Main Page:

Figure 1 - p1791 main page

1- Temperature and humidity sensors:
Four NTC temperature sensors and one humidity sensor is installed in each poultry house. In this section, value of each temperature sensor is shown. There is a color bar above each temperature value which indicates temperatures condition as bellow:

Green: Normal value

The value of the temperature is in the normal range defined for each sensor. Definition of the sensor limits will be explained later in section 'advanced settings' of this document.

Red: High value

The value of the temperature is in higher than defined limits.

Blue: Low value

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The value of the temperature is in higher than defined limits.

Yellow: Damaged sensor

When there is a problem in reading the value of sensor, the color bar changes to yellow. May be the problem is from cabling, connections or the sensor itself.

To prevent detrimental effect on the condition of the house climate, the value of the damaged sensor is replaced by the average temperature value. So sensors failure doesn't cause a any risk in broilers performance.

Failure Detection of sensors is defined by some value limits which would be explained later in this document.

The average temperature (حراره المتوسط) is calculated by adding 4 temperature values and dividing it by 4.

The humidity value of the house is read from the SWD sensor which is installed in the middle of the house. The sensing element is the SENSIRION SHT10 which its technical data is presented in appendix A.

2- Birds age and Target temperature

Target temperature (درجه المطلوبه) is the temperature set point. All temperature dependent equipment operates based on this value. So the climate control system tries to set the house temperature to this point by running supplemental heating system when the inside temperature is less than target temperature and running cooling system when the inside temperature is higher than target temperature.

As explained in broiler environmental management documents, the target temperature should be regulated by the farmer based on the flock behavior. The climate control system sets the target temperature automatically based on birds age and inside humidity and some other parameters. But note that the tuning of the target temperature should be done by the farmer based on his observation of the bird behavior.

For doing this, by touching the target temperature (درجه المطلوبه) value, a window with an input for changing the target temperature is displayed as shown in figure 2. Enter the new value and press "done" button.

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Figure 2 - variable input window

Note that a password is needed for changing all variables in this system. Click on the phrase "lock" in the right above corner of the main page to display the password window (figure 3). Then enter the password and click “done” button. Now you can enter the target temperature new value.

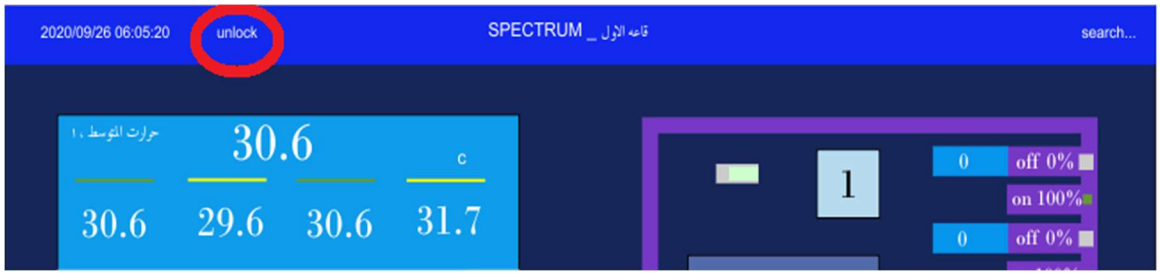

Figure 3 - lock phrase in the right above corner of the main page

Note: All temperature and humidity values must be entered in tenths of a degree in this system. For example, 34.2 must be entered as 342, 33 must be entered as 330 and 65% must be entered as 650

To prevent human error, input values are limited to an acceptable range. For example, the system doesn’t allow you to change the target temperature of day one, above 36.0 and below 28.0 degrees Celsius. Method of changing these limitations will be explained later in this document in section “Variables”.

As mentioned before target temperature in this system varies automatically based on birds age. This is done by function number 2 named *dayTemp.* More details about

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FUNCTIONs will be explained later in section "advanced settings", but for now you can just check the function *dayTemp* as below:

Setting >> password >> functions >> dayTemp (2) >> edit

As you can see, the function is a piecewise linear one with the *ageday1* as input. So it checks the birds age as input and produces a minus number as below:

ageday1	0	10	40	50	1000
output	0	-20	-70	-80	-80

Figure 4 - effect of birds age on target temperature defined in function dayTemp

So if you set the first day target temperature to 33.0, this function will decrease it to 31.0 for age 10. Also system interpolates values between table columns. For example, for day 25, *dayTemp* function output would be about

-45, so the target temperature is 28.5:

Target temperature = 330 – 45 = 285

Please note that all temperature and humidity values are considered in tenth of a degree. 28.5 is considered and calculated in this system as 285.

