
User Manual

Version 1.0

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A. Introduction

Thank you for purchasing the Docol ADN series temperature controller. We sincerely appreciate your decision and believe that our machine will meet your expectations in product quality and experimental results. We are delighted to provide this manual that will serve as guidance for operating this controller. In particular, we would urge you to read through the safety warnings below, although this plug-and-play controller is very easy to operate, your safety is paramount.



SAFETY WARNINGS

- This controller was designed to be used only with selected heating devices that have limited power and their own thermal cut off protection, such as a thermostat or thermal fuse in case of controller failure. Do not use it with an untested device.
- Do not place any objects on the top of controller surface that is used to vent excess heat during its operation.
- The maximum output electric current this controller can handle is 8 ampere at 12 VDC, which is 96 watts.
- **Always place the temperature sensor in the right position (the rodent rectum, or the surface of a heating pad) when the controller is on and connected to a heating device.** Leaving the sensor elsewhere will form an open loop operation; controller will assume the temperature is low and will provide full power to the heater even if the heating pad is already over-heated.
- This controller is designed to control devices recommended by Docol Corporation only. Using it to control a not recommended device can be dangerous and cause fire. Docol Corporation is not liable for damages caused by misuse of the controller.
- If an abnormal display or noise is observed, turn the controller off, unplug the power cord and contact the customer service for technical support before using it again.
- Clean the controller only when it is cool and unplugged.

B. Specifications

Input voltage:	100 to 240 VAC 50 /60 Hz.
Output voltage:	12 VDC.
Maximum output current:	8A.
Control action:	Heating.
Control mode	PID, PI, PD, P or On/off.
Output switching device:	400W MOSFET Trigger Switch.
Sensor type:	T-thermocouple, polyvinyl coated 24 AWG wire, epoxy and silicon-rubber coated tip.
Sensor tip dimensions:	2-3 mm diameter, 5-8 mm tip length.
Sensor cable length,	4.92 ft (1.5 m).
Temperature resolution:	0.01 °C.
Temperature range:	0-100.00 °C
Temperature accuracy:	+/- 0.1°C (in 25-40 °C range).
Data logger:	MicroSD card, 16G.
PC connection port:	RS232 9-pin female, works with RS232 to USB converter.
Alarm:	piezo continuous sound electronic alarm buzzer.
Dimensions:	7.5x5.5x4.5 inch (190 x140x115 mm) WxHxD.
Weight:	1.60 lb.

C. Operating Instruction

1. Description of the controller.

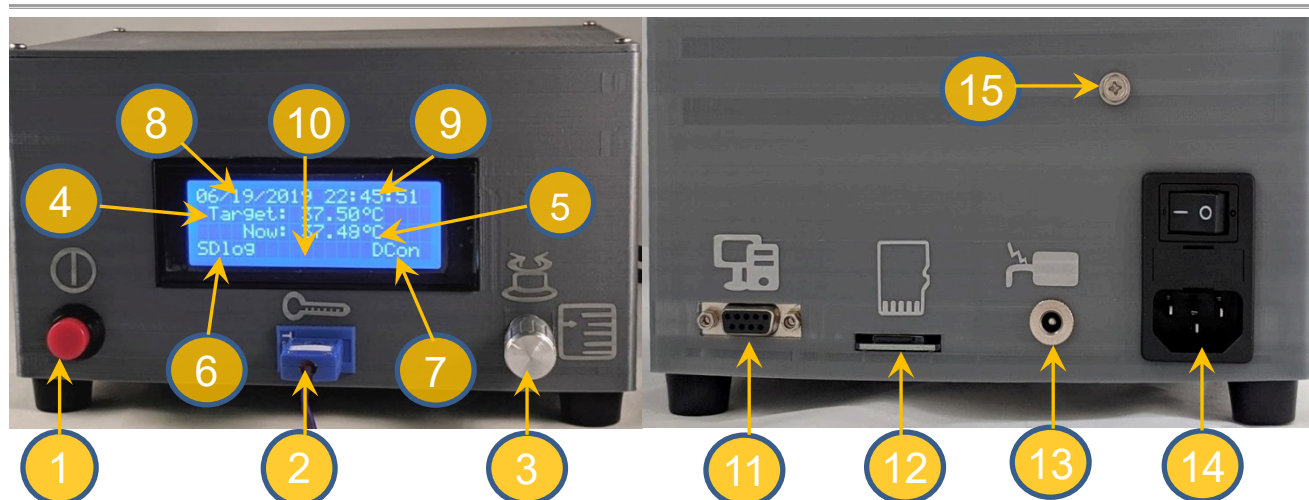


Figure 1. Front (left) and back (right) panels

(1) **The On/Off button** - press to turn on or turn off the controller.

(2) **T-thermocouple panel jack** - where to connect with the t-type thermocouple sensor probe.

