1. Title:

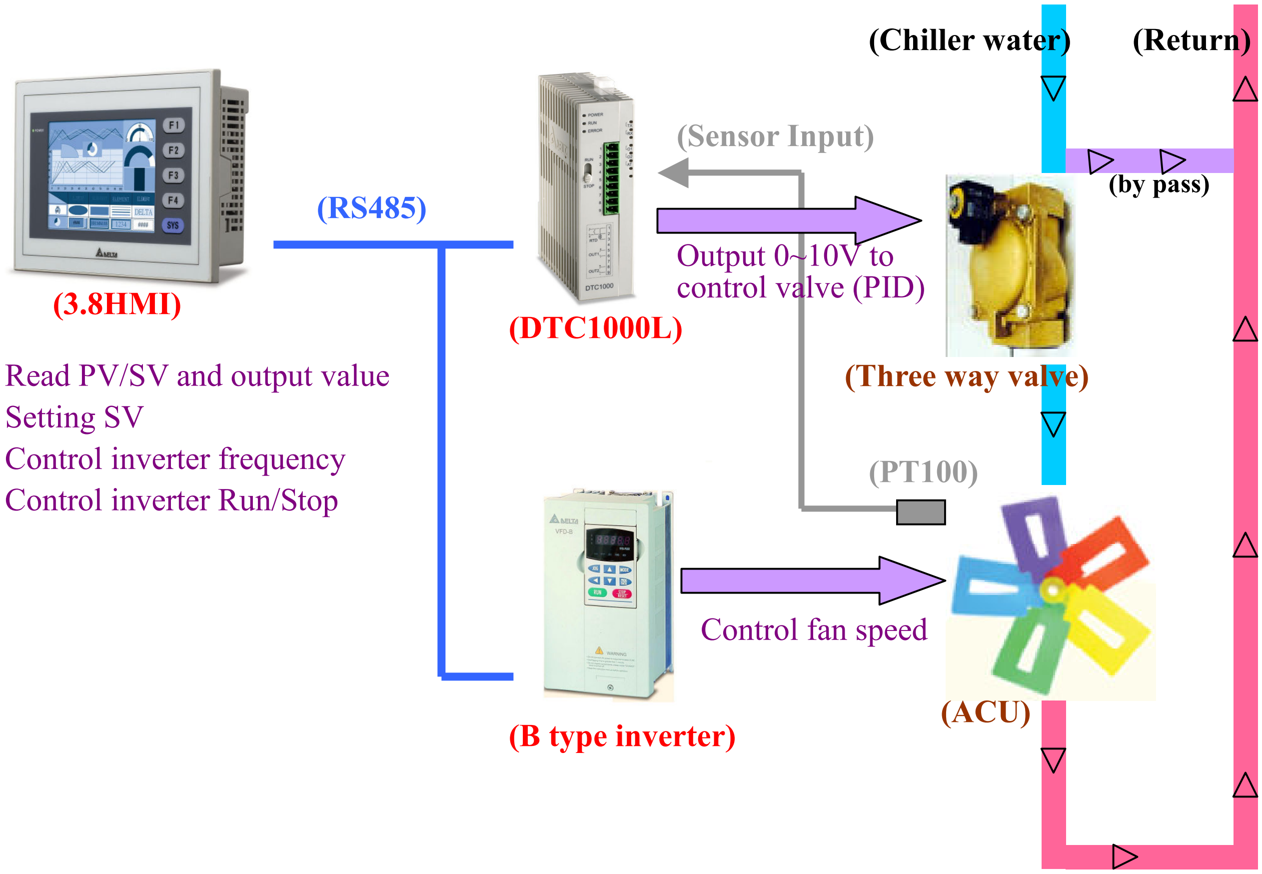
Central Air Temperature Control

2. Overview:

The central air system in office or factory building usually use chiller to provide chiller water to every ACU (air control unit). We can use temperature controller to detect then control inverter running frequency to make the environment more comfortable, but this method is only saving energy when the frequency is slowly. If we also need constant temperature requirement, it must be involve chiller water valve in this control loop. The DTB/DTC series controller are provide PID function and current / linear voltage output method for the valve use. We also can add HMI in system to achieve monitor operation frequency; temperature setting and valve adjustment functions in this case.