Target temperature also depends on outside temperature to prevent cold air drop when outside temperature is so low. This dependency is done by function number 28 named *outtarget*, you can check this function as follows:

Setting >> password >> functions >> outtarget (28) >> edit

Again it is a piecewise function with outside temperature as input:

Out temp	-1000	0	70	100	1000
output	5	5	5	0	0

As you can see in above table, when outside temperature is lower than 7 degrees Celsius, the target temperature increases 0.5 degree Celsius.

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Setting the start date:

The start date of brooding period can be defined for each house separately. Set the start date as follows:

Setting >> password >> Start Date

Press "now" button to set the start date to today or set any date as start date by entering year, month, and day as shown in figure 5. The "clear" button will clear all logger data related to this house. Logger will be explained later in this document in section "advanced settings".

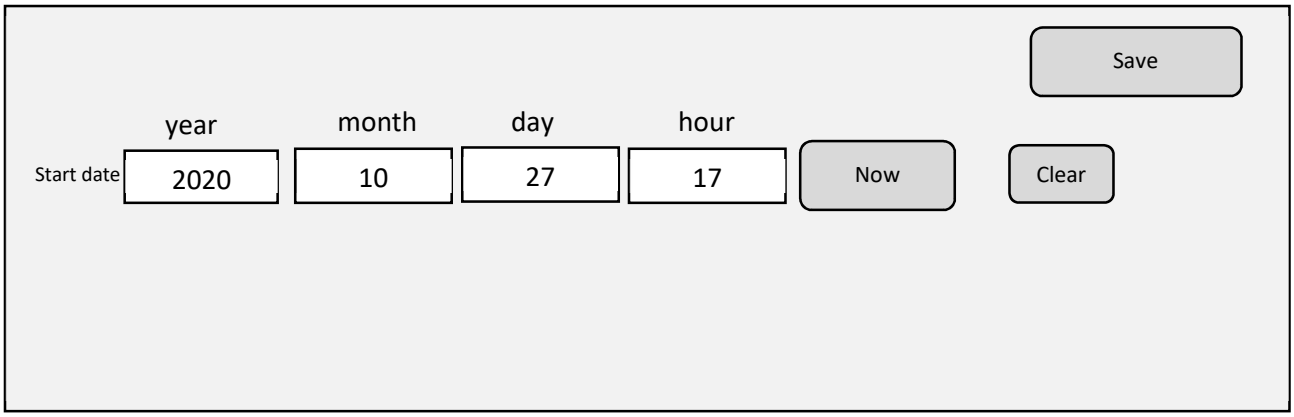

Figure 5 - start date setting

3- Outdoor temperature and humidity (درجه الحراره و رطوبه الخارجيه)
Value of outside temperature and humidity is displayed in this part of main page. These values are read from an outside sensor which uses SHT10 sensor element by Sensirion. The main effect of outside temperature is on total ventilation calculation. This effect is described later in this section. Outdoor humidity is displayed as percent of relative humidity (%RH). System decides to apply minimum, transitional or tunnel ventilation based on outdoor temperature. Therefore, the correct operation of the outdoor sensor is critical in the proper operation of the ventilation system.

4- Number of birds (عدد الطير)
The flock number of chickens affects the amount of minimum ventilation. System calculates the amount of minimum ventilation based on birds age and number of birds available in the house. So in addition to setting the start date, the number of

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birds must be entered correctly in start of each brooding period. To do this, click on the value of (عدد الطير). A window for entering number of birds is displayed as follows:

Figure 6 - initial number of birds input window

Enter the new number, and press “done” on the keyboard. Now press “Done” button on the left bottom side of window.

To prevent human error, this number is restricted in range of 8000 and 15000 based on your house size and capacity. Obviously, these limitations are changeable and the method of changing is explained later in this document.

As mentioned before, a password is needed for changing all variables in this system. If the system is locked, click on the phrase "lock" in the right above corner of the main page to display the password window (figure 3). Then enter the password and click “done” button. Now you can enter the number of birds new value.

