval modulation) mode.

L64 system project images of the pulse light source in both visible and /infrared range and the latter source is visible to both thermal imagers and VIS-NIR cameras. The latter functionality enables boresight of laser receiver relative to laser transmitters in laser designators or in laser range finders. In this way L64 test system can be used for both testing and boresighting of laser receivers to other EO imagers.

L64 test system is typically offered to test laser receivers working at 1064nm wavelength. However, it can be optionally offered in versions optimized to test laser receivers working at 1550nm, 1530nm, 1570nm, 910nm or at other wavelengths.

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WORK PRINCIPLE:

L64 test system work as:

1. pulsed laser source of regulated power/temporal properties and angular size at 1064 nm spectral band (optionally at 1550nm, 1530nm, 1570nm, 910nm or at other wavelengths)
2. image projector that projects image of the simulated laser source in both visible and infrared range.

In most versions L64 station simulates a spatially static pulse laser source. However, most advanced versions of L64 station are capable to simulate spatially dynamic pulsed source.

DESIGN CONCEPT

L64 test system is built from a set of modules: PG64 pulse generator, AP64 active projector, TS target slider, SI Illuminator, CDT collimator, MAEP platform, PC, frame grabber, L64 Control program, BOR computer program.

PG64 pulsed laser source is the main module of L64 test system. This source can generate optical pulses of regulated, power, pulse repetition frequency, pulse intervals in response to internal or external electrical/optical synchronisation pulses. The P64 source can work in autonomous mode emitting a series of optical pulses or the pulses can be triggered by external electronic/optical signal. The emitted optical pulses are projected with regulated attenuation by AP64 active projector.

Apparent size of simulated pulsed light spot is regulated using TS target slider. Finally, image of pulsed light spot is projected in direction of tested laser receiver by CDT off axis reflective collimator. Regulation of spatial angular position of simulated laser spot can be optionally achieved by putting tested laser receiver on MAEP motorized azimuth elevation platform that enable regulation of angular position of tested laser receiver.

L64 can generate image of pulsed laser spot in both visible/near infrared and far infrared range. It enables boresight of laser receiver to other EO systems (VIS-NIR camera, thermal imager) with help of BOR computer program.

TEST CAPABILITIES

1. Measurement of parameters of laser receivers: receiver sensitivity, receiver dynamic
2. Basic performance tests: reactions of laser receiver to spatially static pulsed laser spots of different power, size and temporal properties
3. Advanced performance tests: reactions of laser receiver to spatially dynamic pulsed laser spots of different power, size and temporal properties
4. Boresight of laser receiver to optical axis of a reference optical sensor (VIS-NIR camera, thermal imager)
5. L64 can work in two basic modes: PRF and PIM.

VERSIONS

L64 test system is a modular system that can be delivered in form of a series of versions. There are significant differences between these versions of L64 test system. The main criterion is type of pulse modulation. It is assumed that in basic version (code X) user can use ultra precision regulation of pulse repetition frequency (PRF mode). In advanced version (code Y) L64 can work on two modes: PRF mode and PIM (pulse interval modulation) mode. Both basic versions can be later divided into four sub-versions.

In case of version X the division criterion are listed below:

1. Pulse width/ PRF range. More advanced versions offer continuous regulation in wider range.
2. Range of radiant exitance. Advanced versions offer wider range of regulation and higher max peak power.
3. Method of regulation of radiant exitance. Simpler version require manual change of attenuators to change radiant exitance. This operation is motorized for advanced versions.
4. Dynamic of continuous electronic regulation radiant exitance. Advanced versions offer wider dynamic of electronic regulation of radiant exitance.
5. Temporal delay. Advanced version enables regulation of temporal delay between the electrical trigger pulse and the optical pulse (simulation of variable distance to the target).
6. Multiply target response. Advanced versions enable simulation of case when emitted laser beam is reflected by several targets.
7. Method of regulation of target size. Simpler versions require manual change of targets to enable step regulation of target size. Advanced versions enable continuous regulation of target angular size.
8. Support to boresight of laser receiver to thermal imagers or VIS-NIR cameras. Simulated laser spot can be seen by VIS-NIR cameras or by thermal imagers in advanced versions.
9. Spatial angular position of pulsed laser spot. Typical versions enable simulation of spatially static target. Most advanced version enables PC control of angular position of simulated target.

