80 mJ Laser Target Designator/Rangefinder Module

Model: LDR80K1

1. PRODUCT DESCRIPTION

The LDR80K1 laser rangefinder/designator can measure the distance to a target and provide coded laser designation for laser-guided artillery shells. It is mainly intended for airborne platforms where high reliability is required. The unit features a compact size, low weight, long-range ranging and designation capability, high accuracy, and excellent environmental adaptability.

2. MAIN FUNCTIONS

The laser rangefinder/designator is equipped with an independent power-on control signal. By setting this signal high or low, the unit can be switched on or off.

Through the serial interface, the laser rangefinder/designator supports the following control functions:

1. Responds to laser ranging and laser designation commands, and can stop ranging or designation at any time upon receipt of a stop command.
2. During ranging, each laser pulse outputs one set of distance data and status information.
3. After 1 Hz ranging is started, if no stop command is received, the unit will automatically stop after 5 minutes.
4. After 5 Hz ranging is started, if no stop command is received, the unit will automatically stop after 5 minutes.
5. The designation time and laser code can be configured, and the currently selected settings can be read back.
6. Responds to laser designation commands and emits laser pulses according to the pre-set mode and code.
7. During laser designation, each pulse outputs one set of distance data and status information.
8. Designation commands have priority. If a designation command is received during continuous ranging, ranging shall be stopped and the designation command shall be executed immediately. While executing a designation command, the unit will not respond to any other commands except the stop-designation command.
9. The unit can report the cumulative number of emitted laser pulses (the data is retained when the device is powered off).
10. Supports self-test functions (including power-on self-test, periodic self-test, and start-up self-test) and outputs fault codes.
    a. Power-on self-test includes:
       High-temperature alarm.

    b. Start-up and periodic self-test include:

- High-temperature alarm;

- Laser output / no output status.

Note: Since charge/discharge faults and laser output/no-output faults can only be detected while the laser is firing, the power-on self-test is not required to check these two fault types. During start-up and periodic self-tests, the laser rangefinder/designator reports the detection results from the last ranging or designation operation.

11. Supports temperature monitoring and reports the current operating temperature of the system.
12. Provides a temperature alarm output.

3. KEY PERFORMANCE PARAMETERS

1. Operating modes :Ranging and laser designation.

2. Pump source :Laser diode array.

3. Operating wavelength: 1.064 μm.

4. Average energy per designation cycle: Average single-pulse energy per designation cycle ≥ 80 mJ.

5. Pulse energy fluctuation :Within one designation cycle, the single-pulse energy variation shall not exceed 10% of the average energy (over the full temperature range, with statistics taken 2 s after laser emission starts).

6. Beam divergence :≤ 0.30 mrad.

7. Pulse width :15 ns ± 5 ns.

8. Optical axis parallelism error :Parallelism error between the optical axis and the mounting reference: ≤ 0.5 mrad.

9. Ranging performance:

- Minimum measuring distance: ≤ 300 m
- Maximum measuring distance: ≥ 10 km(for a 2.3 m × 2.3 m target with diffuse reflectance ≥ 0.2, visibility ≥ 23 km, and relative humidity ≤ 70%)
- Ranging rates: 1 Hz, 5 Hz, single-shot
- Ranging accuracy: ≤ 5 m
- Probability of correct ranging: ≥ 98%
- Continuous ranging operating time: 5 min(At 5 Hz: continuous operation for 5 min, rest time ≤ 3 min, then ranging can be continued.)

10. Laser designation performance:

- Nominal designation repetition rate (for verification): 20 pps
- Short designation mode: each cycle has 17 s of designation time and 30 s interval; up to 8 consecutive cycles
- Long designation mode: each cycle has 60 s of designation time and 45 s interval; up to 4 consecutive cycles
- After completing one long and one short designation cycle, the interval before the next designation shall be within 30 minutes.

