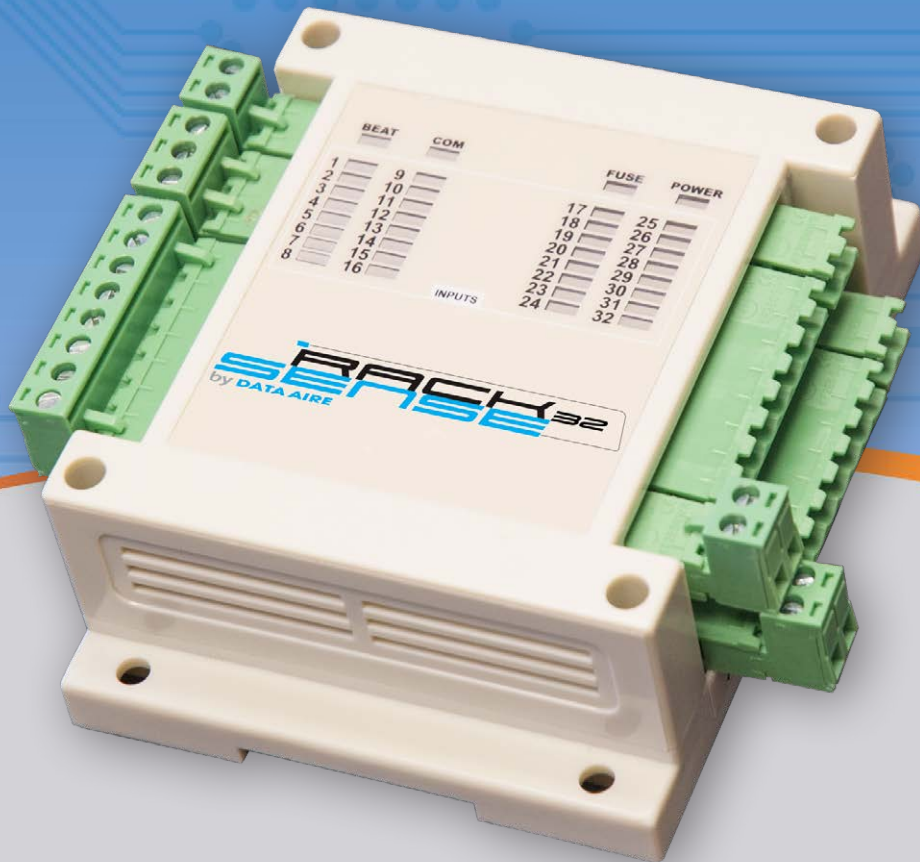


RackSense 32

Installation, Operation & Maintenance Manual



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1. Introduction

1.1. Overview

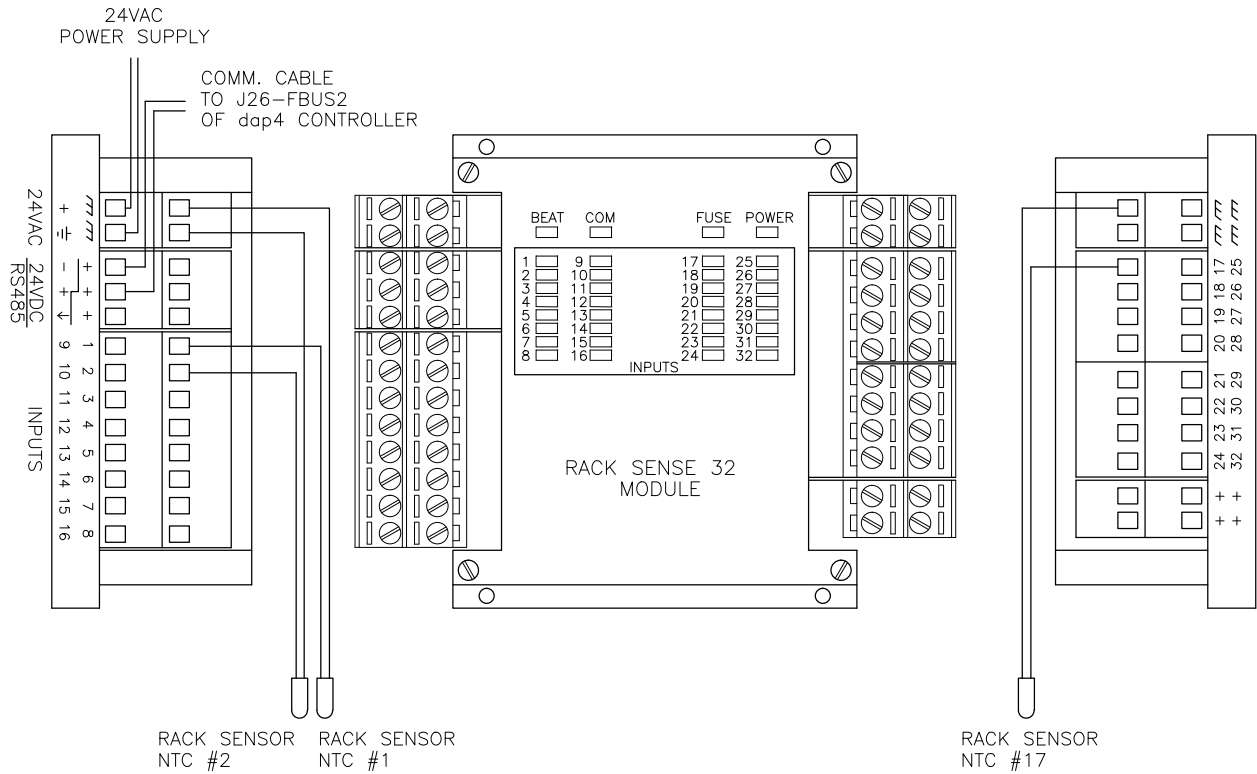
RackSense 32 Module is designed to connect dap4 controller with up to 32 Rack Inlet temperature sensors for monitoring and/or control. With rack temperature sensors dap4 will maintain the inlet air temperature of the server racks or cold aisle temperature within a desirable temperature range while providing energy savings. dap4 will adjust the chilled water valve or compressor cooling stages to maintain cold aisle or return air temperature while the fan speed is controlled independently by Rack Inlet temperature sensors. This control sequence is only offered in Data Aire gForce and In-row series. Several sensor configurations are offered to provide control flexibility for a balance or unbalance load.

1.2. Features

- Supports up to 32 Rack temperature sensors
- Rack inlet sensors can be configured for monitoring and/or control
- Five different selections of the rack inlet temperature calculation:
 - Averaging of all control sensors
 - Highest of all control sensors
 - Averaging of highest selectable number of sensor
 - Highest of the sensor groups, maximum 16 groups
 - Averaging of highest selectable sensor groups number
- Rack temperature high and low temperature alarm