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Table 1. Parameters of four sub-versions of L64X test system

Parameter	Version A	Version B	Version C	Version D
Collimator type[1]	Off axis, reflective	Off axis, reflective	Off axis, reflective	Off axis, reflective
Collimator aperture[2]	150mm	150mm	150mm	150mm
Collimator resolution	> 50 lp/mrad	> 50 lp/mrad	> 140 lp/mrad	> 140 lp/mrad
Center wavelength of emitted radiation	1064±1 nm (option: other wavelengths)	1064±1 nm (option: other wavelengths)	1064±1 nm (option: other wavelengths)	1064±1 nm (option: other wavelengths)
Width of spectral band	≤2 nm	≤2 nm	≤2 nm	≤2 nm
Power uniformity at collimator output[3]	≤10%	≤10%	≤10%	≤10%
PC control of pulse width, PRF, or PIM	Yes	Yes	Yes	Yes
Pulse time width range/regulation type	20-100ns	10-500ns; continuous regulation	10-500ns; continuous regulation	10-500ns; continuous regulation
Resolution of pulse time width regulation	10ns	0.5ns	0.5ns	0.5ns
Temporal stability of pulse time width	3ns	1ns	1ns	1ns
Uncertainty of pulse time width regulation	10%	5%	5%	5%
Pulse Repetition Frequency range in internal synchronisation mode	10 Hz – 10 kHz	1Hz – 20 kHz	1Hz – 20 kHz	1Hz – 20 kHz
Pulse Repetition Frequency range in external synchronisation mode	0.1 to 10 kHz	0.1 to 20 kHz	0.1 to 20 kHz	0.1 to 20 kHz
PRF stability	1 µs raster 0.001% at 10Hz	1 µs raster 0.001% at 10Hz	1 µs raster 0.001% at 10Hz	1 µs raster 0.001% at 10Hz
Radiant Exitance [W/cm^2] at collimator output (for max target size)[4]	1µW/cm^2 to 0.1mW/cm^2 (at max target size)	50nW/cm^2 to 0.1mW/cm^2 (at max target size)	50nW/cm^2 to 0.3 mW/cm^2 (at max target size)	50nW/cm^2 to 0.4 mW/cm^2 (at max target size)
Peak to peak non stability (peak power)	<5%	<2.5%	<2.5%	<2.5%
Method of regulation of peak power	1)Step manual optical attenuators, 2)Continuous electronic regulation	1)Step manual optical attenuators, 2)Continuous electronic regulation	1)Step manual optical attenuators, 2)Continuous electronic regulation	1)Continuous motorized optical attenuator, 2)Continuous electronic regulation
Dynamic of continuous electronic regulation	5:1	10:1	10:1	10:1

1 Inframet can offer also on axis reflective collimators or refractive collimators
2 Collimators of aperture up to 300mm are optionally available.
3 Measured at central 100mm diameter using 25mm aperture
4 Exitance at collimator output depends on target angular size. The values refer to a case of maximal target.

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Target size range	0.25-10mrad (six steps: 0.25; 0.5;1; 2;4;10 mrad)	0.25-10mrad (six steps: 0.25; 0.5;1; 2;4;10 mrad)	0.25-10mrad (continuous regulation)	0.25-10mrad (continuous regulation)
Method of regulation of target size	Manual change of targets	Manual change of targets	Manual change of targets	Continuous PC control of target size
Temporal delay relative to synchronisation (simulated distance to primary target)	No	No	0.1-650µs (15-97500m)	0.1-650µs (15-97500m)
Multiply target simulation	No	No	Yes	Yes
Maximal number of simulated targets	1	1	10	10
Regulated temporal delay between multiply targets	No	No	150-2500ns (22.5-375m)	150-2500ns (22.5-375m)
Support to boresight of laser receiver to thermal imagers or VIS-NIR cameras	No.	Yes. Simulated target emits visible light. Software boresight support.	Yes. Simulated target emits visible light and thermal radiation. Software boresight support.	Yes. Simulated target emits visible light and thermal radiation. Software boresight support.
Spatial angular position of pulsed laser spot	Static target	Static target	Static target	PC control of target angular position in 8º FOV (bigger FOV is possible, too)
Optical pulse monitor output[5]	No	Yes	Yes	Yes
Sensitivity of optical monitor	-	about 3.5V/W	about 3.5V/W	about 3.5V/W
Synchronisation modes	1) internal electrical trigger(free run) 2) external electrical trigger (start series of pulses or pulse to pulse operation)	1) internal electrical trigger(free run) 2) external electrical trigger (start series of pulses or pulse to pulse operation)	1) internal electrical trigger(free run) 2) external electrical trigger (start series of pulses or pulse to pulse operation)	As in versions A-C but additionally pulses can be triggered by external optical signal
PC communication port	USB 2.0	USB 2.0	USB 2.0	USB 2.0
Synchronisation output	No	Yes. TTL standard	Yes. TTL standard	Yes.TTL standard
Input trigger voltage range	2.4V to 4.1V	2.4V to 4.1V	2.4V to 4.1V	2.4V to 4.1V
Power supply	AC230V	AC230V	AC230V	AC230V
Working temperature	+5ºC to +35ºC	+5ºC to +35ºC	+5ºC to +35ºC	+5ºC to +35ºC