Number of mortalities (هلاکات):

In addition to entering the initial number of birds in the start of brooding period, the number of mortalities can be entered day by day. This helps the farmer in analysis of poultry welfare and health. The remaining number of birds is shown in (طیر الموجود) part. Also the percent of mortality is shown next to the number of available birds and is calculated as follows:

$$percent\ of\ mortality = \frac{total\ number\ of\ mortalities}{\text{initial number of birds}} * 100\ \%$$

To enter number of dead chickens, click on the value of available bird number (طير الموجود), and enter the number of mortalities (هلاكات), as shown in figure 7.

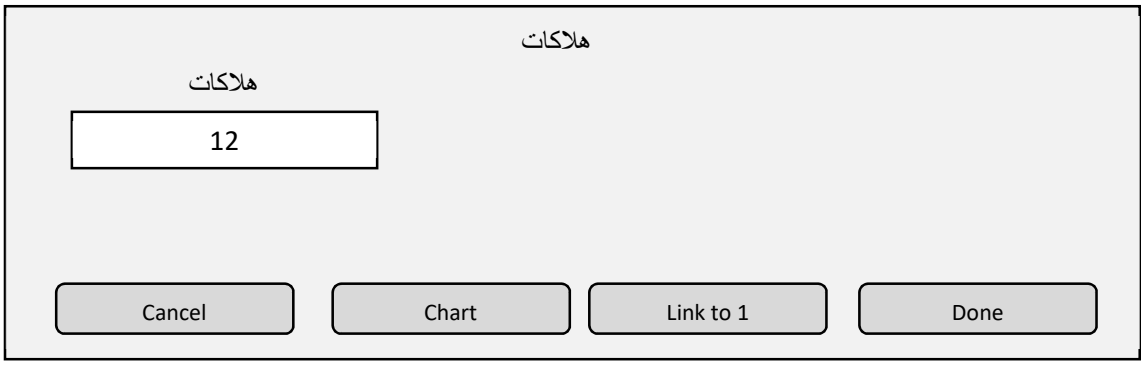

Figure 7 - number of mortality input window

5- House schematic

A simple schematic of the poultry house is shown in right side of main page as shown in figure 1. Heaters and fans positions and status are illustrated in this simple schematic. As can be seen in the schematic, there are 2 heaters, 4 small fans and 5 big fans in each house. The status of each fan and heater are shown as follows:

Green: Switched on

If the equipment is switched on,

It's color changes to green.

Note that the green color just means that the system has issued turn on command. If there is any problem in cabling, electrical cabinet equipment and so on, the system cannot detect it, unless it has an error detection system(EDS).

White: Switched off:

If the equipment is switched off, It's color changes to white. Note that the white color just means that the system has issued turn off command. If there is any problem in cabling, electrical cabinet equipment and so on, the system cannot detect it, unless it has an error detection system(EDS).

Yellow: Damaged

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If the equipment has an error detection system(EDS) and EDS detects a failure in equipment, its color changes to yellow. Big fans in your house have EDS system.