3. Configuration:

This case is for a signal area or a meeting room to do a constant temperature control, and just use three Delta products (HMI; T/C and inverter) to achieve control system.



4. Application benefit:

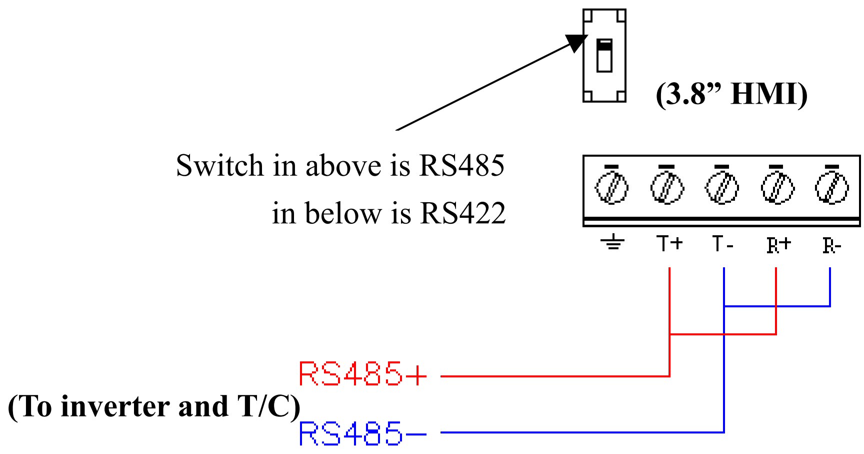
In some traditional control systems, the fan is running in fixed frequency, it will cause when temperature achieve the setting value but it still output too much cool air and make the environment not comfortable and waste energy. From the motor energy principle, the frequency and running speed are cube relation. So half of the running speed will require only 1/8 of the energy. We can via T/C PID functions to control valve and inverter running in suitable output, it spends low cost and save energy everyday, so the economic efficiency is very worthy of our investment.

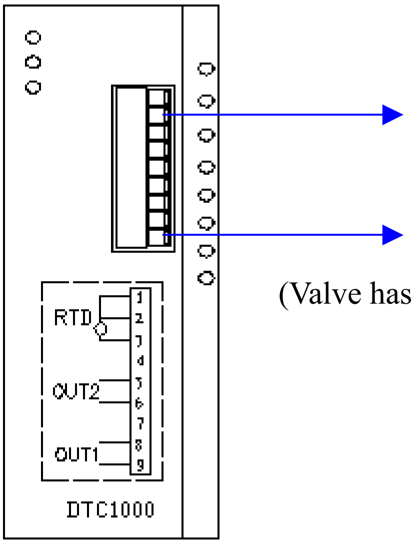
If system doesn't have only one chiller, we can also use PLC program and T/C to detect chiller water temperature then control which chiller need to running or unload. Because chiller is consumption the greater part energy, so control chiller action at the right moment also have good energy save efficiency.

5. Required hardware and software components:

	model	Parameter setting
HMI	3.8 吋	3.8" is most economic and fit the requirement
Inverter	B type	1) 02-00 = 4 (source frequency via RS485) 2) 02-01 = 3 (source operation control by RS485) 3) communication format: 9600、7、E、1
T/C	DTC1000L	1) Setting to **Cool** control 2) Choose to **PID** control (P=1、I=240、D=0)

6. Connect diagram:





(PIN 1 、2 、3 to PT100 Sensor)

(PIN 8 、9 to control valve)