BLOCKS OF L64X TEST STATION

L64XA test station: PG64XA pulse generator, AP64-XA active projector, TS target slider, set of targets, set of attenuators, CDT15150SR collimator, PC, L64A Control program

L64XB test station:PG64XB pulse generator,AP64XB active projector, TS target slider, set of targets, set of attenuators, SI Illuminator, CDT15150SR collimator, PC, frame grabber, L64B Control program, BOR computer program.

5 Output of optical module that converts emitted pulses to electrical signal

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L64XC test station: PG64XC pulse generator, AP64XC active projector, MT motorized target, set of attenuators, SI illuminator, CDT15120HR collimator, PC, frame grabber, L64B Control program, BOR computer program.

L64XD test station: PG64XD pulse generator, AP64XD active projector, MT motorized target, MA motorized attenuator, SI illuminator, CDT15120HR collimator, MAEP platform, PC, frame grabber, OC optical converter, L64D Control program, BOR computer program, MOT Control program.

VERSION L64Y – PIM mode

L64Y station can work on both two modes: PRF (pulse repetition frequency) mode and PIM (pulse interval modulation) mode. L64Y station can be offered also in four versions (L64YA, L64YB, L64YC, L64YD) like L64X version. Parameters of L64Y are the same as L64X listed in Table 1. The difference is ability to generate pulses at PIM modulation.

There are myriads of possible PIM codes that can be used in different applications. Therefore customer is expected to inform Inframet on number and details of required codes. Later two options are possible:
Y1 – customer requires a fixed number of predefined codes (number of codes not higher than 20). Inframet delivers software where user can choose code to be used to emit optical pulses.
Y2 - Inframet delivers software tool that enable user to define great number of PIM codes. User is expected to inform Inframet about mathematical formulas used to created PIM code and limits on regulation parameters.

COLLIMATOR

Inframet typically offers L64 station based on a reflective CDT15150 collimator of active aperture 150mm b ut other collimators can be used too. However it should be noticed that collimator of bigger aperture (more convenient for boresight of big multi sensor system) means also lower output exitance at collimator output comparing to typical collimator of 150mm aperture. There is inverse situation when using collimator of smaller aperture.

CODES

L64XA, L64XB, L64XC, L64XD are codes for L64 station of parameters as described in Table 1. L64Y1A, L64Y1B, L64Y1C, L64Y1D, L64Y2A, L64Y2B, L64Y2C, L64Y2D are codes for versions of L64 station that additionally offer work in PIM mode.

SUMMARY

L64 test station is extremely powerful station for testing laser receivers operating at 1064nm spectral band (or other wavelengths). It enables expanded testing at laboratory conditions and gathering information about tested receiver typically possible to obtained only after long and costly field tests.

Main features:

1. Ability to work in both PRF and PIM modes. L64 offers precision regulation of PRF almost from 0.5 Hz up to 20 kHz when typical test stations have problems to emit pulses of PRF over 10kHz and below 10 Hz. Inframet delivers software tool that enables user to define great number of PIM codes, too.
2. L64 is capable to regulate pulse width in ultra wide range from 10ns to 500ns in situation when typical test stations generate pulses of fixed pulse width (typically about 20ns). .
3. Pulse light source in L64 is integrated with visible light source and a blackbody. This means that the same pulsed light source that emit 1064 nm pulses emits also typical visible light and thermal radiation. Therefore pulsed light source can be seen by human eye using optical sights or by VIS-NIR cameras or by thermal imagers. This solution is very useful to minimize boresight errors of laser receiver relative to optical axis of imaging sensors.
4. L64 stations generate pulses of peak power that can be regulated in a very wide range. Typical dynamic of regulation is at least 2000 times in situation when typical stations barely offer regulation with more than 5 times.
5. Ultra precision regulation of pulse width with 0.5 ns resolution. Typical stations enable regulation of pulse time width with resolution not better than 5 ns.
6. L64 station enables generation of pulses with regulated delay relative to trigger pulse (regulated distance simulation), continuous regulation of target angular size, continuous regulation of target angular position. Additionally temporal profiles of power of generated pulses can be programmed and multiply reflections can be simulated.
7. These six features not met in typical test stations are extremely important for many applications because they enable realistic simulation of complex field scenarios at laboratory conditions.

L64 station represent a new generation of test station for testing laser receivers. Its performance significantly exceed performance of other commercial test stations available on market.

Version 3. 1

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