# SOLDERING STATION


## SPECIFICATIONS:

- Power Supply : +24V$_{DC}$ +/- 10%
- Power: 50W
- Display LCD 16x2 + 2x LEDs
- Buzzer
- 3x Buttons
- USB (FW can be upgraded via USB)
- Temperature range: 100-400°C
- Temperature accuracy: <10°C (*)
- Temperature stability: <2°C (*)

(*) Without air flow and no load

## FEATURES AND BENEFITS:

- Extreme Low cost
- PID temperature controller

## VERSION HISTORY

| VERSION | NOTE | DATA |
|---|---|---|
| *1.0.0* | *First Release* | *30/09/2024* |
| | | |
| | | |
| | | |
| | | |

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# 1 PRODUCT OVERVIEW

## 1.1 PRODUCT OVERVIEW

The diagram-block of Solder Station is shown in the following picture.

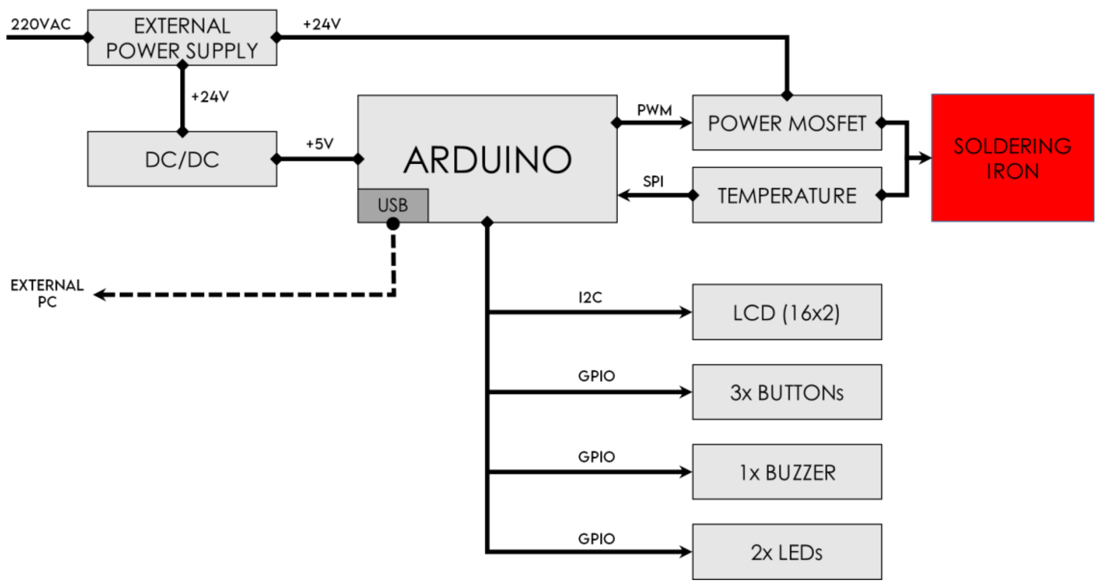


***Figure 1***

The DC/DC converter is responsible for deriving the necessary +5V power supply from the +24V bus, which is provided by an external power source, to power all components.

The core of soldering station is Arduino Uno R3 Board. Arduino Uno is a microcontroller board based on the ATmega328P. The MCU is able to read the heating temperature by means of MAX6675 connected to MCU through SPI protocol. In addition, the MCU directly drives the power-mosfet via one PWM signal.

One LCD is used to interface with the operator. The LCD only needs two pins to drive it using I2C serial protocol. The only other connections required are for the power supply (+5V). The two-line display shows the set temperature and the actual temperature. For simplicity, temperature is set by pushing two buttons. This allows the iron to be adjusted from about 100°C to 400°C. The third buttons is used for pre-configured temperature: 100°C, 200°C and 300°C.

Moreover two LEDs and one buzzer are available. These elements are connected to MCU.

# 2 SOLDERING IRON HEATER (YIHUA 907A)

## 2.1 SOLDERING IRON HEATER (YIHUA 907A)

The Yihua 907A is a soldering iron featuring a +24V, 50W power rating and a K-type thermocouple sensor. The price of the 907A is approximately €15."