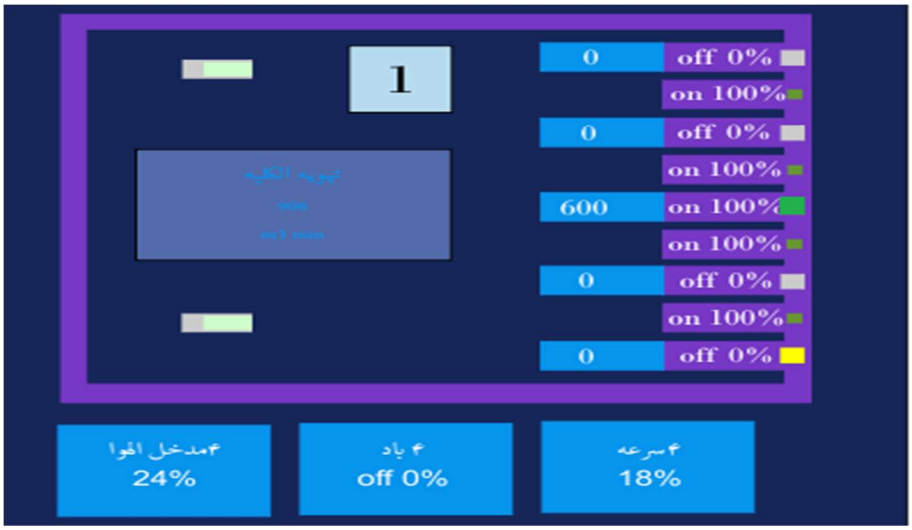

Figure 8 - house schematic and RMP of working fans

As you can see in figure 8, there is a number next to each big fan. This number is the rotation speed of fan in RPM. These RPMs are read from error detection system (EDS). It uses electromagnetic sensors (Hall effect sensors) to measure rotation speed of fans. EDS can detect any failure in electrical equipment, cabling, belt or motor which causes the fan not to rotate in predefined speed when the turn-on command is issued from the climate control system.

Total ventilation:

In the middle of the house schematic, amount of total ventilation (تهویه الکلیه) is shown in m3/min. Here we are not going to talk about the method of calculation of this number, but it's important to know how this amount of ventilation is applied in the house.

There are 2 types of fans in each house:

Four Small fans with capacity of about 9000 m3/hour or 150m3/min

Five big fans with capacity of about 36000 m3/hour or 600m3/min

Small fans speed is controlled by an inverter driver. So the total capacity of small fans is about 36000 m3/hour or 600 m3/min.

The procedure is as follows:

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If the total calculated ventilation is less than 600 m3/min, this is provided by small ventilators and inverter (سرعه). Minimum value for inverter output frequency is 20.00 Hz. For example, if the calculated ventilation is 300m3/min, the inverter speed would be about 25.00 Hz. Take note that all small ventilators contactors are turned on and the speed is controlled by inverter. So the small squares in house schematic (small ventilators) are always green, showing they are switched on, and speed is speed is controlled by inverter (سرعه).

If total calculated ventilation is more than 600 and less than 1200, a big fan is switched on and small fans speed are controlled by inverter again.

This process will continue in the next steps as well. Each big ventilator 600 m3/min and inverter 600 m3/min.

Inverter value is determined by function number 31 named *inverter*, you can check this function as follows:

Setting >> password >> functions >> inverter (31) >> edit

It is a piecewise function with total ventilation (تهويه الكليه) as input:

تهويه الكليه	0	240	450	600	601	840	1050	1200	1201	1800	…
output	0	0	65	100	0	0	60	100	0	100	…

As you can see in above table, when outside total ventilation is lower than 240 m3/min, the inverter output is 0%. This is because inverter minimum frequency is set on 20.00 Hz and there is no need to have any voltage on inverter input for amount of ventilation less than $20.00\ \text{Hz}/50.00\text{Hz} * 600(\text{m3/min}) = 240\ (\text{m3/min})$.

As shown in figure 8, the total ventilation is 906 m3/min. all small ventilators are switched on (green small squares), one big ventilator is switched on, and inverter output has a value of 18%. This value causes a frequency of about 25.00 Hz in inverter. Because the big ventilators have EDS, rotation speed of working ventilator is shown in the schematic.

Note: 50.00 Hz in inverter is maximum frequency of main power supply and causes fans to work in its nominal speed. The relationship between the ventilator and the frequency in the allowable range is almost linear.

By the way, the amount of total ventilation can be tuned based on famer observation of birds' behavior, litter quality and air quality.

For doing this, by touching the total ventilation (تهويه الكليه) value, a window with an input for changing the total ventilation coefficient is displayed as shown in figure 9. Farmer can change the total ventilation by changing this coefficient. Entering number 100% means that total ventilation is applied as calculated by the system. For decreasing total ventilation about 10%, enter 90% for (تصليح تهويه الكليه) and for increasing total ventilation about 10% enter 110% for (تصليح تهويه الكليه). After entering the new value, press "done" button.

Figure 9 - total ventilation coefficient input window

Inlet opening:

Inlet windows are controlled by electronic winches. These winches accept a 0-5v input voltage. Analog outputs range of climate control system is 0-10v. so setting the output to 50%, causes inlet windows to be opened completely in whole calibration range. Analog outputs and their settings will be explained later in section "advanced settings".

