# S W U D  S E R V I C E  A N D  T R O U B L E S H O O T I N G

TABLE OF CONTENTS

# GENERAL INFORMATION

# Model Number Description

Trane Model SWUD Commercial Self-Contained units are identified by a multiple-character model number that precisely identifies each unit. An explanation of the alphanumeric identification codes used for SWUD units follows.

Use of the unit model number will enable the owner/operator, installing contractors, and service engineers to define the operation, components and options for any specific unit.

| Model No. | S | W | U | D | 020 | 3 | D | AA | F | 1 | 05 | 055 | 3 | 1 | C | 1 | C | 0 | 1 | C | BDEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Digit No. | 1 | 2 | 3 | 4 | 5,6,7 | 8 | 9 | 10,11 | 12 | 13 | 14,15 | 16,17,18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27,etc. |

**Digit 1**
**Unit Model**
S = Self-Contained

**Digit 2**
**Condenser Cooling Medium**
W = Water-Cooled Condenser
S = Special Condenser

**Digit 3**
**Evaporator Airflow Direction**
U = Upflow
S = Special

**Digit 4**
**Development Sequence**
D = "D" Development Sequence

**Digits 5, 6, 7**
**Unit Nominal Tons**
020 = 20 Tons
022 = 22 Tons
025 = 25 Tons
029 = 29 Tons
032 = 32 Tons
035 = 35 Tons
038 = 38 Tons
042 = 42 Tons
046 = 46 Tons
052 = 52 Tons
058 = 58 Tons
065 = 65 Tons
072 = 72 Tons
080 = 80 Tons

**Digit 8**
**Unit Voltage**
3 = 230/60/3
4 = 460/60/3
5 = 575/60/3
6 = 200/60/3
S = Special

**Digit 9**
**Plenum Type**
D = Discharge Plenum (Std. Height) - Factory Hole(s)
L = Discharge Plenum (Low Height) - Factory Hole(s)
P = Discharge Plenum (Std. Height) - Field-Cut Hole(s)
W = Discharge Plenum (Low Height) - Field-Cut Hole(s)
0 = Without Plenum
S = Special Plenum

**Digits 10, 11**
**Design Sequence**
AA = "AA" Design Sequence

**Digit 12**
**Fan Type**
F = Full Capacity
U = Undersized Fan
S = Special Fan

**Digit 13**
**Motor Type**
1 = High Efficiency, Open, Drip-Proof Motor
2 = Open, Drip-Proof Motor
3 = Totally-Enclosed, Fan-Cooled Motor
S = Special Motor

**Digit 14, 15**
**Motor Horsepower**
05 = 5 Hp
07 = 7.5 Hp
10 = 10 Hp
15 = 15 Hp
20 = 20 Hp
25 = 25 Hp
30 = 30 Hp
40 = 40 Hp
50 = 50 Hp

### Digit 16, 17, 18
### Supply Fan RPM
040 = 400 Rpm
045 = 450 Rpm
050 = 500 Rpm
055 = 550 Rpm
060 = 600 Rpm
065 = 650 Rpm
070 = 700 Rpm
075 = 750 Rpm
080 = 800 Rpm
085 = 850 Rpm
090 = 900 Rpm
095 = 950 Rpm
100 = 1000 Rpm
105 = 1050 Rpm
110 = 1100 Rpm
115 = 1150 Rpm
120 = 1200 Rpm
125 = 1250 Rpm
130 = 1300 Rpm
135 = 1350 Rpm
140 = 1400 Rpm
145 = 1450 Rpm
150 = 1500 Rpm

### Digit 19
### Air Temp. Control
1 = Zone Temp. - Cooling Only
2 = Zone Temp. - Cooling & Heating
3 = Supply Air Temp. - Cooling Only
S = Special

### Digit 20
### Airflow Volume Control
1 = Inlet Guide Vanes
0 = Without Volume Control
S = Special

### Digit 21
### Unit Economizer
W = Waterside Economizer, Mechanically Cleanable, Full Capacity
L = Waterside Economizer, Mechanically Cleanable, Low Capacity
C = Waterside Economizer, Chemically Cleanable, Full Capacity
D = Without Economizer
S = Special

### Digit 22
### Waterside Valves
1 = Modulating, Energy-Saving w/Econ. (Spring Return)
2 = Modulating, Standard w/Econ. (Spring Return)
3 = Cond. Pressure Control Valve w/o Waterside Econ. (Spring Return)
0 = Without Valves
S = Special

### Digit 23
### System Control
T = Tracer Interface
C = Standard Unit Control Module
S = Special

### Digit 24
### Heating Type
E = Electric Heat
0 = Without Heat
S = Special

### Digit 25
### Unit Connection
1 = Disconnect Switch, Unfused
2 = Terminal Block
S = Special

### Digit 26
### Filter Type
A = Construction Throwaway Filters
B = High Velocity Cleanable (Metal) Filters
C = Medium-Efficiency Throwaway Filters
0 = Without Filters
S = Special

### Digits 27, 28, etc.
### Optional Items
B = Dirty-Filter Sensor
D = Mixed-Air Temperature Protective Device
E = Spring Isolators
F = Extended Rpm Range (+50/-50)
G = Supply-Air Temp. Adjustment (Reset/2-10 VDC/4-20 mA)
L = Water Flow-Switch
0 = Without Water Flow Switch
V = Night Heat - Morning Warmup
W = Time Clock
S = Special

## UNIT/CUSTOMER DISPLAY/UNIT CONTROL INTERFACE

The display/control interface allows the user to select major operating modes of the UCM and control display of UCM parameters. A three position rocker switch and pushbutton switch are used in conjunction with a five digit vacuum fluorescent display.

The rocker switch selects the unit operating mode: STOP, AUTO-LOCAL(local setpoints), and AUTO-REMOTE (BAS or serial communication supplied setpoints).

The ADVANCE DISPLAY pushbutton allows single step advance through the display menu, or automatic advance by holding the pushbutton down.

The display shows both operating and diagnostic hexadecimal codes, control status indicators, the settings of all local potentiometer adjustments, and actual controlling set points and specified temperatures. The display works in conjunction with the ADVANCE DISPLAY button to step through the operating mode, the most recent diagnostic code (if any), other diagnostic codes generated since the diagnostics were last reset (if any), and unit control set points. Depressing and releasing the button advances the display one code at a time. Depressing and holding the button scrolls the display through the codes and setpoints until the button is released. If the button is held down, the scrolling stops at the operating code.

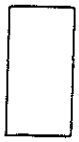
## Control System Operation

Unit control is by a microprocessor based Unit Control Module(UCM).

## Operator Interface

### Unit Switch

The " Unit Switch" is provided to set the control mode of the unit. It is a rocker switch with three positions; Stop/Reset, Auto Local, and Auto Remote.



AUTO REMOTE Top

AUTO LOCAL Center

STOP/RESET Bottom

STOP/RESET - When the switch is in the Stop/Reset position, all normal cooling and heating functions are disabled. All outputs are set to their de-energized state and all actuators are driven to initial positions.

All UCM internal information and current diagnostics are not cleared until the switch is moved to AUTO. Diagnostic history information is only reset or cleared by holding in the Advance Display button while switching from Auto Local to Stop/Reset.

- The UCM can be manually reset by moving the Unit Switch from either the Auto Local or Auto Remote switch position to the Stop/Reset position.

- The UCM is also reset whenever power is applied to the unit. In this case, all diagnostic information is reset or cleared.

- The Tracer can access the unit and read and write data but cannot override local control.

AUTO LOCAL - With the switch in the Auto local position, the unit operates as a stand alone unit. The unit is controlled by the internal UCM microcomputer in response to sensor inputs. The Tracer can access the unit and read and write data but cannot override local control.

AUTO REMOTE - With the switch in the Auto Remote position, the unit is still controlled by the internal UCM microcomputer, but control is overridden by the Tracer through the serial communications interface (SCI). Temperature control is based on setpoints stored in SCI memory.

-Setpoints on the face of the UCM are not used when the unit switch is in the Auto Remote position, with the exception of the following setpoints: supply air temperature control band and supply air pressure control band. These two setpoints must be adjusted at the UCM, regardless of which position the unit switch is in.

NOTE: The SCI memory is loaded with factory settings as shipped. These settings will not allow the unit to run with the unit switch in the Auto Remote position until the TRACER downloads operating setpoints.

## Unit Control Module (UCM)

The display on the UCM visually indicates operating codes, diagnostic codes, and setpoints. The display uses five digits of seven segments each. A cutout in the control panel door allows the operator to view the display without opening the door. The Unit switch and advance display pushbutton are also accessible without opening the door.

The left digit of the display shows the menu reference letter. When displaying the operating mode, the third and fourth digits show the operating code. With diagnostics, the fourth and fifth digits show the diagnostic code. With setpoints (unit operating states as set by the potentiometers), the first digit will show the setpoint reference letter and the third through fifth digits show the setpoint value. The decimal point (for setpoint values containing a decimal values) is to the left of the last or fifth digit.

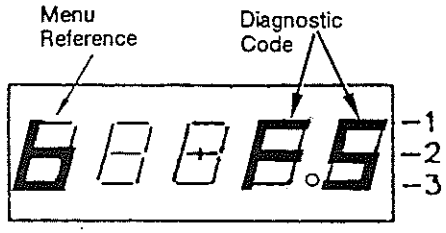
Figure 23 illustrates example diagnostic, operating and setpoint values which may be shown by the display.

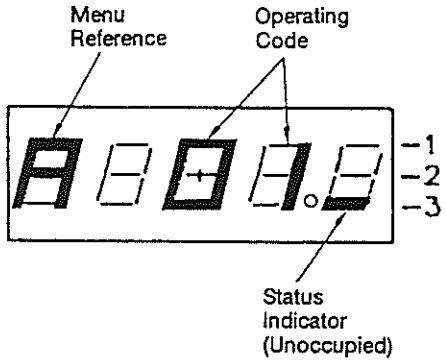
When displaying the operating mode, the fifth digit of the display is reserved for three machine control status indicators. The three horizontal segments of the digit from the top to the bottom will be used to indicate Timed Override, Frost Protect, and Unoccupied, respectively.

