DX MASTER

(The Dual Circuit Air Conditioning Control System)

DX Master is a cooling control air conditioning system. It comprises on the following equipment:

1. Compressor Units = 02 Nos per System
2. Loading / Unloading solenoid valves = 02 Nos (01 for each compressor)
3. Condenser Fans = 04 Nos
4. Electronic Expansion Valves (EXVs) or Thermal Expansion Valves (TXVs) = 02 Nos for each System
5. Compressor Motor Drive Control (VFD, Star or Delta) = 02 Nos for each System

System Inputs and Outputs

1. **Digital Temperature Sensors (DS18B20) = 08 Nos.**
   a. Suction Line Temperature Sensor for Circuit A (TSL-A).
      (Low Temperature Alarm = -2˚C to 50˚C Selectable)
   b. Suction Line Temperature Sensor for Circuit B (TSL-B).
      (Low Temperature Alarm = -2˚C to 50˚C Selectable)
   c. Discharge Line Temperature Sensor for Circuit A (TDL-A).
      (High Temperature Alarm = 20˚C to 150˚C)
   d. Discharge Line Temperature Sensor for Circuit B (TDL-B).
      (High Temperature Alarm = 20˚C to 150˚C)
   e. Spray Temperature Sensor for Circuit A (TSP-A).
   f. Spray Temperature Sensor for Circuit B (TSP-B).
   g. Supply Air Temperature Sensor (TSA).
   h. Return Air Temperature Sensor (TRA).
      (Selectable Target Temperature)

2. **Pressure Sensors (4-20mA) = 04 Nos.**
   a. Suction Line Pressure Sensor for Circuit A (PSL-A) with Enable / Disable option.
      (Low Pressure Alarm = 20 PSI to 150 PSI)
   b. Suction Line Pressure Sensor for Circuit B (PSL-B) with Enable / Disable option.
      (Low Pressure Alarm = 20 PSI to 150 PSI)
   c. Discharge Line Pressure Sensor for Circuit A (PDL-A) with Enable / Disable option.
      (High Pressure Alarm = 100 PSI to 600 PSI)
   d. Discharge Line Pressure Sensor for Circuit B (PDL-B) with Enable / Disable option.
      (High Pressure Alarm = 100 PSI to 600 PSI)

3. **Pressure Switches – 06 Nos.**
   a. Suction Line Pressure Switch for Circuit A (SSL-A) with Enable / Disable option.
   b. Suction Line Pressure Switch for Circuit B (SSL-B) with Enable / Disable option.
   c. Discharge Line Pressure Switch for Circuit A (SDL-A) with Enable / Disable option.
   d. Discharge Line Pressure Switch for Circuit B (SDL-B) with Enable / Disable option.
   e. Oil Pressure Switch for Circuit A (SOP-A) with Enable / Disable option.
   f. Oil Pressure Switch for Circuit B (SOP-B) with Enable / Disable option.

4. **Loading / Unloading Solenoid Valve (LUSV) – 01 Solenoid for each Compressor**

5. **VFD Control Output on RS-485**

Operation

It is ESP32 microcontroller based TIO444 control system for DX unit.

HMI will be used to control and monitor the system.

This control has 02 independent compressor circuits with 01 Evaporator in sharing.

Both compressor circuits should by Enabled/Disabled individually from HMI.

Modes of Operation
1. **Manual Operation:**
   a. Any of the 02 compressors or both may be operated as required in Manual Mode Selection.
   b. All functions of the compressor(s) running will be performed automatically as described below in Auto Operation.
2. **Auto Operation:**
3. When 02 compressors are available, following priority will be set:
   a. The compressor having LESS Running Hours will be set as MASTER and operate first. 2nd compressor having MORE Running Hours will be set as SLAVE and operate later.
   b. If MASTER compressor fails or non-operational, 2nd compressor will be set as MASTER. If MASTER compressor operates at its full capacity and unable to achieve target, SLAVE compressor will be operated to assist MASTER compressor to achieve the required target.
4. **Delay in Compressor's Next Operation:**
   a. Whenever compressor comes to STOP, a delay of 600 seconds should be placed before next starting.

