

Controls from sub-zero to high temperatures. Ideal for keeping warm, keeping cold, and cultivating
PWM temperature controller kit for Peltier element



Model number MK- 515

User Manual

MYCOMKITS.COM's "MK-515 Controls from below zero to high temperatures. Ideal for keeping warm, cold, and cultivating. PWM temperature controller kit for Peltier elements" controls Peltier elements with a simple circuit and PID control program. This is a temperature controller kit that can generate temperatures from °C to 70°C.

Because it is small, you can easily create a small thermal or cold storage to heat canned coffee on the table, cool plastic bottles, or perform temperature-controlled culture experiments.

Note: Product does not include Peltier element and power supply. Obtain and use the Peltier element and its power supply that match your application.

Please refer to the "Terminology Explanation" for "PID control", "Peltier element", etc.

Please refer to the usage video posted on the product page (link below).

<https://www.mycomkits.com/SHOP/MK-515.html>

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Features

- PWM control of Peltier element temperature from -3°C to +70°C
- Reach within $\pm 0.1^\circ\text{C}$ in a short time and maintain it
- Can control Peltier elements from 5V to 24V
- Maximum current is 5A
- Maximum current flowing through the Peltier element can be limited
- PID (proportional integral derivative) control coefficients (P, I, D) can be adjusted

- Temperature sensor (thermistor) B constant can be set

Law related

◆Disclaimer

Our company cannot be held responsible for the following matters.

- Damage or breakage of the product or malfunction or malfunction due to modification that is not our responsibility.
- Direct and indirect effects and loss of profits caused by this product

◆Safety precautions

⚠Warning : Ignoring this item and handling the product incorrectly may result in death or serious injury .

If water or foreign matter gets inside, stop using it.

- Continuing to use the product may cause fire or electric shock. Please take the above steps and contact your retailer or our inquiry center.

Do not use in locations exposed to water or humidity.

- It may cause electric shock or malfunction.

Do not place anything that could cause a fire, such as a lit candle, cigarette, or matches, on top of the device.

The tips of the connection pins and the pins on the back of the board are sharp, so be especially careful when handling them.

- Touching the tip may cause injury. Please be careful that children do not touch the tip.

Be very careful not to accidentally put the included resistors, capacitors, etc. into your mouth.

- Please be careful that children do not accidentally put the included capacitors, resistors, LED connectors, etc. into their mouths. The sharp tip can cause injury.

⚠Caution : Ignoring this item and handling the product incorrectly may result in injury due to electric shock or other accidents, or damage to nearby property.

Do not place it in an unstable place.

- The tips of the connection pins are sharp, so falling may cause malfunction or injury.

Specifications and features

Temperature setting range -99.9°C to +99.9°C
(actual control range depends on the Peltier element used and its power supply capabilities)
(recorded in non-volatile memory)

Temperature setting resolution 0.1°C

Temperature measurement range from approx. -3.0°C to approx. +70.0°C

Temperature measurement resolution 0.1°C

Temperature measurement error of approximately 1°C or more (A simple circuit is used for personal and hobby use, and the error depends on the environmental temperature and measurement temperature. However, the error is almost fixed, so accurate temperature is required. (If so, please measure and add or subtract the value when setting.)

Temperature control method PID (proportional integral derivative) control method. (For details, please refer to "Terminology")

P Value setting range 1 to 99 (recorded in non-volatile memory)

I value setting range 0.1 to 9.9 (recorded in non-volatile memory)

D value setting range 1 to 99 (recorded in non-volatile memory)

B constant 3000 to 5000 (recorded in non-volatile memory)

Current limit setting range 1 to 999 (The maximum current depends on the maximum current of the Peltier element used. For example, if a 12V3A Peltier element is used, 999 indicates a maximum current of 3A. This value is the maximum current of the Peltier element used. This is the pulse width of the PWM signal that drives the. 100% current is applied when it is 999. (Recorded in non-volatile memory)

Peltier element voltage DC5V to 24V (If it is 7V or more, it can also be used as a power supply for the control circuit. **Note: However, when controlling a Peltier element of less than 7V, it is necessary to connect a separate power supply of 7V or more for the control circuit. Control (with power supply terminal for circuit)**)

Control circuit voltage DC7V to 24V (can be shared if the power supply for the Peltier element is 7V or higher)

Peltier element current maximum 5A (Absolute maximum current 7A)

Control circuit current approximately 50mA

Drive method PWM method (pulse width modulation method)

PWM signal frequency 2000Hz

Temperature sensor thermistor (NTC), B constant 3435, 10 k Ω at 25° C. Comes with approximately 50cm electric wire

Three types of power connectors:

1. DC jack type (J5) Shaft diameter 2.1mm, outer diameter 5.5mm (shaft is positive). Peltier element voltage supply. If it is 7V or higher, it can be shared with the control circuit power supply.
2. "E + " "GND" (J 1, J2) Terminal block (screw terminal). Peltier element voltage supply. If it is 7V or higher, it can be shared with the control circuit power supply (electrically connected to the DC jack connector above)
3. "VCC " "GND" (J 1, J2) Terminal block (screw terminal) ...Power supply terminal exclusively for control

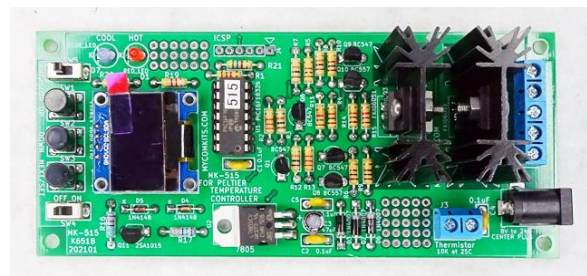
circuit. No connection is required if the power supply voltage for the Peltier element is 7V or higher. If the voltage is less than 7V, connect a voltage of 7V or higher.