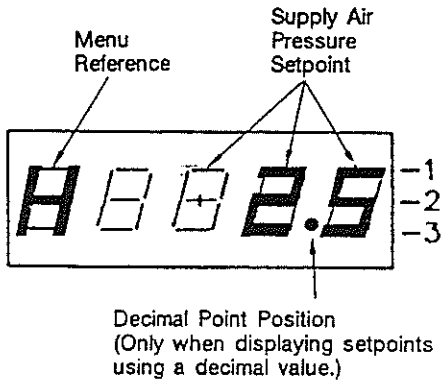
The status indicators will be displayed simultaneously with the following operating state codes to give additional information required to help determine the operating state of the machine. The codes need not be displayed simultaneously with diagnostics, setpoints, or temperature values.

| Status Indicators | Code |
|---|---|
| Timed Override | Top horizontal segment of least significant digit lit. |
| Frost Protect | Center horizontal segment of least significant digit lit. |
| Unoccupied | Bottom horizontal segment of least signigicant digit lit. |

**Figure 23**
**UCM Display Readout Samples**



## ANNUNCIATORS (STATUS INDICATORS)

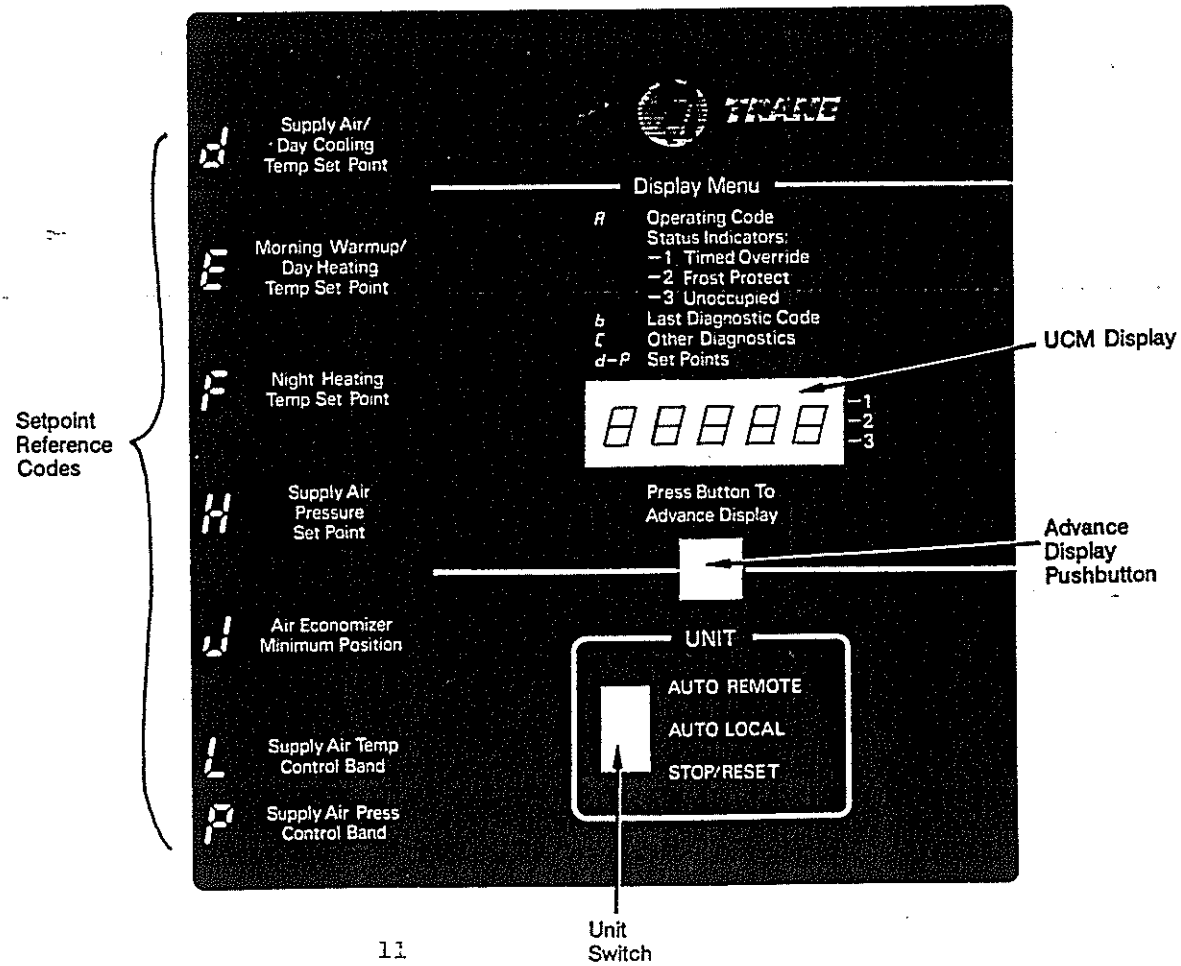
Three annunciators (horizontal segments in the rightmost display digit) identify function status:

1) TIMED OVERRIDE (upper segment) - indicates zone/night heat sensor push-button was depressed. This annunciator will not light due to TRACER timed override, which is treated as a mode change.
2) FROST PROTECT (middle segment) - indicates that one or more compressors has been shut off to prevent frost build-up.
3) UNOCCUPIED (lower segment) - indicates the unit is in the unoccupied mode. TRACER override operation is also indicated.

When no diagnostics occur, the selected menu is displayed continuously. When a diagnostic occurs, the display does the following depending on the nature of the diagnostic:

1) The display "alternates" between the current operating code and the diagnostic code for any condition that causes the entire machine to shutdown, or,
2) For Entering Air Low Temperature, the display will "alternate" as in 1, even though manual reset is not required, or,
3) For all other diagnostics, the display will "flash" the current operating code to indicate that some type of failure has been detected.

## OPERATOR PANEL



Advance Display Button

The display works in conjunction with the Advance Display button to step through the operating codes, the most recent(Last) diagnostic code if any, other diagnostic codes generated since the diagnostics were last reset, if any, and unit control active set points. Depressing and releasing the button advances the display one code at a time in the order given above. Depressing and holding the button scrolls the display thru the codes and setpoints until the button is released. If the button is held down, the scrolling will stop at the operating code.

Depressing the Advance Display button advances the display to the "most recent" diagnostic code. The display will "flash" if any diagnostic exists that requires a manual reset to restore full machine operation. The display will be continuous if manual reset is not required to restore full operation. The "last diagnostic" information is retained until the unit diagnostic is reset or until a new diagnostic occurs.

Depressing the Advance Display button then causes the history display to show any "C" diagnostics that have occurred since the diagnostics were last reset. Any specific diagnostic code is not shown more than once even if it has occurred several times. No time sequence of occurrence is provided. The "C" register diagnostic conditions which are still present will "flash" until the condition which caused the diagnostic goes away. The "C" register diagnostic conditions which are no longer present will be on solid.

The "b" or "C" register display, except for the reference codes, will be blank when no diagnostic codes are present.

Depressing the Advance Display button following the last diagnostic advances the display to the set point adjustments. The display will "flash" if the set point being displayed is at either end point.

Depressing the Advance Display button following the last set point advances the display back to the operating code. The operating code will alternate with the diagnostic code as above if a manual reset is required to restore full machine operation. Otherwise, the current operating code is displayed continuously.

## Setpoints

Setpoint adjustments are made with potentiometers that are located on the front of the UCM. The setpoints can be adjusted while the unit is running. The actual setpoint value can be read from the display by setting the display menu to the corresponding setpoint reference code.

The following setpoints are available:

Supply Air/Day Cooling Temperature Setpoint
Morning Warmup/Day Heating Temperature Setpoint
Night Heating Temperature Setpoint
Supply Air Pressure Setpoint
Airside Economizer Minimum Position Setpoint
Supply Air Temperature Control Band
Supply Air Pressure Control Band

## Service Start

When the Advance Display button is held in while switching from Stop/Reset to Auto, the normal compressor start delay timers are overridden. The unit will go into the pre-cool mode for 3 minutes and then all compressors will be staged on in sequence in 5 second intervals. After the 5 minute compressor on limit, the unit will go back to normal operation. If a compressor diagnostic code or condition occurs, that particular compressor will be bypassed, and the diagnostic code will be displayed. This function is provided to check compressor operation after repairs.

## Extended Menu Display

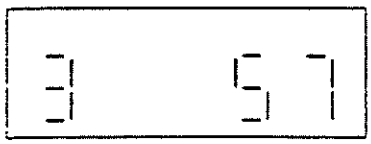
An extended menu display is accessible when UCM Board A3, DIP switch SW2, position 4 is on. The extended menu is displayed after the setpoints and before the operating code. Five different values can be read. Displayed parameters are:

1-Supply Air/Day Cooling Temperature Setpoint:
Indicates supply air/day cool temperature setpoint from an active source other than front panel setpoint potentiometer.

| | |
|---|---|
| AUTO REMOTE: | Remote (TRACER) Day Cool Setpoint |
| | TRACER provided default Day Cool Setpoint |
| | TRACER Day Cool Setpoint modified by UCM setpoint reset function |
| | External BAS Setpoint (Analog Input) |

AUTO LOCAL: RESET ON-Front panel Day Cool Setpoint modified by UCM setpoint reset function
External BAS Setpoint (Analog Input)
RESET OFF-Not Defined

2-Zone/Night Heat Temperature (from zone/night heat temperature sensor)
3-Supply Air Temperature (from sensor)
4-Morning Warmup Temperature (from sensor)
5-Entering Air Temperature (from sensor)



Depressing the ADVANCE DISPLAY button following the last display returns the display to the "A" display.

