Figure 1. The physical photo of ATFC106D

FEATURES

Digital Display for Parameter Setting and Monitoring

High Output Power for TEC: 12V20A

High Efficiency: >98%

No Heat Sink Required

Penal Mounting Design

Over Current Protected

Communication Function

Compact Size: 152.6mm(L)×76.0mm(W)×20.4mm(H)

APPLICATIONS

Drive and monitor TEC/Fan assemblies, show the real-time status of the controller on the computer.

DESCRIPTION

ATFC106D is designed for regulating an enclosed chamber temperature by driving a TEC array and a fan array. In addition, upon detecting the chamber temperature goes beyond the safety windows, see the table below, it cuts off an AC power switch by sending the relay control signal. The ATFC106D is a digitally controlled TEC/fan assembly controller for driving TEC assemblies with fans and monitoring the working status at the same time. It allows setting the parameters of the set-point temperature window, the safety temperature window, monitoring the heat sink hot side temperature, heat sink cold side temperature, and the chamber temperature, as shown in Figure 1. The controller integrates a digital display, a TEC controller, a fan controller, and temperature controlled relay control output into one assembly, see Figure 3.

In the controller, there are 2 control loops: TEC and Fan. The former has a bi-directional output for achieving both heating and cooling effects, the latter switches the fan on and off.
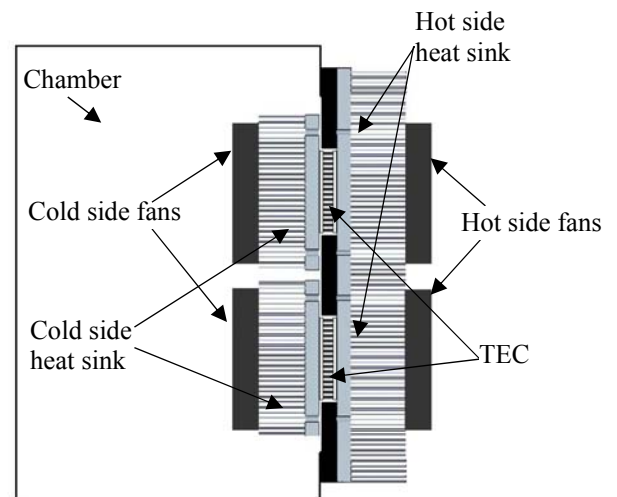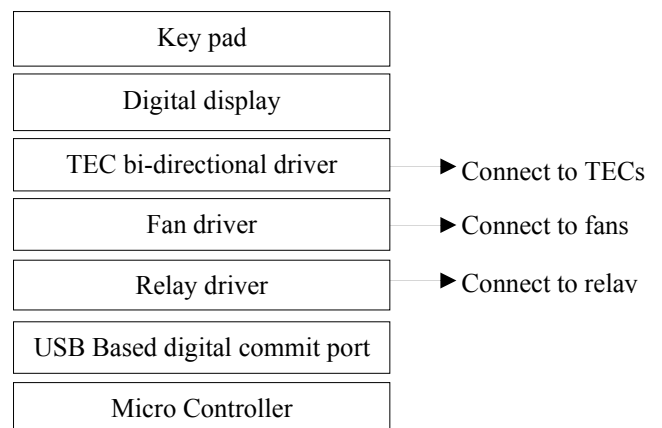

Figure 2. TEC/Fan Assembly

Figure 3. Block Diagram of the ATFC106D TEC/Fan Assembly

As shown in Figure 4, a digital display is used to show these temperatures: **Safety High Temperature**, **Safety Low Temperature**, **Cool On Temperature**, **Heat On Temperature**, **Satisfied**, **TEC Outside Temperature**, **TEC Inside Temperature** and **Chamber Temperature**. There are 8 LEDs indicating which of these temperatures is shown in the display.

The **Safety High Temperature**, T1, is the temperature point on which the chamber air temperature gets too high that the load control relay is turned off, but the TECs keep cooling down the chamber air.

The **Cool On Temperature**, T2, is the temperature point on which triggers the TECs to start cooling down the chamber air.

The **Heat On Temperature**, T3, is the temperature point on which triggers the TECs to start heating up the chamber air.

