



## Technical Specification of Verification and Inspection for Laser Speedometers

S/N

CNMV 203

Rev

2

1. These Technical Specifications are developed pursuant to Paragraph 2, Articles 14 and 16 of the Weights and Measures Act.
2. The date of promulgation, document number, date of enforcement and content of amendment are listed as follows:

Rev	Date of Promulgation	Document No. (Ching-Piao-Szu-Tsu)	Date of Enforcement	Content of Amendment
1	2006-09-19	09540003940	2007-01-01	<ol style="list-style-type: none"> <li>1. Add the definition of the categories of the laser speedometer, the terminology, and the intended use for law enforcement, and the requirement for the technical documents, and relative manual.</li> <li>2. Add the null display confirmation function when the speedometer is idle or no targeting vehicle detected, low-voltage indication or alarm function, direction discrimination function.</li> <li>3. Add the range detection checking at 48m and 49m and conducting the speed accuracy detection when speed at 50km/h and 100km/h, and perturbation checking.</li> </ol>
2	2009-09-18	09840004380	2010-01-01	

3. Reference standards:

DOT HS 809 239 : Speed-measuring device performance specification-lidar module ( 2006 )

IEC 60825-1: Safety of laser products - part 1. Equipment classification, requirements and user's guide (2001/01).

Date of Promulgation

2009-09-18

**Bureau of Standards, Metrology and Inspection****Ministry of Economic Affairs**

Date of Enforcement

2010-01-01

1. Scope:

- 1.1 This specification applies to Lidar Module laser speedometers with/without photo-taking device (hereafter “laser speedometer”) subject to verification and inspection for law-enforcement applications.
- 1.2 A Lidar Module laser speedometer in this specification means a device that transmits coherent infra-red light pulses against on a moving vehicle and receives the reflected pulses so as to measure the time of flight using the laser pulses reflected from the moving vehicle, and then calculates and displays the speed of the target vehicle based on the pulse repetition rate.

2. Terms and Definitions

- 2.1 Laser Speedometer: The equipment for laser speed inspection, integrating extra equipment for collecting, handling or recording related images
- 2.2 Cosine Effect: The effect due to the moving direction of vehicles and the signal of the radar speedometer do not in parallel.
- 2.3 Laser Target Speed Simulator: A device used in a laboratory, capable of receiving lasers from the speed detection device and delivering the corresponding signals that contain time lag
- 2.4 Target Vehicle: The vehicle targeted accurately by the visual aiming device on the speed detection device

3. General requirements:

- 3.1 When each type is sent for initial verification for the first time, the following documents should be provided:
  - (1) Documents to identify the laser speedometer under test are specific used.
  - (2) Documents to identify the laser speedometer under test meets IEC 60825 Class 1 (FDA Class 1 in USA ) laser safety requirements.
  - (3) User manuals and product specifications ( including operation instructions, electrical specification of the laser speedometer, with or without photo-taking device, measurement method, error range, complete assembly drawing, and related techniques data, etc. )
- 3.2 When each type of a laser speedometer with photo-taking device is sent for initial verification for the first time, related explanations regarding Cosine Effect, speed measurement and the layout of installation shall be stated in the related documents as in the (3) in paragraph 3.1.
- 3.3 A photo clearly showing the information such as the target vehicle, the plate number, serial number of the speedometer, time (including year, month, day, hour and minute), speed and location, etc. shall be provided when apply for verification.
- 3.4 The laser speedometer shall be installed and used correctly, according to its original factory’s manual.
- 3.5 After a laser speedometer passes verification, no any software or hardware can be used to switch to the detection model that will affect its accuracy.

3.6 If a laser speedometer without photo-taking device is re-modified to a laser speedometer with photo-taking device, the re-verification is required before it can be used, and documents as paragraphs 3.1~3.3 shall be provided when apply for re-verification.

#### 4. Verification and inspection equipment

4.1 The evaluation of the uncertainty to the verification and inspection equipment: shall be down before the verification and inspection equipment can be used and the verification and inspection equipment shall be traceable to national standards. The requirements for the equipment shall include:

- (1) Rangefinding equipment: resolution  $\leq 1$  cm
- (2) Universal frequency counter or oscilloscopes: resolution  $\leq 0.001$ Hz
- (3) Optical power meter: wavelength shall cover  $905 \text{ nm} \pm 50 \text{ nm}$  and the power range shall meet requirements of IEC 60825 Class 1.
- (4) The laser target speed simulation system:
  - Delayed time range  $0.2 \mu\text{s} \sim 5 \mu\text{s}$
  - Input trigger signal  $< 100 \text{ ns}$
  - Pulse repetition rate  $\geq 390 \text{ Hz}$

#### 5. Structure

5.1 On the main part, the laser speedometer shall bear the following information:

- (1) Name or trademark of the manufacturer
- (2) Model number and the serial number

5.2 The main part of the laser speedometers shall bear the power supply specifications.

5.3 The main part of a laser speedometer and its accessories shall be sent to for verification with its power cord and signal connection line for testing.