(3) **Menu knob with push button** - press to enter menu, turn to select submenu or menu items, press again to enter submenu; when inside a submenu, turn to select submenu items, press to confirm selection or execute a submenu item, turn to change item value, press again to confirm/exit change made. If inside the menu system and leave the knob untouched for 20 seconds, the system will go back to running mode.

(4) **Display of set target temperature** - this is the LCD screen space where the set target temperature will be displayed when the controller is in running mode.

(5) **Display of current measured temperature** - this is the LCD screen space where the current measured temperature will be displayed when the controller is in running mode.

(6) **SDlog** - the display of "SDlog" means the measured temperature data is being saved to the microSD card and it is working properly. The controller will save temperature data in a comma separated cvs file on each running day and name the file according the date information, which will read like yyymmdd.cvs.

(7) **DCon** - Indicator for "DC power output is on", when the DC power output is off it will display "DCoff".

(8) **Display of current date.**

(9) **Display of current time.**

(10) **LCD screen space** where additional information will displayed, for example, it will display "ATed" after having completed auto-tune process.

(11) **RS232 port** for connecting to a PC or laptop. It may connect to the serial port through a serial cable, or to a USB port through the RS232 Adapter cable USB20RS232-PL2303 (sold separately). For capturing the temperature data, you may use your own serial port monitoring software, or download the free software CoolTerm at <http://freeware.the-meiers.org/#CoolTerm>.

(12) **MicroSD card slot.** The controller comes with a 16 GB Class4 MicroSDHC Flash Memory Card. When the controller starts, it will check if the microSD card is present, having enough free space and writable access.

(13) **DC jack** 5.5x2.5mm – DC power output connecting to DC heating pad.

(14) **AC power module** – connecting to wall plug of 100 to 240 VAC 50/60 Hz.

(15) **Grounding screw.**

2. Connecting the controller

The connection of controller should be done in the following steps.

- 1) Plug the t-couple temperature sensor to the front of the controller.
- 2) Plug the power cord to the AC power module at the back of the controller and to the power outlet on the wall, put the power switch in "OFF" position.
- 3) Plug the heater to the back of the controller. If the heater has a switch, put it in the off position.
- 4) Affix the temperature probe tip to the heating pad surface and cover with a piece of paper.

- 5) Connect the RS232 port at the back of the controller to your PC directly through a serial cable or to a USB port through the RS232 adapter cable USB20RS232-PL2303 (sold separately). Using your own serial port monitoring software or download the CoolTerm at <http://freeware.the-meiers.org/#CoolTerm>.
- 6) Switch on the AC power at the back of the controller and wait 5 seconds.
- 7) Push on the ON/OFF button at the front, the controller will start up and initialize itself. Make sure the controller powers up properly, date and time displayed correctly, and the temperature display is in the range expected.
- 8) Turn on the heating device if it has a switch.

3. Modifying the configuration through menu system.

1) Main menu

When the controller is in running mode, push the menu knob 1-2 times, the system will enter the main menu. The main menu is arranged on the LCD screen like Table 1. Slightly turn the menu knob, use the indicating "arrow" sign to select a submenu, press the menu knob to enter the selected submenu. The meanings of the submenus were described below:

Table 1. Main menu

AdjClock	SetTemp
PIDcntr	Others
SvConf	FctrRST
Alarm	Exit

AdjClock is for adjusting the system clock, which is displayed on the top line of the LCD screen. The system time is used for temperature data logging and real-time serial port data monitoring.

SetTemp is for setting the target temperature, sampling time, and data noise reducing factor.

PIDcntr is for setting up the PID configuration.

Others is for other settings including the On/Off mode, hysteresis, turning on or shut off the Load, turning on or off the SD card data log, and system reboot (sftReset).

SvConf is for saving the changed configuration values so that it stays when the controller is powered off.

FctrRST is for restoring the factory configuration.

Alarm is for setting up the system alarm and temperature alarm.

Exit is for exiting the main menu and back to running mode.

2) AdjClock submenu is arranged like displayed in the Table 2.

At the main menu screen slightly turn the menu knob, let the indicating "arrow" sign pointing to the "AdjClock" submenu, push the menu knob to enter it. When the screen has entered AdjClock submenu, slightly turn the menu knob, let the indicating "arrow" sign pointing to the submenu item, and push the menu knob to confirm selection. After having confirmed the selection, the date time value can be modified, slightly turning the menu knob to change date time, then push the menu knob again to confirm/exit the change of that item; repeat this action until items year, month, date, hour and minute have all reflected current date time. After having changed date time information, select the "SetClock" item and push the menu knob to set the clock. The internal battery will keep the clock running when the controller is powered off, when it is powered on again, the system clock will remain current. For returning to the main menu, select "MainMenu" and push the menu knob. Below are the brief descriptions of the submenu items:

Table 2. Adjusting Clock

YYYY	MM	DD	H24	Min
(Year)	(Month)	(Date)	(Hour)	(Minute)
SetClock				
MainMenu				

YYYY: year in 4-digits.