- Excluding out-of-range sensors (comparing with the highest and/or lowest value in the same group).

2. Hardware and Wiring Connections

- RackSense 32 module, P/N 160-700-060
- Rack temperature sensors must be factory provided sensors, P/N 160-700-050.
- Communication cable (field provided) connects RackSense 32 module (RS-485 port) to dap4- J26 FBus2 port. 22 AWG communication shielded cable is recommended. Factory provides cable if it is factory installed.
- 24 VAC power supply is connected to 24 + and – terminal of the module. RackSense 32 module can share the same power supply with dap4 controller if it is unit installed.
- Rack temperature sensors are connected between Ground terminals of the module and input terminal of the module. See diagram on following page.
- LEDs on module:
 - POWER: on = power presents, off = no power
 - COM: on = communication with dap4 is established, off = no communication
 - FUSE: off = fuse is okay, on = fuse is blown
 - BEAT: solid or blink = communication is okay, off = communication interrupted
 - Other LEDs are not used.

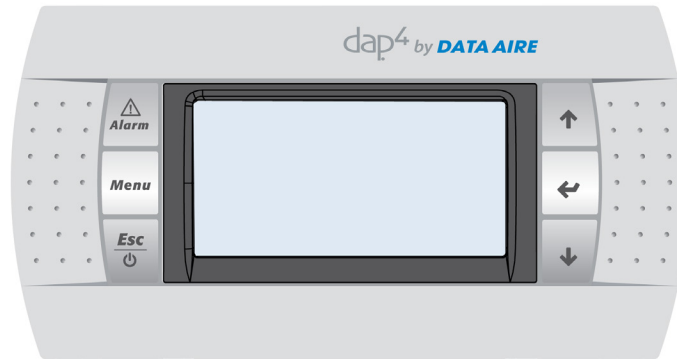


3. Sensors Location





In discharge air temperature control mode of chilled water system, the discharge air temperature and rack inlet temperature sensors must be field installed. In DX system, the remote mount control sensor is also field installed. The sensors' location will greatly affect the system control. Below are some guidelines for these temperature sensors locations:

