60 mJ Laser Target Designator/Rangefinder Module

Model: LDR60K1

1. PRODUCT DESCRIPTION

The LDR60K1 Laser Target Designator/Rangefinder is capable of measuring target distance and providing laser designation for laser-guided munitions. It is primarily designed for **airborne applications** requiring high reliability. The system features **compact size, lightweight construction, long-range ranging and designation capability, high accuracy,** and **excellent environmental adaptability.**

2. MAIN FUNCTIONS

The **Laser Target Designator/Rangefinder** is used for target ranging and laser illumination, providing fire control guidance for missiles and other precision-guided weapons. It features the following functions:

a) **Laser ranging capability:** outputs distance data and status information for each laser pulse during measurement;
b) **Command response:** responds to laser ranging commands and can stop ranging immediately upon receiving a stop command;
c) **Cumulative laser pulse counting;**
d) **Temperature monitoring:** measures and reports the current internal temperature to the host system;
e) **Parameter configuration:** allows the user to set illumination time and laser code, and outputs the selected configuration;
f) **Laser designation:** responds to laser illumination commands and emits laser pulses according to the preset mode and code;
g) During laser designation, **each pulse outputs distance data and status information;**
h) Supports **externally commanded illumination frequency settings** (coded laser designation mode, with a reserved software interface supporting up to eight fixed codes);
i) **Power-on self-test (POST):** automatically performs internal diagnostics upon power-up, reports self-test results, and then enters standby mode;
j) **Periodic self-test:** conducts regular self-diagnostics during operation without affecting normal performance; if a fault is detected, a self-test report is generated and transmitted;
k) **Manual self-test:** when receiving a self-test command from the host system, the device performs functional checks and reports the results.

3. KEY PERFORMANCE PARAMETERS

3.1 Operating Conditions

a) Target size: 2.3 m × 2.3 m.
b) Target reflectivity (for laser): ≥ 0.2.
c) Visibility: ≥ 20 km.
d) Operating temperature: −40 °C to +55 °C.
e) Storage temperature: −45 °C to +65 °C.

3.2 Technical Specifications

The specific technical requirements for the laser target designator/rangefinder are as follows:

a) Operating modes: ranging, illumination (designation).
b) Laser wavelength: 1064 nm ± 3 nm.
c) Average pulse energy: ≥ 60 mJ.
d) Pulse energy stability: within a single illumination cycle, the energy fluctuation of individual pulses shall not exceed ±10% of the average energy (measured over the full temperature range, statistic taken 2 s after emission begins).
e) Beam divergence: ≤ 0.3 mrad.
f) Laser pulse width: 15 ns ± 5 ns.
g) Spatial pointing instability of the laser beam: ≤ 0.05 mrad.
h) Non-parallelism between the mounting datum plane and the laser emission axis: ≤ 0.3 mrad.
i) Ranging frequency: 1 Hz / 5 Hz / single-shot.

- 1 Hz continuous ranging duration: ≥ 10 minutes, then rest 1 minute;
- 5 Hz continuous ranging duration: ≥ 5 minutes, then rest 1 minute.

j) Minimum measurable distance: ≤ 300 m.
k) Maximum measurable distance: ≥ 10 km (large target).
l) Ranging accuracy: ±2 m.
m) Probability of valid ranging (detection probability): ≥ 98%.

n) Illumination (designation) performance:

- Illumination frequency: per weapon-system requirements (fundamental frequency 20 Hz);
- Coding method: precise frequency coding; supports user-defined precise frequencies;
- Coding accuracy: 2.5 μs.

o) Illumination cycles:

- Short-cycle mode: single illumination duration 17 s, interval 10 s, up to 6 consecutive cycles;
- Long-cycle mode: single illumination duration 47 s, interval 30 s, up to 2 consecutive cycles.
  After completing one short-cycle or long-cycle sequence, the next illumination shall not begin earlier than 30 minutes later.

p) Code types: precise frequency code, 8 fixed code patterns.
q) Laser turn-on (response) time: ≤ 800 ms (time from receipt of ranging/illumination command to emission).

r) Power-on startup time: ≤ 10 s.
s) Service life: ≥ 1,000,000 pulses (one million emissions).

t) Dimensions and mass

- Overall envelope: ≤ 116 mm × 52 mm × 96 mm;
- Mass: ≤ 680 g.

u) Power

- Standby power consumption: ≤ 5 W;
- Peak power consumption: ≤ 120 W;
- Operating voltage range: 18 V – 32 V.

v) Electronic "three-proof" treatment
After PCB design and debugging, printed circuit boards shall be coated with a three-proof (conformal) coating to provide protection against moisture, dust and corrosive environments.