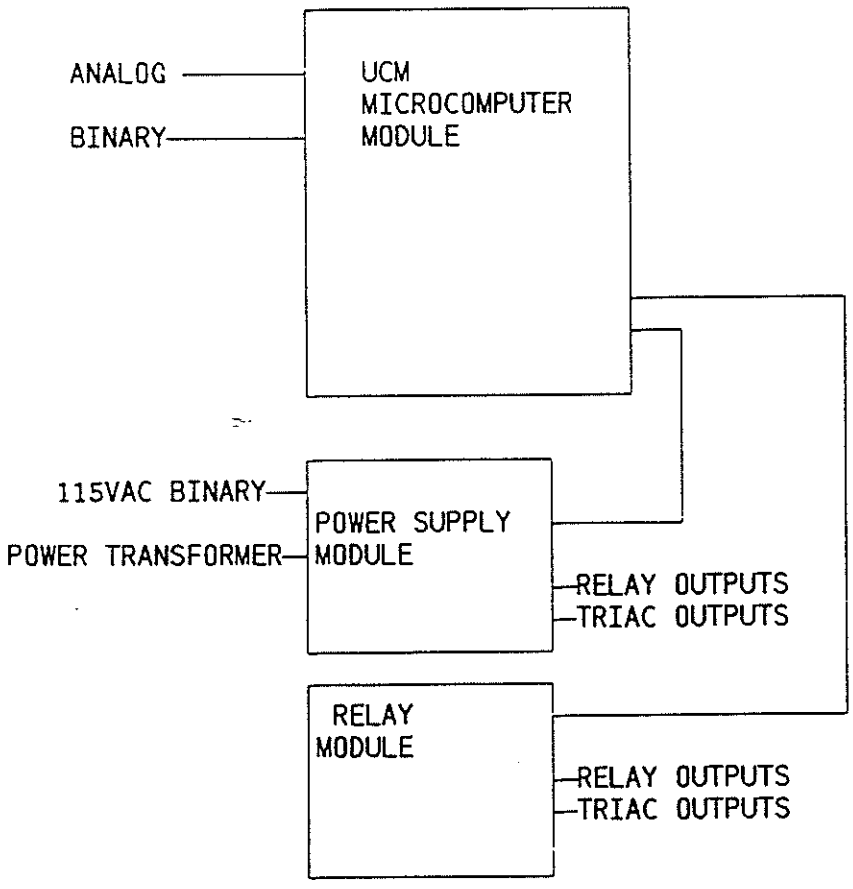
HARDWARE ARCHITECTURE SUMMARY

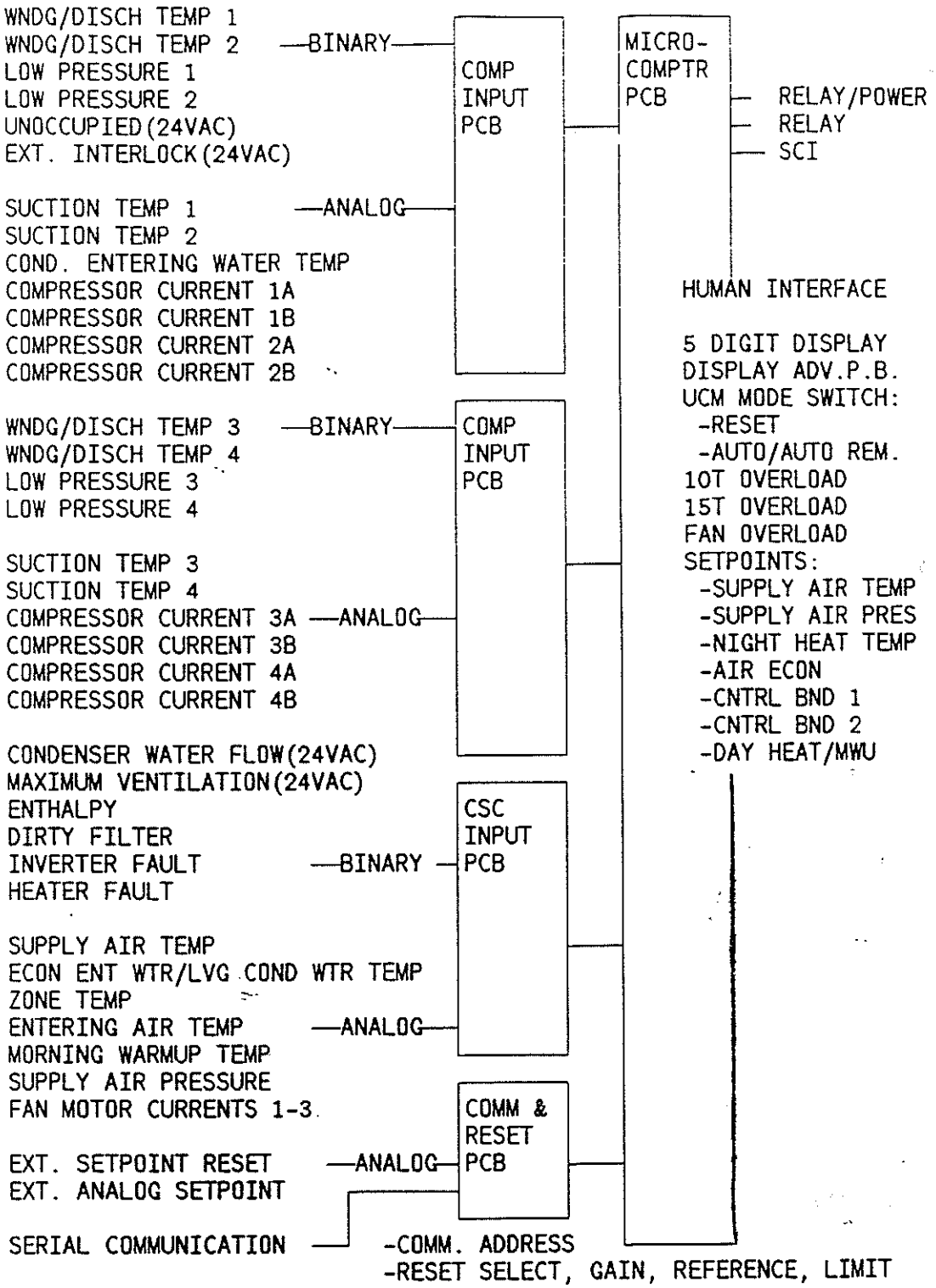
The UCM consists of 7 printed circuit boards enclosed in three modules. The boards enclosed in the 1U1 module are the microcomputer board, 2 compressor input board #1, 2 compressor input board #2, commercial self-contained input board, and a communications and reset board. The 1U2 module encloses the power supply board. The 1U3 module encloses a relay board.

An optional relay outputs package allows operation of 4 1U3 module output relays.

An optional 1U4 inverter interface module will allow operation of an optional evaporator fan motor inverter.

SYSTEM BLOCK DIAGRAM




WNDG/DISCH TEMP 1
WNDG/DISCH TEMP 2
LOW PRESSURE 1
LOW PRESSURE 2
UNOCCUPIED(24VAC)
EXT. INTERLOCK(24VAC)
BINARY
COMP INPUT PCB
SUCTION TEMP 1
SUCTION TEMP 2
COND. ENTERING WATER TEMP
COMPRESSOR CURRENT 1A
COMPRESSOR CURRENT 1B
COMPRESSOR CURRENT 2A
COMPRESSOR CURRENT 2B
ANALOG
WNDG/DISCH TEMP 3
WNDG/DISCH TEMP 4
LOW PRESSURE 3
LOW PRESSURE 4
BINARY
COMP INPUT PCB
SUCTION TEMP 3
SUCTION TEMP 4
COMPRESSOR CURRENT 3A
COMPRESSOR CURRENT 3B
COMPRESSOR CURRENT 4A
COMPRESSOR CURRENT 4B
ANALOG
CONDENSER WATER FLOW(24VAC)
MAXIMUM VENTILATION(24VAC)
ENTHALPY
DIRTY FILTER
INVERTER FAULT
HEATER FAULT
BINARY
CSC INPUT PCB
SUPPLY AIR TEMP
ECON ENT WTR/LVG COND WTR TEMP
ZONE TEMP
ENTERING AIR TEMP
MORNING WARMUP TEMP
SUPPLY AIR PRESSURE
FAN MOTOR CURRENTS 1-3
ANALOG
EXT. SETPOINT RESET
EXT. ANALOG SETPOINT
COMM & RESET PCB
SERIAL COMMUNICATION
-COMM. ADDRESS
-RESET SELECT, GAIN, REFERENCE, LIMIT
MICRO-COMPTR PCB
RELAY/POWER
RELAY
SCI
HUMAN INTERFACE
5 DIGIT DISPLAY
DISPLAY ADV.P.B.
UCM MODE SWITCH:
-RESET
-AUTO/AUTO REM.
1OT OVERLOAD
15T OVERLOAD
FAN OVERLOAD
SETPOINTS:
-SUPPLY AIR TEMP
-SUPPLY AIR PRES
-NIGHT HEAT TEMP
-AIR ECON
-CNTRL BND 1
-CNTRL BND 2
-DAY HEAT/MWU

MODULES

Micro Module

1U1 contains 5 pc boards housed in a large sheetmetal enclosure. It contains the microcomputers and the majority of the signal conditioning circuitry for the system. It contains only low voltage circuitry and is located in a low voltage section of the commercial self contained control panel. The pcb assemblies contained in this module are:

A. Micro/Display Board
B. Compressor Input Board (2)

C. Commercial Self Contained Input Board
D. Serial Communications Link

Power Supply Module

1U2 contains 1 pc board in a small sheetmetal enclosure. It contains power conditioning circuitry for the rest of the system along with high voltage input circuits, phase rotation circuitry, and relay and triac outputs. Since there are high voltage inputs to this module it is located partly into the high voltage section of the CSC control panel. The pcb assembly contained in this module is:

A. Power Supply/Relay Board

Relay Module

1U3 contains 1 pc board in a small sheetmetal enclosure. It contains its own 12V regulator and a number of relay and triac output circuits which drive optional equipment.

The unit control module system consists of several physical pieces:
1. A main unit control module which contains sensor input circuits, human interface, service adjustments, and control electronics.

2. A power supply module with dc power supply circuits, three phase power detection circuits, relay and triac outputs, and 115vac logic inputs.

3. A relay output module, which contains relay and triac outputs.

4. Power transformers necessary to provide reduced ac voltages to the power supply and control modules.

## TROUBLESHOOTING PROVISIONS

The UCM provides general troubleshooting abilities through diagnostic and status displays covering all input circuits. Output circuits may be tested by setup of normal operating input conditions which result in specific, predictable output states. No provision is made for manually controlling output states. A service start-up mode is provided to allow compressors to be started in sequence and run for a short period of time without the normal timing provided by temperature control. This is intended to provide the serviceman with a predictable startup sequence for use in observing compressor starts. Test points for power supply lines are provided on the main UCM module. Other signals are identified as module interconnection cable points which are accessible to test probes.

## UNIT/CUSTOMER CONTROL PARAMETER INPUT INTERFACE

The control input interface allows adjustment of user parameters using the display.
To adjust a setpoint, the display advance pushbutton is used to select the desired setpoint. The setpoint value can then be adjusted while viewing the resulting value on the display. Clockwise rotation of setpoint potentiometers increases setpoint values.

If the potentiometers are adjusted when the display is not showing a setpoint value, the setpoint will be changed.

The display flashes when a range extreme is encountered. When a setpoint potentiometer is at a high or low limit setting the display flashes.

| PARAMETER | LOW LIMIT | HIGH LIMIT | RESOLUTION | UNITS |
|---|---|---|---|---|
| Supply Air/Day Cooling Temp Setpnt | 50 | 90 | 1 | deg. F |
| Mrng Warmup/Day Heating Temp Setpnt | 40 | 90 | 1 | deg. F |
| Night Heating Temp Setpoint | 40 | 90 | 1 | deg. F |
| Supply Air Press. Setpoint | 0.5 | 4.0 | 0.1 | "wtr |
| Air Econ. Minimum Position | 0 | 50 | 1 | % open |
| Supply Air Temp Control Band | 2 | 12 | 1 | F deg. |
| Supply Air Pressure Control Band | 14 | 100 | 1 | %GAIN |

The supply air temp control band actually adjusts the deadband of the temperature control function. The deadband value represents the entire range of the deadband, including positive and negative error from setpoint.

The supply air pressure control band represents the gain of the control algorithm.

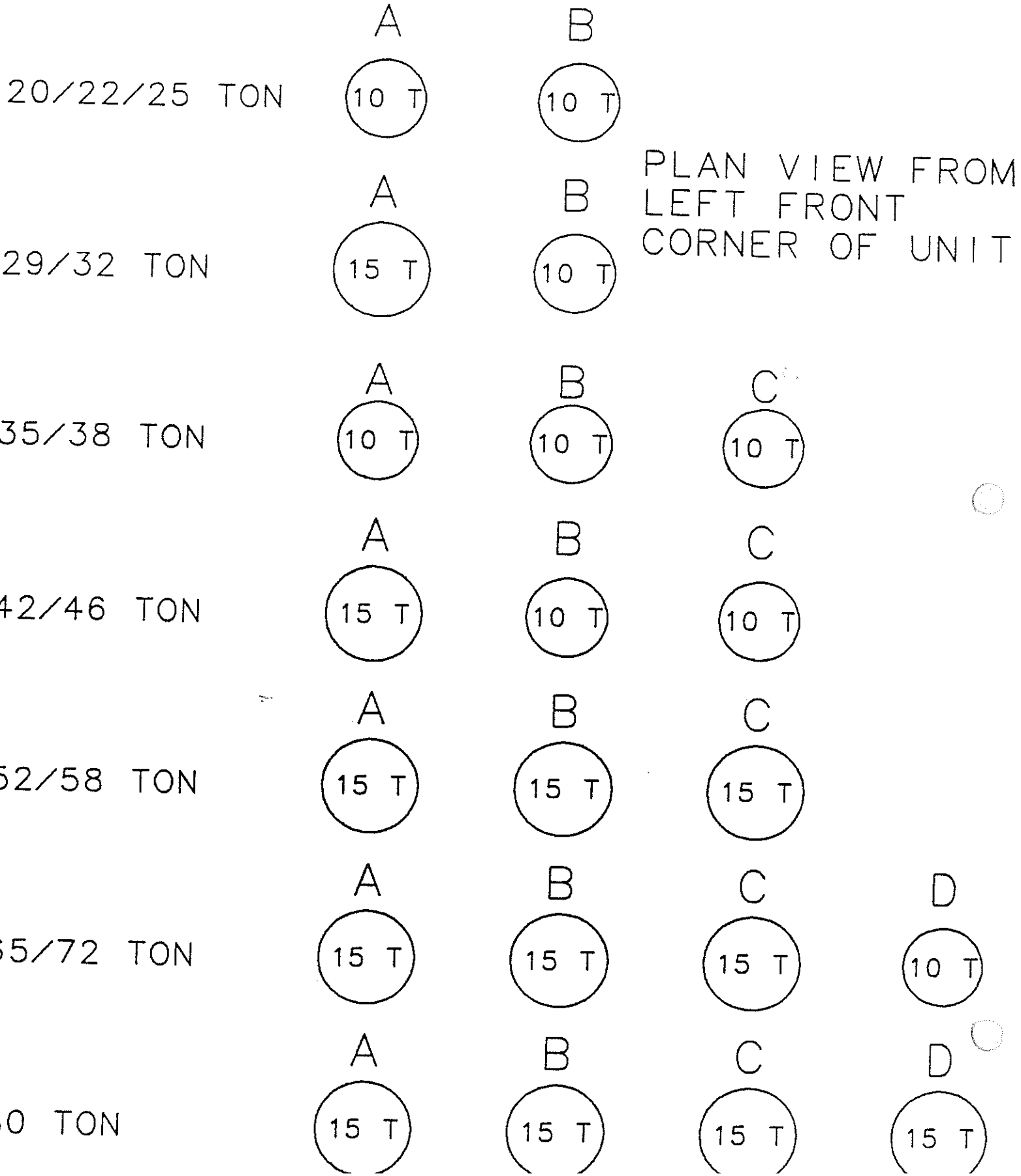
The following setpoint relationships are enforced internally, but not reflected in the display or external communications:

