# LC-081 SERIAL TEMPERATURE SCANNER
## User Guide

### OVERVIEW

The LC-081 or Layad Circuits' Serial Temperature Scanner is a UART ("Serial") interfaceable non-contact thermal reader. The device is designed to be used with a larger system with a any UART/Serial-capable host microcontroller such as Arduino or Raspberry Pi. It comes with all the necessary electronics to perform temperature scanning of people or objects and output the reading into its seven segment display and UART port via the attached female pinheader-terminated wires. The LC-081 comes in 3 distinct Modes and can use either Fahrenheit and Celsius as its unit of measurement.

The device aims to replace sensor-module solutions (e.g. MLX90614) by improving upon the issues accompanying such sensor-only implementation including the need for a separate proximity sensor, display, power regulator, level shifter, buzzer, enclosure, warning LEDs, and audio notification. It also simplifies use for human body temperature measurements as the device is pre-calibrated for such Finally, the difficulties associated with I2C implementation such as bus sharing issues or the need to for an external library are eliminated.

**NOTE: This device is meant for educational purposes only (e.g. product prototypes) and does not replace medical or industrial grade thermometers.**

### FEATURES

- Ready interface port for microcontrollers via UART serial interface.
  - 9600 baud rate, 8 data bits, no parity, and 1 stop bit
  - Simple serial text protocol
  - TX only at 3.3V logic
- Modes
  - Body Mode
  - Surface Mode
  - Counting Mode
- 2 Units of measurement
  - Celsius
  - Fahrenheit
- Automatic Alarm for "high" readings
- Accuracy : ±0.2 degrees
- Measurement Distance: ~5-10 cm
- Input power: 5V
- Typical Power Consumption: <200mA
- Peak Power Consumption: <450mA
- Integrated casing, LCD readout and buttons
- Works with both 5V and 3.3V logic
- Response Time: ~0.5sec
- Arduino, Raspberry Pi, ESP8266, ESP32 compatible

### PIN FUNCTIONS

There are two sets of color codes for the wired header port of the device. Your unit should come in either one of them. Refer to the tables below.

**Code 1: Brown-Red-Orange**

| Wire Color | Function |
|---|---|
| Brown | GND: (-) Ground |
| Red | VCC: (+) 5Vdc power |
| Orange | TXD: Serial Transmit Pin. Connect to the serial receive pin of the host MCU. |

**Code 2: Black-White-Gray**

| Wire Color | Function |
|---|---|
| Black | GND: (-) Ground |
| White | VCC: (+) 5Vdc power |
| Gray | TXD: Serial Transmit Pin. Connect to the serial receive pin of the host MCU. |



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### UART/ SERIAL PORT

The Device has no RXD terminal as it only outputs data on its TXD terminal/pin. Although the power required is 5V, the TXD signal is at 3.3V logic, therefore, it may be used directly with 5V logic host controller (e.g. Arduino Uno, Mega, Nano) or with a 3.3V host such as Raspberry Pi, ESP8266 or ESP32 without the need for a level shifter circuit. The baud rate is 9600 at the standard configuration of 8 data bits, no parity and 1 stop bit.

### POWER REQUIREMENTS

The unit should be powered from a regulated 5V power source that can reliably deliver current of up to 450mA.

#### Powering at the Wired Terminal

The LC-081 maybe powered from the 5V pin of most Arduino board as these are typically rated at 1A. However, care should be exercised when there are other electrical loads being supplied by the Arduino regulator or if the device is to be used in the long term. We recommend using a separate 5V regulator circuit that can supply ≥ 500mA such as an LM7805 with heatsink or a buck converter module such as LM2596. Refer to the current consumption table below:

| Device State | Current Consumption |
|---|---|
| Idle state | 190mA ±100mA |
| Peak current while in active operation | <450mA |

#### Powering at the USB port

A microUSB port is also available as power source. Please check that your microUSB power supply has a 5V output. Some smart power supplies may output more than 5V and should therefore not be used with this device.

**Warning: When the microUSB port is powered, do not connect the VCC wire to another 5V power source. Only the TXD and GND should be connected to the host microcontroller in this case.**

While the casing has a battery slot, it has no use. The device is designed to be powered at the wired terminals. Any battery implementation should consider powering the whole system, including the host microcontroller.

### SIZE VARIANTS

The device comes in 2 sizes, the “large” and the “small” variant. Please contact Layad Circuits for additional information.