MM: month in 2-digits.

DD: date in 2-digits.

H24: hour in 24-hour format.

Min: minute.

SetClock: set the clock basing on changed date time information.

MainMenu: going back to the main menu.

3) SetTemp submenu is for setting the target temperature at which the controller will maintain the heated object. At the main menu screen slightly turn the menu knob, let the indicating "arrow" sign pointing to the "SetTemp" submenu, and push the menu knob to enter it. The configuration of data collection settings is also included in this submenu. Table 3 shows the submenu items with their default values and valid ranges.

Table 3. Temperature

Menu items	Default value	Valid Range
Set Temp.	37.50	0-100
sampleTime	500	250-3000
deNoise	10	0-100
BacktoMainMenu		

When the screen has entered SetTemp submenu, slightly turn the menu knob, let the indicating "arrow" sign pointing to the submenu item that need to modify or execute, push the menu knob to confirm selection or execute

an item. After having confirmed the selection for a changeable item, slightly turn the menu knob to change its value, and then push the menu knob again to confirm/exit the change made. Below are the brief descriptions of the submenu items:

Set Temp.: the target temperature set in Celsius degree.

sampleTime: the interval in milliseconds between two temperature data collecting points.

deNoise: the factor for reducing data noise. The controller performs many measurements for each data collecting point and use the average of these measurements as collected temperature data, by this way the data noise caused by measurement error will be greatly reduced. The deNoise number is the number of repeated measurements for each data collecting point.

BacktoMainMenu: going back to the main menu.

4) PIDcntr is for the configuration of PID settings. At the main menu screen slightly turn the menu knob, let the indicating "arrow" sign pointing to the "PIDcntr" submenu, and push the menu knob to enter it. This submenu is arranged like Table 4a; the default values and valid ranges for these items are listed in Table 4b. When the screen has entered PIDcntr submenu, slightly turn the menu knob, let the indicating "arrow" sign pointing to the submenu item that need to modify or execute, push the menu knob to confirm selection or execute an item. After having confirmed the selection for a changeable item, slightly turn the menu knob to change its value, and then push the menu knob again to confirm/exit the change made. Below are the brief descriptions of the submenu items:

Table 4a. PID settings

Mode=(value)	
P= (value)	I=(value)
D=(value)	Damp=(value)
BacktoMainMenu	

Table 4b. PID default values and valid range

Items	Default value	Valid range
Mode	Manual	Manual, AutoCorr, ATune(AT), AT + AutoCorr
P	250	0 - 1000
I	5	0 - 10
D	2500	0 - 10000
Damp	0.70	0.1 - 10

Mode. The controller has several modes to perform PID-controlled heating, including Manual, AutoCorr, ATune(AT), and AT + AutoCorr. The meaning of each mode is described below:

Manual: PID parameters are to be set manually. The controller has default values for the PID parameters, which are optimized against the DC-powered heating pad DC-30W12V-9859 (sold separately). In most cases using the Manual mode and the default PID parameter values will be enough.

AutoCorr: the controller will automatically adjust the current PID parameters basing on the measured temperature data and its built-in correcting algorithm.

ATune(AT): This is the auto-tune mode. When the controller is set this mode, after having returned to running mode, it will perform automatic tuning process for determining the optimal PID parameters, and the LCD will show "ATing" in the space between "SDlog" and "DCon"/"DCoff". For performing auto-tune, the heating pad and temperature sensor must be connected to the controller and operate the controller in the same condition as in real experiments. After having finished auto-tune process, the controller will adopt the newly determined PID parameters, and the LCD screen will display "ATed" in the space between "SDlog" and "DCon"/"DCoff".

AT + AutoCorr: This is the combination of auto-tune and auto-correction. When set in this mode, the controller will first perform auto-tune, then adopt the parameters determined through auto-tune, and then automatically adjust the parameters according to the measured temperature data and its built-in correcting algorithm.

P value is the proportional gain constant. This parameter control the output of the controller based on the difference between the measured and set temperature (the **Error**). A high proportional gain results in a large change in the output for a given change in the difference between the measured and set temperature. If the proportional gain is too high, the system can become unstable. In contrast, a small gain results in a small output response to a large input error, and a less responsive or less sensitive controller.

I value is integral gain constant. This parameter controls the output of controller based on the difference between the measured and set temperature integrated with time (called **past Error**). It is proportional to both the magnitude of the Error and the duration of the Error. The integral in a PID controller is the sum of the instantaneous Error over time and gives the accumulated offset that should have been corrected previously. The accumulated error is then multiplied by the integral gain and added to the controller output.