4. INTERFACE

4.1 Electrical Interface

Rangefinder connector model: J30J-15ZKP
Mating plug model (on the electro-optical system side): J30J-15TJL (WL150A4)

The specific signal definitions of the laser target designator/rangefinder are shown in **Table 1**.

Table 1 — Electrical Interface Definition

Pin No.	Signal Definition	Input/Output	Description	Remarks
1.	+28V	Input	The power supply characteristics comply with the relevant requirements of MIL-STD-810G.	Power Supply
2.	+28V			
3.	+28V			
4.	+28V_GND			
5.	+28V_GND			
6.	+28V_GND			
7.	Power-On Control (+)	Input/Output	Refer to the requirements specified in the Power-On Control section.	I/O Control
8.	Power-On Control (-)			
9.	RS422_RX+	Input/Output	The logic level and drive	The transmit/receive pin

10.	RS422_RX-		capability comply with the RS-422 interface standard. Characteristic impedance: 120 Ω.	definitions correspond to the laser rangefinder itself.
11.	RS422_TX+			
12.	RS422_TX-			
13.	RS422_GND			
14.	External Synchronization Control Signal	Input	The logic level and drive capability comply with the RS-422 interface standard.	External synchronization signal used to control laser coding.
15.	External Synchronization Control Signal (–)			

4.2 Mechanical Interface

The mechanical interface is shown in **Figure 1** below.

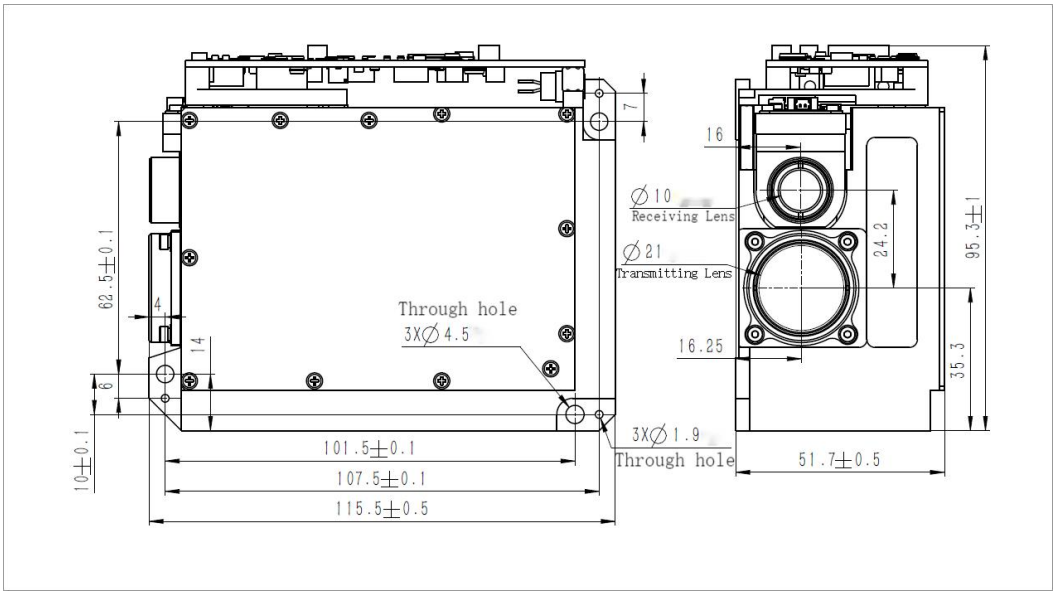

Figure 1 — Mechanical Interface

5. ENVIRONMENTAL REQUIREMENTS

5.1 Temperature Requirements

5.1.1 High-Temperature Requirements

- Operating temperature: ≤ +55 °C

- Storage temperature: ≤ +65 °C

5.1.2 Low-Temperature Requirements

- Operating temperature: ≥ −40 °C
- Storage temperature: ≥ −45 °C

5.2 Vibration Requirements

The equipment shall withstand flight-induced vibration and shocks occurring during takeoff and landing. All components shall also meet the environmental conditions of vehicle transport.