Display device 0.96inch, 127 x 64 dots OLED (organic LED), white

Display contents Set temperature (SET), actual temperature (ACT), P value (P GAIN), I value (I GAIN), D value (D GAIN), current limit value (L LIMIT), B constant (B VALUE), PWM signal pulse width, start/stop status (START/STOP)

status display LED control, the red LED (D1) lights up when heating, and the blue LED (D7) lights up when cooling.

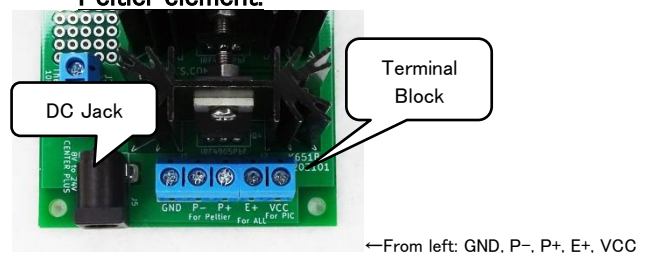
Size 130.5x57.0x32.0mm (height)



Connection method

Here, 1. Power connection, 2. Peltier element connection, 3. Temperature sensor connection, 4. A temperature sensor is attached to the Peltier element and connected in this order.

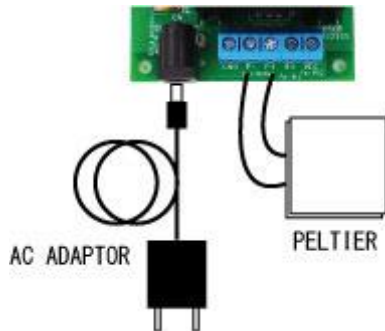
Note: There is no power switch for the Peltier element, so if you connect the power to the Peltier element terminal and an air cooling fan is connected, the air cooling fan will rotate. be careful. However, when the power switch for the control circuit is off, no current flows to the Peltier element.



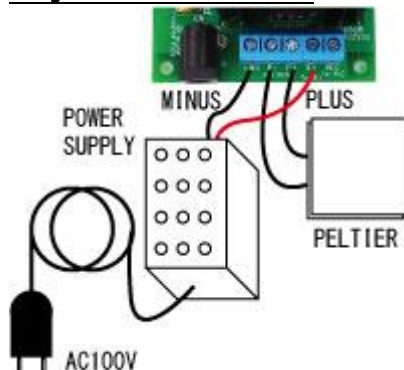
1. Power connection: There are 3 types of connection methods. A) Use a 7V or higher AC adapter, B) Use a 7V or higher power supply, C) 5V output AC adapter for a Peltier element operating at 5V or a power supply for the power supply and control circuit (7V or higher) There are 3 types of cases of use.

A) When using a DC plug when the Peltier element voltage is 7V or higher, use the DC jack (J5). Insert the DC plug (shaft diameter 2.1mm, outer diameter 5.5mm (shaft is positive)) of an AC adapter (for example, 12V5A) that matches the voltage and current specifications of the Peltier element to be

used into the DC jack (J 5). If the voltage is 7V or higher, no power supply is required for the control circuit. GND, E+, and VCC of the terminal block are not used.



- B) When connecting the power supply wire to the terminal block when the Peltier element voltage is 7V or higher, use the "E+" "GND" (J1, J2) terminal block (screw terminal). Connect a DC power supply (for example, 12V5A) that meets the voltage and current specifications of the Peltier element you are using. Connect the positive to E+ and the negative to GND. If the voltage is 7V or higher, no power supply is required for the control circuit. Terminal block VCC is not used. **Note: Electrically connected with the DC jack connector above.**



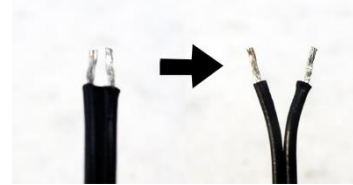
- C) If the Peltier element voltage is less than 7V, it is necessary to connect the power supply for the control circuit in addition to the Peltier element voltage connections of "A" and "B" above. "VCC" "GND" (J1, J2) Use terminal blocks (screw terminals). Connect the positive end of a power supply of 7V or more and 100mA or more (such as a 9V 500mA power supply) to V CC and the negative end to GND as a power supply exclusively for the control circuit. When using a 5V output AC adapter for Peltier elements, terminal block E+ is not used. **Note: No connection is required if the power supply voltage for the Peltier element is 7V or higher. If the voltage is less than 7V, connect a voltage of 7V or higher.**

2. Connect the wire whose surface heats up when a positive potential is applied to "P + " and the other wire to "P - ". **Note: Depending on the direction of the current, Peltier elements generate heat when they are on the same side, and cool when they are on the same side. If a Peltier element is already**

installed, check which wire will generate heat or cool down when a positive voltage is applied to the surface. If you connect it the other way, it will generate heat even though it is supposed to be cooling. In the worst case, the device and peripheral circuits will be destroyed. See figure below.

冷却 (吸熱) ∇ 発熱 (放熱) ∇

3. Connecting the temperature sensor: Connect the temperature sensor (thermistor) with attached wire to the terminal block (J3). There is no polarity. If it is difficult to connect, use nippers or a cutter knife to open the ends of the two wires and insert them (see the photo on the left).