The **Safety Low Temperature**, T4, is the temperature point on which the chamber air temperature gets too low that the load control relay is turned off, but the TECs keeps heating up the chamber air. There is an option that when the chamber temperature gets too low, the load control relay is not turned off so that the load is still on and works as a heating element, helping increase the chamber temperature.

The LED indication logic for the above 4 temperatures is shown in Table 1.

Table 1. LED Indication Logic Form

Temperature Regions	TEC	Fan	Relay Output	LED1	LED2	LED3	LED4	LED5
T > T1 Temp. too high[1]	Cooling	On	Off	🔴	⚫	⚫	⚫	⚫
T1 > T > T2 Temp. high	Cooling	On	On	⚫	🟡	⚫	⚫	⚫
T2 > T > T3 Temp. good	Off	Off	On	⚫	⚫	🟢	⚫	⚫
T3 > T > T4 Temp. low	Heating	On	On	⚫	⚫	⚫	🟡	⚫
T4 > T Temp. too low	Heating	On	Off	⚫	⚫	⚫	⚫	🔴

There are 2 ARROW keys: ▲ and ▼, for increasing or lowering the temperature values when setting the set-point temperatures.

There is a SET key, to store the displayed temperature into the set-point temperature memories in the control software.

There are 8 temperature parameter indicating LEDs, each is dedicated to indicate which of the above 8 temperatures is being shown in the display.

There is 1 LED indicating when the chamber temperature is within the normal operating temperature, i.e. T2 > T > T3.

There are 2 LEDs, indicate setting temperature or displaying temperature modes respectively.

The total LED indicating logic is shown in Table 4.

The display can display the temperature from −4°F to 185°F.

All the buttons, the LEDs, and the display are protected by a vinyl face and is of water proof.

The controller has a metal front plate for panel mounting. There is a seal slot so that the mount will be water proof.

On the back side of the controller, there are 2 terminal blocks with 8 ports and 3 IC ports, see Table 5.

OPERATING PRINCIPLE

This controller has two modes, the working mode and the setting mode.

A. The working mode

When the controller is powered up, it is in the working mode automatically:

a. One of five LEDs, **Safety High** LED, **Cooling** LED, **Satisfied** LED, **Heating** LED and **Safety Low** LED, will be lit up, which is in line with the current state of the controller.

b. **Chamber Temp** lights. The display screen shows the temperature of the chamber at this time. It can be altered to the temperature of **TEC outside** and **TEC inside** by pressing "▼" and the corresponding LEDs will be lit up.

c. The ºF LED is lit up by default when the controller is on.

d. The LED near the "SET" key has two lighting modes:

Red off: normal;

Red On: this light is lit up when there are some faults. The potential faults and the reasons are shown in Table 2.

e. The display screen is controlled by the button "On/Off". The display screen is off by default when the controller is powered up, so please turn on the display screen by pressing the button "On/Off". This button is used to turn on or off the display screen.

B. The setting mode

The setting mode needs a password to enter. When the button "set" is pressed, "2500" is shown on the display, the first two digits stand for the version model of the program and the last two figures are for the password. Use "▲" to change the last second figure (0－9 recurring), and the "▼" to change the last figure. The default password is "10". After you enter the right password, you can begin to set the controller. The **Setting Mode** LED and the **Safety Low Temp.** LED are both lit up.

a. Setting the temperature

At first, **Safety Low Temp.** can be set by pressing "▲" and "▼". After that, press "Set" to confirm. Then, **Heat On Temp** LED is lit up. Apply the same methods to set **Heat On Temp**, **Cool On Temp** and **Safety High Temp**. The default temperatures of **Safety High Temp**, **Cool On Temp**, **Heat On Temp** and **Safety Low Temp** are 131ºF, 88 ºF, 55 ºF and 20 ºF respectively.

b. Setting the temperature unit

After temperature setting, the "ºF" LED is lit up, due to "ºF" being the default temperature of the system. This unit can be altered to "ºC" by pressing the key "▲"

After all the setting, press "Select" to withdraw from this setting. Please note that in the setting mode, the button "On/Off" doesn't function.