- Vibration spectrum:

  - From **15 Hz to 33 Hz**, constant-displacement sinusoidal vibration with amplitude **0.91 mm**;
  - From **33 Hz to 700 Hz**, constant-acceleration sinusoidal vibration with amplitude **2 g**.

- Duration: 1 hour per axis in three orthogonal directions (X, Y, Z).

Test conditions:
The product shall be mounted on the vibration platform in its normal operating configuration and powered on during testing.
After vibration testing, the equipment shall operate normally.

5.3 Shock Requirements

- Vertical axis: ≥ 10 g
- Lateral axis: ≥ 10 g
- Longitudinal axis: ≥ 10 g

Shock waveform: post-peak sawtooth, duration **11 ms**; applied along **X, Y, and Z axes**, both directions on each axis, **18 shocks in total**.

Test conditions:
The product shall be mounted on the shock test platform in its normal operating configuration and powered on during testing.
After shock testing, the equipment shall operate normally.

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6. TEST SOFTWARE OPERATION INSTRUCTIONS

6.1 Communication Connection

- **Asynchronous serial communication standard:** RS-422

- **Baud rate:** 115200 bps

Check the communication cable and click **"Detect"** until an available serial port is found.
Select the serial port and set the baud rate to **115200 bps** for connection.

6.2 Receiving Information

Output data are displayed in the software's **Receive Data** window.
Click **"Clear"** to delete historical data and start a new reception.
After each command is executed, corresponding feedback data will be received.

6.3 Command Transmission and Status Indication

6.3.1 Status Bar Indication of Operating Status and Fault Display

The status bar icons indicate the system's operating and fault conditions:

- A **gray "**  **"** icon represents the **initial or idle state** (not running).
- A **green "**  **"** icon indicates **normal operation**.
- A **red "**  **"** icon signifies a **fault condition**.

6.3.1.1 Initialization State

When the software opens the serial port but no heartbeat packet or command response is received from the device, the system remains in the **initialization state**, and **all icons appear gray**.

6.3.1.2 Heartbeat Packet and Status Display

A **heartbeat packet** is sent from the lower computer (device) to the host every **10 seconds**.
When the connection is normal, upon receiving the heartbeat, the host software displays:

- **Operating status:** "  " (green – normal operation)
- **Status indicator:** "  " (green – system healthy)

Each data packet returned from the device also includes **temperature information**.

The **temperature value**, in degrees Celsius (°C), is displayed in the **Status "**  **"** area of the interface.

Here's a precise and professionally formatted English translation for your section **6.3.1.4–6.3.2.9**, written to match the formal technical style of your manual:

6.3.1.4 Other Operation Indicators

The operation indicators display the command currently being executed by the system in real time.

6.3.1.5 Other Status Indicators

The status indicators show the system's real-time operating condition.
If a **red fault indicator** appears, the current operation must be stopped immediately, and the fault should be identified and rectified to prevent equipment damage.

6.3.2 Command Panel — Sending Commands

Overview:
The command panel includes buttons for **Laser Pulse Count Query**, **Code Query**, and **Temperature Read Query**.
The query results are displayed in the corresponding areas of the **Status Bar**.
Buttons for **Laser Emission** and **Illumination Commands** (including "Stop Ranging/Illumination") are also provided.
Feedback data from all commands are displayed in the **Receive Data Window**.

6.3.2.1 Laser Pulse Count Query

During operation, the device records the total number of laser pulses emitted in both ranging and illumination modes.
When a **Laser Pulse Count Query** command is sent, the device returns data containing the pulse count, which will be displayed in the status bar.