- Rack inlet sensors should be located in the cold aisles or rack inlet only.
- Rack inlet sensors should be 10 to 30 ft. away from each other if they are installed in the cold aisle.
- Sensors should be centered between the equipment rows if they are installed in cold aisle.
- If sensors are located at the rack inlet (front of the rack), it is recommend to install the sensors at the center of the racks. Averaging measurement method is recommended in this case.
- Wall mount and column mount sensors are not recommended.
- Discharge air temperature sensor should be approximately 5 - 15 ft. away from the unit.
- Remote Mount sensor of a DX system should be at least 15 ft. away from the discharge of the unit and in a good ventilated area.
- Avoid the supply air bypass that could cause a system short cycle.

4. dap4 settings for RackSense 32



dap4 Rack sensor settings for monitor or control.

	<p>Enter Button: move cursor, save settings.</p>
	<p>Up/Down Buttons: advance screens, change values or settings.</p>
	<p>Menu Button: go to menu mode</p>
	<p>ESC Button: turn unit on/off, back to main menu, back to normal display mode.</p>

To enter RackSense 32 sensor settings, press Menu then use Enter, Up and Down key to enter factory password. Default factory password is 0002.

- 4.1. Go to menu J - Factory Settings - Fan settings. Select CW mode or DX mode for “Mod to Rack” setting. When this mode is selected, the Modulate Min. speed and Modulate Max. speed setting are required. See fan speed control algorithm on page 8 for detailed logic.
 - Ramp step rate: 0.5% - the fan speed increment percentage setting.
 - Ramp Pause Delay: 2 min - setting of time delay period after each fan speed adjustment period for rack temperature to adjust.

- 4.2. Go to next screen - Compressor settings for Return air temperature control or Supply air mode control mode selection
- Control - Return Temp / Supply Temp. Default setting is: Return Air.
In chilled water system, either Supply Temp. or Return Temp. control mode can be selected.
In DX system only return air temperature control can be used, supply air control mode is not allowed on on/off compressor system, it is only available on variable speed compressor system.
- 4.3. Continue to Menu J - Factory setting – Rack settings screen for the following selections:
- Temp Sensor Used: None or 2 - 32. Enter number of rack sensor connected here. Only selected rack Temp. Sensors will show in the next screen menu-External Rack Temps. * sign means more than 3 rack temperature sensors connected, which requires a RackSense 32 module.
 - Groups Used: None or 2 -16. Enter desired group number here.
 - Exclude T Band: 10°F (5-99°F)
When a rack temperature sensor reading is outside the average reading of the other sensors by more than this setting for 1 minute, it will be excluded from the control temperature sensor calculation for a minimum of five minutes.
 - Use Average of sensors / Highest of sensors / Average of the Groups / Highest of groups – This setting defines the sensor calculation method.
 - Refresh rate: 5 minutes to 24 hours. Default is 5 minutes. This defines how often dap4 recalculates which rack sensors are used for control.
 - Sensor usage: Control/ Control+ Alarm/ Monitor/ Monitor+Alarm/ Disable.
Default setting is: Control. For instance:
 - Snsor #
 - iT01: Control+Alarm A
 - T02: Monitor+Alarm A
 Use this menu to program a rack sensor for control and/or monitoring. Also assign the group for each sensor (A-P), if groups are used.
- 4.4. Press ESC for main menu, then select Menu K - Alarms and Limits, then press Enter the go to:
- Freeze alarm screen - Freeze-stat alarm: yes / no - optional - Freeze stat sensor required.
 - Setpoint: 35° (32-40°F). This menu requires a freeze-stat sensor installed to optional analog sensor 1 (B2).
 - Rack sensor alarm - Hi Rack Temp Limits – default 85° (60° to 100°F) – This will be used to determine the High rack inlet temperature alarm on rack inlet sensors that are selected to Monitor w/ alarm or control w/alarm.
 - Rack sensor alarm - Lo Rack Temp. Limits setting – default 50° (40 to 80°F) – This will be used to determine the low rack inlet temperature alarm on rack inlet sensors that are selected to Monitor w/ alarm or control w/alarm.
- 4.5. Press ESC for main menu, then select Menu B - Setpoint for Rack Temperature setpoints and deadband.
- Rack Inlet air temperature setpoint - default is 72°F (65-80°F)
 - Rack inlet deadband - default is 1°F (1-10°F) with 1/10 increment

5. Control Algorithm

When a RackSense 32 Module is connected to dap4, the dap4 will allow setting up for rack inlet temperature control. See programming section on page 6 for details.