Safeties Checks for Starting of Compressor

1. Control system will check following safeties will be checked prior starting the compressors:
   a. Phase Failure/Phase Reversal/Phase Loss/Under Voltage/Over Voltage (Close = OK)
   b. Suction Line, Discharge Line and Oil Pressure Switches for both circuits are Closed = OK
   c. Suction Line, Discharge Line and Spray Temperature Alarms for both circuits.
   d. Suction and Discharge Lines Pressure Alarms for both circuits.
2. Compressor will be allowed to start only when above safeties are good and no alarm(s) exist.
3. Then, system will operate one of the 02 methods as below:
   a. Compressor(s) Operation with Loading / Unloading S/V
   b. Compressor(s) Operation with Variable Frequency Drive (VFD)

Compressor Operation with Loading / Unloading Solenoid Valve

This function should have Enable / Disable option on HMI.

For starting the DX unit, following theme will be adapted:

1. Press DX unit START Button on HMI
2. Delay for 10 – 15 Seconds (Selectable).
3. Starting Delay will be indicated on HMI
4. After completion of delay time, respective compressor will start to run.
5. Delay for 10 – 15 Seconds (Selectable).
6. Delay Timer will count down on HMI.
7. DX unit Running Indication will replace the Starting Delay indication.
8. After completion of delay time, Loading / Unloading Solenoid Valve will energize to put compressor on load.
9. Loading / Unloading valve will remain energized till Return Air Temperature target is achieved (17 - 30˚C Selectable).
10. After achieving Return Air Temperature Target, Loading / Unloading Solenoid Valve will be de-energized.
11. Compressor will keep running for 120 seconds after de-energizing of Loading / Unloading Solenoid Valve.
12. If target temperature is increased up to the Starting Temperature (18 – 30 Seconds Selectable) during above 120 seconds compressor run time, Loading / Unloading Solenoid Valve will be energized again to achieve the desired target.

13. If target temperature remains stable and does not increase up to the Starting Temperature, compressor will stop.

14. System will keep monitoring the Return Air Temperature.

15. Whenever Return Air Temperature equals the Starting Temperature, compressor will start again as per procedure listed above.

Compressor Operation with Variable Frequency Drive (VFD)

This function should have Enable / Disable option on HMI.

For starting the DX unit, following theme will be adapted:

1. Press DX unit START Button on HMI
2. Delay for 10 – 15 Seconds (Selectable from HMI).
3. Starting Delay will be indicated on HMI
4. After completion of delay time, respective compressor will be started by the VFD.
5. Selection of Starting and Maximum Speeds (Frequencies) of VFD should be provided on the HMI.
6. VFD will remain running till Return Air Temperature target is achieved (17 - 30˚C Selectable).
7. After achieving Return Air Temperature Target, VFD will slows down by 5 Hz steps. VFD will remain in each step for 03 seconds.
8. If target temperature is increased up to the Starting Temperature (18 – 30 Seconds Selectable) during above VFD slow down time, VFD will increase its speed again up to full limit to achieve the desired target.
9. If target temperature remains stable and does not increase up to the Starting Temperature, VFD will be stopped.
10. System will keep monitoring the Return Air Temperature.
11. Whenever Return Air Temperature equals the Starting Temperature, compressor will start again as per procedure listed above.

Electronic Expansion Valve (EXV) Operation

When any of the compressor (s) is required to be started, relevant EXV must be closed by 25% prior to run the compressor (s).

Following function settings are required to be implemented on HMI:

1. Manual EXV operation facility to be provided on HMI so that EXV can be operated/jogged forward or reverse in steps.

2. Automatic EXV operation should maintain Suction Gas Superheat (SPH) @ $12°F \pm 2°F$ by using PID control on 04 Wire and 05 Wire (Selectable) EXV operations as listed below:

   a. If Suction Superheat (SPH) Value decreases => EXV should be closed in steps as required

   b. If Suction Superheat (SPH) Value increases => EXV should be opened in steps as required