6.3.2.2 Self-Test

Clicking the **Self-Test** command causes the device to enter a diagnostic mode, simulating normal operation and checking internal functional status.
The system returns its operating state; any detected faults will be shown in the status bar.

6.3.2.3 Single-Shot Ranging

The **Single-Shot Ranging** command triggers one laser pulse and returns the result of that measurement, including **main/echo signal information** (see Section 6.5 for details) and the computed distance.

6.3.2.4 1 Hz Ranging

Upon receiving this command, the device continuously emits laser pulses at a frequency of **1 Hz** and returns measurement results identical in format to those of single-shot ranging.

6.3.2.5 5 Hz Ranging

Upon receiving this command, the device continuously emits laser pulses at a frequency of **5 Hz** and returns measurement results identical in format to those of single-shot ranging.

6.3.2.6 Single Illumination

This command sets the device to illumination (designation) mode, emitting coded laser pulses according to a **17 s illumination duration** and **10 s interval**, for up to **six consecutive cycles**.
Each illumination returns **main/echo signal information** and the corresponding **illumination distance**.

6.3.2.7 Continuous Illumination

This command sets the device to illumination mode with a **47 s illumination duration** and **30 s interval**, for up to **two consecutive cycles**.
Each illumination returns **main/echo signal information** and the corresponding **illumination distance**.

6.3.2.8 Short Illumination

This command sets the device to illumination mode with a **cycle duration shorter than 60 s**, performing **one illumination cycle** before stopping automatically.
Each illumination returns **main/echo signal information** and the corresponding **illumination distance**.

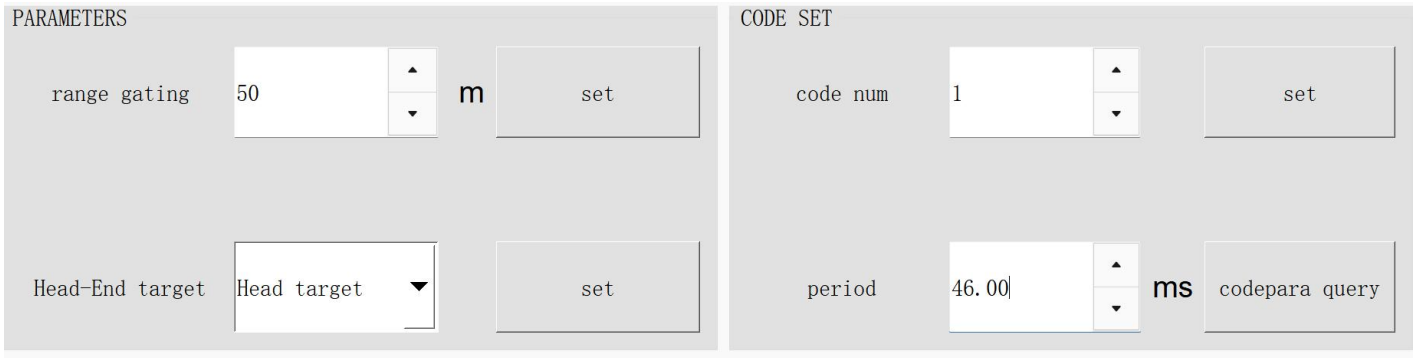
6.3.2.9 Stop Ranging/Illumination

When this command is received, the device immediately stops its current operation.
Each working sequence must be terminated by issuing the **Stop Command**.

Note 1:
The **Code Selection Field** allows the user to select the current code number.
If the selected code has been configured previously, it will include the corresponding **code period information** in the **Code Settings Field**.

Note 2:
The **Duration Field** defines the working duration for the selected code.
When the **Short Illumination** command is used, the system will operate according to the code's period (e.g., 50 ms) and the specified duration (e.g., 30 s).

6.4 Parameter Settings and Code Configuration



6.4.1

The **Parameter Settings** panel includes **Range Gate** and **First/Last Target** options.
The **Range Gate** defines the minimum display distance for "Distance 1" (as described in Section 6.5).
Targets closer than this distance will display a range value of 0.
The **First/Last Target** option switches the displayed result between the **first target** and the **last target**.