The amount of opening of the inlet windows is proportional to the amount of ventilation. This number is shown as (مدخل الهواء) in the main page.

you can change the amount of opening inlet windows. For doing this, by touching the value of (مدخل الهواء), a window with an input for changing the inlet coefficient is displayed as shown in figure 10. Farmer can change amount of inlet windows opening by changing this coefficient. Entering number 100% means that amount of opening is applied as calculated by the system. For decreasing inlet opening about 10%, enter 90% for (تصليح مدخل الهواء) and for increasing inlet opening about 10% enter 110% for (تصليح مدخل الهواء). After entering the new value, press "done" button.

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Figure 10 - inlet opening coefficient input window

As mentioned before, the amount of opening of the inlet windows is proportional to the amount of ventilation. This is done by function number 9 named *inlet*, you can check this function as follows:

Setting >> password >> functions >> inlet (9) >> edit

Again it is a piecewise function with total ventilation (تهويه الكليه) as input:

تهويه الكليه	0	650	1100	2200	10000
output	9	18	30	50	50

As you can see in above table, when outside total ventilation is 650 m3/min, the inlet opening is 18 (36%) and so on. Interpolation is done between the table columns. For example, for total ventilation about 900, opening is calculated about 24 (48%).

6- Ventilation settings (التنظيمات)

By clicking button "التنظيمات" in the left bottom corner of main page, ventilation setting page is displayed as shown in figure 11.

Figure 11 operator settings

For better understanding these settings, we should know some basics of minimum and transitional ventilation, and the method of their implementation in this system. All parts of calculation are changeable but it would be better done after studying section "advanced settings" of this document. For now, we just describe the basics and check the implementation methods without careful review of details.

Ventilation calculations:

With a background in poultry ventilation knowledge, we know that there is a minimum amount of ventilation needed for each bird in any age. There are several tables available for minimum ventilation based on birds age, outdoor temperature, inside humidity and some other parameters. As mentioned in ventilation documents, none of these tables are practical for all poultry house conditions and always there is a need of tuning based on behavior, welfare and health of flock.

We have used one of these minimum ventilation tables in your farm which says a minimum of 0.015 m3/min of fresh air is needed for each kg of alive birds in the house.

In addition, as mentioned in Ross0308 documents, if we have a ventilation about 2 cfm for each kg of alive birds, the inside temperature doesn't exceed more than 2 degrees Celsius above outdoor temperature. This is a vital note for transitional ventilation. In other words, if we have 2 cfm/kg (~ 0.06 m3/min/kg) ventilation rate, all metabolic heat is exhausted out from the house. So we call this calculated ventilation rate as "transitional ventilation rate". Based on Ross0308 performance objectives, for 10,000 of birds, the transitional ventilation rate can be calculated as follows:

Age (day)	0	7	14	21	28	35	42
Weight(as hatched) (kg)	0.043	0.208	0.519	0.985	1.573	2.235	2.918
Transitional vent. Rate(m3/min)	25.8	124.8	311.4	591	943.8	1341	1750

Figure 12 - transitional ventilation rate for 10,000 of ross0308 chickens based on 2cfm/kg vent.

As you can see in the above table, the intended weights are above normally achievable values. So usually some tuning is needed.
Above calculations are done in function number 3 named *vent10000*. You can check this function as follows:

Setting >> password >> functions >> vent1000 (3) >> edit

Again it is a piecewise function with birds age (ageday1) as input:

age	0	5	10	14	21	28	35	42	60	1000
output	25	80	176	288	557	900	1260	1680	1800	1800

As you can see in above table, when age is 14 days, output ventilation for 10000 chicks is 288 m3/min and so on. Interpolation is done between the table columns. For example, for age 30 days, output ventilation is calculated about 1000 m3/min.

Now there is an important question. When the system selects between minimum ventilation and transitional ventilation? This is done related to outdoor temperature. If outdoor temperature is so cold, system goes to minimum

ventilation (0.015 m3/min/kg), when it's near target temperature, system goes to transitional ventilation (0.06 m3/min/kg). when it's warmer more ventilation is applied to the house. So changes in ventilation is basically related to outdoor temperature. The values of outdoor temperature that causes the system to enter to minimum ventilation (0.015 m3/min/kg), 150% of min. vent. (0.0225 m3/min/kg), 200% of min. vent. (0.03 m3/min/kg) and etc. are displayed in setting page and are editable by operator as shown in figure 13.