The included temperature sensor

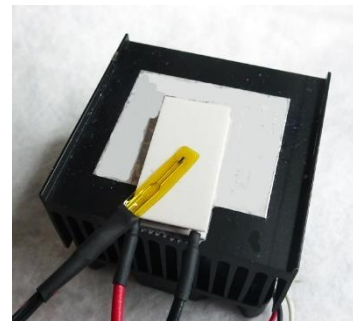
sensor uses an element with a B constant of 3435, and this value is set in internal non-volatile memory (does not disappear even when the power is turned off) at the time of shipment. If you do not use the included temperature sensor, please set the B constant of your thermistor on the "B constant setting screen (see instructions for use)". **Note: The only temperature sensor (thermistor) that can be used is one that exhibits 10kΩ at 25°C. Also, the B constant is limited to 3000 to 5000.**



← Temperature sensor

(thermistor) terminal
↓ Temperature sensor with attached wire (thermistor. 10k@25 °C)

4. Attaching the temperature sensor to the Peltier element:



surface or cooling surface).
←Installation example

The location of the temperature sensor is important. Although it depends on the purpose of use, basically attach the Peltier element in close contact with the surface where it will be used (heating

How to use

1. Power on...Slide the power switch (SW4, slide switch, right end of the photo) to the ON side (upper side). Starting from the first line on the screen, the previously set temperature (SET), the actual temperature measured by the temperature sensor (ACT), the pulse width, and whether it is



running (START) or stopped (STOP) are displayed.
Note: If the START switch is on, temperature control will begin when you turn on the power.

↓ This shows that the set temperature (SET) is 40.0°C, the actual temperature (ACT) is 19.2°C, the PWM signal pulse width is zero, and it is in the stop (STOP) state.



2. Setting the temperature...Press the UP switch on the initial screen after powering on to increase the set temperature (SET, displayed on the first line) by 0.1 °C. Press and hold to increase continuously. Press the DOWN switch to decrease the set temperature by 0.1°C. If you keep pressing it, it will decrease continuously. The setting range is -99 °C to +99 °C. The two pushbutton switches with round caps in the photo on the left are the UP and DOWN switches. The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

3. Setting the P value (setting the proportional control coefficient) ...Press the NEXT/SET (next screen) switch on the initial screen after turning on the power, and the P value will be displayed on the first line. Temperature is controlled using PID control method. Set the P value in the range from 1 to 99. Press the UP switch to increase. Press and hold to increase continuously. Press the DOWN switch to decrease. If you keep pressing it, it will decrease continuously.



The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

← P value (P GAIN) Setting example. On screen it is set to 75

4. I value setting (integral control coefficient setting) ...If you press the NEXT/SET (next screen) switch when the P value setting screen is displayed, the I (eye) value will be displayed on the first line. . Temperature is controlled using PID control method. Set its I (eye) value in the range from 0.1 to 9.9. Press the UP switch to increase. Press and hold to increase continuously. Press the DOWN switch to decrease. If you keep pressing it, it will decrease continuously. The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

← I (eye) value (I GAIN) Setting example. On screen it is set to 1.0



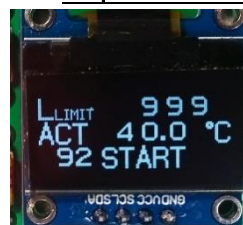
5. D value (setting the coefficient of differential control) ...If you press the NEXT/SET (next screen) switch when the I (eye) value setting screen is displayed, the D value will be displayed on the first line. Temperature is

controlled using PID control method. Set the D value in the range from 1 to 99. Press the UP switch to increase. Press and hold to increase continuously. Press the DOWN switch to decrease. If you keep pressing it, it will decrease continuously. The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

← D value (D GAIN) Setting example. On screen it is set to 1 0



6. Setting the current limit value (LIMIT) ...If you press the NEXT/SET (next screen) switch on the D value setting screen, the maximum pulse width of the PWM signal will be displayed as the current limit value on the first line. Set the current limit value in the range from 1 to 999. Press the UP switch to increase. Press and hold to increase continuously. Press the DOWN switch to decrease. If you keep pressing it, it will decrease continuously. Setting the maximum value to 999 indicates that the maximum current will flow. **The "maximum current" is determined by the connected Peltier element and its power supply. For example, if the maximum current of the connected Peltier element is 2A and the maximum current of the connected power supply is 2A or more, the "maximum current" will be 2A.** Since the Peltier element is controlled by a PWM signal, by limiting the pulse width, the voltage applied to the Peltier element is controlled and the current is easily limited. It does not measure and control the current. This is a simple method. **For example, if the maximum current of the connected Peltier element is 5A and the maximum current of the connected power supply is 3A, if the current is not limited, the power supply will enter an overcurrent state and the output will turn off, or in the worst case ,have trouble.** If you set the current limit value (LIMIT) to 500, the maximum current will only be about 2.5A, so you can control it even with a Peltier element that flows up to 5A. Note that the maximum current is determined by the Peltier element.



The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

← Current limit value (L LIMIT) setting example. On the screen it is set to 9 99 (maximum value)

7. Setting the B constant (B VALUE) ...If you press the NEXT/SET (next screen) switch when the current limit value (L LIMIT) setting screen is displayed, the B constant will be displayed on the first line. The specifications of thermistors used as temperature sensors are basically defined by the B constant. The temperature is calculated from this B constant and the resistance value of the thermistor. Set that B constant. Set the B constant in the range from 3000 to 5000. Press the UP switch to increase. Press and hold to increase continuously. Press the DOWN switch to decrease. If you keep pressing it, it will decrease continuously. The B constant of the temperature sensor (thermistor) that comes with the product is 3435, so it is set to 3435 at the time of shipment. If you use your own thermistor, set its

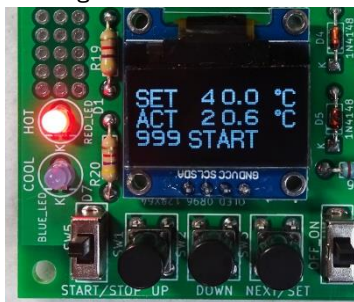
B constant. Thermistors that can be used exhibit $10K\Omega$ at $25^\circ C$ and have a B constant in the range of 3000 to 5000 (please contact us if it is outside this range). The set value is recorded in non-volatile memory (which does not disappear even when the power is turned off).

←B constant (B VALUE) setting example. On the screen it is set to 3 435

8. Starting temperature control...Regardless of the display screen, temperature control will start by sliding the START/STOP switch (SW5, slide switch, left end of the photo) upwards.