D value is the derivative gain constant. Derivative action contributes the output power based on the rate of temperature change. The derivative of the process error is calculated by determining the **slope of the Error** over time and multiplying this rate of change by the derivative gain constant. Derivative action can be used to minimize the temperature overshoot by responding to its rate of change. The larger the number is, the faster the action will be. The derivative action change the controller output based on the rate of change rather than the net amount of change. This will allow the controller to act sooner. Derivative action can be used to minimize the temperature overshoot by responding to its rate of change.

Damp value is the factor that used to reduce the initial temperature overshoot at the startup of the controller. A typical PID-controlled heating system will have temperature overshoot when the system starts up, and then gradually approaches the set target temperature. The larger the Damp value, the stronger the reduction of initial overshoot, but also the slower warm up of the system. The default value is optimized against the DC-powered heating pad DC-30W12V-9859 (sold separately) so that it balances the warm up speed and reduction of initial overshoot. This value does not need change if using the optimized DC-powered heating pad DC-30W12V-9859.

BacktoMainMenu: going back to the main menu.

5) Others submenu contains parameter settings in several different categories. At the main menu screen slightly turn the menu knob, let the indicating “arrow” sign pointing to the “Others” submenu, and push the menu knob to enter it. This submenu is arranged like Table 5a and has default value and valid range for each item as listed in Table 5b. When the screen has entered Others submenu, slightly turn the menu knob, let the indicating “arrow” sign pointing to the submenu item that need to modify or execute, push the menu knob to confirm selection or execute an item. After having confirmed the selection for a changeable item, slightly turn the menu knob to change its value, and then push the menu knob again to confirm/exit the change made. Below are the brief descriptions of the submenu items:

On/OffMode will turn on or off the On/Off mode. When it is set “True” the controller will use On/Off controlling mode other than PID controlling of the heating process. Its default value is “False”, which enables the PID controlling of heating process.

Hysteresis is the parameter only used for On/Off controlling mode. It is a temperature band between the two pints set for turning on and turning off the heating device in On/Off mode. The larger this value, the less frequent the heating pad switched on/off, but the more fluctuate of the controlled temperature. The default value is set to 0.30, which allows the controller to switch on the heating pad when measured temperature drops to 0.30 Celsius degrees below the target temperature and switch off the heating pad when the measured temperature reaches set target temperature.

Load is the setting to switch on/off the output to the electric load (heating device). When it is set to “ON”, the controller will output signals to its switching device that will turn on/off the electric current to the heating pad according to the controlling algorithm it uses. When it is set to “OFF”, the controller will not output signals to its switching device, so the heating pad will not be switched on no matter what the measured temperature is.

SD provides the option to turn on/off the data logging function for saving temperature data to the microSD card. When it is set to “Logger” (default), the controller will save each measured temperature data to the microSDcard along with date and time information associated with the data. This data saving function will be turned off then it is set to “None”.

Back going back one level to the previous menu.

sftReset will reboot the controller.

6) SvConf is the menu item that will save the changed configuration settings in the controller's built-in flash memory so that the changes stay when the controller is powered off.

7) FctrRST is the menu item for restoring factory configuration.

8) Alarm submenu provides options to turn on/off the system alarm and temperature alarm and to set the temperature high and low limits that trigger the alarm. At the main menu screen slightly turn the menu knob, let the indicating “arrow” sign pointing to the “Alarm” submenu, and push the menu knob to enter it. This submenu is arranged like Table 6a and has default value and valid range for each item as listed in Table 6b. When the screen has entered the Alarm submenu, slightly turn the menu knob, let the indicating “arrow” sign pointing to the submenu item that need to modify or execute, push the menu knob to confirm selection or execute an item. After having confirmed the selection for a changeable item, slightly turn the menu knob to change its value, and then push the menu knob again to confirm/exit the change made. Below are the brief descriptions of the submenu items:

sysAlarm is for the system alarm settings. The alarm will buzz at 1000Hz when there is an error in microSD card access. Its default setting is “OFF”, and can be enabled by setting it to “ON”.

tempAlarm is for the temperature alarm settings. This alarm will buzz at 5000Hz when the measured

Table 5a. Other settings

On/OffMode= (value)	
Hysteresis= (value)	
Load= (value)	SD= (value)
Back	sftReset

Table 5b. Default values of other settings

Items	Default value	Valid range
On/OffMode	False	True, False
Hysteresis	0.30	0 - 5
Load	ON	ON, OFF
SD	Logger	Logger, None

Table 6a. Alarm settings

sysAlarm= (value)	
tempAlarm=(value)	
AHT=(value)	ALT=(value)
BacktoMainMenu	

Table 6b. Default values of alarm settings

Items	Default values	Valid range
sysAlarm	OFF	ON, OFF
tempAlarm	OFF	ON, OFF
AHT	0	0 - 10
ALH	0	0 - 10

temperature reaches the set low/high limit. Its default setting is “OFF”, and can be enabled by setting to “ON” and setting **ALT/AHT** to a value larger than “0”. When the controller starts and the heating pad is warming up or when the controller is performing auto-tune, the temperature alarm setting will be suppressed.

