L64

Tester of directional pulsed laser receivers

Fig. 1.Photo of the L64 test system

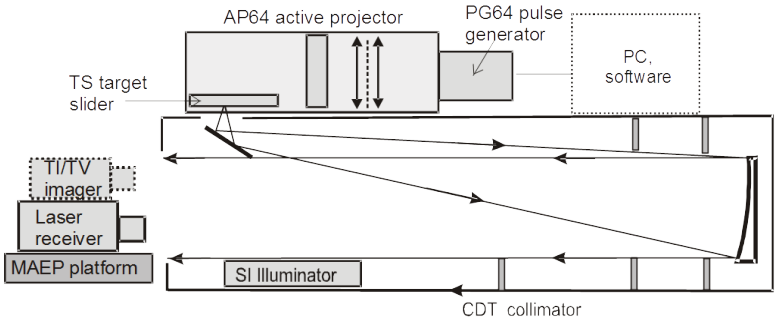

Fig. 2. Block diagram of L64 test system

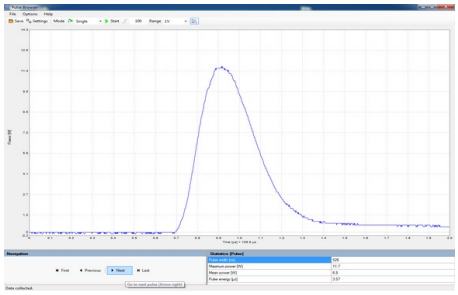

Fig. 3. Laser pulse emitted by L64 system

1 Basic information

Directional receivers of pulse laser radiation have found a series of applications in laser seekers, LIDARs, laser range finders or optical communication systems. Task of these directional receivers is to detect pulse/modulated laser radiation emitted by a pulsed/modulated laser source located in its field of view. Directional receivers used in LIDARs, laser range finders or optical communication systems are characterized by very narrow FOV due to their design by combining single small detector with an imaging optics. Directional receivers used in laser seekers are characterized by wide FOV due to their typical design by combining a large quadrant detector with an imaging optics. In case of the latter group the receiver is not only to detect pulsed laser source but also to align its optical axis to point to the detected pulsed laser source.

1064nm wavelength is characterized by best spectral transmittance of atmosphere at most geographic conditions if compared to other typical wavelengths like 1530nm, 1550nm, 1570nm, 910nm or 980nm. At the same time there are commercially available laser transmitters of ultra high peak power that emitt lasers pulses at 1064nm spectral band. Therefore receivers of pulsed 1064nm radiation are preferred in long range applications.

L64 test system is a laser spot projector that simulate to the tested directional laser receiver a laser spot emitting/reflecting pulsed laser radiation at typically 1064nm wavelength. Advanced software allows regulation of peak power, pulse width, pulse repetition frequency/pulse interval, angular size and angular position of simulated pulsed laser source and makes possible realistic simulation. The station can generate laser pulses working typically in pulse repetition frequency (PRF) mode. However, it can be optionally delivered capable to work in PIM (pulse interval modulation) mode, too.

L64 system project images of the pulse light source in both visible and /infrared range and therefore the source is visible to both thermal imagers and VIS-NIR cameras. The latter functionality enables boresight of laser receivers relative to laser transmitters in laser designators or in laser range finders.

Finally, 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, 980nm or at other wavelengths.

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2 Work principle

L64 test system works as an image projector that can project image of a pulsed laser source of following features:

1. wavelength: 1064 nm (optionally 1550nm, 1530nm, 1570nm, 910nm or at other wavelengths),
2. regulated pulse peak power,
3. regulated temporal properties (typically regulated pulse repetition frequency/pulse time widht and optionally pulse interval modulation),
4. regulated angular size,
5. regulated angular position,
6. image of the simulated laser source is visible for both VIS-NIR cameras and thermal imagers.

3 Design concept

L64 test system is built from a set of modules: PG64 pulse generator, AP64 active projector, TS target slider, SI Illuminator, CDT10100 collimator, MAEP platform, laptop, and L64 Control 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 interval in response to internal or external electrical/optical synchronization pulses. The emitted optical pulses are transmitted with regulated attenuation by AP64 active projector.