During temperature control, the second line displays the actual temperature, and the third line on the left displays the pulse width of the PWM signal (0 to 999, proportional to the output current), then START (starting). At the same time, the red LED and blue LED indicate whether it is in a heating state (red LED lights up) or in a cooling state (blue LED lights up).

↓ This shows the state of heating to the target of $40^\circ C$. The temperature of the object shows $20.6^\circ C$. It shows that the maximum current is flowing when the pulse width of the PWM signal is the maximum, 999. The red LED lights up to indicate heating status.



↓ This shows the state of cooling to the target of $40^\circ C$. The temperature of the object shows $43.6^\circ C$. The pulse width of the PWM signal is 662, which means that about 60% of the maximum current is flowing. The blue LED lights up to indicate the cooling state.



Immediately after changing the temperature setting value, the temperature of the object will be higher or lower than the set temperature several times (approximately 2 or 3 times), and it will eventually reach the set temperature. Set. This phenomenon is described as "vibrating." The PID value must be set to reduce this vibration. For more information, see "Terminology".

↓ An example of a screen where the final temperature is stabilized at $40^\circ C$. The pulse width of the PWM signal is 97, so it shows that about

10% of the maximum current (999) is flowing and it continues to heat up and is stable.



9. Stopping temperature control...Regardless of the display screen, slide the START/STOP switch (SW5, slide switch, left end of the photo) downward to stop temperature control.

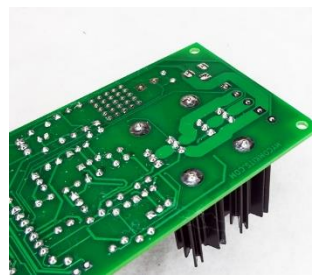
At the same time, the pulse width of the PWM signal on the third line becomes zero and STOP is displayed. You can also stop it by sliding the power switch (slide switch on the far right) to the



OFF side. **Caution: If the MK-515 main unit or Peltier device is abnormally hot, or in an emergency, turn off the START/STOP switch or power switch, or disconnect the AC adapter immediately. Setting values are recorded in non-volatile memory and will not be erased even when the power is turned off.**

Precautions for use

1. Depending on the Peltier element used, the MK-515 can draw up to 5A or more current. The back of the board has exposed metal terminals through which a large current flows. Since it is a huge



current, there is a possibility of abnormal heat generation and fire due to poor contact, incorrect settings, incorrect connections, or component failure. If this happens, immediately turn off or remove the power

source to eliminate the problem. If the problem persists, please contact us.

Glossary

>What is PID control ? ... It is one of the control methods to bring the temperature of the target object closer to the set temperature. It is an acronym for proportional (P), integral (I), and derivative (D). This is called side-by-side PID control. In the MK-515, the pulse width (0 to 999) of the PWM signal that drives the Peltier element is calculated according to each value of PID. As per the following formula.

PWM signal = P value component + I value component + D value component

P value (proportional value) component = P value

x temperature difference

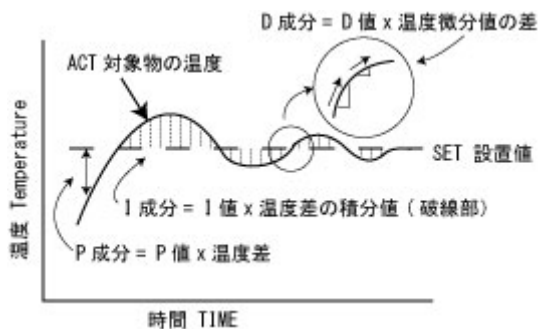
I value (integral value) component = I value x integral of temperature difference

D value (differential value) component = D value x difference in slope of temperature

<P value (proportional value) component> is calculated by multiplying the difference between the set temperature and the temperature of the object by the set P value. For example, if the set temperature is 40°C and the object temperature is 25°C, the difference is 15°C. Multiply that 15 by the P value (for example, 50) to get 750, and use that as the PWM value. A simple temperature control device may use only this P value to flow current through the Peltier element, and when the difference becomes negative, the current is turned off to control the temperature. This can be easily achieved using a relay. However, if the temperature is controlled using only the P value, the vibration will not stop.

<I value (integral value) component> is calculated by integrating the difference between the set temperature and the temperature of the object, and then multiplying that value by the I value. The integral value of the temperature difference is added as long as there is a difference, so the PWM value gradually increases and slowly approaches the set temperature. For example, if the I value is 1.0 and the temperature difference is 0.5°C, the integral value (0.5 = 1 x 0.5) will increase rapidly over time and may eventually increase to a maximum of 999. At this time, since the temperature difference is 0.5°C, the P value component is 25 (if the P value is 50), so almost no current can flow. In other words, the P value cannot be controlled, but the I value can be controlled because it increases in proportion to time.

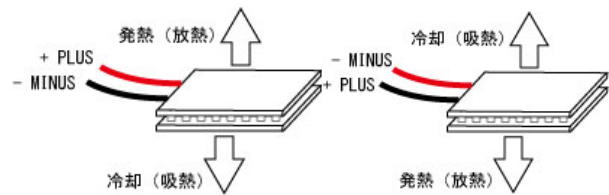
<D value (differential value) component> is calculated by multiplying the difference in slope between the set temperature and the temperature of the object by the D value. Even if the temperature difference is small, if the temperature change is rapid, it is difficult to control with the P value and I value, but it can be controlled with the D value component.