For Constant Volume units only:
For the Mrng Warmup/Day Heating Temp Setpoint,
(Mrng Warmup/Day Heating Temp Setpnt) is less than or equal to
(Supply Air/Day Cooling Temp Setpnt - 3)

For both VAV and Constant Volume units:
For the Night Heating Temp Setpoint,
(Night Heating Temp Setpoint) is less than or equal to
(Mrng Warmup/Day Heating Temp Setpnt)

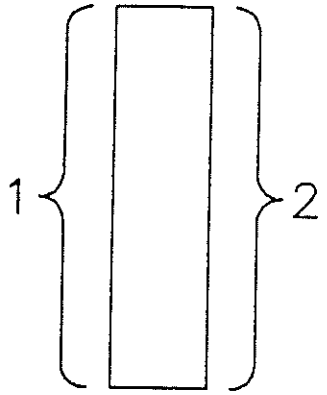
# REFRIGERANT CIRCUITS

## COMPRESSOR LOCATIONS IN UNIT

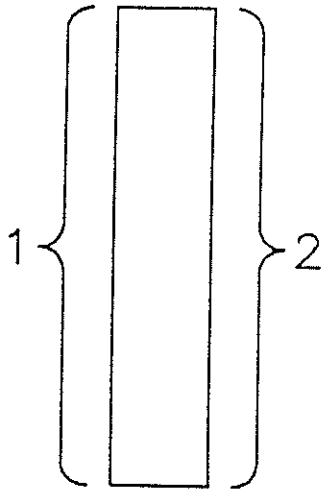


| UNIT TONS | NO. OF COMPRESSORS | CAPACITY CONTROL STEPS | | | |
|---|---|---|---|---|---|
| | | STEP | NO. 10 TON | NO. 15 TON | COMPRESSOR |
| 20-22 | 2-10T | 1 | 1 | 0 | B |
| | | 2 | 2 | 0 | A,B |
| 25 | 2-10T | 1 | 1 | 0 | B |
| | | 2 | 2 | 0 | A,B |
| 29 | 1-15T | 1 | 1 | 0 | B |
| | 1-10T | 2 | 0 | 1 | A |
| | | 3 | 1 | 1 | A,B |
| 32 | 1-15T | 1 | 1 | 0 | B |
| | 1-10T | 2 | 0 | 1 | A |
| | | 3 | 1 | 1 | A,B |
| 35 | 3-10T | 1 | 1 | 0 | B |
| | | 2 | 2 | 0 | A,B |
| | | 3 | 3 | 0 | A,B,C |
| 38 | 3-10T | 1 | 1 | 0 | B |
| | | 2 | 2 | 0 | A,B |
| | | 3 | 3 | 0 | A,B,C |
| 42 | 1-15T | 1 | 1 | 0 | B |
| | 2-10T | 2 | 0 | 1 | A |
| | | 3 | 1 | 1 | A,B |
| | | 4 | 2 | 1 | A,B,C |
| 46 | 1-15T | 1 | 1 | 0 | B |
| | 2-10T | 2 | 0 | 1 | A |
| | | 3 | 1 | 1 | A,B |
| | | 4 | 2 | 1 | A,B,C |
| 52 | 3-15T | 1 | 0 | 1 | B |
| | | 2 | 0 | 2 | A,B |
| | | 3 | 0 | 3 | A,B,C |
| 58 | 3-15T | 1 | 0 | 1 | B |
| | | 2 | 0 | 2 | A,B |
| | | 3 | 0 | 3 | A,B,C |
| 65 | 3-15T | 1 | 0 | 1 | B |
| | 1-10T | 2 | 1 | 1 | B,D |
| | | 3 | 1 | 2 | A,B,D |
| | | 4 | 1 | 3 | A,B,C,D |
| 72 | 3-15T | 1 | 0 | 1 | B |
| | 1-10T | 2 | 1 | 1 | B,D |
| | | 3 | 1 | 2 | A,B,D |
| | | 4 | 1 | 3 | A,B,C,D |
| 80 | 4-15T | 1 | 0 | 1 | B |
| | | 2 | 0 | 2 | B,D |
| | | 3 | 0 | 3 | A,B,D |
| | | 4 | 0 | 4 | A,B,C,D |

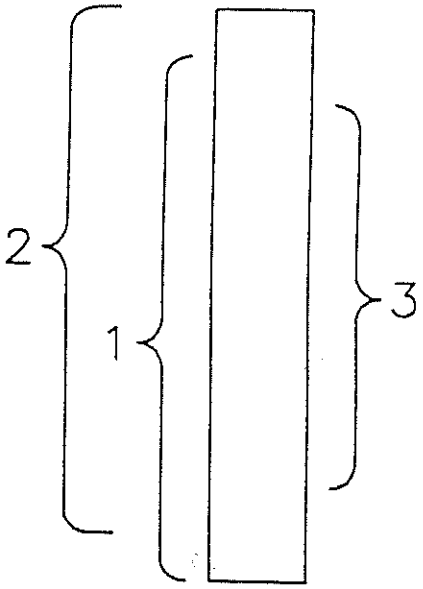
# EVAP COIL CIRCUITS




20/22/25 T

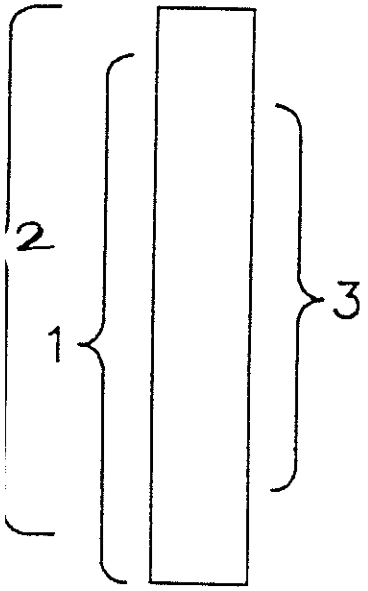



29/32 T

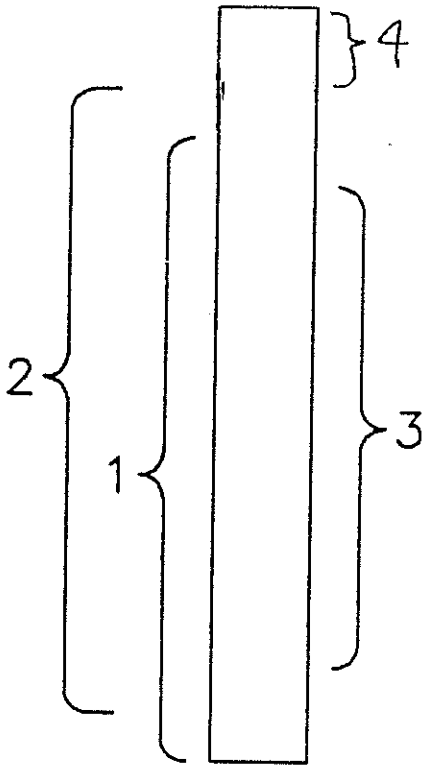



35/38 T

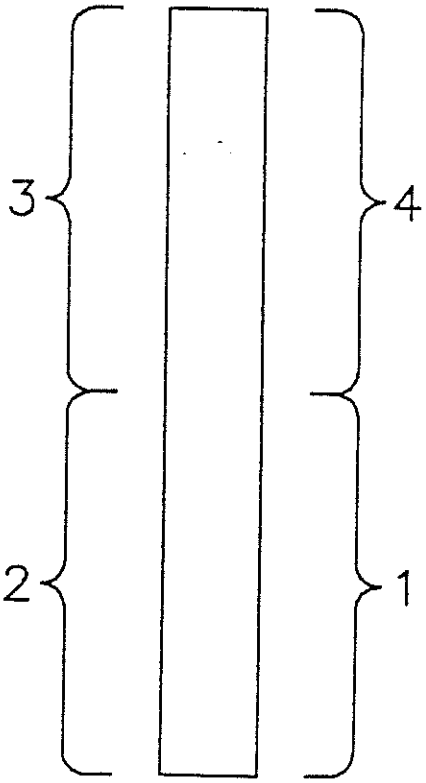
AIR FLOW




2/46/52/58T




65/72 T




80 T

# O P E R A T I O N

LIST OF STANDARD FEATURES

Description

Compressor Protection
- Starting and running current overload
- Short cycling
- Low pressure cutout
- High pressure cutout
- High compressor motor winding temperature

Supply fan starting and running current overload

Unit operating mode switch

Extensive operating mode and diagnostic display

Evaporator coil frost protection

Crankcase heaters cycled off when compressor is on

External interlock Auto/Stop input

Fan on/Ventilate input for maximum ventilation

Occupied/Unoccupied input for time of day scheduling

Unit power connections
- reverse phase protection

Alarm annunciation - generic interface

OPTIONAL FEATURES

VAV Units

- Supply air pressure control (Inlet guide vanes)

Constant Volume Units

- Zone temperature control - cooling only
- Zone temperature control - heating/cooling

Miscellaneous Options

- Supply air temperature reset based on zone temperature
- Supply air temperature setpoint input based on remote generic signal
- Modulating waterside economizer
- Dirty filter indication
- Energy saving waterside economizer
- Airside economizer
- Night heat/morning warmup
- Night setback/timed override
- Programmable night setback/morning warmup
- Time of day scheduling (time clock)
- Serial communications - TRACER compatible
- Condenser water pump control logic
- Condensing pressure control valve
- Water flow proving switch
- Command of external heat
- Generic interface outputs
  - Heat/cool mode
  - Unoccupied mode
  - Ventilation mode
  - Cooling tower interlock

WHEN - USED SENSOR/UNIT CONFIGURATION CHART

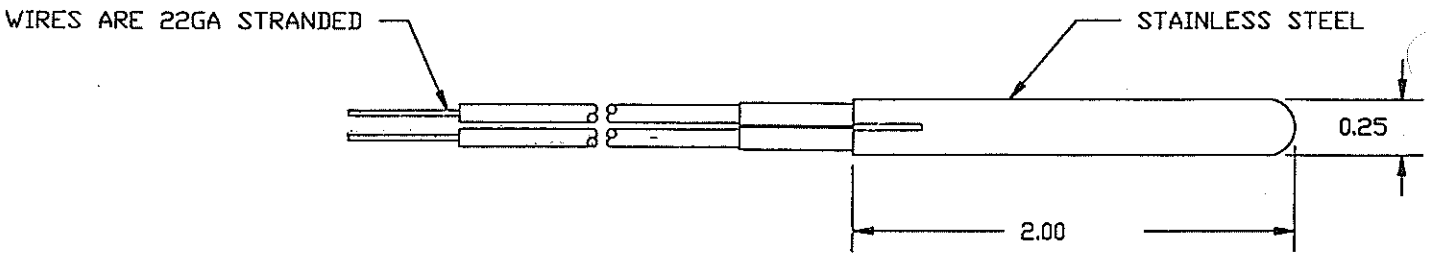
| STANDARD UNIT SENSORS | SENSOR DIAGRAM |
|---|---|
| ENTERING AIR TEMPERATURE | A |
| ENTERING CONDENSER WATER TEMPERATURE | A |

| OPTIONAL UNIT SENSORS | CV/ VAV | CPC | ECON | ECON TYPE WATER/AIR | SENSOR DIAGRAM |
|---|---|---|---|---|---|
| SUPPLY AIR TEMPERATURE | VAV | --- | --- | --- | A |
| | CV | --- | ECON | --- | |
| ENTERING ECONOMIZER WATER TEMPERATURE | --- | NONE | ECON | WATER | A |
| LEAVING CONDENSER WATER TEMPERATURE | --- | CPC | --- | --- | A |