11. Laser coding:

- Meets the weapon system coding requirements and provides user-programmable code expansion capability.
- Supports external synchronization input; the external signal can control the laser emission pattern for coding.
- Coding method: precise frequency code (eight groups of pre-stored period-code patterns).
- Coding accuracy: ≤ 2.5 μs.

12. Dimensions : ≤ 116 mm × 52 mm × 96 mm

13. Weight: ≤ 680 g

15. Electrical characteristics

- Input voltage: DC 18 V to 32 V
- The electrical and electronic components inside the laser rangefinder/designator are compatible with the system power characteristics.
- Average power: ≤ 80 W; peak power: ≤ 120 W
- After PCB design and debugging are completed, all circuit boards are coated with conformal coating to provide moisture, salt-spray and fungus protection.

15. External power input requirements

- When sharing the same power supply with motor or other inductive loads, the laser rangefinder/designator should use a soft-start (3–5 s). At the instant of sudden power-on, the induced voltage generated by motors and other inductive loads at the module input may be several times the nominal input voltage, which can cause over-voltage damage.
- During power-up, it is recommended to use the dedicated power-on control function of the laser rangefinder/designator to stagger its power-on time from other loads. After other loads have powered up and stabilized, then enable power to the rangefinder/designator.
- The power input of the laser rangefinder/designator should be isolated from other inductive loads. If conditions allow, a DC filter (30 V / 10 A) can be added at the module's power input.
- The power supply for the laser rangefinder/designator shall satisfy the peak power demand. When testing the module alone, with a DC supply voltage of 24 V, the supply current should be greater than 6 A. If the output voltage is lower, the rated output current of the supply should be increased accordingly.

4. INTERFACE

4.1 Electrical Interface

- One full-duplex RS-422 interface; signal levels and drive capability comply with the RS-422 interface standard.
- One I/O interface (for controlling the laser rangefinder / designator power on/off).
- One external synchronization control signal.

1) Interface definition:

The cable outlet direction of the connector is parallel to the length direction (rearward cable exit).
Connector model on the laser rangefinder side: J30J-15ZKP;
Mating plug model on the electro-optical system side: J30J-15TJL (WL150A4).

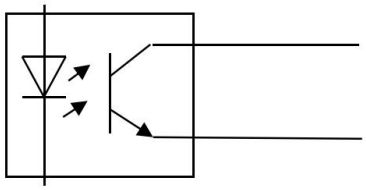
Table 1 — Electrical Interface Definition

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 capability comply with the RS-422 interface standard. Characteristic impedance: 120 Ω.	The transmit/receive pin definitions correspond to the laser rangefinder itself.
10.	RS422_RX-			
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 (–)			

2) Power-on control

The system computer board provides an optocoupler open-collector output as the power-on control interface for the laser rangefinder/designator.

A power supply control unit is integrated inside the laser rangefinder/designator. This unit controls power on/off of the laser according to the state of the power-on control interface. The power-on control signal is an open-collector signal, as shown in the schematic.



Power-on control +	Open-collector output: maximum withstand voltage: 30 V
Power-on control	Maximum collector current: 30 mA

Table 2 Laser rangefinder / designator power supply control mode

Signal state	Power switch status
Output transistor open-circuit	Power off
Output transistor conducting	Laser rangefinder / designator powered on