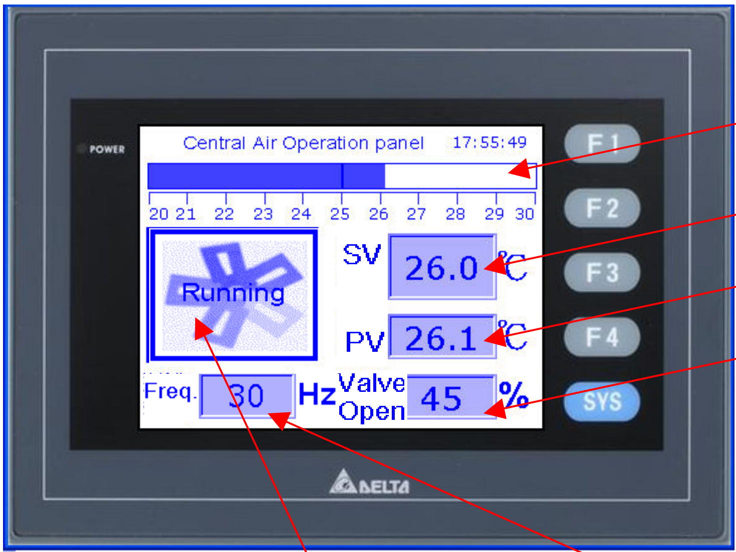
(Valve has current and linear voltage signal two methods be selected)

7. Program and description:

In this case we're not including PLC for cost saving, the control program are using HMI's macro function to do. Below content describe the page framework and macro program how to editing.

(inverter address is 1, and temperature controller address is 3)

HMI display page:



$100(PV value, display by bar method)

H4701 (input to T/C's SV directly)

$100 (PV value, display by numeric method)

$103 (valve open percentage)

$200(frequency display, figure by macro function)

Read H2101.0(Run LED status)(Alternate Button)
(picture change with 8 Status Graphic by $160 value)
When inverter is running, using Screen Cycle Macro to change picture act the fan in animation running.

Macro program:

There're three Kinds of macro in this case. (Clock macro; Button On/Off macro and Cycle macro)

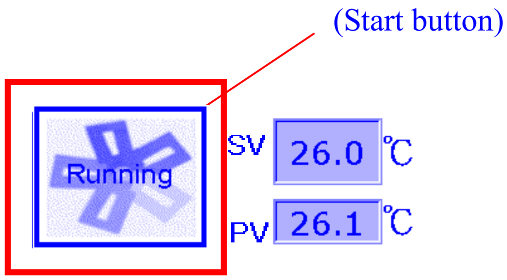
Clock macro description: Figure running frequency and write it to inverter.

1	# Read PV and output value
2	$100 = (3@TEMP_CTRL-1000)
3	$102 = (3@TEMP_CTRL-1012)
4	$103 = $102 / 10
5	# T/C output % figure to inverter frequency
6	IF $102 <= 600 THEN GOTO LABEL 1
7	$150 = $102 * 5
8	GOTO LABEL 2
9	LABEL 1
10	$150 = 3000
11	LABEL 2
12	(1@INVERTER-2001) = $150
13	$200 = $150 / 100

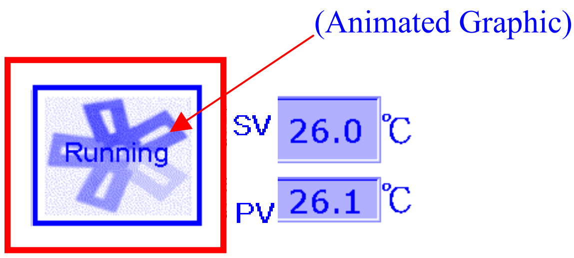
1) Comment
2) Read H1000 (PV) of T/C then move to $100 for display.
3) Read H1012 (output%) then move to $102.
4) The $102 value is accuracy to one decimal point, so divided 10 to take integer part out and storage in $103 for display.
5) Comment
6) If output value $102 smaller than 60.0%, going to LABEL1 to setting $150 to K3000(means frequency running least at 30Hz.
7) If output value $102 larger than 60.0%, multiply 5 to control the varies frequency around 30~50Hz range.
8) Go to the line 11
9) Label 1 location
10) When output value $102 smaller than 60.0%, setting frequency to 30Hz.
11) Label 2 location
12) Moving the frequency $150 that we figure to Inverter H2001.
13) Dividing 100 to get the frequency integer part for display in HMI screen.

Button on/off macro description: To control inverter Run or Stop.

1) The button is alternate type, when it's ON, running the "editing on macro" `1 (1@INVERTER-2000) = 2` to setting H2000 for K2 to running inverter.
2) When button's OFF, running the "editing off macro" `1 (1@INVERTER-2000) = 1` to setting H2000 for K1 to stop Inverter.