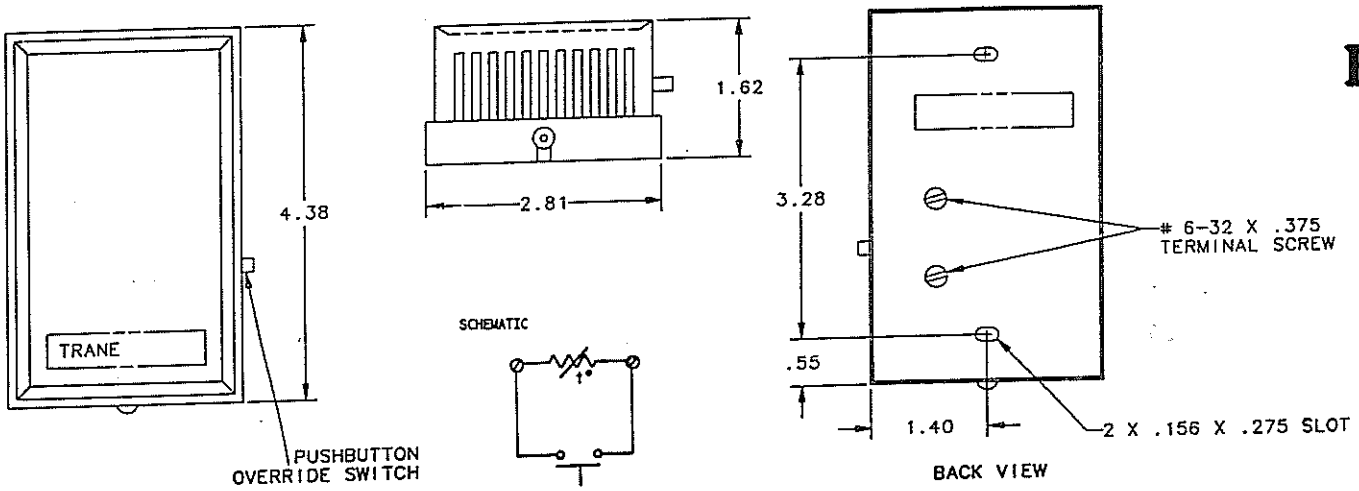
| OPTIONAL SHIP-WITH SENSORS | CV/ VAV | NHMW | SATA | DPC | SENSOR DIAGRAM |
|---|---|---|---|---|---|
| VAV MORNING WARM-UP TEMP | VAV | NHMW | --- | --- | C |
| CV ZONE TEMP | CV | NONE | --- | --- | C |
| CV ZONE OR VAV NIGHT HT. TEMP (W/BUTTON) | --- | NHMW | --- | --- | B |
| SUPPLY AIR RESET TEMPERATURE SENSOR | --- | --- | SATA | --- | C |
| SUPPLY AIR (STATIC) PRESSURE PROBE | --- | --- | --- | DPC | D |

--- = DON'T CARE
CPC = (CONDENSING) HEAD PRESSURE CONTROL OPTION
NHMW = NIGHT HEAT/MORNING WARMUP OPTION
SATA = SUPPLY AIR TEMPERATURE ADJUSTMENT OPTION
DPC = DUCT PRESSURE CONTROL (INLET VANES, INVERTER, INVERTER READY)
NONE = OPTION NOT ORDERED/INSTALLED

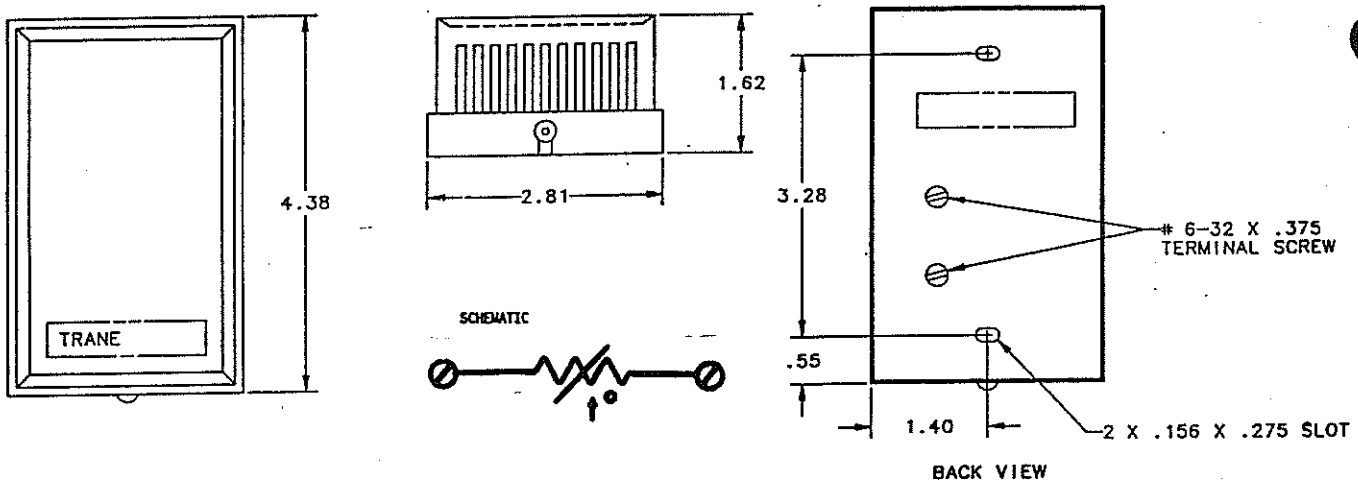
A



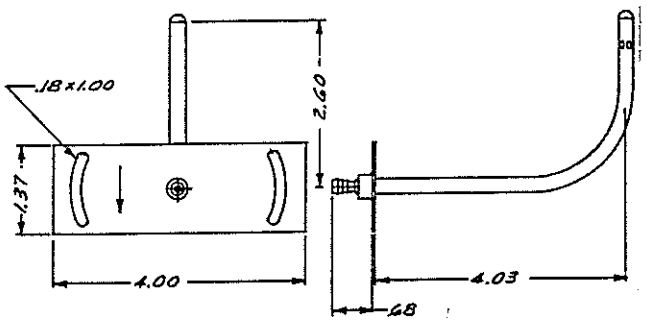

B




C




D




STATIC DUCT HEAD FOR ¼ O.D. PLASTIC TUBING

ZONE TEMPERATURE

This temperature is used for constant volume heating or cooling zone temperature control and VAV night heat control. If shorted for 1 second, it provides a (BAS)communicated bit value used for timed system override when the UCM is in the Auto/Remote mode, and a 2 hour override of unoccupied status to occupied when in the Auto/Local mode.

ZONE OVERRIDE OPERATION

UCM IN LOCAL MODE

If the zone sensor switch is depressed and released, the UCM will be forced from unoccupied to occupied for 2 hours. If the UCM is already in the occupied mode, the override function will maintain occupied mode for the next two hours. If the button is depressed during the two hour interval, the occupied mode will be extended to provide two hours from the last time the button was depressed.

Zone Temperature Control

The zone temperature control strategy for non-VAV systems provides economizer and mechanical cooling capacity control to maintain the zone temperature at the day cooling setpoint. In addition, if heating is installed and occupied heating control is required, one stage of heating capacity is controlled to maintain the zone temperature at the day heating setpoint.

For mechanical cooling control, the temperature control performance with respect to the setpoint is determined by the proportional control limits and is a function of the number of cooling stages. For loads at or within the cooling capacity of the unit, the zone temperature with respect to the cooling setpoint will be maintained within a deviation of -1.0 to +3.2 deg. F. For occupied heating, the deviation of the zone temperature with respect to the heating setpoint is -3.0 to +0.25 deg. F. for loads at or within the capacity limits of the heating stage.

An interstage time delay is used for unit loading for constant volume systems (similar to VAV capacity control) to improve system stability. Due to the nature of the application and the desire to provide immediate mechanical cooling shutdown (e.g. for a zone setpoint change), no interstage time delay is used for unit unloading. However, a minimum time of at least 5 minutes will lapse after the termination of mechanical cooling until it can restart.

## Supply Air Temperature Control

The supply air temperature control system for VAV systems provides control of the mechanical cooling stages and economizer (if provided) to maintain the unit supply air temperature at the supply air temperature setpoint.

The economizer control uses an algorithm to modulate the economizer capacity to satisfy the supply air temperature setpoint. The control is designed to regulate the supply air temperature to within the supply air temperature control band.

The unit cooling capacity will match the existing load and will maintain an average supply air temperature within the supply air temperature control band region of the setpoint. The supply air temperature control band is a temperature band that is centered at the supply air temperature setpoint and is adjustable from 2 to 12 deg. F. No change is cooling capacity will occur when the supply air temperature is within the control band. If the supply air temperature swings outside the limits of the control band, the mechanical cooling capacity will increase or decrease by 1 level accordingly.

Each change in cooling level is followed by a minimum time delay of 5 minutes before another change can be made. This time delay promotes stability by allowing the system to respond to the change before any further control action is taken.

The control band limits should be physically interpreted as the bound of acceptable supply temperature offset from setpoint. Any sustained supply temperature outside the control band will result in a change in the required cooling stage. Due to the potentially large airside delta T of a cooling stage, some control offset is desirable. The control band around the supply air setpoint should be set according to the expected airside delta T of a cooling stage. The setting is provided to allow the system to assume an operating point near setpoint that is adequate for the conditioned space and to reduce equipment cycling. The following control band settings are recommended:

2 cooling stage unit: 9 deg. F.
3 cooling stage unit: 7 deg. F.
4 cooling stage unit: 6 deg. F.

However, if closer control is desired, the control band setting can be reduced to enhance equipment cycling so that the average supply air temperature will equal the setpoint. In steady state, the control algorithm is designed to provide a range of equipment cycle rates from 6 to about 2.5 cph according to the existing load conditions and control band setting. The farther the supply air temperature swings with respect to the control band limit around the setpoint, the faster the equipment will cycle. Some load conditions could, however, establish a constant level of cooling capacity for supply air temperatures within the control band.

## Supply Air Pressure Control

The supply air pressure control system provides control of the unit supply air pressure to a setpoint by modulating the position of the supply fan inlet guide vanes or by modulating the speed of the supply fan with a frequency inverter driving the supply fan motor.

Measured pressure is also used to provide duct overpressure protection. The evaporator fan motor is locked out at 1.0" over the supply air pressure setpoint.

The control is designed to provide steady state regulation of supply air pressure to within +- 0.05 in. W.C. of the setpoint. The supply pressure control band setpoint is directly proportional to the control algorithm proportional gain. A setting of 20-25% is considered a good value for typical systems and should provide stable, responsive control.

CONDENSER WATER FLOW

This input is sensed as a 24VAC binary signal. When 24VAC is present at the input terminals, water flow is present and compressors can be operated. When 24VAC is not present, compressor operations may be stopped according to the specific control sequence in operation.

ENTHALPY SENSOR

This contact closure input is used to enable/disable airside economizer operation. When closed, airside economizer operation is enabled; when open, airside economizer operation is stopped/disabled.

DIRTY FILTER SENSOR

This input is sensed as a contact closure input, and when closed, indicates excessive pressure across the filter section in the unit.