***Figure 2***

The pinout is shown in the following picture, where:

- Heater: ≈ 2Ohm
- Thermistor: ≈ 14Ohm at room temperature
- Tip to ESD pin: < 2Ohm

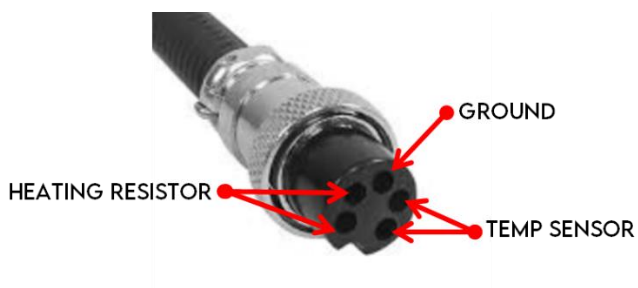


***Figure 3***

# 3 BOARD

## 3.1 DC/DC CONVERTER

For the power input (+5V), a small LDO step-down regulator module is used to supply the MCU and the rest of the circuit. The LM2596 is a versatile voltage regulator designed to efficiently convert higher input voltages (+24V) into lower ones (+5V). It can handle input voltages ranging from 4.5V to 40V and provides an adjustable output voltage between 1.5V and 35V.

The main characteristics are:

- the output ripple is (about) 30mV
- the maximum output current is 3A
- the efficiency is typically 92% (depends on input/output voltage difference and load).
- the switching frequency of (around) 150 kHz.

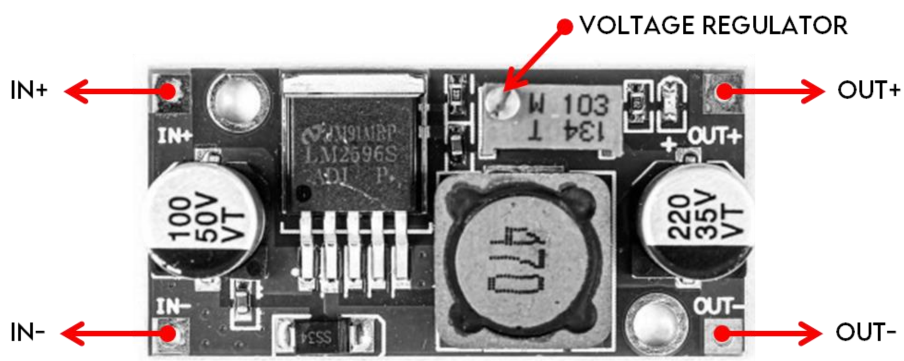


***Figure 4***

## 3.2 TEMPERATURE SENSOR (MAX6675)

A thermocouple (temperature sensor) is located into soldering tip. The thermocouple creates a voltage depending on the temperature difference between the hot end and the cold junction. The low voltage is read by MAX6675 and it is converted into digital signal.

The MAX6675 performs cold-junction compensation and digitizes the signal from a type-K thermocouple. The data is output in a 12-bit resolution, SPI-compatible. This converter resolves temperatures to 0.25°C, allows readings as high as +1024°C, and exhibits thermocouple accuracy of 8 LSBs for temperatures ranging from 0°C to +700°C.

## 3.3 POWER MOSFET

The MCU switches the heater on and off via the MOSFET. The project uses a simple logic level N-channel MOSFET as a switching device for PWM control. Furthermore a BJT-Push-pull circuit is implement in order to increase the performance of MOSFET.

## 3.4 DISPLAY, LEDS AND BUTTONS

LED signals definitions:

- *On*: The LED is constantly on.
- *Off*: The LED is constantly off.
- *Blinking*: The LED blinking will have an On and Off sequence with a frequency of approximately 2.5 Hz: On for approximately 200 ms followed by Off for approximately 200 ms.

| | ON | OFF | BLINKING |
|---|---|---|---|
| LED1 - GREEN | The temperature is reached the setpoint. | The actual temperature is greater than setpoint. | - |
| LED2 - GREEN | - | The MOSFET is off. | The MOSFET is on. |

There are three buttons for temperature adjustment. The TEMP+ (TEMP-) button increases (decreases) the desired temperature by +1°C (-1°C). If the button is held down for about 2 seconds, the temperature will increase (decrease) by +10°C (-10°C). The adjustable temperature range is 0-400°C. Pressing the central SETUP button will set the temperature to +200°C, +300°C, or +400°C.