AHT is the high limit of the temperature alarm. It is set to “0” by default. Setting it to a value larger than “0” will enable the alarm when **tempAlarm** is set to “ON”, and the alarm will be triggered when measured temperature has reached “**Set Temp.** (target temperature) + **AHT**”.

ALT is the low limit of the temperature alarm. It is set to “0” by default. Setting it to a value larger than “0” will enable the alarm when **tempAlarm** is set to “ON”, and the alarm will be triggered when measured temperature has reached “**Set Temp.** (target temperature) - **ALT**”.

BacktoMainMenu: going back to main menu.

9) **Exit** exits the menu system and goes back to the run mode.

D. Performance Improvement

This controller is shipped with optimized parameters using the 30W DC-powered heating pad (catalog number DC-30W12V-9859) and maintaining surface temperature at 37.5 °C. You may need to change these parameter values if you connect to different heating device.

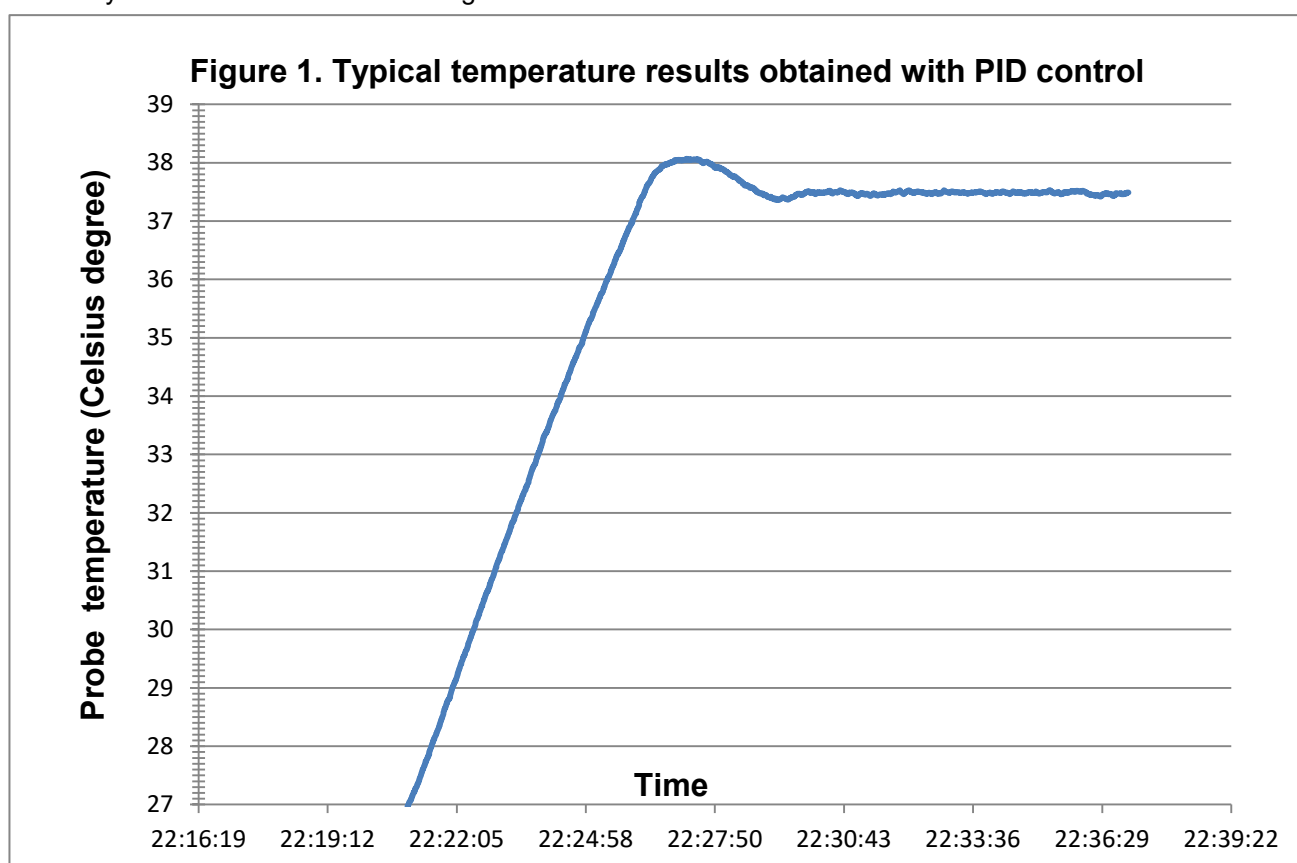


Figure 1 shows a typical temperature monitoring result, which was obtained using the default PID settings, and the temperature sensor was placed in the center of the heating pad and covered with a piece of paper towel, the target temperature was set to 37.50 Celsius degree. The heating pad temperature was maintained within a very tight range of ± 0.05 Celsius degrees, the temperature fluctuation was almost eliminated.