UNOCCUPIED MODE EXTERNAL INPUT

This input is sensed as a 24 VAC signal, which is used to cause operation in the unoccupied mode.

EXTERNAL INTERLOCK INPUT

This input is sensed as a 24VAC signal and when present allows operation of the unit in all normal modes. When not present, the unit is forced to the "OFF" mode.

Condensing Pressure Control

The condensing pressure control system maintains sufficient compressor condensing pressure by modulating the position of the condenser water valve to reduce the unit condenser capacity for entering condenser water temperatures in the range between 50 and 35 deg. F.

The control is based on regulating the leaving condenser water temperature to maintain the required value which is a function of the entering condenser water temperature, the type of unit, and the number of operating cooling levels. The control regulates the unit leaving water temperature by control of the condenser water valve. At a given mechanical cooling level, the condensing pressure control approximately maintains a particular condenser water temperature rise throughout the 35 - 50 deg. F. range of entering condenser water temperatures.

Condensing Pressure Control Valve(for units without Waterside Economizer)

A 2-way modulating ball valve on the inlet of the unit will throttle the condenser water flow to maintain a relatively constant condensing pressure. The condensing pressure will be controlled by the UCM based on the water temperature leaving the unit. The leaving unit water temperature required will be determined by the number and size of compressors running, the inlet water temperature, and the unit size. If the leaving water temperature rises to 70 degrees F, the valve will maintain 70 degrees F until the valve is wide open.

The water valve will be open in the low entering air protection, pre-cool, and cooling modes. The valve will be closed in all other modes, including power off.

The condensing pressure control valve provided is intended for use in recirculating and non-recirculating water systems. Application should be done carefully to be sure adequate water circulation is maintained to the cooling tower during cold weather.

When the condensing pressure control valve is used, the unit is locked out of mechanical cooling at a minimum entering water temperature of 34±2 degrees F.

Physical/Mechanical

The condensing pressure control valve must be ordered as an option. The valve and actuator are factory mounted and wired and located within the unit enclosure.

Control sensors will be placed on the unit inlet and unit outlet pipe.

Maximum water pressure is limited to 400 PSIG.

A condenser valve position of => 35% is maintained during active condensing pressure control to protect against possible nuisance compressor shutdown due to low condenser water flow rate. Under some operating conditions, the valve may be driven to minimum position (35%) which causes the leaving condenser water temperature to be below the desired value. The condensing pressure will then follow the system conditions during this limit condition.

HEATER FAULT INPUT

This input is used to enable the electric heat failure diagnostic when electric heat is installed. Optionally, it may be used to create a heater failed diagnostic for external, customer supplied heater sources.

The general logic sense is:

Closed circuit- Generate diagnostic if no electric heat current detected after commanding heat.

Open circuit- Do not generate heat fail diagnostic under any conditions.

Note that a compressor current diagnostic will be generated if current is detected.

SUPPLY FAN ON - VENTILATE INPUT

This input is sensed as a 24VAC signal and when present, commands the evaporator fan to run, allowing only fan operation. When this signal is not present, normal operating modes take precedence.

## Optional Supply-Air/Day Cooling Temperature Setpoint Adjustment: Supply Air Temperature Reset or External Setpoint Input

### Supply Air Temperature Reset

Means are provided for reset of the supply air temperature. The supply air temperature is reset upwards as the space temperature drops below the remote space reset reference. The amount that the supply air temperature is reset upwards is based on the reset gain setting. A reset limit adjustment, based on the following formula, is also provided to set the maximum amount that supply air can reset upwards.

```
Gain *(Reset Ref - Zone Temp)
+ Base Setpoint = New Setpoint

New Setpoint ≤ Reset Limit
```

Three rotary switches are provided to make reset adjustments. They are Reset Gain, Reset Reference and Reset Limit. The rotary switches are located on the serial communications printed circuit board in the UCM panel.
The Reset Gain switch can be set from 1 to 8 F, the Reset Reference switch can be set from 60 to 80 F and the Reset Limit switch can be set from 65 to 90 F. Allowable ranges and increment settings are given in below:

| Reset Reference | Reset Gain | Reset Limit |
|---|---|---|
| 60 F | 1 F/F | 65 F |
| 64 F | 2 F/F | 68 F |
| 66 F | 3 F/F | 71 F |
| 68 F | 4 F/F | 74 F |
| 69 F | 5 F/F | 77 F |
| 70 F | 6 F/F | 80 F |
| 71 F | 7 F/F | 85 F |
| 72 F | 8 F/F | 90 F |
| 73 F | | |
| 74 F | | |
| 75 F | | |
| 76 F | | |
| 77 F | | |
| 78 F | | |
| 79 F | | |
| 80 F | | |

Supply air temperature reset, when selected, remains active when the Unit switch is in either the AUTO/LOCAL or AUTO/REMOTE position.

### External Supply Air Temperature Setpoint Input

External set-point input may be used only with the Unit switch in the AUTO/LOCAL position. One of the configuration switches (SW2) on board A5 is used to enable or disable the UCM setpoint reset or input functions in the AUTO/LOCAL or AUTO/REMOTE modes. Additional A5 board configuration switches are provided to select an internal setpoint reset or external setpoint signal. External setpoint input may be accomplished with a 4-20mA or 2-10 VDC input signal. Refer to Table 3.

When the supply air temperature adjustment option is selected, a space temperature sensor is shipped with the unit for field installation in the remote space. This sensor is installed only if the supply air temperature reset is used.

### Supply Air Temperature Adjustment Configuration Switches

The setpoint reset board (A5) configuration switches are set at the factory but can also be adjusted in the field. The switches consist of binary dip switches and rotary switches. The dip switches slide and have two possible positions; the rotary switches have eight or 16 positions.

**Note:** DIP switches 1 thru 5 on switchblock SW2 in the OFF position will disable the reset and setpoint input function. These switches are factory preset for supply air temperature reset and must be reset in the field if external setpoint input (4-20 mA/2-10 VDC) is desired.

**Table 3**
**External Setpoint Input Values**

| Supply Air Temp. Set-point (F) | Reset Signal Input (4-20 mA) | Reset Signal Input (2-10 VDC) |
|---|---|---|
| 50 | 4 | 2 |
| 55 | 6 | 3 |
| 60 | 8 | 4 |
| 65 | 10 | 5 |
| 70 | 12 | 6 |
| 75 | 14 | 7 |
| 80 | 16 | 8 |
| 85 | 18 | 9 |
| 90 | 20 | 10 |

## UNIT/CUSTOMER CONTROL OUTPUT INTERFACE

The UCM provides triac and isolated relay outputs for motor, actuator, and control interlock use. All actuator outputs used in the unit control use triacs in 24VAC circuits. All motor control outputs use electrically isolated relay contacts operating in 115VAC circuits. All customer and unit control interlock outputs use electrically isolated relay contacts operating in 24 or 115VAC circuits.

### MOTOR CONTROL OUTPUTS (115VAC)

SUPPLY FAN- Controls supply fan motor contactor.

COMPRESSOR A/OIL HEATER A- Controls compressor "A" motor contactor and oil heater.

COMPRESSOR B/OIL HEATER B- Controls compressor "B" motor contactor and oil heater.

COMPRESSOR C/OIL HEATER C- Controls compressor "C" motor contactor and oil heater.

COMPRESSOR D/OIL HEATER D- Controls compressor "D" motor contactor and oil heater.

### ACTUATOR CONTROL OUTPUTS (24VAC)

COND PRESS VALVE OR ECON WTR VALVE OPEN/CLOSE- A pair of triac outputs used to control actuator positioning of a water valve either for waterside economizing or condenser pressure control.

INLET GUIDE VANES OPEN/CLOSE- A pair of triac outputs used to control actuator positioning of fan inlet guide vanes.

AIR ECON OR ENGY SAVING MOD VALVE OPEN/CLOSE- A pair of triac outputs used to control actuator positioning of a water valve for waterside economizing or an air damper for economizing control.

### INTERLOCK/CONTROL INTERFACE RELAYS (115/24 VAC)

HEAT- When on, is used to operate a heating source(such as electric heat) via a pilot circuit.

HEAT/COOL- When on, indicates that the heating control is active; when off, that a cooling or ventilation mode is active or the unit is off. This output is intended to be used in a VAV system where control changeover from heating to cooling modes is required by the zone control equipment. Operates a pilot control circuit connected to VAV box controlling circuitry.

DIRTY FILTER- When on, indicates that a high pressure has been detected across the air filter section of the unit. Intended to be connected to a customer's pilot circuit or annunciator.

ALARM- When on, indicates that the UCM is in a diagnostic/alarm conditon. Intended to be connected to a customer's pilot circuit or annunciator.

UNOCCUPIED MODE- When on, indicates that the UCM has been placed in the unoccupied operating mode. This output is intended to be used as a customer interface to other ventilation equipment or VAV zone air control equipment, where a specific ventilation operating point is required. Intended to operate a pilot control circuit connected to VAV box controlling circuitry.

VENTILATION- When on, indicates that the UCM has been placed in the fan on/ventilate mode, and is on during all occupied modes. This output is used to interface with customer ventilation equipment or VAV zone air control equipment, where a specific ventilation operating point is required(full open dampers, valves, etc.). Intended to be connected to a customer's pilot duty control circuit.

COOLING TOWER/COND WTR PUMP INTLK- When on, is expected to cause necessary customer supplied condenser water supply equipment to be active to support unit cooling operations. Intended to be connected to a customer's pilot control circuit. This may include water pump or cooling tower control equipment.

Notes:

The HEAT output relay is operational with an electric heat, steam heat, or hot water coil heat option.

The optional HEAT/COOL, UNOCCUPIED MODE, VENTILATION, and COOLING TOWER/CONDENSER WATER PUMP INTERLOCK output relays are provided as part of a relay outputs package. This package is currently provided as part of the night heat/morning warmup option.

UCM OPERATING INTERFACE LOGIC

The UCM determines an operating mode based upon a number of command inputs and an order of precedence between them. The table below lists normal operating mode precedence for required inputs. When an input is not assigned a value, a "don't care" is implied.

| UCM Switch | BAS Status | SCL Status | Ext. Int. | Unocc.Mode | Fan On | UCM MODE |
|---|---|---|---|---|---|---|
| Stop/Reset | - | - | - | - | - | Stop/Mfg Ovrd. |
| Auto/Local | - | - | OFF("0") | - | OFF | Stop |
| Auto/Local | - | - | - | - | ON | Max Ventilation |
| Auto/Local | - | - | ON | On("1") | OFF | Unoccupied Mode |
| Auto/Local | - | - | ON | Off("0") | OFF | Occupied Mode |
| Auto/Rem. | - | - | OFF("0") | - | OFF | Stop |
| Auto/Rem. | - | - | - | - | ON | Max Ventilation |
| Auto/Rem. | - | Failed | ON | OFF | OFF | Diagnostic "DF" |
| Auto/Rem. | - | Locked | ON | OFF | OFF | |
| Auto/Rem. | Off>Tcoml | Default | ON | - | OFF | Default Mode |
| Auto/Rem. | ONLINE | ONLINE | ON | OFF | OFF | per BAS cmd. |
| Auto/Rem. | ONLINE | ONLINE | ON | ON | OFF | Unoccupied, or BAS STOP BAS Max Vent |

SWITCH TRANSITIONS

Stop/Reset to Auto switch transition: Causes reset of all active diagnostics and lockouts which are present. Also, forces the display to the unit operating code display(A XXZ).

Stop/Reset to Auto switch transition with DISPLAY ADVANCE button held down: Initiates the service startup mode, sequencing all compressors on.

Auto to Stop/Reset switch transition with DISPLAY ADVANCE button held down: Causes clearing of all historical records of diagnostics.