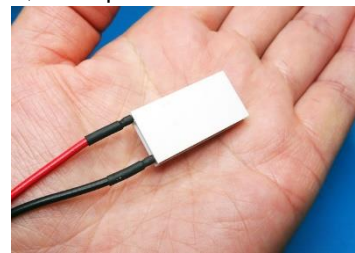
>What is a Peltier element ? ... It takes advantage of the Seebeck effect, in which heat flows from one metal to the other when a current is passed through a joint between two metals, to achieve cooling (heat absorption) and heat radiation (heat generation). It is an element that performs. In other words, it is not an element that generates heat when an electric current is passed through it, like a heater, but instead it absorbs heat from one side and radiates it to the other side. Please fully understand this mechanism. The direction of the current determines which side is cooled or dissipated. Basically, it is a plate-shaped element with a thickness of about 5 mm, and many types are sold ranging in size from

about 5 mm square to about 100 mm square. It is used to stabilize the temperature of the element in electronic elements and electronic devices. It is used for. What you need to be aware of is that this element transfers heat by passing an electric current through it. When one side cools (absorbs heat), the other side radiates that heat. Conversely, if one side generates heat, the other side absorbs heat and cools down. Please note that they operate completely differently than typical heating elements. When one side is cooled (heat absorbed), the other side becomes hot, so a huge heat sink or cooling fan is required in proportion to the cooling temperature to dissipate that heat. If heat dissipation is insufficient, the temperature of the cooling surface will rise and "thermal runaway" will occur, causing the cooling surface to heat up and possibly destroy the object.

↓ Heat radiation and heat absorption of Peltier element



↓ Example of Peltier element

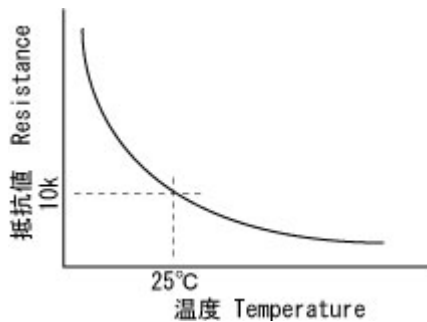


>What is the B constant?...It is a constant that indicates the relationship between the temperature and resistance value of the thermistor used as a temperature sensor. Generally, elements with a resistance of 10 kΩ at 25°C are often used. Negative resistance (NTC: Negative Temperature Coefficient) because the resistance value decreases in proportion to temperature. It is called. The MK-515 uses a thermistor as a temperature sensor, and uses the following formula to calculate the temperature from its resistance value and B constant.

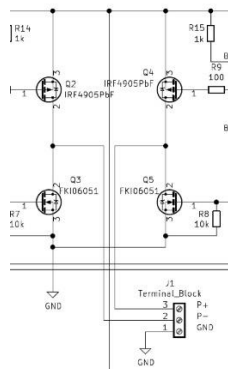
↓ Calculation formula for calculating temperature from B constant and resistance value

$$R = R_0 \times e^{\left(B \left(\frac{1}{(T+273)} - \frac{1}{(T_0+273)} \right) \right)}$$

↓ Relationship between thermistor temperature and resistance value



➤ **H-type drive circuit**...A circuit that combines four transistors to arbitrarily control the direction and magnitude of the current flowing through the electronic element. It is called an H-type because of the configuration in which two transistors are arranged on the left and right with the output terminal in between, as shown in the figure below. The figure below is the actual circuit diagram used in MK-515. When transistors Q4 (upper right) and Q3 (lower left) are on, the P+ terminal becomes positive and the P- terminal becomes negative. Conversely, when transistors Q2 and Q5 are on, the P- terminal becomes positive and the P+ terminal becomes negative, and current flows in the opposite direction to the Peltier element.



Program description

This program is created using CCS's compiler.

The H-type drive circuit is controlled using the full bridge circuit control function (CWG function) built into the PIC microcontroller (around line 290). The value of the temperature sensor (thermistor) is read as a voltage using a 10-bit AD converter (around line 354), that value is converted to a resistance value, and the temperature is calculated using the set B constant. A moving average of 16 times is calculated for the temperature sensor value to suppress reading errors (around line 354). The frequency of the PWM signal generation circuit is set to 2000 Hz by dividing the microcontroller's clock signal 8MHz.

The P value component, I value component, and D value component are calculated from the temperature information obtained from the temperature sensor and the target set temperature, and the PWM value is calculated (around line 858). Based on that PWM value, the output polarity of the H-type drive circuit and the width (duty) of the PWM signal are set. For "PID

control", please refer to "Terminology".

PWM value (0 to 999) = P value component + I value component + D value component

P value (proportional value) component = P value x temperature difference

I value (integral value) component = I value x integral of temperature difference

D value (differential value) component = D value x difference in slope of temperature

The width (duty) of the PWM signal is always displayed on the left edge of the third line of the OLED display to indicate the magnitude of the flowing current (around line 226).

The program is open to the public, so please check it out and feel free to change it if necessary. Created using CCS's C compiler.

Circuit description

The power supply for the control circuit of this MK-515 and the power supply for the Peltier element can be the same or different.

The voltage for the microcomputer is stabilized by lowering the voltage connected to the device to 5V using a voltage regulator. For this reason, a minimum of 7V or more is required as a power supply for the control circuit. Therefore, if the power supply voltage of the Peltier element is 7V or higher, it can be shared. In other words, there is only one power source. However, if you use a Peltier element below 7V, for example a 5V Peltier element, you will need to connect a power supply of 7V or higher, for example 9V, to a dedicated terminal block (screw terminal) for the control circuit.

A 0.96-inch OLED (organic LED) dot matrix panel is used as the display device. The resolution is 128x64 dots. Since it is I2C controlled, it is controlled using two signal lines. Three lines of text with a character height of 16 dots are displayed on this screen.

As the temperature sensor uses a thermistor (also called NTC), an element whose resistance value changes depending on the temperature, a constant current circuit generates a current of approximately 120uA, and when that current flows, it is generated at both ends of the thermistor. It detects voltage and calculates temperature from that voltage value. Since a 10kΩ thermistor is used at 25°C, a voltage of approximately 1.2V is generated at 25°C. Constant current circuits are simple circuits that use one transistor, so the current value varies slightly depending on the ambient temperature and added resistance value.