1. Default PID settings

The default settings are optimized for maintaining the heating pad surface temperature. From Figure 1 above we can see there are only tiny fluctuations of surface temperature, which is within a range of ± 0.05 Celsius degrees. You may use the default settings for *in vivo* experiments and place the temperature sensor probe into the rectum of a rat or mouse for *in vivo* feedback. Minor changes of P value or D value maybe needed for best performance depending on the experiment settings, such as the depth of anesthesia and the covers on the top of the animal. You may also use the auto-tune function; see below, to determine optimal PID parameters for your settings.

2. Auto-Tune

Every type of heater has its own optimal set of PID tuning parameters for achieving the best controller performance. The controller must have been programmed with the optimal PID tuning parameters for the heater to be used. If you are a PID expert, you can determine these PID tuning parameters manually through a short running, or you may manually adjust the default setting to meet your needs. The beauty of this controller is that it provide the auto-tune function that determines optimal parameters automatically, you may simply enable this function and let the controller to determine the optimal settings.

Use auto-tune function to optimize controller performance settings

At the main menu screen slightly turn the menu knob, let the indicating “arrow” sign pointing to the “**PIDcntr**” submenu, and push the menu knob to enter it. When the screen has entered PIDcntr submenu, slightly turn the menu knob, let the indicating “arrow” sign pointing to the “**Mode**” submenu item, push the menu knob to confirm selection, then slightly turn the menu knob to change its value, and then push the menu knob again to confirm/exit the change made. Go back the running mode through menu exit route or simple leave the menu knob untouched for over 20 seconds.

When the controller is set this mode, it will perform automatic tuning process for determining the optimal PID parameters, and the LCD will show “ATing” in the space between “SDlog” and “DCon”/“DCoff”. For performing auto-tune, the heating pad and temperature sensor must be connected to the controller and operate the controller in the same condition as in real experiments. The auto-tuning function will heat up your heater then let it cool down. It will repeat this heat cycle several times. Based on the response time of the whole heating system, the controller will calculate and set the PID parameters for your heater. After having finished auto-tune process, the controller will adopt the newly determined PID parameters, and the LCD screen will display “ATed” in the space between “SDlog” and “DCon”/“DCoff”. After you have tested the auto-tuned PID parameters and approved the change, you may enter the main menu and save the configuration by run (select and confirm) the “**SvConf**” menu item.

3. ON/Off mode

The ON/OFF mode disables PID control, so the controller will perform like a regular thermostat and the temperature fluctuation around the set target temperature like in Figure 2 below. The ON/OFF mode adopts a uniquely coded program for reducing temperature fluctuation and is also able to maintain temperature in a tight range.

Because the controlling results of ON/OFF mode is inferior to the PID mode, only use the ON/OFF mode if you have a special reason or you really don't like the PID control.