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

L64 can generate also image of pulsed laser spot in both visible/near infrared and far infrared spectral range.

4 Emission modes

Typical L64 station can generate pulse images of laser light source working in PRF (pulse repetition frequency) mode. In this mode the station emits light pulses of constant frequency. It should be noted that the emission frequency can be regulated in wide range by user of L64 station but when the station start emission of laser pulses then the frequency is constant.

The station can work using three synchronization modes:

1. internal electrical trigger(free run)
2. external electrical trigger (start series of pulses or pulse to pulse operation),
3. external optical signal.

The station offers very high accuracy of regulation of both pulse repetition frequency because this feature is crucial in most applications of directional laser receivers.

5 Test capabilities

L64 system is basically an imitator of a laser pulsed light source of regulated temporal-spatial properties. L64 system does not analyze output signal generated by the tested directional laser receiver. Therefore the user is expected to do such analysis by himself. The analysis of reactions of tested directional laser receiver to a series of pulsed images projected by L64 station enables to do following tests:

1. Measurement of receiver sensitivity,
2. Basic performance tests: reactions of laser receiver to a simulated laser source of manually regulated properties: pulse power, temporal properties (PRF, pulse time width, PIM), angular size, and angular position,
3. Advanced performance tests: reactions of laser receiver to a simulated laser source of automatically regulated source properties (pulse power, temporal properties (PRF, pulse time width, PIM), angular size, and angular position) according to preset scenario. In this case the station can realistically simulate laser spot located at variable distance (shorter distance – stronger peak pulse power and bigger angular size),
4. Measurement of aligning error of optical axis of the laser receiver to optical axis of a reference optical imager (VIS-NIR camera, thermal imager) – valid only for the case when such reference imager is used.

6 Technical specifications

L64 station can be delivered in form of a series of versions of different design and different test capabilities. Below are presented technical specifications of most advanced version.

Table 1. Technical specifications of most advanced version of L64 test system

L64

Tester of directional pulsed laser receivers

Parameter	Value
Tested receiver	
Application	Seekers, LIDARs, LRFs, optical communication systems
Optical aperture	< 100mm
Wavelength	1064nm (other wavelengths optional)
Design	1. large quadrant detector with an imaging optics 2. single detector with an imaging optics
Max weight of tested receiver	Up to 12kg (option 30 kg)
Basic parameters	
Collimator type	Off axis, reflective
Collimator aperture	100mm
Collimator resolution	> 100 lp/mrad
Power uniformity at collimator output[1]	≤10%
Center wavelength of emitted radiation	1064±3 nm
Width of spectral band	≤3 nm
Pulse emission modes	
Emission modes	1. Preset pulse repetition frequency (PRF) 2. Preset pulse interval modulation algorithm (PIM)
Pulse Repetition Frequency range in internal synchronisation mode	1Hz – 20 kHz
Pulse Repetition Frequency range in external synchronisation mode	0.1 to 20 kHz
PRF stability	1 µs raster 0.001% at 10Hz
Number of PIM codes	1)Predefined up to 20 PIM codes, 2)Software to create new PIM codes
Synchronization/triggering	
Synchronization modes	1) internal electrical trigger(free run) 2) external electrical trigger (start series of pulses or pulse to pulse operation), 3)external optical signal
Synchronization output	Yes. TTL standard
Input trigger voltage range	2.4V to 4.1V
Pulse intensity properties	
Regulation type	Manual or automatic according to pre-programmed temporal trajectory (simulation of variable distance)
Radiant Exitance [W/cm^2] at collimator output (for max target size)	100nW/cm^2 to 40 mW/cm^2
Dynamic of regulation or radiant exitance	At least 400 000:1
Peak to peak non stability (peak power)	<2%
Resolution of regulation of radiant exitance	Not worse 1%