5.4 All the switches, buttons, and knobs of the main part of the radar speedometer and its accessories shall be function smoothly and reliably. There shall be no mal-contact, loosening or malfunction which will interrupt the operation.

5.5 There shall be no obvious scratches or cracks causing refraction that affect the detection of the speed.

5.6 The laser speedometer shall be equipped on a sturdy stand as the user manual required or held by hand firmly..

5.7 The speed indication of a laser speedometer shall be displayed in digital.

5.8 The value indicating speed on a laser speedometer shall be displayed simultaneously, clearly and unambiguously.

5.9 The speed indication of a laser speedometer shall be expressed as kilometers per hour (km/h).

5.10 The resolution of the speed indication of a laser speedometer shall be  $\leq 1$  km/h; the resolution of the distance shall be  $\leq 0.1$ m (meter).

5.11 The speed detection range of laser speedometers shall at least cover the range from 16 km/h to 300 km/h.

5.12 When inspecting the aiming distance accuracy, the display of speed on the laser

speedometer shall be empty or 0 km/h.

5.13 If a laser speedometer uses a DC power supply, a low-voltage indication function shall be built-in.

5.14 A laser speedometer shall have been built-in the function of the directions discrimination of coming vehicles or leaving vehicles.

## 6. Verification and inspection procedure

6.1: Structure and specifications of laser speedometers shall be verified and inspected in accordance with the following items and order:

- (1) Structure
- (2) Rangefinder accuracy
- (3) Laser pulses repetition rate
- (4) Optical power of laser beam
- (5) Speed detection accuracy

6.2 The procedure of the accuracy verification of the range-finding is as follows:

- (1) Make sure that the distance between the laser speedometer and target equipment is 48m, 49m and 50m respectively by a rangefinder by using a rangefinder, and then place the laser speedometer on the correct position, as shown in Fig. 1.
- (2) The reflection side of the target equipment is a circular plate with a 25 cm diameter. There shall be no obstacles behind the disk.
- (3) The laser speedometer without photo-taking device shall aim at the center of the target device through the target point of the rangefinder device, so as to measure and record the distance between the laser speedometer and target device.
- (4) If the laser speedometer with photo-taking device equipped a rangefinder device, the procedure in the item (3) shall be conducted, and then be sure to confirm the center of the pointing of the photo-taking device corresponds with and the pointing of the rangefinder.

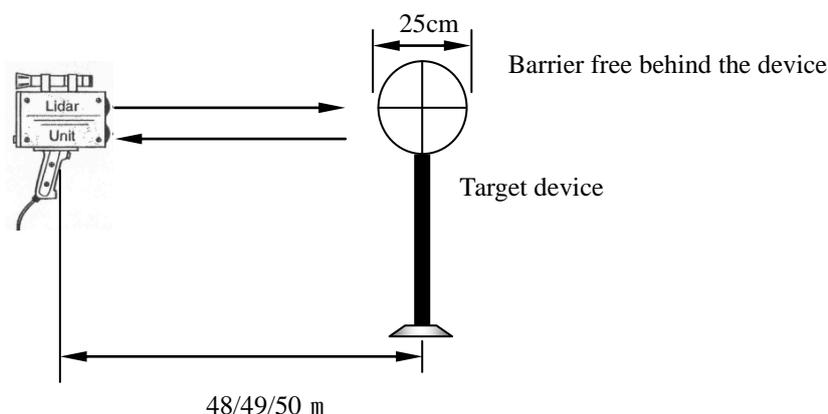


Fig. 1: Rangefinder verification device

## 6.3 Verification of Laser PRR:

- (1) Make sure that the wavelength of the optical power meter is same as that of the laser

speedometer under test.

- (2) Let the laser speedometer under test emit laser beam to a PRR light detector and then send the output of the detector to an oscilloscope. The oscilloscope will read PRR (Pulse Repetition Rate) shown in Fig. 2.

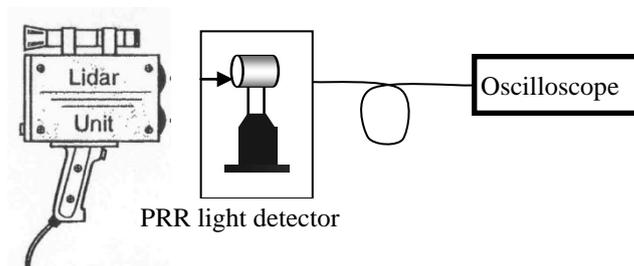


Fig. 2: Laser PRR verification Device

#### 6.4 Verification of the laser power:

Have the laser beam emitted by the laser speedometer under test through a convex lens and a plate that with a hole in 7mm diameter in center is 100mm apart from the convex lens point to a light detector of the optical power meter. The procedure lasts for 10 seconds and read the maximum power of the laser beam. The verification device is shown in Fig. 3.