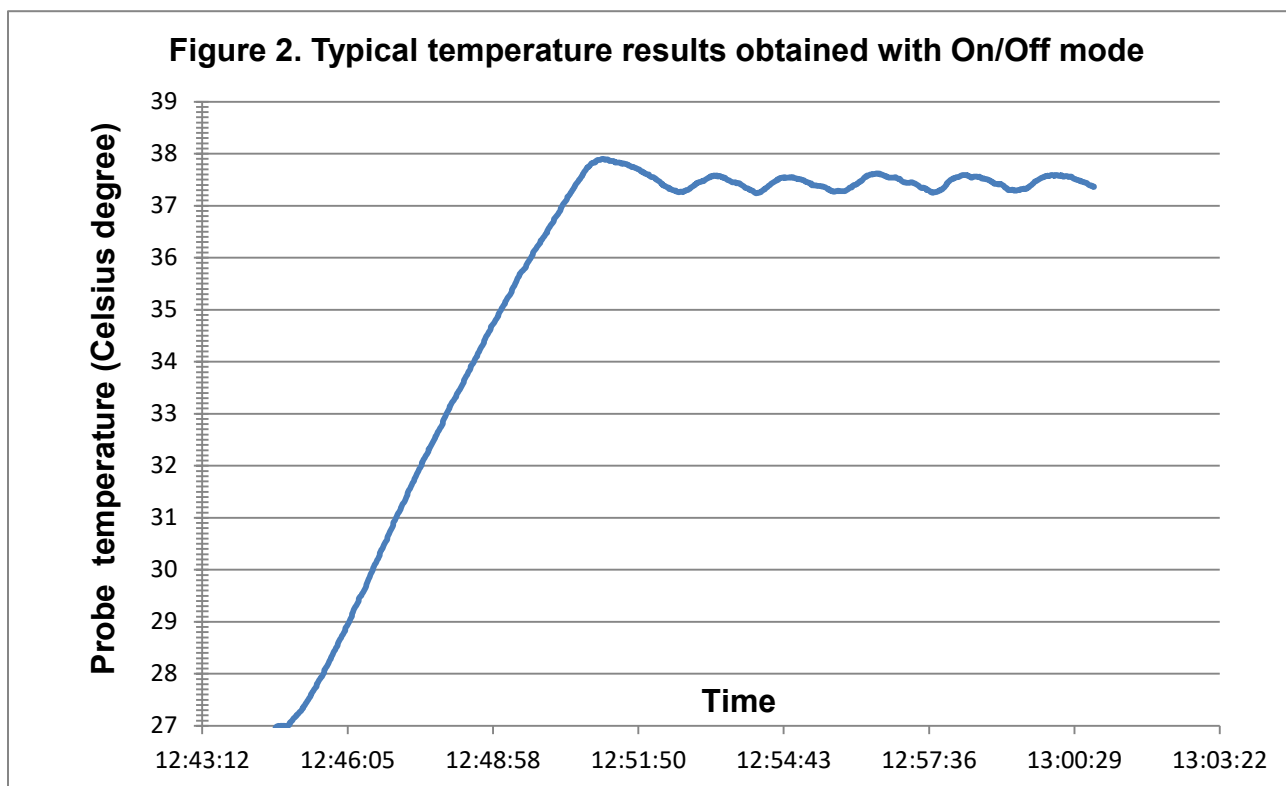


Figure 2 shows a typical temperature results obtained using ON/Off mode, and the temperature sensor was placed in the center of the heating pad and covered with a piece of paper towel, the target temperature was set to 37.50 Celsius degree. The measured heating pad temperature was maintained within the range of +/- 0.15 Celsius degrees.

E. Data log and PC connection

1. Data log

About the data logger. When the controller starts up, it performs a self-checking for the presence of microSD card, card storage free space, and writable access. The data log function is enabled by default. Measured temperature data are saving to the provided 16GB microSD card in real-time as a comma separated cvs file. A new file will be saved on each running day, and the file is named according to the date in a format of "yyyymmdd.cvs".

Enable/disable the data logger. At the Main menu screen slightly turn the menu knob, let the indicating "arrow" sign pointing to the "Others" submenu, and push the menu knob to enter it. When the screen has entered Others submenu, slightly turn the menu knob, let the indicating "arrow" sign pointing to the submenu item "SD", push the menu knob to confirm selection, and then slightly turn the menu knob to change its value, and push the menu knob again to confirm/exit the change made. There are two options to select from for the SD item, "Logger" (default) enables the data logging function, and "None" turns this function off.

Use the saved data. To use the saved data for analysis, the controller must be first turned off and switch off the power, then push on the card edge to get the card released. You may directly insert it to a card reader that has a microSD slot or using a SD card adaptor and insert to a SD card slot. **Insert the card back to the card slot on the back of the controller before powering on the controller again.**

Additional information for ON/OFF mode. When the controller is running in ON/OFF mode, it recognizes the temperature changing direction for better control by doing a raw of two measurements, and these two measurements are written in a line in the data file.

2. PC connection

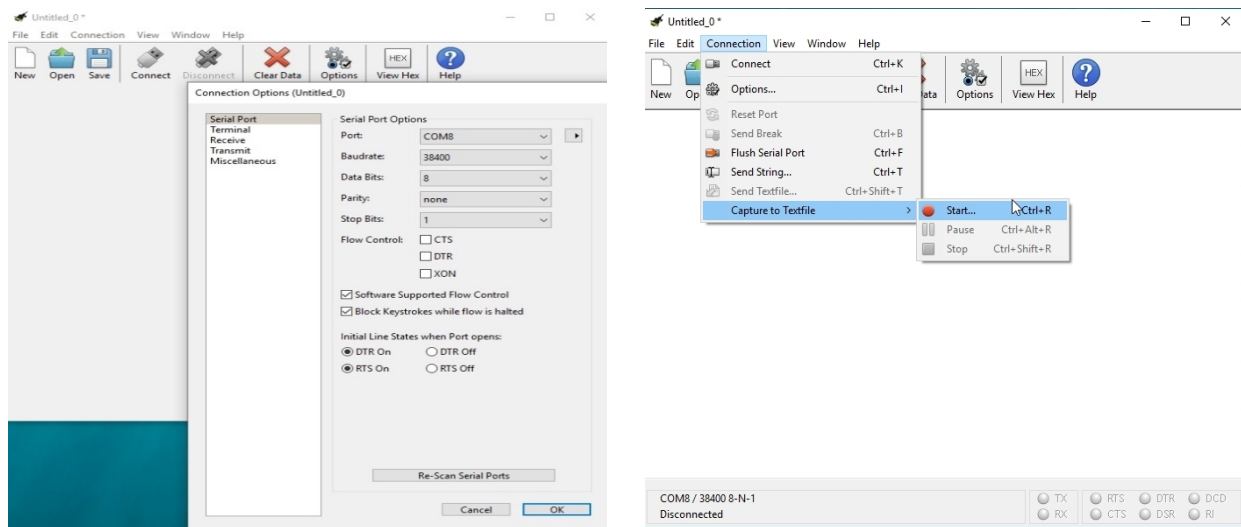
The controller is equipped with an RS232 serial port for PC connection, which provides the capability for real-time data monitoring and saving data directly to PC.