### USER BUTTONS AND POWER SWITCH

The user buttons and their functions are described in the table below.

#### Large Variant

| | |
|---|---|
| ON/OFF Switch | Control this witch to turn the power on and off |
| Mode/Unit Button | Short presses will switch the units between °C and °F, and long press to change modes between Body, Surface, and Counting modes. |

#### Small Variant

| | |
|---|---|
| ON/OFF Button | Press once to turn ON and long press to power OFF the device |
| Mode/Unit Button | Short presses will switch the units between °C and °F, and long press to change modes between Body, Surface, and Counting modes. |

### MODES

The LC-081 has 3 Modes that serves different purposes as described below:

#### 1. Body (B) Mode

This mode is designed for scanning human body temperature**.** It is the primary purpose of this device and has a range of 32-42 °C or 89.6-107.6 °F. It has an alarm function where readings that reach 37.5-42 °C or 99.5- 107.6 °F (default setting) will generate an alarm by



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flashing the front red lights continuously for 5 seconds. The scanner will be disabled within that 5 second. A voice alarm is also generated.


When Body mode is set, the format of the output serial data is as follows:

**@,<Temperature>,<Unit>,<Mode>,#<CR><LF>**

Where:

- Temperature – the temperature reading in 3 whole digits and 1 decimal digit
- Unit – either 'C' (0x43) for Celsius or 'F' (0x46)for Fahrenheit
- Mode – 'B' (0x42) for body mode
- CR – carriage return character (0x0D)
- LF – line feed / new line character (0x0A)

Examples:

**@,036.5,C,B,#**

**@,097.7,F,B,#**

**2. Surface (S) Mode**

This mode is designed to measure temperature of objects thus having a much wider range. It has a tested coverage of 0.3- 99.8 ºC or 32.5-212.4 ºF.


When Surface mode is set, the format of the output serial data is as follows:

**@,<Temperature>,<Unit>,<Mode>,#<CR><LF>**

Where:

- Temperature – the temperature reading in 3 whole digits and 1 decimal digit
- Unit – either 'C' (0x43) for Celsius or 'F' (0x46)for Fahrenheit
- Mode – any of the following: 'S' (0x53) for surface mode
- CR – carriage return character (0x0D)
- LF – line feed / new line character (0x0A)

Examples:

**@,025.4,C,B,#**

**@,077.7,F,B,#**

**3. Counting (C) Mode**

In this mode, the Serial Temperature Scanner act as a person/object counter. It will count and beep each time someone or something was detected within its proximity. Be noted that changing the mode or power cycling will reset the counter.


When Counting mode is set, the format of the output serial data is as follows:

**@,<Count>,<Unit>,<Mode>,#<CR><LF>**

Where:

- Count – 5 digit count
- Unit – 'N' (0x4E) for no unit
- Mode – 'C' (0x43) for counting mode
- CR – carriage return character (0x0D)
- LF – line feed / new line character (0x0A)

Example:

**@,00001,N,C,#**

**ALARMS**

When HI or Lo is displayed in the front panel accompanied by a flash of red lights, this indicates that the measurement is out of range.




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*The measured temperature is higher than the specified range of 42 °C/107.6 °F for Body and 99.8 °C /212.4 °F for Surface.*


*The measured temperature falls below the specified range of 32 °C/89.6 °F for Body and 0.3 °C/32.5 °F for Surface.*

The serial output date will show an Error code shown below:

**@,00000,0,0,# <CR><LF>**

Where:

- @,00000,0,0,# - this is the error code
- CR – carriage return character (0x0D)
- LF – line feed / new line character (0x0A)

Example:

**@,00000,0,0,#**

**FACTORY RESET**

Press and hold the power button for 6 secs until **rST** is displayed. It will reset the High Temperature Setting and Low temperature Setting to the default settings.

**SETTINGS MENU**

A series of settings may be adjusted by accessing the settings menu. **We do not recommend changing any of these**. However, we are enumerating them in this section for reference. Note that specific variants may omit certain settings.

To access the menu, follow the procedure below:

Large Variant:

- Turn the power off
- Press and hold the mode button
- Turn on the power while the button is still pressed
- The firmware version momentarily displays on the front panel. At this point release the button
- The display will then show the dots lighting up in sequence. At this point press and hold the button again to enter the menu

Small Variant:

- Press and hold both power button and mode button to enter the settings menu.