Figure 13 - ventilation to outdoor temperature relation settings

For doing this, by touching each of above temperature, a window with an input for changing it is displayed as shown in figure 14. To prevent human error, these numbers are restricted. Obviously, these limitations are changeable and the method of changing is explained later in this document. حراره التهويه الاقل, حراره التهويه 150% and حراره التهويه 200% are time constant values and don't change with increase in birds age. But other temperatures are related to target temperature and will decrease as birds' age increases.

As mentioned before, a password is needed for changing all variables in this system. After entering the new value, press "done" button.

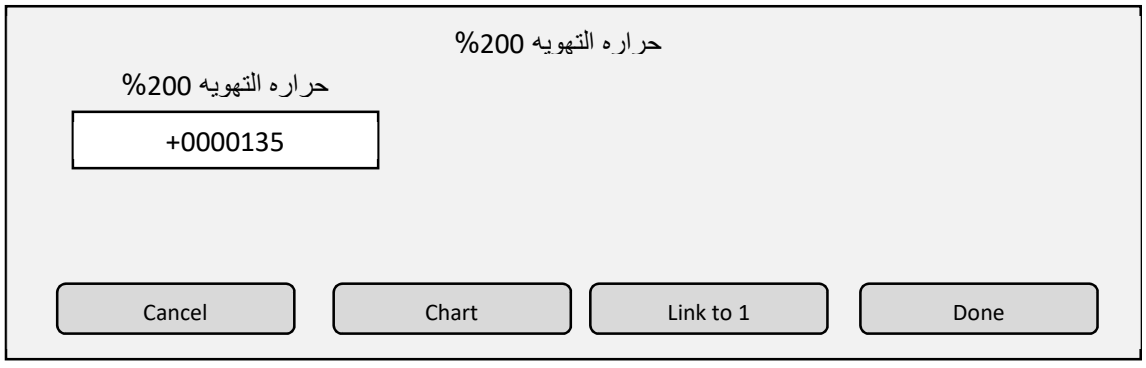

Figure 14 - outdoor temperature set points for ventilation changes

note that all temperature and humidity values are considered in tenth of a degree. 13.5 should be entered in this system as 135.

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Cooling pad settings:

Cooling pad works with both inside and outdoor temperature. So there are two set points for cooling pad as shown in figure 11. When the outdoor temperature is higher than "حراره الخارج للباد" and average inside temperature is higher than "حراره الداخل للباد", system turns the cooling pad pump on. When any of the above conditions are not met, system turns the cooling pad pump off.

Heaters:

There are two heaters in each house. The left one works with temperature sensors number 1 and 3 and the other one works with temperature sensors number 2 and 4.

The sensors number 3 and 4 can be disabled for heater control for example in first days of brooding period. For doing this, by touching حساس آخر القاعه, a window with an input for changing it is displayed as shown in figure 15. Select يشتغل or لا يشتغل to change the status of end sensors activity. When the end sensors are inactive, their back-ground color changes to gray. In this case they are not used to control heaters, and are not used in temperature average. By the way no alarm is issued because of their out of range values in this case.

Figure 15 - change activity status of end temperature sensors

Also you can set an offset for set point of end sensors in heater control in اختلاف الحراره. This number only works if end sensors are active.

When the حساس آخر القاعه is inactive (لا يشتغل):

Heater 1:

$$on: (sensor1 < (target\ temp. - 0.2))$$

$$off: (sensor1 > (target\ temp.))$$

Heater 2:

$$on: (sensor2 < (target\ temp. - 0.2))$$

$$off: (sensor2 > (target\ temp.))$$

When the حساس آخر القاعه is active (يشتغل):

Heater 1:

$on: (sensor1 < (target\ temp. - 0.2))or\ (sensor3 < (target\ temp. - 0.2 -$ (اختلاف الحراره))

$off: (sensor1 > (target\ temp.))\ and\ (sensor3 > (target\ temp. -$ (اختلاف الحراره))

Heater 2:

$on: (sensor2 < (target\ temp. - 0.2))or\ (sensor4 < (target\ temp. - 0.2 -$ (اختلاف الحراره))

$off: (sensor2 > (target\ temp.))\ and\ (sensor4 > (target\ temp. -$ (اختلاف الحراره))

For example, if target temperature is 30.0 and اختلاف الحراره is -1.0 then heater 1 starts working when sensor 1 temperature is less than 29.8 or sensor 3 is less than 28.8 degrees Celsius. It stops working when sensor 1 temperature is higher than 30.0 and sensor 3 temperature is higher than 29.0. please pay attention to AND and OR operands in above conditions.