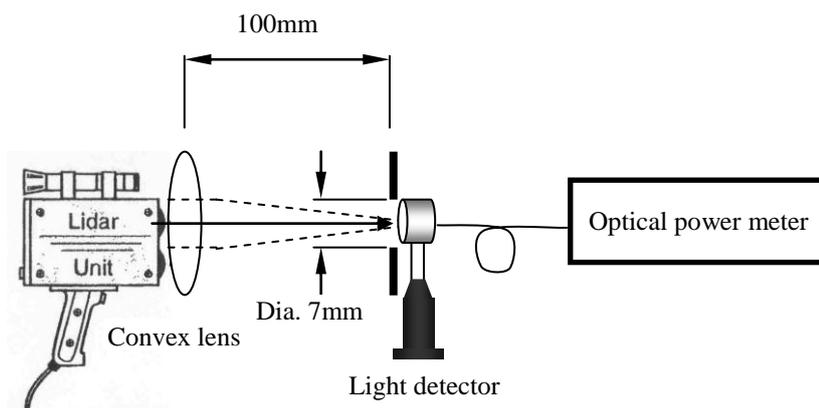


Fig. 3: Optical Power meter verification device

6.5 To verify the speed detection accuracy, use the laser speed simulation system to produce different flying time of the laser pulse, so as to simulate the distance changing caused by different speeds of vehicles. The verification procedure is as follows:

- (1) In a laboratory, set the testing module of the laser speedometer to match the receiving/transmission module of the speed simulation system, which includes the receiver and transmitter, as shown in Fig.4.
- (2) Based on the simulated speed ( $v$ ), the simulation system will simulate the changes of a series of distances ( $d$ ) and times ( $t$ ) of target vehicle. The formula is:

$$d = c_{air} \cdot t_{RT} / 2$$

$$v = d / t$$

where  $C_{air}$  represents the speed of light in the air (approx. 299705663 m/s) and  $t_{RT}$

represents the simulated back and forth time of laser light from the laser speedometer to the target vehicle.

- (3) Measure the Pulse repetition rate (PRR) of the laser speedometer under test and calculate the time gap ( $t$ ) between two consecutive pulses.

$$t=1/PRR$$

- (4) Simulate the speed of the target vehicle corresponding to the data getting from (2) and (3).
- (5) Trigger the PC speed simulation program and the laser speed simulation system to conduct the verification.
- (6) The verification of speed accuracy shall include at least ten combinations of speed and distance verification data at different distances and speeds.
- (7) When the laser speedometer is been conducting the verification of speed detection accuracy at 50 km/h and 100 km/h, the speed accuracy shall not be affected or interfered by shaking. Any wrong displays of speed or fault detections shall not be recorded as the measured results.

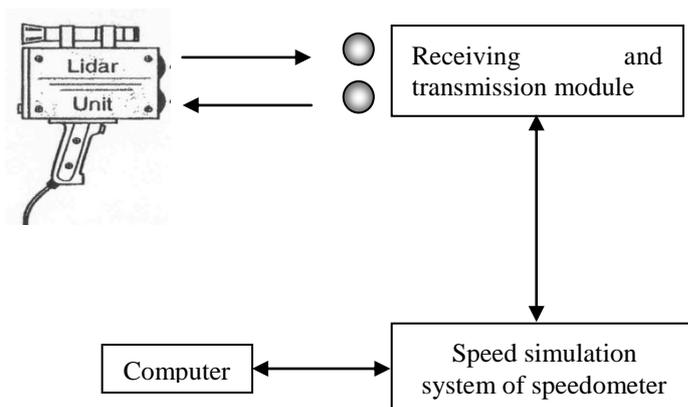


Fig. 4 、 speed accuracy verification device

6.6 The period of validity of verification is 1 year, commencing from the day that a verification compliance mark is affixed to the speedometer and expiring on the first day of the following month of the following year.

## 7. Maximum permissible errors for verification and inspection

7.1 Maximum permissible errors for verification of laser speedometers are as follows:

- (1) Ranging accuracy:  $\pm 0.3$  m
- (2) Laser PRR: pulse repetition rate  $\leq 390$  Hz, pulse repetition rate variation  $\leq 0.1\%$  .
- (3) Speed detection accuracy: shall not be 2km/h faster than simulated speed or 3km/h slower than the simulated speed.

7.2 The maximum permissible errors for inspection are the same as those of for verification.

## 8. Verification compliance marks

8.1 The placement of the verification compliance tag of laser speedometer shall be obvious and on the cover of the main part.

8.2 After the speedometer passes verification, a verification compliance certificate shall be granted.