On Chilled Water system, dap4 will adjust the chilled water valve based on a discharge air temperature reading or return air temperature reading to maintain discharge air or return air temperature while the fan speed is controlled independently by Rack inlet temperature sensors. In discharge air temperature control mode the return air temperature sensor is used for monitoring, safety alarms. In the return air control mode, an optional discharge air temperature sensor can be used for monitoring.

On DX cooling system, dap4 will cycle the compressor stages based on a return air temperature reading or an optional remote mount sensor (which can be located in a cold aisle) to maintain space temperature while the fan speed is controlled independently by rack inlet temperature sensors. In the return air control mode, an optional discharge air temperature sensor can be used for monitoring. An optional freeze-stat is recommended if cold aisle temperature control is used.

When system starts, dap4 goes through its self-test (approximately 40 seconds). After completing self-test, the unit status will display as unit OFFbyKEY. Pressing and holding ESC button for 5 seconds, will display the Time Before Start Delay and start counting down from the programmed start-up delay. The factory start-up delay setting is five (5) seconds. The fan will start upon completion of the Time Start Delay. The fan is programmed and wired to run continuously. The Cooling, Reheat, Humidifier and Dehumidification functions are inhibited for one (1) minute after the fan starts; this allows the temperature and humidity sensors time to adjust.

Fan speed control algorithm

The default control logic for the fans in rack inlet supply temperature control mode is “Fan Mod to Rack”. Other fans speed control modes such as Constant Speed or Valve Position Speed, etc. are also available for selection. Refer to the dap4 IOM for other fan speed control modes algorithm.

In Fan Mod to Rack (Fan modulating to rack temperature setpoint) mode, the fans will be controlled based on the Rack inlet temperature. The rack inlet temperature can be the maximum or the average of the rack inlet / cold aisle control temperature sensors. Maximum speed and minimum speed percentage settings are required. Fan speed ramp step rate and speed adjustment delay can be used to tune the fan speed if it is oscillated.

The maximum speed range for Chilled Water unit is 60% to 100% with 100% default value. The minimum speed range for Chilled Water unit is 40% to 70% with 60% default value.

The maximum speed range for DX unit is 80% to 100% with 100% default value. The minimum speed range for DX unit is 60% to 90% with 70% default value.

When started in this mode, the fan will first operate at the constant speed for 5 minutes. After that, the fan speed will proportionally increase or decrease to maintain the Rack Inlet temperature setpoint.

The fan speed will modulate as follows:

- If measured rack inlet temperature is higher than the rack temperature setpoint plus the rack temperature deadband, fan speed will increase an amount of the Ramp Step Rate percentage which is the maximum percentage that fan speed can change per second. For example: If Ramp Step Rate is set to 0.2%, it will take 5 seconds for the fan speed to ramp up 1%. Fan speed will continue to ramp up until the Rack Inlet temperature setpoint is reached but fan speed cannot exceed the maximum allowed speed. If measured Rack Inlet temperature is lower than the Rack temperature setpoint, fan speed will decrease an amount of the Ramp Step Rate percentage which is the maximum percentage that fan speed can change per second. For example: If Ramp Step Rate is set to 0.2%, it will take 5 seconds for the fan speed to slow down 1% fan speed will decrease until the Rack Inlet setpoint is reached but fan speed cannot be lower than the minimum allowed speed.

- If fan speed increases or decreases 5% but the rack temperature setpoint is still not satisfied then fan speed will operate the last adjusted speed for an amount of time that is set in the Ramp Pause Delay menu. This time delay will allow the discharge temperature to adjust. The Ramp Pause Delay default setting is 2 minutes with a range of 1 to 5 minutes.
- Otherwise, fan speed will stay constant.
- Fan speed will automatically increase to the maximum speed when reheat or humidification is required. Fan speed will revert to the rack temperature setpoint control when the call for reheat or humidification is satisfied.