A sequence of settings will be presented to the user after entering the menu.

- To change value/setting of each menu – short press the buttons
- To save the current selected value/setting - press and hold both buttons for small variant or the mode button for large variant. The next setting is automatically presented.

The settings are as follows. Not all settings may appear on a particular variant.

**1. High Temperature Alarm Setting**

This sets the temperature at which the High Temperature Alarm, e.g. temperature considered as fever. The default is 37.5 Celsius.

**2. Low temperature Setting**

This setting has 2 options, **Lo/nor** and **32.0**. It is recommended to keep this setting in the Lo/nor option.

- **LO** or **nor** – when temperature measured is 32.0 °C or lower, an alarm is generated and the “Lo” is displayed on the front panel. This indicates that the measurement is out of range and should be repeated. The serial data shall send out the error code (refer to MODES section). This is the default setting. “LO” and “nor” are the same.



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- **32.0** – In this option, the device will attempt to output whatever is measured out into the serial port regardless if this is out of the body mode temperature range. The display on the front panel shall remain as 32.0 and no alarm is generated.

**3. Language setting -** Selects between Chinese (CH), English (EN), Italian (IT), Korean (HR), Spanish (SP) and other languages. The default is English (EN).

**4. Volume setting:**

Select Vo0 to Vo5 volume level. Vo5 is the highest and Vo0 is silent. The default is Vo2

**5. Buzzer Setting**

Choose between a short beep (d1) and a doorbell tone (d0) on every detected proximity. The default is d1

**6. S-setting**

Do not change this parameter. This is a reserved setting.

**7. Automatic Shutdown**

In A1 option, the device will automatically shutdown if no operation is performed in 12 hours. Power cycle or long press the power button to wake the device up. A0 option disables this feature and keeps the device awake indefinitely.

**8. Firmware**

Display the firmware version number

**9. Menu Exit**

After switching to the version number, long press the two buttons for the small variant, or the mode button for the large variant, to exit the settings menu. The device will automatically exit if no operation is detected within 10 seconds.

## DEVICE LAYOUT


## SPECIFICATION

| | |
|---|---|
| Product Code | LC-081 |
| Product Name | Serial Temperature Scanner |
| Display | Seven Segment |
| Accuracy | ±0.2 degrees |
| Response Time | 0.5s |
| High Temperature Alarm Setting | 37.5-42 Celsius *(Default)* |
| Measuring Distance | 5-10cm |
| Input Voltage Power | 5V |
| Typical Current | <200mA |
| Peak Current | <450mA |
| Infrared Measuring Range | 0-50 Celsius |
| Weight | <160g : small unit<br><230g : large unit |