6.4.2

Modify the **code number** and set a **cycle period** within the appropriate range.
Click **Set** to apply the period time to the selected code number — this is a required operating parameter for coded illumination.

6.5 Distance Display

6.5.1

Distance 1 displays the calculated target distance during ranging or illumination operation.
When no ranging or illumination has been performed, or when the **Clear** button is clicked, the distance display appears as shown above.
During normal ranging or illumination, **Distance 1** shows the measured distance.
If the target is out of range or the measurement is invalid, **Distance 1** displays **0xFFFF**.

6.5.2

The **Main Pulse** represents the laser pulse signal transmitted by the device, while the **Echo Pulse** represents the signal received by the device.

- When a **main pulse** is present, it indicates that the laser pulse has been successfully emitted; the feedback value is **1**.
- When an **echo pulse** is present, it indicates successful reception of the reflected laser signal; the feedback value is **1**.
  If either the **main** or **echo** signal displays **0**, it means that transmission or reception was incomplete, and the device status should be checked.

6.6 Program Upgrade

When a firmware upgrade is required, switch the software to the **Program Upgrade** page as shown below.

6.6 (continued)

At this stage, the **Program Upgrade** button is gray and unavailable.
Click **Select Firmware File** (usually a *.bin* file).
When the receiving interface displays the character **'C'**, it indicates that the system is in **upgrade waiting mode**.
At this point, the **Program Upgrade** button becomes active.
Click **Program Upgrade** to begin the update.
Wait until the progress bar reaches **100%** — the firmware update is then complete, and the system will **automatically restart** after the update.

7. COMMUNICATION PROTOCOL

7.1 Scope

This document defines the software communication protocol between the **Computer Board** (hereinafter referred to as **UP**) and the **Laser Target Designator/Rangefinder** (hereinafter referred to as **LDR**).

7.2 Communication Protocol Between the Computer Board and the Laser Designator

7.2.1 Interface Description

Communication between the **UP** and **LDR** uses a **four-wire RS-422 interface**, supporting bidirectional data transfer:

- From **UP to LDR** — *control commands*;
- From **LDR to UP** — *status feedback*.

7.2.2 Communication Standard and Baud Rate

For both control commands and return codes, communication parameters are defined as follows:

- **Asynchronous serial communication standard:** RS-422
- **Baud rate:** 115200 bps
- **Start bit:** 1

- **Data bits:** 8
- **Stop bit:** 1
- **Parity bit:** None

For each byte, data is transmitted with the **least significant bit (LSB) first**.
For multi-byte data, the **low byte is transmitted first**.

7.2.3 Message Format

The communication message format is defined as follows:

Table 2 — Message Format Description

Message Header (1 byte)
Subsystem ID (1 byte)
Message Body
Message Trailer (1 byte, checksum)

"The Message Header" is **0xDD**, which serves as the synchronization code indicating the start of a data frame.
The **Subsystem ID** is **0x03**, identifying the **laser target designator/rangefinder (LDR)**.
The **Message Body** contains the specific control commands or returned status information (see *Data Protocol* for details).
The **Message Trailer** is a **checksum**, calculated as the sum of all bytes in the message body modulo 256.

7.2.4 Timing Control

After the LDR powers on and completes initialization, it reports a **"ready" message** every **10 seconds**.
The UP sends various **control commands** to the LDR as required.
Upon receiving any command, the LDR must return a corresponding **status frame** within **20 ms**; responses exceeding this time are considered invalid.

For **ranging** and **illumination commands**, the LDR continuously returns status frames at each pulse cycle until laser emission stops.
For the **laser pulse count query command**, the returned bytes represent the total number of emitted pulses.
For **ranging** and **illumination commands**, the returned bytes represent the **target distance**.

During continuous ranging or illumination, the LDR must be able to immediately respond to a **Stop Command** from the UP and return a **stop status frame**.
When the preset ranging or illumination duration is completed, the LDR automatically returns a **stop status frame**.
Other commands are ignored during continuous ranging or illumination.
Commands received during these operations (e.g., another ranging or illumination command) will **not** be executed afterward.