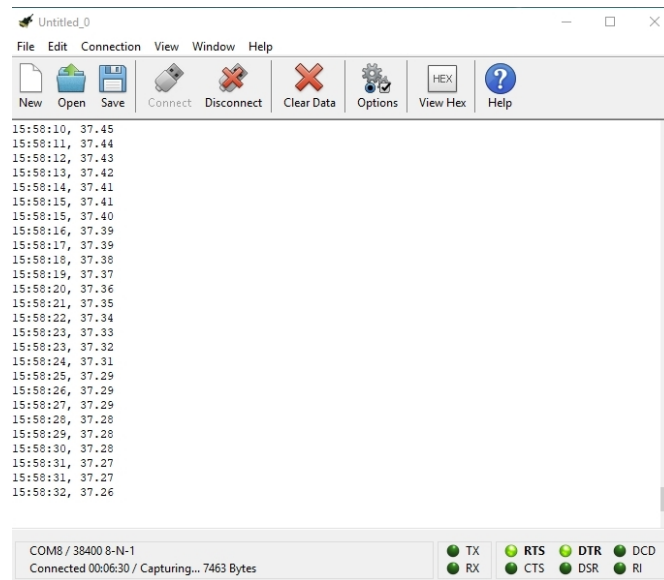
Connect the RS232 port at the back of the controller to your PC directly through a serial cable or to USB port through the RS232 adapter cable USB20RS232-PL2303 (sold separately). Most modern PCs don't provide a RS232 serial port but only provide USB ports. So the USB to RS232 adapter cable will be needed in most cases. You may use the suggested cable on our web or find a similar one that has PL2303 chipset.

Software is needed to perform real-time monitoring. You may use your own serial port monitor software or download the free software **CoolTerm** at the link: <http://freeware.the-meiers.org/#CoolTerm>.

The serial connection should be established at Baudrate 38400, data bits 8, parity none, stop bits 1.

Using the CoolTerm software. On the CoolTerm main interface, 1) click on the "Connection" menu, scroll down and click on "Options", set Baudrate 38400, data bits 8, parity none, stop bits 1, and confirm setting by click "OK" at lower right corner; 2) click on the "Connection" menu, scroll down to "Capture to Textfile" and click on the "Start" at right submenu, select and confirm data saving location on your PC; 3) Click on the "Connect" icon. The controller will save time and temperature data in a txt file in comma separated format. Below are the screen cuts of typical interfaces in using the CoolTerm software.





Connected and capturing to text file

F. Warranty

Docol Corporation warrants this controller to be free from defects in materials and workmanship for a period of one (1) year from the date of the original purchase when the device is utilized under normal condition. The sensor of the controller is warranted for 90 days. This warranty is subject to the following conditions:

If the appliance is found to be defective in material or workmanship by Docol Corporation, we will repair or replace it free of charge. A dated proof of purchase may be required.

Docol Corporation's liability is limited solely to the cost of the repair or replacement of the unit at our discretion. This warranty does not cover normal wear of parts and does not apply to any unit that has been tampered with or used for commercial purposes. This limited warranty does not cover damage caused by misuse, abuse, negligent handling or damage due to faulty packaging or mishandling in transit. This warranty does not cover damage or defects caused by or resulting from damages from shipping or repairs, service or alterations to the product or any of its parts which have been performed by a repairperson or facility not authorized by Docol Corporation.

This warranty is available to the original purchaser of the unit and excludes all other legal and/or conventional warranties. The responsibility of Docol Corporation, if any, is limited to the specific obligations expressly assumed by it under the terms of the limited warranty. In no event is Docol Corporation liable for incidental or consequential damages of any nature whatsoever. Some states/provinces do not permit the exclusion or limitation of incidental or consequential damages and therefore the above may not apply to you.

This warranty gives you specific legal rights and you may also have other rights that vary from state to state or province to province.

***Important:** Carefully pack item to avoid damage in shipping. Be sure to include proof of purchase date and to attach a tag to item before packing with your name, complete address and phone number with a note giving purchase information, model number and what you believe is the problem with the item. We recommend you insure the package (as damage in shipping is not covered by your warranty). Mark the outside of your package "ATTENTION CUSTOMER SERVICE". We are constantly striving to improve our products and therefore the specifications contained herein are subject to change without notice.