Table 2. Fault Code Interpretation

Fault #	Fault Name	Description
1	Chamber temperature too low	Chamber Temperature is lower than the lower safety limit value
2	Chamber temperature too high	Chamber Temperature is higher than the higher safety limit value
3	Fan output over current	The fan current is > 5A
4	Under voltage lock out	The voltage of the power supply is < 10V
5	Relay output over current	The relay current is > 5A
6	Over-heat protection	The temperature of the PCB ≥ 110C
7	TEC output over current	The TEC current is >20A

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SPECIFICATIONS

Table 3. Characteristics

Parameter	Value	Parameter	Value
Input voltage	12VDC ± 5%	Default T1	131°F(55°C)
Max. input current	25A	Default T2	88°F(31.1°C)
Output voltage for TEC	12V ± 5%	Default T3	55°F(12.8°C)
Max. output current for TEC	20A	Default T4	20°F(−6.7°C)
Output voltage for Fan	12V ± 5%	Temperature accuracy	±1.5°F
Max. output current for Fan	2A	Operating temp. range	−4°F to +185°F (−20°C to 85°C)
Output voltage for Relay	12V ± 5%	PCB dimension	72mm x 126mm
Max. output current for Relay	0.5A	Output connector	Terminal block
Relay drive side	high side		

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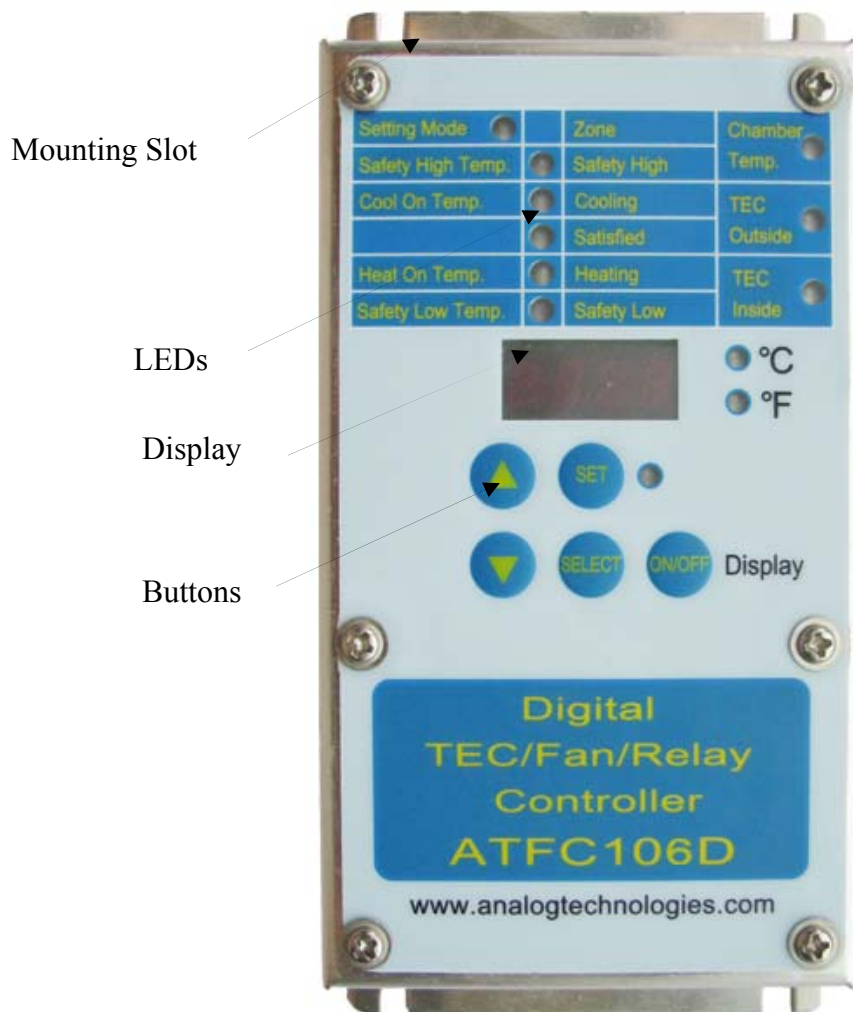
Figure 4. Front Control Panel of the ATFC106D