1 Measured at central 60mm diameter using 25mm aperture

Temporal properties of laser pulse	
Range of regulation of pulse time width	10-500ns; continuous regulation
Resolution of pulse time width regulation	1 ns
Uncertainty of pulse time width regulation	5% or 1 ns
Temporal delay of laser pulse relative to synchronization pulse	0.1-650µs
Simulated laser source	
Target shape	Rhomboid (option circle)
Target size range	0.2-15mrad (continuous regulation)
Method of regulation of target size	Continuous PC control
Angular position of simulated laser source	
Angular position of pulsed laser source	Dynamic. PC control. Tested receiver on MAEP platform
Angular range	Azimuth up to 50º Elevation up to 6º
Speed of regulation of angular position	Azimuth – 1.5º/s Elevation – 0.5º/s
Resolution of angular position	0.05º
Target movement trajectory	Pre-programing up to 10 angular positions
Boresight	
Support to boresight of laser receiver to thermal imagers	Yes. Simulated source is visible to thermal imagers
Support to boresight of laser receiver to VIS-NIR cameras	Yes. Simulated target is visible to VIS-NIR cameras
Other parameters	
PC communication port	USB 2.0
Power supply	AC230V
Working temperature	+5ºC to +35ºC
Storage temperature	-5ºC to +55ºC

7 Options

Most of directional laser receivers work in PRF (pulse repetition frequency) mode. However, some of such receivers can work in PIM (pulse interval modulation) mode. Therefore Inframet offers optional L64 stations capable to work in PIM (pulse interval modulation) mode, too. 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:

1. Customer requires a fixed number of predefined codes (number of codes not higher than 20). Inframet delivers software where user can choose the code to be used to emit optical pulses.
2. 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.

8 Versions

L64 station can be delivered in form of a series of versions of different design and different test capabilities. The specs presented in Table 1 refer to most advanced typical version (work at PRF mode) coded as L64XD version. The station can be optionally delivered in several versions of different test capabilities:

1. L64XD - most advanced version capable to work in typical PRF mode. Technical details in Section 6. This is recommended version for expanded testing typical directional laser receivers working in PRF mode.
2. L64XC – as in L64XD but additionally no automatic continuous regulation of laser source properties (pulse peak power, PRF, target angular size, target angular position) with time according to pre-programmed temporal trajectory (simulation of variable distance scenario). Manual regulations using control software of all source properties are still possible.
3. L64XB – as in L64XC but additionally the station simulates only spatially static pulses light source (no regulation of source angular position). No support to boresight of laser receiver to thermal imagers or VIS-NIR cameras, too. No optical synchronization.
4. L64XA – as in L64XB but additionally but maximal radiant exitance at collimator output is limited to 0.4 mW/cm^2. This is low cost version recommended for basic checks (sensitivity) of directional laser receivers.

There can be also optional versions capable to work in PIM mode,too.

Y1 –Inframet delivers software where user can choose the code to be used to emit optical pulses (number of codes not higher than 20).

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.

Please add code of option to main code. Example: L64XD-Y2 means L64XD station with option Y2.

9 Summary

L64 test station is extremely powerful station for testing directional 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. L64 offers wideregulation 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.
2. L64 stations generate pulses of peak power that can be regulated in a very wide range. Typical dynamic of regulation is at least 400 000 times. Maximal radiant exitance at collimator output can be as high as 40 mW/cm^2. This high dynamic of regulation coupled with high maximal power enables realistic simulation of real scenarios when distance receiver to source vary from dozen of kilometers to hundred of meters. It should be noted that dynamic of regulation of power of simulated source offered by competitors systems it typically not more than 500 times.
3. 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).
4. 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.
5. Ultra precision regulation of pulse width with 1 ns resolution. Typical stations enable regulation of pulse time width with resolution not better than 5 ns.
6. Advanced software that make possible to test reactions of laser receiver to a simulated laser source of automatically regulated source properties (pulse power, temporal properties (PRF, pulse time width, PIM), angular size, and angular position) according to preset temporal scenario. In this case the station can realistically simulate scenario when distance source-receiver changes with time (shorter distance – stronger peak pulse power and bigger angular size).

7. Optional ability to work in PIM mode. Inframet delivers software tool that enables user to define a great number of PIM codes, too.

These seven 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.

To summerize, 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 6. 1

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