***Figure 5***

The 16x2 display shows:

- the current temperature of the soldering iron
- the desired temperature (setpoint)
- the duty cycle value (0-100%)

# 4 FIRMWARE

## 4.1 FW - INITIALIZATION

In the *setup()* function, the following components are configured:

- I/O pins for LEDs, buzzer, buttons, and PWM output.
- LCD display to show the current temperature, setpoint, and duty cycle.
- MAX6675 temperature sensor to read the soldering tip temperature.
- PID controller to regulate the set temperature.

After initialization, the system checks whether the probe is connected:

- If disconnected, the display shows an error message, and the buzzer emits an alert sound.
- If connected, the PID is activated, and the system enters operational mode.

## 4.2 FW - MAIN LOOP

The main loop handles:

- Temperature reading every 50 ms.
- Display updates every 50 ms with the current temperature, setpoint, and duty cycle.
- Temperature adjustment using the TEMP+, TEMP-, and SETUP buttons.
- Standby management after a predefined period of inactivity.

## 4.3 FW - TEMPERATURE ADJUSTMENT

The SETUP button cycles the temperature between 200°C, 300°C, and 400°C.

The TEMP+ button increases the temperature:

- +1°C for single presses.
- +10°C for long presses.

The TEMP- button decreases the temperature following the same logic.

## 4.4 FW - TEMPERATURE CONTROL WITH PID

The PID calculates the necessary power to maintain the set temperature.

The PID output controls a MOSFET via a PWM signal.

The duty cycle (%) is calculated based on the PWM signal (0-100%).

## 4.5 FW - STANDBY MODE

If the system remains inactive for an extended period:

The display shows "STAND-BY" and prompts the user to press a button to reactivate it.

The temperature is set to 10°C to save energy.

Pressing any button restores normal operation.

## 4.6 FW - LED AND BUZZER INDICATIONS

LED1 turns on when the temperature approaches the setpoint.

LED2 blinks when the PWM power exceeds 20%.

The buzzer emits a sound in case of a probe error.

## 4.7 FIRMWARE – PID

The PID (Proportional-Integral-Derivative) controller regulates the soldering iron's temperature by adjusting the PWM signal sent to the MOSFET. This ensures the temperature reaches and maintains the setpoint accurately.

Reading the Temperature: The thermocouple measures the current temperature.

Computing the PID Output: The PID algorithm calculates the necessary power based on the difference between the set temperature and the actual temperature.

Adjusting the Heating Power: The PWM signal is modified accordingly to maintain the desired temperature.

If the temperature is too low, the PID increases the power. If it's too high, it reduces it. This prevents overheating and ensures a stable temperature.

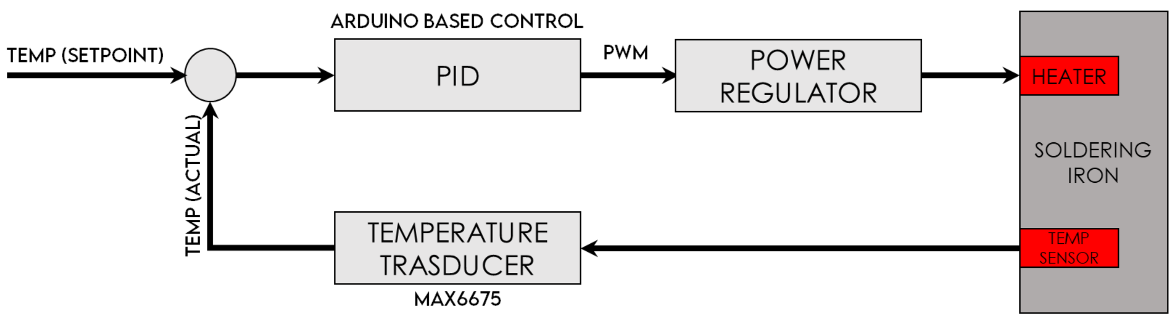


***Figure 6***