4.2 Mechanical Interface

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

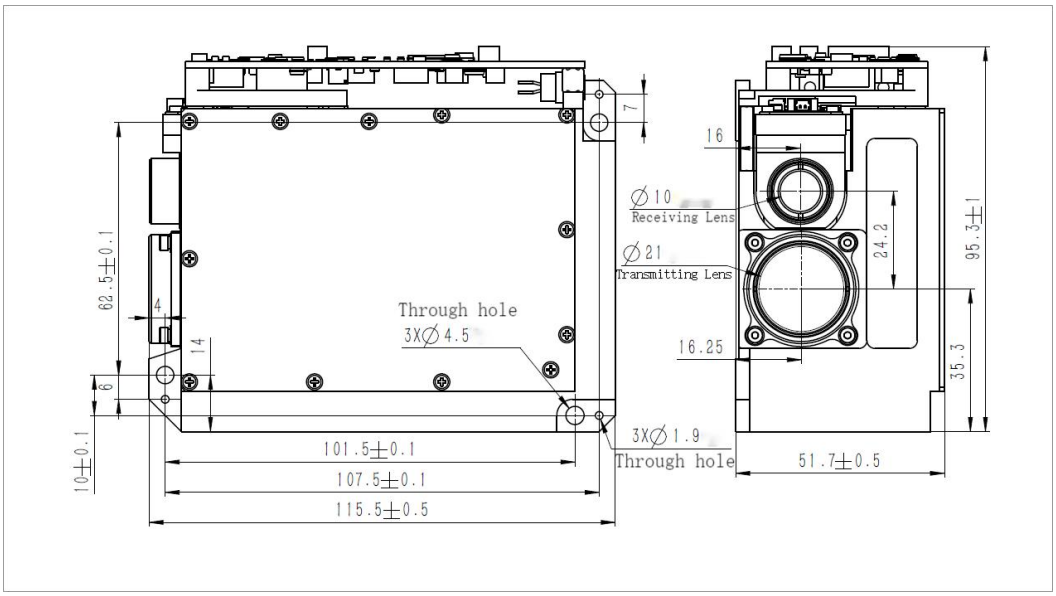


Figure 1 — Mechanical Interface

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.

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:** "standby" (green – normal operation)
- **Status indicator:** "ready state" (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** "temperature" 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

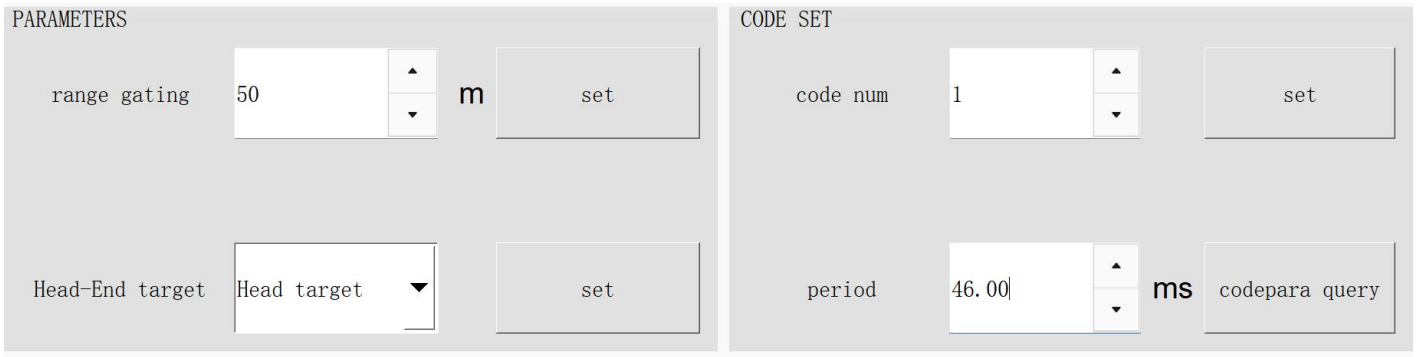
When this command is received, the device immediately stops its current operation.
Each working sequence must be terminated by issuing the **Stop Command**.

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



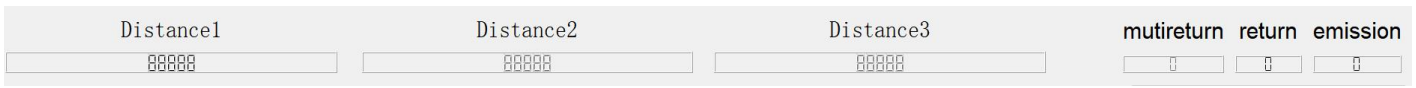
6.4.1

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.

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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			