Figure 5. Front Control Panel

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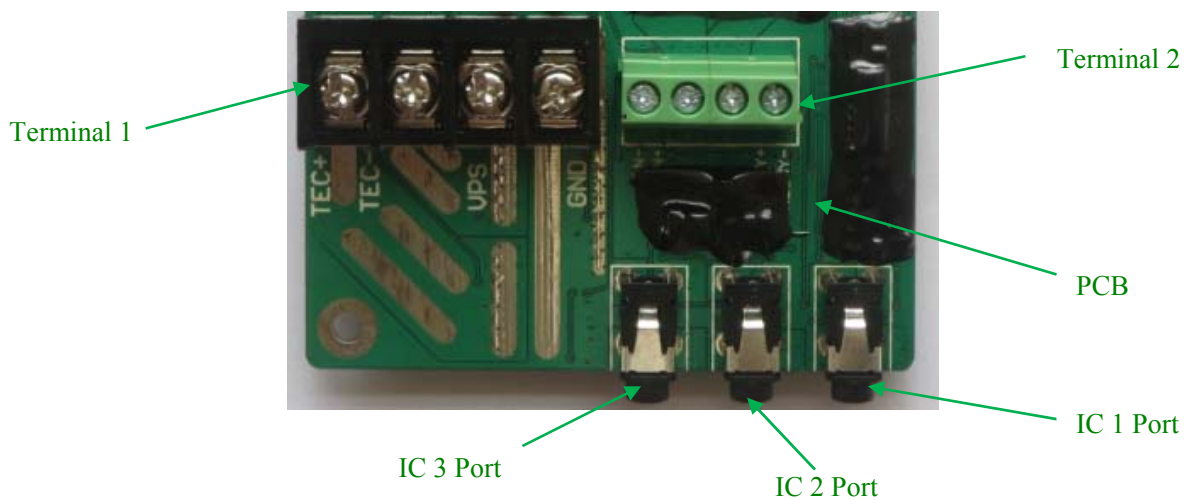
Figure 6. The Temperature Sensor

Table 4. LED Indication Protocol

Digital Display	Set Temp LED	T1 LED	T2 LED	T Satisfied	T3 LED	T4 LED
Actual Temp.	●	🔴	●	●	●	●
Actual Temp	●	●	🟡	●	●	●
Actual Temp	●	●	●	🟢	●	●
Actual Temp	●	●	●	●	🟡	●
Actual Temp	●	●	●	●	●	🔴
Set-point Temp for T1: Safety High	🟢	🔴	●	●	●	●
Set-point Temp for T2: Cooling	🟢	●	🟡	●	●	●
Set-point Temp for T Satisfied	🟢	●	●	🟢	●	●
Set-point Temp for T3: Heating	🟢	●	●	●	🟡	●
Set-point Temp for T4: Safety Low	🟢	●	●	●	●	🔴

One controller assembly will include: a PCB assembly which contains: two terminal blocks, 3 IC ports, 5 buttons, a digital display tube and 12 LEDs. Pin assignments of the terminal blocks and IC ports are shown in Table 5 below. The terminal blocks and IC ports are marked in Figure 5.

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Table 5. Pin functions

Terminal Block	Pin #	Pin Name	Description	Note
Terminal 1	1	TEC+	TEC positive terminal	Output
	2	TEC−	TEC negative terminal	Output
	3	12V	Power ground	Input
	4	GND	Signal ground	Input
Terminal 2	1	FAN−	Fan negative terminal	Output
	2	FAN+	Fan positive terminal	Output
	3	RELAY+	Relay positive terminal	Output
	4	RELAY−	Relay negative terminal	Output
IC port 1		IC1	The chamber sensor input	Input
IC port 2		IC2	The TEC outside sensor input	Input
IC port 3		IC3	The TEC inside sensor input	Input

Communication function

Utilizing serial port communication, Single Chip Micyoco sends data to computer through USB serial communication interface. With the data received from the SCM, computer decodes the data to get the real-time status of SCM control system. Then the computer will show the user window procedure which is made by the windows.