PWM signals control the polarity (direction) of the voltage applied to the Peltier element and the magnitude of the current using a circuit in which MOSFET transistors are arranged in an H-shape. The PWM signal is generated by dividing the PIC microcontroller's own clock signal of approximately 8 MHz to generate a PWM signal with a frequency of approximately 2000 Hz.

The low side of the H-type drive circuit uses NMOS type FK106051 (or T K7R4A10PL, TK40A06N1S4X). The high side uses PMOS type IRF4905. The gate terminal of the IRF4905 on the high side has a large capacitance and a different potential, so it cannot be directly driven by a PIC microcontroller, so it is driven by a push-pull circuit that combines BC547 and BC557. The FK106051 on the low side is controlled only when the output polarity changes, and the IRF4905 on the high

side is controlled by a PWM signal. Please refer to "H-type drive circuit" in "Terminology".

The MOSFET "IRF 4905" used in the kit can drive up to 74 A, and "FKI06051" 1 (or T K7R4A10PL, TK40A06N1S4X) can drive up to 69 A (the latter is 50 A). However, the printed circuit board pattern that allows current to flow from the MOSFET to the screw terminal has a limit of 5A. MOSFETs have resistances of $0.02\ \Omega$ and $0.005\ \Omega$, respectively, so they heat up a little in proportion to the current (power consumption = current x current x resistance).

(Electric power is emitted as heat) at a maximum of 5A, so air cooling fans are basically unnecessary.

Note: As mentioned above, the absolute maximum current that can be output by this device is 7A based on the board pattern width, MOSFET internal resistance value, and terminal maximum current. Please be careful.

How to assemble the kit product

Before assembling, please check that the parts listed in the parts list are included.

For information on how to install each part, how to read the silkscreen print on the PCB, how to read the resistance value, etc., please refer to the "Useful Notes on Electronic Work" (PDF) on the web.

First, solder the short components (resistors, diodes), then the capacitors.

ICs, electrolytic capacitors, diodes, LEDs, and transistors have polarities and orientations, so please pay attention to the white printing (silk printing) on the board when installing them. There is a dent on the IC and its socket indicating the pin 1 side, which is clearly silk-printed on the PCB.

The polarity of the electrolytic capacitor is silk-printed on the PCB, so check it carefully before inserting and soldering the leads.

LEDs have a straight line drawn on the cathode side. The shorter wire of the LED is the cathode.

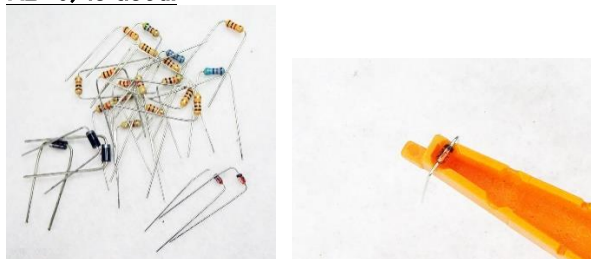
A semicircle is drawn on the transistor to indicate its shape, so please align the direction with the marking and solder.

Finally, temporarily attach the MOSFET to the heat sink, insert it into the printed circuit board, check its position, remove it from the printed circuit board again, tighten the screws firmly, then insert it again into the printed circuit board and solder.

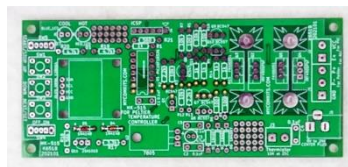
Please double check the polarity of the components before connecting power.

Detailed assembly instructions

Note: Resistors and diodes (1N4007) are basically mounted by bending them to a width of 10.16mm (0.4 inch, 400mil). Only the small diode (1N4148) is mounted by bending it to a width of 7.62mm (300mil). In the photo, a convenient pin bending tool (Sanhayato, RB-5) is used.



● Mount two small 1N4148 diodes. Please note the polarity (direction). A black band is printed on the cathode side.



● Solder the 1/4W carbon resistor and metal film resistor (R16, R17). Basically, carbon resistors are brown (cream), metal film resistors are blue, and a colored band is printed on top of it to indicate the resistance value. For example, 1k ohm is brown, black, and red. Carbon resistors have three bands that indicate the value, but metal film resistors have four bands. be careful. For the relationship between color and resistance value, please download and refer to the "Useful electronic work notes" (PDF) available on the website.



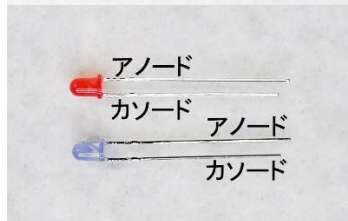
● Solder the three diodes (1N4007), paying attention to their orientation. A white band is printed on the cathode side.



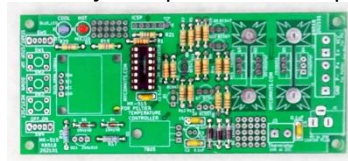
Solder 4 ceramic capacitors 0.1uF (104) (blue or brown).



● Solder the blue and red LEDs. It has polarity. The long lead wire is the anode, and the short lead wire is the cathode. In the diagram of the LED on the printed circuit board, a straight line is drawn on the cathode side.



● Solder the IC socket. There is a dent on the IC and its socket that indicates the pin 1 side, and it is also clearly silk-printed (white print) on the PCB.



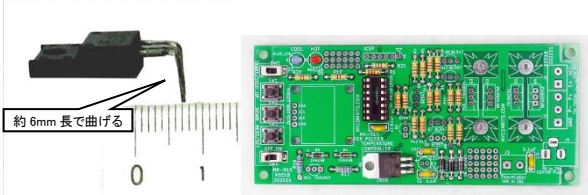
● Solder the three tact switches (push button switches). L



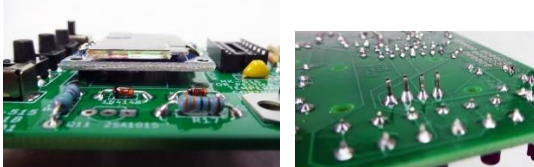
● Solder the two slide switches.