Cycle macro description: When inverter in Run condition, using “animated graphic” function to display like animation.



1) Reading inverter H2101.0(Run LED status) address, if Run LED is on, starting change 8 pictures for animated.
2) Go to the line 9
3) Label 1 position
4) When the animated has changed in 8th picture, then go to label10 to setting $160=0 for return to first picture.
5) Within the number 8, increase $160 for display next picture.
6) Go to the line 9
7) Label 10 position
8) Coordinate with 4)
9) Label 2 position

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1  IFB 1@INVERTER-2101.0 == ON THEN GOTO LABEL 1
2  GOTO LABEL 2
3  LABEL 1
4  IF $160 >= 7 THEN GOTO LABEL 10
5  $160 = $160 + 1
6  GOTO LABEL 2
7  LABEL 10
8  $160 = 0
9  LABEL 2
```

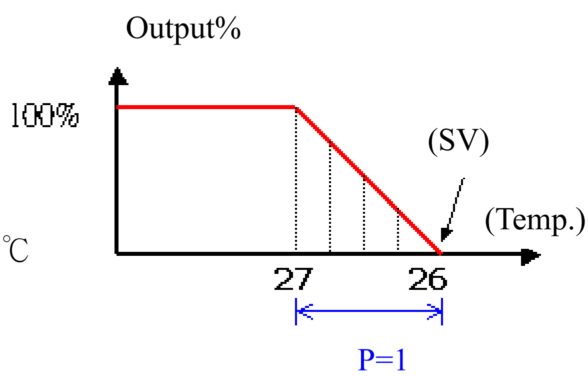
8. Others: Temperature controller PID principle

In this case, we’re using the PID function of T/C and P=1; I=240; D=0 to adjust valve for constant temperature control. The air condition is a very slowly variation environment, so we don’t need to exercise “Auto Turning” to figure the PID values, just use the PID principle to setting these values by ourselves.

The overall output percentage is P + I + D + Iof, the D is for interference response and Iof is for preset output, because this is a slowly variation environment, therefore these two parameters don’t need to setting we just close it to 0 value. Below we will describe how to setting P; I values and how they are work.

P value:

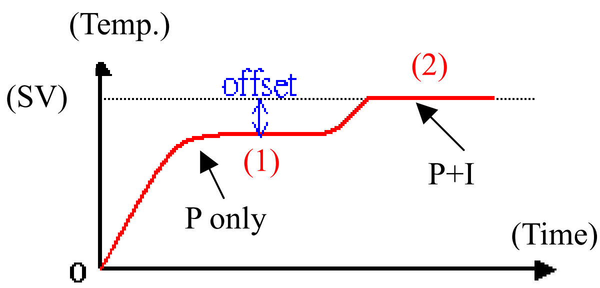
1) The air condition is using for cooling control, so the control mode need to setting (Ctrl=Cool).
2) If our desire temperature is 26℃, so SV is setting to 26.
3) As right diagram, if P set to 1, means when 26+1=27℃ the P output percentage is 100%.



4) When temp. reach 26℃, the P output percentage is 0%, so when temp. in 26~27 range the output is varied by linear method.
5) If the chiller capacity is enough, the temperature won't be over the 27℃, because it will output 100% to cooling down.
6) When temperature reach 26℃, depend on this principle the P output value will be 0%, so in this close status it'll hard to maintain the constant temperature, we must to coordination with I output to fit the base requirement output value.

I value:

1) If the system only has P control, that will only achieve right diagram (1) situation. It will has an inaccuracy and hard to in constant temperature requirement.
   At this time, if we coordinate with I output, that will make the output percentage higher to (2) situation.



2) The I is doing the integration once in a period time,
   if the I value too small, that means controller will integrate more quickly (in a short time do once) and make the output percentage larger. So if the I output over the requirement that maybe cause the over shooting problem.
3) The I value of Delta's controller is preset for 240, it belongs to a large value. Because the air condition not a very quick response system, so we just use this preset value will be OK. If you need the T/C output percentage has quickly response we can reduce P or I values, of cause it must in not cause over shooting condition to do.

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