## EXTERNAL SUPPLY AIR TEMPERATURE SETPOINT INPUT

The input is used to provide an operating setpoint commanded by an external analog signal provided by the customer. The input is an analog process signal of either 2-10 VDC or 4-20 mADC. The full range of input setpoint values are available. Refer to the supply air temperature adjustment option description for further detail.

## SUPPLY AIR RESET TEMPERATURE

This temperature is measured for use in the setpoint reset function. The planned application of setpoint reset is to increase the supply air temperature setpoint when return air temperature decreases. Refer to the supply air temperature adjustment option description for further detail.

## Programmable Night Setback/Morning Warm-up

This option is the same as the night heat/MWU option, except that a programmable timer is supplied and wired to the Unoccupied input. The programmable timer is mounted in the control panel cover and is accessible without opening any unit panels. The timer is a seven day timer with a minimum of 4 operations per day (two on and two off). The timer has a permanent built-in rechargeable battery back-up system.

**Refer to SWUD I.O.M. for programming information.**

## Time Clock

A programmable timer is supplied and wired to the occupied/unoccupied input to provide on/off control of the unit.

The timer is mounted in the control panel, and is the same as the programmable timer.

## Electric Heat

Electric heat is available only as a factory installed option. A single KW rating is available for each unit tonnage.

## WATERSIDE ECONOMIZER

Standard modulating economizing is selected for those applications where the water flow through the unit is not be interrupted by the unit. Valve control action is such that the unit flow rate is substantially constant at all times. This is accomplished by driving the economizer and condenser valves complementary when the valves are actively controlling (as in Economizing).

Energy saving economizing is selected for those applications where the water flow through the unit can be stopped, and is expected to be stopped when the unit is not cooling (to provide waterside pump energy savings).

The economizer logic to enable waterside economizing is as follows:

Economizer enable: True if Economizer entering water temp deviation below entering air temp >= 8 deg. F.
False if Economizer entering water temp deviation below entering air temp <= 4 deg. F.

A hysteresis band of 4 deg. F applies.

When economizing is enabled, the operating mode Economizing is entered following a call for a VAV cooling capacity increase.

The transition mode Pre-Cooling is provided to allow time for valve response prior to cooling and to establish an accurate output from the economizer enable function.

A pre-economizing state exists within the operating mode Economizing in order to maximize the economizer cooling capacity on entry to economizing, flush the economizer coil, and to reduce valve actuation. The economizer valve is driven to a wide open position for a period of 3 minutes. After this 3 minute pre-econ state, the economizer control algorithm becomes active and modulates as necessary.

The transition to economizing from mechanical cooling enters the pre-econ state. Since the supply air temperature rate of change is relatively large when a compressor turns off, the algorithm should not respond to this and the economizer valve remains wide open.

Airside, standard modulating waterside, or energy saving waterside economizing can be used for CV systems. As with VAV systems, standard modulating waterside economizing is selected for those applications where the water flow through the unit is not to be interrupted by the unit. Valve control action is such that the unit flow rate is substantially constant at all times. The condenser and economizer valves are driven in a complementary fashion when the valves are actively controlling.

Energy saving waterside economizing is selected for those applications where water flow through the unit can be stopped, and is expected to when the unit is "off" (to provide waterside pump energy savings).

The economizer logic to enable waterside economizing is as follows:

| | | |
|---|---|---|
| Economizer enable: | True | If economizer entering water temperature deviation below entering air temp >= 8.0 |
| | False | If economizer entering water temperature below entering air temp =< 4.0 deg F |
| | No change | Else |

The economizer logic to enable airside economizing is as follows:

| | | |
|---|---|---|
| Economizer enable: | True | if enthalpy control true |
| | False | if enthalpy control false |

When economizing is enabled (favorable), the operating mode "Economizing" is initially entered when the zone is occupied, cooling is active, and cooling is required.

## Energy Saving Waterside Economizer Valve

Units with the energy saving waterside economizer use the same valve arrangement as the standard economizer; The only difference is that the condenser inlet valve becomes an on-off only valve. And consequently, as the economizer water valve modulates water flow, total water flow through the unit is modulated or shut off. The condenser inlet valve is always closed when the economizer function is enabled.

Under initial conditions(power up), the economizer valve and the condenser valve remain fully closed.

When economizer cooling is first called for, the economizer valve is driven full open and the condenser valve remains fully closed. The economizer inlet valve will then modulate in response to supply air temperature.

Whenever the supply air fan is off, both valves are positioned to shut off total unit water flow.

The Cooling Tower/Condenser Water Pump Interlock output is energized only when water is required.

## Physical/Mechanical

Mechanically cleanable or non-cleanable economizer coils are available. The low capacity coil is available only as a cleanable coil.

All economizer (standard and energy saving) control valves and piping between the economizer coil and condenser are factory installed and are located within the unit enclosure.

All wiring between controls and control valves, etc., is completed at the factory.

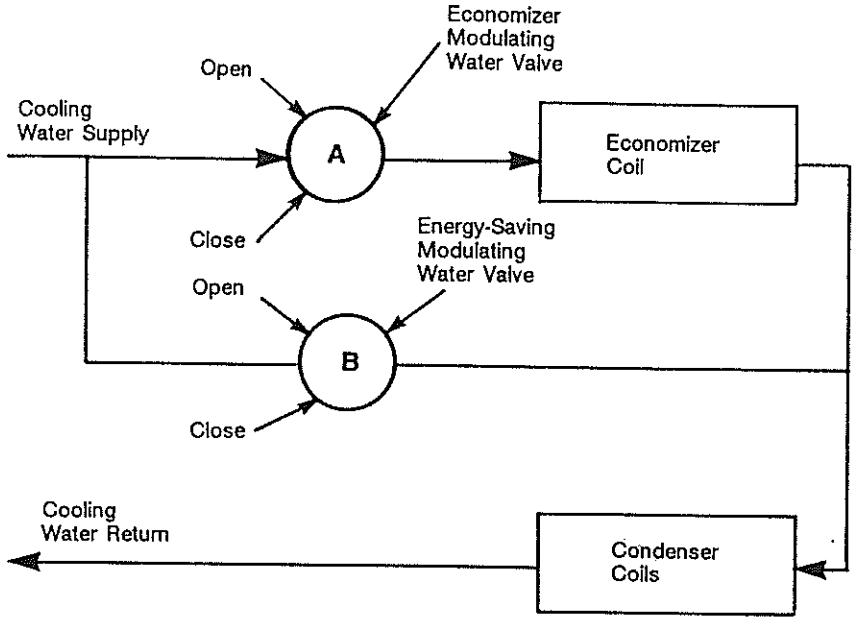
Economizers will be arranged for water connections and controls on the left side of the unit.

Economizer header bleed ports are accessable by removing the right rear corner panel.

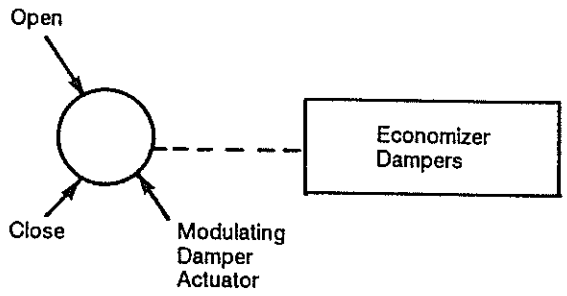
## Waterside/Airside Economizer Control Diagrams

### Std. & Energy-Saving Modulating Waterside Economizer

Notes:
1. For Standard economizer, both water valves are modulated in opposite directions to provide relatively constant water flow through the unit. Total water flow is never shut off.
2. For Energy-Saving economizer, the energy-saving water valve is fully closed during economizing. Both water valves are fully closed when cooling water is not required.

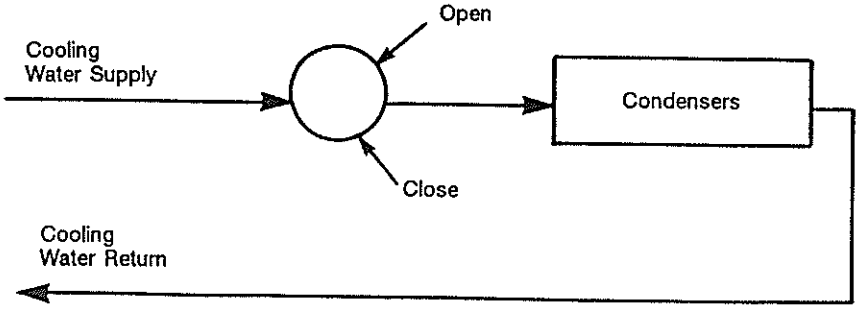



### Airside Economizer w/Minimum Position for Ventilation




### Modulating Water Regulating for Condenser Head Pressure Control

Note: Condenser head pressure control can be used with airside economizer, but not with waterside economizer.



The waterside economizer control sequence is described

CV WATERSIDE ECONOMIZER CONTROL SEQUENCE

| Economizer type | Economizer enable | Operating Mode | Valve control action | |
|---|---|---|---|---|
| | | | Economizer | Condenser |
| Std mod. | True | Economizing | Active | Active |
| | True | E Cool 1-4 | Open | Closed |
| | False | Cool 1-4 | Closed | Open |
| | x | Off | Off | Off |
| | x | Stop/Reset | Closed | Open |
| | x | Auto | Closed | Open |
| | x | Fan on | Closed | Open |
| | x | Pre-Cool | Closed | Open |
| | x | Heat | Closed | Open |
| | x | Max. vent | Closed | Open |
| | x | Freeze prot. | Open | Closed |
| ES mod. | True | Economizing | Active | Closed |
| | True | E Cool 1-4 | Open | Closed |
| | False | Cool 1-4 | Closed | Open |
| | x | Off | Off | Off |
| | x | Stop/Reset | Closed | Closed |
| | x | Auto | Closed | Closed |
| | x | Pre-Cool | Closed | Open |
| | x | Fan on | Closed | Closed |
| | x | Heat | Closed | Closed |
| | x | Max. vent | Closed | Closed |
| | x | Freeze prot. | Open | Closed |

x = don't care

VAV STANDARD WATERSIDE ECONOMIZER CONTROL SEQUENCE

| Economizer type | Economizer enable | Operating Mode | Valve control action | |
|---|---|---|---|---|
| | | | Economizer | Condenser |
| Std mod. | True | Economizing | Active | Active |
| | True | E Cool 1-4 | Open (max.) | Closed |
| | False | Cool 1-4 | Closed | Open (max) |
| | x | Power Off | Off | Off |
| | x | Stop/Reset | Closed | Open |
| | x | Auto | Closed | Open |
| | x | Freeze prot. | Open | Closed |
| | x | Pre Fan | Closed | Open |
| | x | Fan on | Closed | Open |
| | x | Pre Cool | Closed | Open |
| | x | Morning Wm Up | Closed | Open |
| | x | Heat | Closed | Open |
| | x | Max. vent | Closed | Open |

x = don't care

VAV ENERGY SAVING WATERSIDE ECONOMIZER CONTROL SEQUENCE

| Economizer type | Economizer enable | Operating Mode | Valve control action | |
|---|---|---|---|---|
| | | | Economizer | Condenser |
| ES mod. | True | Economizing | Active | Closed |
| | True | E Cool 1-4 | Open (max.) | Closed |
| | False | Cool 1-4 | Closed | Open (max.) |
| | x | Power Off | Off | Off |
| | x | Stop/Reset | Closed | Closed |
| | x | Auto | Closed | Closed |
| | x | Freeze prot. | Open | Closed |
| | x | Pre Fan | Closed | Closed |
| | x | Fan On | Closed | Closed |
| | x | Pre Cool | Closed | Open |
| | x | Morning Wm Up | Closed | Closed |
| | x | Heat | Closed | Closed |
| | x | Max. vent | Closed | Closed |

x = don't care

When the economizer control is active, the valve actuator is controlled according to the control algorithm.