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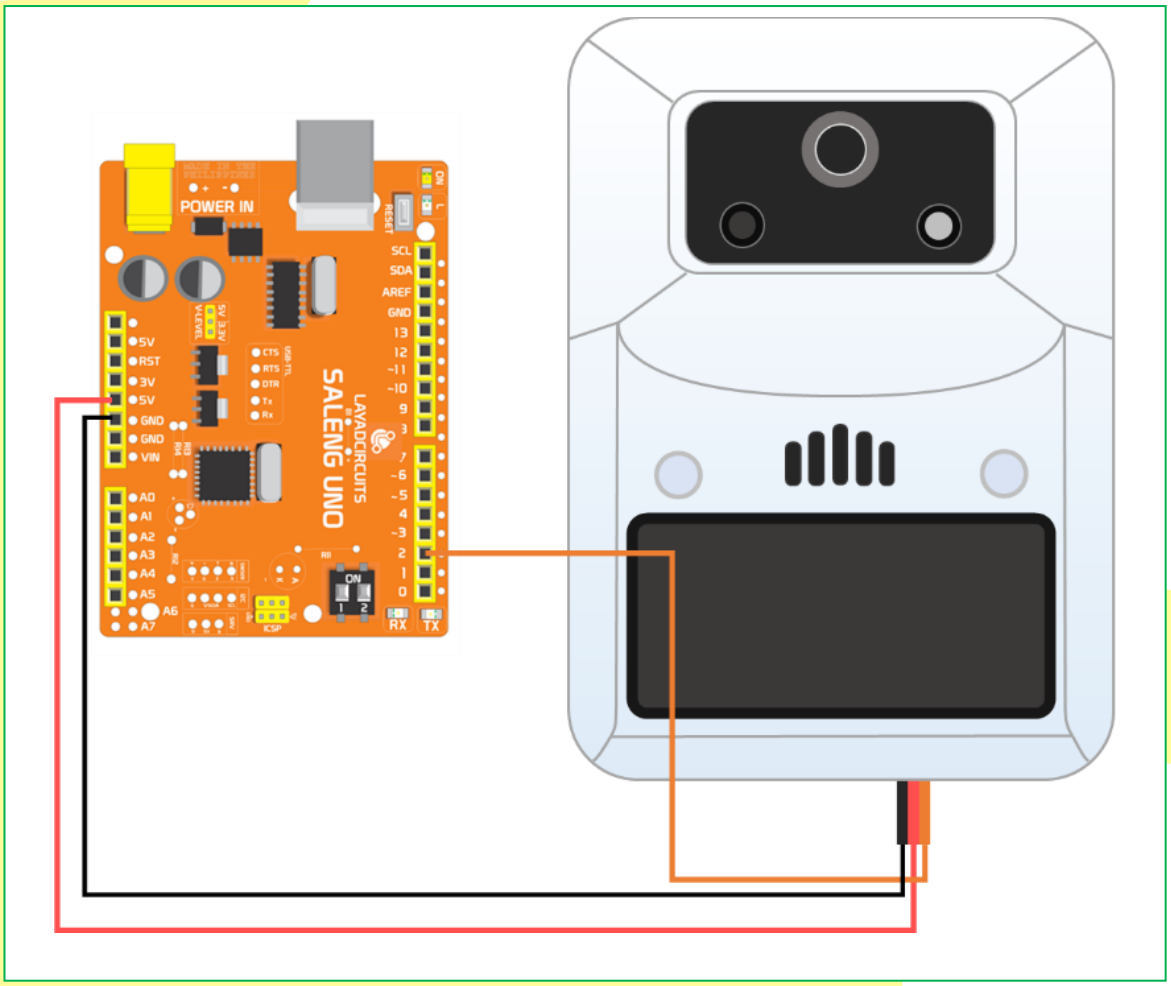
## APPLICATION NOTES

### EXAMPLE WIRING: LC-081 TO ARDUINO UNO

In this diagram, the LC-081 is connected to an Arduino UNO using SoftwareSerial with RXD define at pin 2 and TXD defined at pin 3. Although we are declaring pin 3 as the TXD of the Arduino, we do not need it for the LC-081.



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**EXAMPLE CODE #1**

This is a simple code used to print the **raw** data received from the LC-081 into the Arduino Uno's hardware serial port and viewed from the Serial Monitor set to 9600 baud rate. Wiring follows the previous diagram.

```
#include <SoftwareSerial.h>
SoftwareSerial IRscanner(2,3);//RX,TX

void setup()
{
Serial.begin(9600); // serial monitor port
IRscanner.begin(9600); //LC-081 serial port
}

void loop()
{
  while (IRscanner.available()>0)
  {
    Serial.write(IRscanner.read());
  }
}
```



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**EXAMPLE CODE #2**



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```
#include <SoftwareSerial.h>
SoftwareSerial IRscanner(2, 3);  // RX, TX
float temperature;

void setup()
{
Serial.begin(9600);              //arduino serial port
IRscanner.begin(9600);           //IR scanner serial port
}

void loop()
{
  while (IRscanner.available()>0)
  {
    static char IRreading[14];
    static unsigned int reading_position=0;
    char store=IRscanner.read();             //store data received as a whole

    if( store!='\n' && reading_position<13 )
    {
      IRreading[reading_position]=store;     //store the whole data as an array
      reading_position++;
    }
    else
    {
      //print temperature
      static char store_number[6]="";
      memcpy(store_number,&IRreading[2],5);  //store only the numbers into an array
      temperature = atof(store_number);      //convert the numbers received as float
      Serial.print(temperature,1);           //print with 1 decimal digit

      //print unit
      if(IRreading[8]=='C'){ Serial.print(" Celsius, "); }
      else if(IRreading[8]=='F'){ Serial.print(" Fahrenhiet, "); }
      else{Serial.print(" no unit, ");}