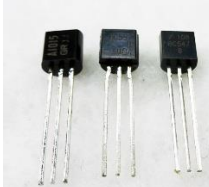
● Solder the voltage regulator IC "7805". Before soldering, be sure to bend the lead wires 90 degrees as shown in the photo. It is impossible to bend after soldering.



● Solder the OLED (organic LED) display. Install the OLED display so that it is as parallel to the printed circuit board as possible. The lead wire is thick, so cut it with sturdy nippers.



● Solder 4 transistors BC547, 2 BC557, and 1 2SA1015. They all have the same shape, so be careful and check the names written on the elements with a magnifying glass. **Caution: Please be careful to insert and solder in the correct position and direction as it has polarity. The transistor model number is printed on the printed circuit board. A semicircle shape is printed on the printed circuit board to indicate the orientation of the transistor. If you make a mistake, it may catch fire or generate heat when energized.**



←From left: 2SA1015, BC557, BC547

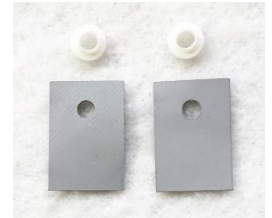


● Solder one 47uF electrolytic capacitor. The polarity (plus sign) of the electrolytic capacitor is silk-printed on the PCB, so please check it carefully before inserting and soldering the leads.

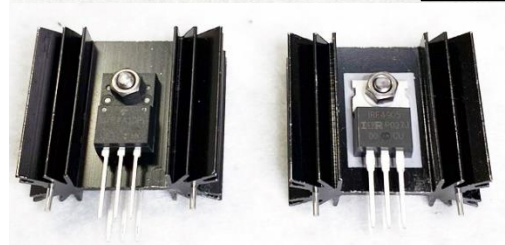


● Attach 4 MOSFETs to 2 heat sinks. **Note: Do not solder yet.** Two types of MOSFETs are used, four in total. Pair different MOSFETs IRF4905 and FK106051 (or TK7R4A10PL, etc.) and screw them to the heat sink (black heat sink).

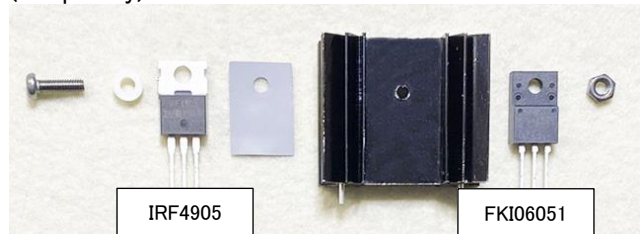
Note: The MOSFET used, its orientation, and the screw orientation are important. Please tighten the screws carefully while looking at the photo. If you insert the screw in the wrong direction, you may not be able to tighten the screw firmly, and it will be difficult to replace the MOSFET if it breaks down. IRF4905, which has metal screw holes, install the insulation washer and insulation sheet at the same time (see photo).



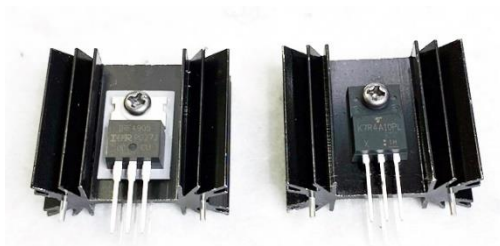
To one heatsink, as shown in the photo below, loosely install (temporarily fasten) screws → FK106051 (or T K7R4A10PL , TK40A06N1S4X , etc.) → heatsink → insulation sheet → IRF4905 → insulation washer → nut.



To the other heat sink, as shown in the photo below, loosely attach the screws → insulation washer → IRF4905 → insulation sheet → heat sink → FK106051 (or T K7R4A10PL , TK40A06N1S4X , etc.) → nut (temporary)

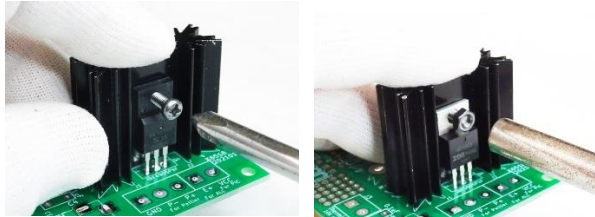


Place the MOSFET in the best position and mount it straight down.

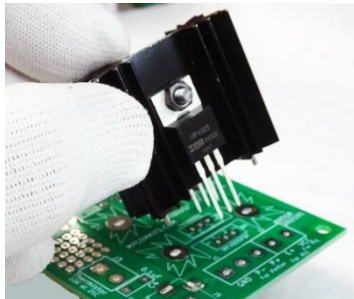


To ensure that they are mounted straight down, you can temporarily insert the heat sinks one at a time into the printed circuit board and tighten the screws firmly. Do the same work for the two heat sinks.

↓ Tighten the screw side firmly ↓ Tighten the nut side firmly



↓ Can be installed straight to the heat sink

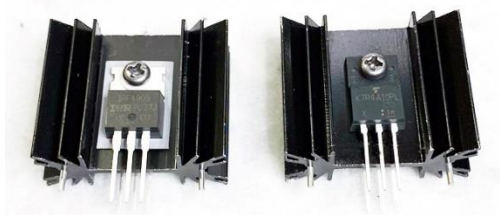


Note: If the fixing pins (2 pieces) of the heat sink are bent, use pliers to straighten them so that they can be inserted.

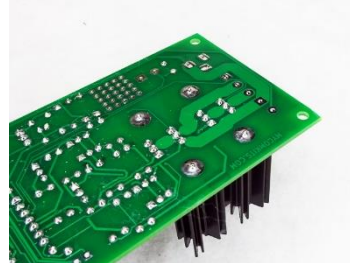
Note: Some of the fins may be bent or scratched. Performance is not affected. Please pardon.