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Input and Output Performance Summary

Digital Output	House equipment	IO Name	Performance Summary
DO - 01	Big Fan 1	س كبيره الاول	$Off: total\ vent. < 1800\ m3/min$ $On: total\ vent. > 1800\ m3/min$
DO - 02	Big Fan 2	س كبيره الثانى	$Off: total\ vent. < 3000\ m3/min$ $On: total\ vent. > 3000\ m3/min$
DO - 03	Big Fan 3	س كبيره الثالث	$Off: total\ vent. < 600\ m3/min$ $On: total\ vent. > 600\ m3/min$
DO - 04	Big Fan 4	س كبيره الرابع	$Off: total\ vent. < 2400\ m3/min$ $On: total\ vent. > 2400\ m3/min$
DO - 05	Big Fan 5	س كبيره الخامس	$Off: total\ vent. < 1200\ m3/min$ $On: total\ vent. > 1200\ m3/min$
DO - 06	Small Fan 1	س صغيره الاول	Always On
DO - 07	Small Fan 2	س صغيره الثانى	Always On
DO - 08	Small Fan 3	س صغيره الثالث	Always On
DO - 09	Small Fan 4	س صغيره الرابع	Always On
DO - 10	---	—	---
DO - 11	Heater 1	بويلر الاول	When the حساس آخر القاعه is inactive (لا يشتغل): $on: (sensor1 < (target\ temp. - 0.2))$ $off: (sensor1 > (target\ temp.))$ When the حساس آخر القاعه is active (يشتغل): $on: (sensor1 < (target\ temp. - 0.2))\ or\ (sensor3 < (target\ temp. - 0.2 -$ اختلاف الحراره$))$ $off: (sensor1 > (target\ temp.))\ and\ (sensor3 > (target\ temp. -$ اختلاف الحراره$))$

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DO - 12	Heater 2	بويلر الثانى	When the حساس آخر القاعه is inactive (لا يشتغل): on: $(sensor2 < (target\ temp. - 0.2))$ off: $(sensor2 > (target\ temp.))$ When the حساس آخر القاعه is active (يشتغل): on: $(sensor2 < (target\ temp. - 0.2))$ or $(sensor4 < (target\ temp. - 0.2 -$ اختلاف الحراره$))$ off: $(sensor2 > (target\ temp.))$ and $(sensor4 > (target\ temp. -$ اختلاف الحراره$))$
DO - 13	---	---	---
DO - 14	---	---	---
DO - 15	---	---	---
DO - 16	---	---	---
DO - 17	Pad Pump	باد	on: $(average\ temp. >$ حراره الداخل للباد$)$ and $(outdoor\ temp. >$ حراره الخارج للباد$)$ off: $(average\ temp. <$ حراره الداخل للباد$)$ or $(outdoor\ temp. <$ حراره الخارج للباد$)$
DO - 18	---	---	---
DO - 19	---	---	---
DO - 20	Alarm	الارم	on: $(average\ temp. > (target\ temp. + 3.0))$ or $(average\ temp. < (target\ temp. - 3.0))$ off: $(average\ temp. < (target\ temp. + 3.0))$ and $(average\ temp. > (target\ temp. - 3.0))$

Analog Output	House equipment	IO Name	Performance Summary
AO - 01	Inlet winches	مدخل الهوا	Proportional to total ventilation as follows تهويه الكليه | 0 | 650 | 1100 | 2200 | 10000 *output* | 9 | 18 | 30 | 50 | 50
AO - 02	inverter	سرعه	Proportional to total ventilation as follows تهويه الكليه | 0 | 240 | 450 | 600 | 601 | 840 | 1050 | 1200 | 1201 | 1800 | … *output* | 0 | 0 | 65 | 100 | 0 | 0 | 60 | 100 | 0 | 100 | …