      //print mode
      if(IRreading[10]=='B'){ Serial.println("BODY"); }
      else if(IRreading[10]=='S'){ Serial.println("SURFACE"); }
      else if(IRreading[10]=='C'){ Serial.println("COUNTING"); }
      else{Serial.println("ERROR");}

      reading_position=0;                    //reset for next message
      while (IRscanner.available()) { IRscanner.read(); }//clear serial buffer

    }
  }
}
```

This code stores the data received from the thermal scanner and converts it into a float variable. Wiring follows the

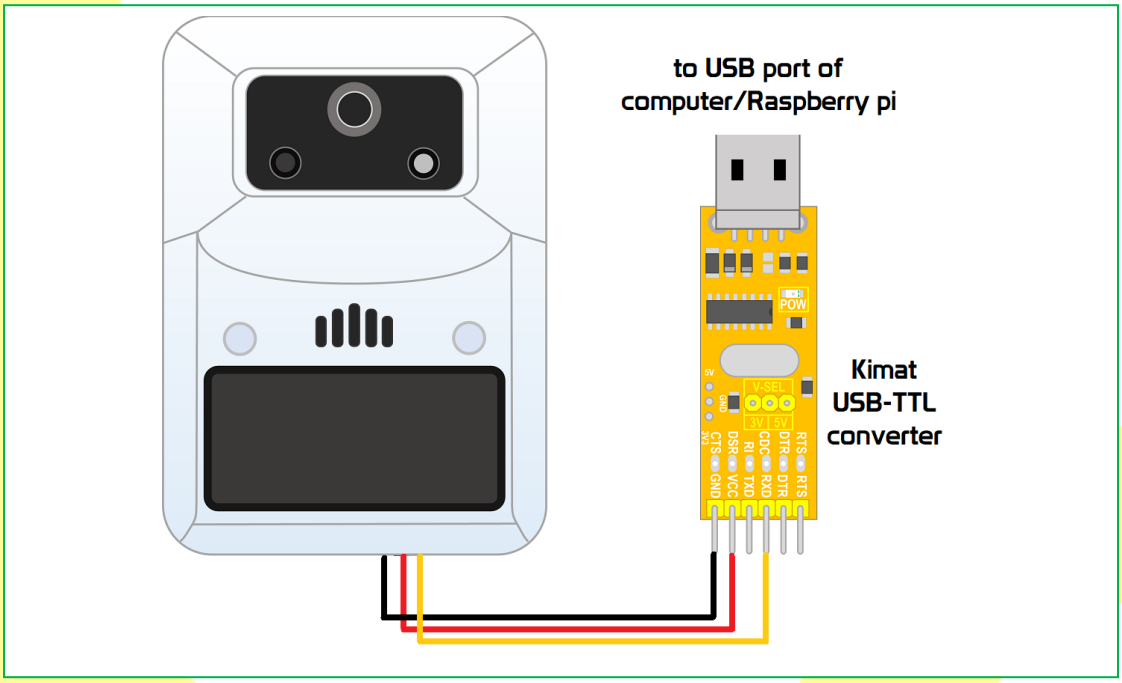
previous diagram.

**DIRECT TO COMPUTER / RASPBERRY PI**

If the device is to be used with a computer as its controller, then a simple UART-to-USB converter module or dongle may be used. Below is an example using the Kimat USB-TTL converter dongle. Other dongles may be used such as those based around FTDI, Prolific or CH340x chips.

Although a Raspberry Pi board has raw UART pins at its GPIO headers where we can interface the LC-081 directly, there may be use cases where a USB connection is necessary or desirable. In such case, the same UART-to-USB converter circuit is required.

In both cases above, the driver software of the converter chip drivers must be installed into the host computer/Raspberry Pi.




Once connected the data can be read out of the serial port (COMx in Windows) set at a baud rate of 9600, 8 databits, No parity and 1 stop bit. Program the application software to receive this data and process or present it accordingly. This computer/Raspberry Pi application is beyond the scope of this document.



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**TROUBLESHOOTING**

| Symptom / Problem | Fix / Solution |
|---|---|
| Seven Segment Display is Dim | Use an appropriate power supply that can output a regulated 5V and at least 450mA of current |
| “Running dots” is replaced with “running dashes” | Use an appropriate power supply that can output a regulated 5V and at least 450mA of current |
| No output data or random output data | Ensure that the receiving device / application has its port set to 9600 baud rate. |

**DOCUMENT REVISION**

v1.01 – 10 Aug 2022 / C.D.Malecdan
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** this is an evolving document **



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