Note: Do not solder yet.

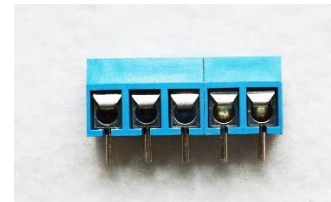
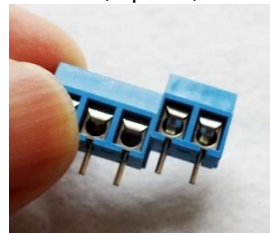
2 heat sinks with MOSFETs firmly screwed on. As shown in the photo below, one shows the screw head and FK106051 (or T K7R4A10PL , TK40A06N1S4X, etc.) , and the other shows the screw head and IRF4905. If it is different, please reinstall it correctly.



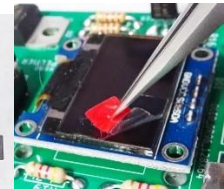
● Solder the two heat sinks to the printed circuit board. **Note:** There is a direction. Match the MOSFET model number printed on the printed circuit board with the MOSFET model number attached to the heat sink (printed on the element. Check with a magnifying glass), insert, and fix the MOSFET lead wire and heat sink. Solder the pins (2 pieces).



● Place two terminal blocks (screw terminals) (3-pole and 2-pole) by sliding them into the grooves on the side before soldering. Solder the remaining terminal block (2 poles) to J3. Solder the DC jack.



● Finally, insert the PIC microcontroller into the IC socket, paying attention to the orientation. There is a dent on the pin 1 side of the IC. Similar markings are also found on the printed circuit board. Attach the special cap to the tact switch by pushing it slightly from above. Finally, remove the protective vinyl (with a red tab, etc.) from the OLED display (you can use it as is).



◆ Troubleshooting (if it doesn't work)

If the device does not work after assembly, in more than 90% of cases it is due to incorrect component installation or poor soldering. Please use a magnifying glass to check again that the correct parts are mounted in the correct positions.

Check the part name and its soldered part again under bright lighting. Are the soldered parts shiny?

Is there a solder bridge between the pads?

the IC pins bent inside the IC? It may not be properly inserted into the socket. This problem often occurs when inserting an IC into an IC socket.

Bill of Materials – MK-515

Resistance (5%, 1/4W)

1K Ω (brown, black, red) R1, 4, 11, 14, 15	5
2.2 K Ω (red, red, red) R2, 13	2
10K Ω (brown, black, white) R 3, 7, 8, 12	4
100 Ω (brown, black, brown) R5, 6, 9, 10	4
56k Ω Metal film 1% (green, blue, black, red) R16	1
3.3k Ω Metal film 1% (Daidai, Daidai, Black, Brown) R17	1
4.7k Ω (yellow, purple, red) R19, 20	2
560 Ω (green, blue, brown) R21	1

Capacitor

0.1 μ F(104) Non-polar C1, 2, 4, 5	4
47 μ F Electrolytic Capacitor C3	1

Semiconductor

LED (red, 3mm, light emitting diode) D1	1
LED (blue, 3mm, light emitting diode) D7	1
Diode 1N4007 D2, 3, 6	3
Diode 1N4148 D4, 5	2
Transistor BC547 (or BC548) Q1, 6, 7, 9	4
Transistor BC557 Q8, 10	2
transistor 2SA1015 Q11	1
Pch MOSFET IRF4905 Q2, 4	2
Nch MOSFET FK106051 (or TK7R4A10PL, TK40A06N1S4X) Q 3, 5	2
Preprogrammed microcontroller IC 16F18 326 (or equivalent) U1	1
Voltage regulator IC LM7805 (or equivalent) U2	1

others

OLED (organic LED , 0.96 inch) display D S 1	1
Tactile switch (4 pin) SW1, 2, 3	3
Tactile switch cap	3
Slide switch SW4, 5	2
IC socket , 14 pin (for U1)	1
Terminal block (2 poles. Screw type. Used by connecting)	2
Terminal block (3 poles. Screw type. Used by connecting)	1
Heat sink for MOSFET (34X30X12 mm) H S1, 2	2
D C jack (shaft diameter 2.1mm, outer diameter 5.5mm) J5	1
Thin thermistor (temperature sensor) with cable	1
Screws (3x10mm or 3x8mm)	2
Nut (for 3mm)	2
Insulating washer (white)	2
Insulating sheet (gray)	2
MK-515 printed circuit board (K 651B) (size 1 31 x 57x32 mm)	1

Note: Semiconductors (transistors, ICs, etc.) are subject to change without notice due to improved performance or difficulty in obtaining them. Please pardon. If you have any questions, please contact support at support@mycomkits.com.

Note: There may be bends or scratches on some parts of the heat sink (radiating fins). Performance is not affected. Please pardon.

Contact information

Please obtain related detailed materials from the MYCOMKITS.COM website below.

<https://www.mycomkits.com/SHOP/MK-515.html>

If you have any questions, please contact us at the email address or phone number listed below.

Contact phone number MYCOMKITS.COM +81-50-5806-3751

Contact email address MYCOMKITS.COM shopmaster@mycomkits.com

Warranty (free repair policy)

1. Warranty period: 1 year after sale for the finished product (MK-515-BUILT). We cannot guarantee the product once the kit is manufactured by the customer.

2. We will repair the finished product (MK-515-BUILT) free of charge only if it is used in accordance with the instructions in the instruction manual and breaks down within the one year warranty period. However, if you are outside Japan, please pay only the shipping fee.

3. In the event of a failure, please let us know the details and symptoms of the failure in as much detail as possible.

Design, manufacturing, sales
MYCOMKITS.COM

CNET LIMITED MYCOMKITS.COM Division

<https://www.mycomkits.com>

Rev. 5.2