Discharge Air Temperature Compensation (optional discharge temperature sensor required):

If the unit fan speed has reached its maximum speed but the rack inlet temperature is still not satisfied then the supply temperature setpoint will automatically decrease 0.1°F every 60 seconds until rack inlet setpoint is satisfied but not drop below the discharge temperature limit which is default to 45°F.

If rack inlet sensors all fail then fan speed will automatically go to maximum speed. If Rack temperature sensors are fixed, the fan speed will go back to rack temperature control in 3 minutes.

NOTE : Valve Position Speed or Mod. To Ret (Modulate to Return Air) fan speed control modes are other efficient ways to control the fan speed in supply air temperature control mode.

6. Safety

6.1. Sensor Failure

If a rack inlet temperature sensor fails, it will be excluded from the temperature control calculation until it is fixed and reports a normal temperature.

If all rack inlet temperature sensors fail, the fan speed will run at the maximum speed.

If discharge air temperature sensor fails, chilled water valve will open at 100%. If this is a DX unit, one compressor will run.

6.2. Freeze-stat on DX system (an optional temperature sensor required)

Freeze-stat temperature sensors are added to DX system with rack inlet temperature control option. These freeze-stat temperature sensors will be wrapped to the compressor suction piping to measure the suction temperature. The freeze-stat temperature settings are in dap4 (Menu K- Alarm and Limits) with 32°F default value. The freeze-stat setting range is 20 to 40°F with 1°F increment.

Below are the conditions to cause a freeze-stat alarm:

- The Freeze sensor must be below the Freeze setpoint.
- The Freeze sensor NTC must be installed to optional Analog #1 and enabled.
- The Unit must be ON.
- This alarm only applies to dap4 controller (not Mini dap4).
- Freeze Alarm must be enabled.

There will be a 5 second delay before the alarm is triggered.

The alarm will be cancelled when the freeze sensor increases 2°F above the freeze-stat setpoint.

The Freeze-stat safety logic is as follows:

If suction temperature drops below the freeze-stat setpoint then the dap4 will take the following actions.

- First, the fan speed will ramp up to the maximum speed for one minute regardless the rack inlet temperature setpoint. If suction temperature rises after one minute then fan speed will continue to run at maximum speed for another two minutes then go back to normal speed.
- If suction temperature continues to drop after fan speed has ran at the maximum speed for one minute then cooling stages (compressors) will cycle off one every minute until suction temperature rises above the freeze-stat set point or until there is no cooling stage to turn off.
- Once the cooling stage is cycled off by freeze-stat setpoint; it can cycle back on when suction temperature rises 2°F above the freeze-stat setpoint but it cannot violate the compressors' short cycle time delay.

7. Optional Zone Master For Rack Temperature Control

When units with RackSense 32 configuration are connected together using Zone Master set-up, two more Zone airflow control modes are added to the zone master 's zone airflow beside Constant and Unity cooling setting: Highest Rack and Average Rack.

- If Zone Airflow is set to Max Rack, the zone master unit will select the highest control rack temperature of each unit in the zone every 5 minutes and use this value to determine the fan speed of all fans in the zone to make sure they operate in parallel fashion based on zone master unit temperature setpoint. Zone master Sync temperature setpoint is recommended. Unit's safeties will override the zone airflow control. For instance, while zone master controls unit's fan speed, unit experiences a freeze-stat alarm, a low discharge temperature alarm or low suction temperature alarm, unit will leave the zone airflow control and follow the unit safety control by speeding up the its fan. Unit will reverse to zone airflow control 15 minutes after the safety alarm condition is cleared.
- If Zone Airflow is set to Avg Rack, the zone master unit will calculate the average value of all the units' control rack temperature every 5 minutes and use this value to determine the fan speed for all fans in the zone to make sure they operate in parallel fashion based on zone master unit temperature setpoint. Zone master Sync temperature setpoint is recommended. Unit's safeties will override the zone airflow control. For instance, while zone master controls unit's fan speed, unit experiences a freeze-stat alarm, a low discharge temperature alarm or low suction temperature alarm, unit will leave the zone airflow control and follow the unit safety control by speeding up the its fan. Unit will reverse to zone airflow control 15 minutes after the safety alarm condition is cleared.

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