Illumination commands have higher priority than ranging commands; illumination commands can interrupt an ongoing ranging operation.

The **self-test results** returned by the LDR must represent the most recent results from the **power-on self-test**, **periodic self-test**, or **manual self-test**.

7.2.5 Exception Handling Requirements

- When either the LDR or UP receives any disordered or corrupted data sequence, the system must not enter an undefined state or freeze. Upon receiving valid data again, normal communication shall resume automatically.
- Both parties shall strictly perform checksum validation. Any message with a failed checksum must be discarded.
- Proper protective mechanisms shall be implemented to ensure that no communication sequence can cause irreversible faults.

7.3 Data Protocol

7.3.1 Output Information

Output information refers to the **commands sent from the UP to the LDR**, as shown in **Table 3** below.

Table 3 — Output Information Description

Byte Index	Field	Content
0	Header	0xdd
1	ID	0x03
2	Command Word 1	See Table 4
3	Command Word 2	See Table 5
4	Command Word 3	See Table 6
5	Checksum	Sum of bytes 0–4 modulo 256

Table 4 Command Word 1 Definition

BIT07	BIT06	BIT05	BIT04	BIT03	BIT02	BIT01	BIT00

0x00: No self-test 0x01: Self-test 0x10: Single-shot ranging 0x02: Ranging at 1 Hz 0x03: Ranging at 5 Hz 0x04: Single-burst designation (short-designation mode: laser on for 17 s per cycle, 10 s interval, up to 6 consecutive cycles) 0x05: Continuous-burst designation (long-designation mode: laser on for 47 s per cycle, 30 s interval, up to 2 consecutive cycles) 0x06: Short designation (one cycle, laser-on time configurable, < 60 s) 0x07: Stop ranging / designation 0x08: Range gating 0x09: Read accumulated laser pulse count 0x11–0x20: Code setting (codes 1–16) 0x21–0x30: Code query (codes 1–16)

Table 5 Command Word 2 Definition

BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
Laser designation: 0x01–0x10 correspond to codes 1–16 Range gating: low byte of gate distance Code setting: low byte of code period							

Table 6 Command Word 3 Definition

BIT15	BIT14	BIT13	BIT12	BIT11	BIT10	BIT9	BIT8
Laser designation: laser-on time setting, 0–60 s Range gating: high byte of gate distance Code setting: high byte of code period							

Input message

The input message is the status information received by JSB from LS, see Table 7.

Table 7 Input Message Description

Byte Index	Field	Content
0	Header	0xdd

1	ID	0x03
2	Status Word 1	See Table 9
3	Status Word 2	See Table 10
4	Target Distance / Accumulated Count / Code Period	The distance value can be directly converted to decimal. Since the range of a 16-bit binary number is 0 to 65535, and the lifespan of a laser detector is 1 million cycles, it is agreed that the number of laser emissions is a multiple of 20, ranging from 0 to 1310700.
5		
6	Laser rangefinder/designator current temperature	Two's-complement representation, range −128 to +127, unit: °C.
7	Checksum	Sum of bytes 0–6 modulo 256.

The definitions of Status Word 1 and Status Word 2 are given in Table 8 and Table 9.

Table 8 Status Word 1 Definition

BIT07	BIT06	BIT05	BIT04	BIT03	BIT02	BIT01	BIT00
0: No laser 1: Laser on	0: Ranging valid 1: Ranging invalid	1/0: Pulse emission flag (toggles between 0 and 1 for each new pulse)	1: Over-temperature alarm 0: Temperature normal	1: UART device fault 0: UART device normal	1: Charge/discharge fault 0: Charge/discharge normal	Temperature control ready status 0: Not ready 1: Ready	

Table 9 Status Word 2 Definition

BIT07	BIT06	BIT05	BIT04	BIT03	BIT02	BIT01	BIT00
0x0–0xF correspond to codes 1–16				0000: Standby 1001: Single-shot ranging 0001: Ranging at 1 Hz 0010: Ranging at 5 Hz 0011: Single-burst designation 0100: Continuous-burst designation 0101: Short designation 0110: Range gating 0111: Stop ranging / designation 1000: Self-test 1011: Code query			