A. Single Chip Micyoco sends 9 sets of numbers to computer. They are hexadecimal numbers. For example: 0x01, 0xa6, 0x01, 0x9e, 0x00, 0xa3, 0x00, 0x02, 0x00. They stand for different meanings, see the table below. But the latest number is no meaning now.

#	Meaning
0x01 0xa6	Chamber temperature
0x01 0x9e	TEC outside temperature
0x00 0xa3	TEC inside temperature
0x00	temperature unit
0x02	TEC working status
0x00	

B. Data Explanation
The first three have the same meaning. Two sets of numbers belong to a group, standing for high and low level respectively. They are all temperatures. Conversion method is as below:
To show it in hexadecimal numbers: 0x01a6=422

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The voltage value that is represented by temperature: ad=5*422/1024=2.060546875

Fahrenheit temperature t1= [(ad-0.546)*1.89/0.0371]-4=73 (rounded)

Celsius temperature: t2= (t1-32)*5/9=22 (rounded)

TEC temperature display unit, 0 stands for Fahrenheit degree and 1 is Celsius degree

TEC work status:

status=0x00	safety low
status=0x01	heating
status=0x02	satisfied
status=0x03	cooling
status=0x04	safety high

C. Actually, these data is operated in the background, and the window display software that user gets can never be seen. The above are only principle, and the user can only get the annotation of each status, and the button which can get the update display.

MECHANICAL DIMENSIONS
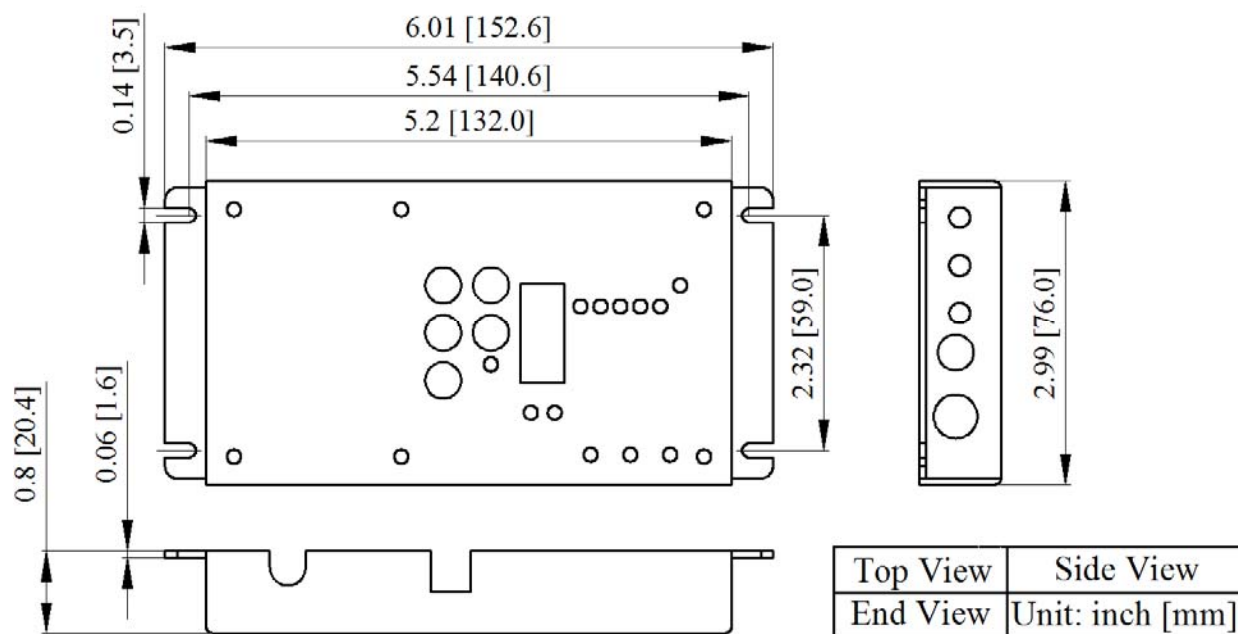
The dimensions of the ATFC106D is shown in Figure 7.

Figure 7. Dimensions of ATFC106D

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