## CONSTANT VOLUME AIRSIDE ECONOMIZING

### Airside Economizer Operation - Non-VAV Units

When outdoor conditions are not suitable for cooling by economizer, the enthalpy control will disable the economizer function and permit the fresh air damper to open only to the minimum position. Cooling demand is met by Cooling Level Steps 1 through 4 compressor operation;

When outdoor conditions are suitable for cooling by economizer, the enthalpy control will permit the economizer to function as a first stage of cooling. The damper position is modulated in response to the zone temperature sensor to maintain the zone temperature setpoint. If additional cooling is required, compressor operation is initiated. During compressor operation, the fresh air damper is fully open.

The airside economizer control sequence is described

CV AIRSIDE ECONOMIZER CONTROL SEQUENCE

| Economizer enable | Operating Mode | Control action |
|---|---|---|
| x | Fan on | Min. pos. if occ |
| x | Fan on | Closed if unoc |
| True | Economizing | Active * |
| True | E Cool 1-4 | Open * |
| False | Cool 1-4 | Min. pos. |
| x | Off | Off |
| x | Stop/Reset | Closed |
| x | Auto | Closed |
| x | Pre-Cool | Min. pos. |
| x | Heat | Min. pos if occ |
| x | Heat | Closed if unoc |
| x | Max. vent | Open |
| x | Freeze prot. | Closed |

x = don't care

* For CV systems, when active or open, the supply air low limit control is activated (airside economizers only)

The CV economizer primary control loop is the same for both the airside and the waterside economizers.

When the economizer control is active, the economizer actuators are controlled according to the required unit supply air temperature. The required supply air temperature is computed by the CV economizer algorithm which provides a supply air temperature setpoint for the unit based on the deviation of the zone temperature from the day cooling setpoint.

Supply temperature low limit protection is provided for units with an airside economizer by bounding the computed supply air setpoint to => 45 deg. F. In addition, if the supply air temperature drops below 45 deg. F during economizer operation, the damper is driven to minimum position. If the supply air temperature rises to => 60 deg. F, normal economizer control resumes.

Ventilation at minimum position is always maintained for the airside economizing units regardless of supply air temperature.

Airside Economizer Operation - VAV Units

When outdoor conditions are not suitable for cooling by economizer, the enthalpy control will disable the economizer function and permit the fresh air damper to open only to the minimum position.

When outdoor conditions are suitable for cooling by economizer, the enthalpy control will permit the economizer to function as a first stage of cooling. Damper position is modulated in response to supply air temperature via the UCM. Compressors may operate as required in response to supply air temperature via the UCM. During compressor operation, the fresh air damper is fully open.

## VAV AIRSIDE ECONOMIZER

Airside economizing control is selected for those applications with an airside economizer and no waterside economizer. Condensing pressure control may or may not be applied with airside economizing.

The economizer logic to enable airside economizing is as follows:

Economizer enable = Enthalpy control (True or False)

When economizing is enabled, cooling is active, and the VAV capacity control calls for an increment in cooling level, the operating mode "Economizing" is entered prior to mechanical cooling.

The control sequence is described

### VAV AIRSIDE ECONOMIZER CONTROL SEQUENCE

| Economizer enable | Operating mode | Economizer control action |
|---|---|---|
| x | Fan on | Min. pos. |
| True | Economizing | Active |
| True | E Cool 1-4 | Open (max.) |
| False | Cool 1-4 | Min. pos. |
| x | Power Off | Off |
| x | Stop/Reset | Closed |
| x | Auto | Closed |
| x | Freeze prot. | Closed |
| x | Pre-Cool | Min. pos |
| x | Morning Wm Up | Closed |
| x | Heat | Min. pos. if occ |
| x | Heat | Closed if unoc |
| x | Max. vent. | Open |

x = don't care

The airside economizer is closed when the supply fan is off.

When the economizer control is active, minimum ventilation is maintained and the economizer actuator is controlled according to the control algorithm.

## Rack for Hot Water Coil or Steam Coil

A factory installed rack will be available which will house a variety of standard steam or hot water coils. The rack must be ordered with the unit, and will ship with the unit.

The rack will include an air distribution baffle to assure relatively even air distribution when the "short coil" is used. The baffle is to be removed and discarded when the "full height" coils are used.

The rack will contain provision to provide coil pitch when steam coils are used.

The rack will permit either side or both side piping of the heating coils. Pipe entrance holes for coil piping must be field cut.

The rack will fit-up directly to the unit face.

The visibly exposed exterior of the coil rack is painted executive beige.

Galvanized steel will be used for rack construction to provide corrosion protection of interior surfaces.

The upstream side of the coil rack incorporates a filter rack for a flat bank of 2" thick filters. Access for filter changeout is from the lift side. The number and size of filters is the same as for unit mounted filters.

## HEATING CONTROL STRATEGY

One stage of electric heat and associated control is available as a factory installed option. Alternatively, one stage of auxiliary heat (e.g. steam or hot water coil) can be field installed and controlled.

The heating control strategy for both VAV and CV systems are discussed together since heating is controlled to maintain a zone temperature in both cases. The following unit configurations and applications exist relating to heating control:

1) VAV: no night heat/MWU option
2) VAV: with night heat/MWU option
3) CV: not a heat/cool unit, no night heat/MWU option
4) CV: not a heat/cool unit, with night heat/MWU option
5) CV: is a heat/cool unit, no night heat/MWU option
6) CV: is a heat/cool unit, with night heat/MWU option

The strategy for VAV systems provides the control of system heat to an unoccupied space (night heat), morning warmup of the conditioned space (early morning prior to occupancy, no outdoor air provided), and maintenance of space comfort before sufficient cooling load exists to require initiation of the VAV system cooling mode (during occupancy, outdoor air provided). Once changeover to VAV cooling mode occurs, heating capability is disabled until the initiation of another unoccupied period.

Like VAV control, the CV control strategy for a non-heat/cool unit with the night heat/MWU option has heat-to-cool changeover capability when the conditioned space is occupied and cooling is required. The unoccupied-MWU-occupied heating sequence exists. Heating is disabled until the initiation of another unoccupied period following the changeover to cooling mode.

For a CV heat/cool unit, where a substantial heating load could exist for much of the time, heat-cool autochangeover capability is provided. This type of unit may or may not have the night heat/MWU option to allow unoccupied and MWU heating control.

In summary, unoccupied CV heating is the same as unoccupied VAV heating and is provided if the night heat/MWU option exists. No cooling capability is provided for either a VAV or a CV system when the space is unoccupied. Heat-cool-heat autochangeover capability is provided if a CV unit is a heat/cool unit.

When the conditioned space is unoccupied, heat and supply fan cycle to maintain the night heat zone temperature at the night heat setpoint. The unoccupied heating control drives operating modes Heat, Fan On, and Auto. Since occupant comfort considerations are waived during unoccupied periods, a simple unoccupied heating control strategy is used to maintain an adequate space temperature that reduces the heat and supply fan cycle rate.

When morning warmup is initiated, the heat is controlled using the morning warmup/day heat zone temperature sensor and morning warmup/day heating setpoint. The unit will enter MWU on exit from unoccupied mode if the conditioned space requires heating.

Following the morning warm up cycle, the conditioned space is occupied, ventilation is provided and the heat is controlled to maintain the morning warmup/day heat zone temperature at the morning warmup/day heat setpoint. Heating mode is retained after the termination of MWU until the system requires cooling. Occupied heating control drives operating modes Heat and Fan on.

The heating control action is "on" for the operating modes Heat and MWU and "off" for the remaining modes.

One notable internal state is identified for heating control. A function is provided which requires sufficient air flow through the unit before heating can be started. However, this feature is based on the supply air pressure and is only provided for units which have supply air pressure measurement capability (VAV w/supply air pressure control or CV w/supply fan fail diagnostic).

The unoccupied heating cycle is described in terms of a typical operating sequence:

| | Action | Current operating mode |
|---|---|---|
| a) | Control algorithm calls for heat. | "Auto" |
| b) | Supply fan starts. | "Fan On" |
| c) | Proof of air flow. (if applicable) | "Fan On" |
| d) | Heat turns on. | "Heat" |
| e) | Control algorithm satisfies. | "Heat" |
| f) | Heat and fan turn off. | "Auto" |

The occupied heating control is described in terms of a typical operating sequence with the supply fan presently running:

| | Action | Current operating mode |
|---|---|---|
| a) | Control algorithm calls for heat. | "Fan on" |
| b) | Heat turns on. | "Heat" |
| c) | Control algorithm satisfies. | "Heat" |
| d) | Heat turns off. | "Fan on" |

Mode transitions:

Three control modes for heating operation are identified: "unoccupied", "MWU", and "occupied".

SERIAL COMMUNICATION

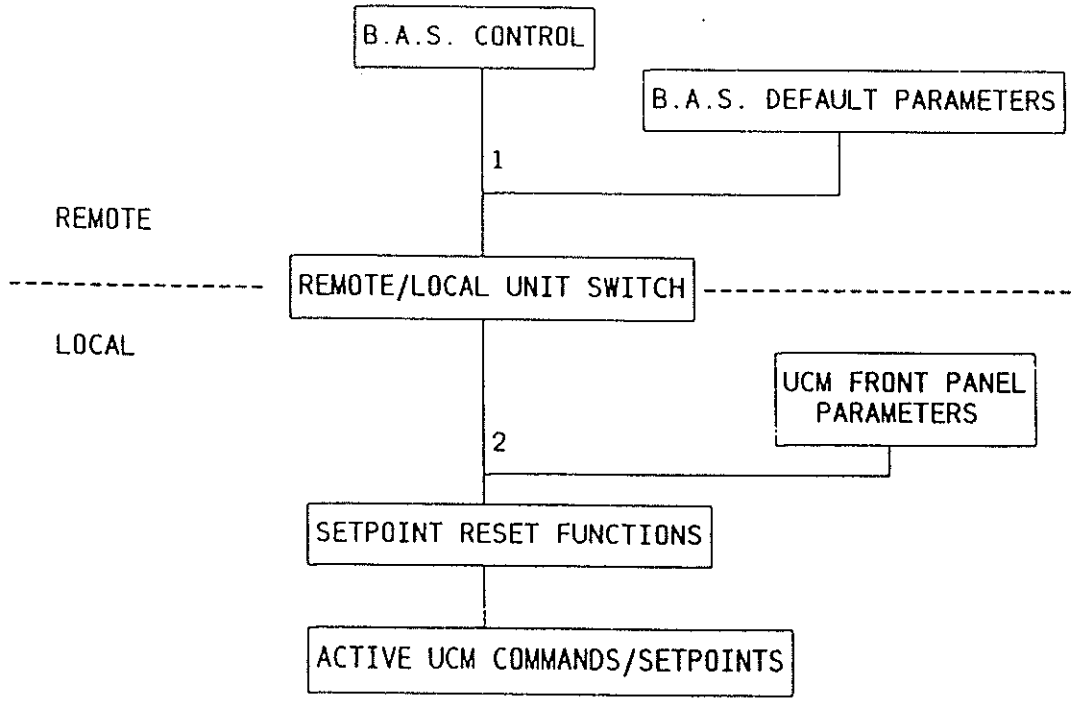
For remote control of the UCM, command codes and setpoints are communicated.

Major communicated variables for building automation control use include:
REMOTE HEATING AND COOLING STAGE LIMIT
REMOTE AIR PRESSURE SETPOINT
REMOTE SUPPLY AIR TEMPERATURE SETPOINT
REMOTE DAY HEATING TEMPERATURE SETPOINT
REMOTE NIGHT HEATING TEMPERATURE SETPOINT
REMOTE ECONOMIZER MINIMUM POSITION
BAS UNIT COMMAND WORD

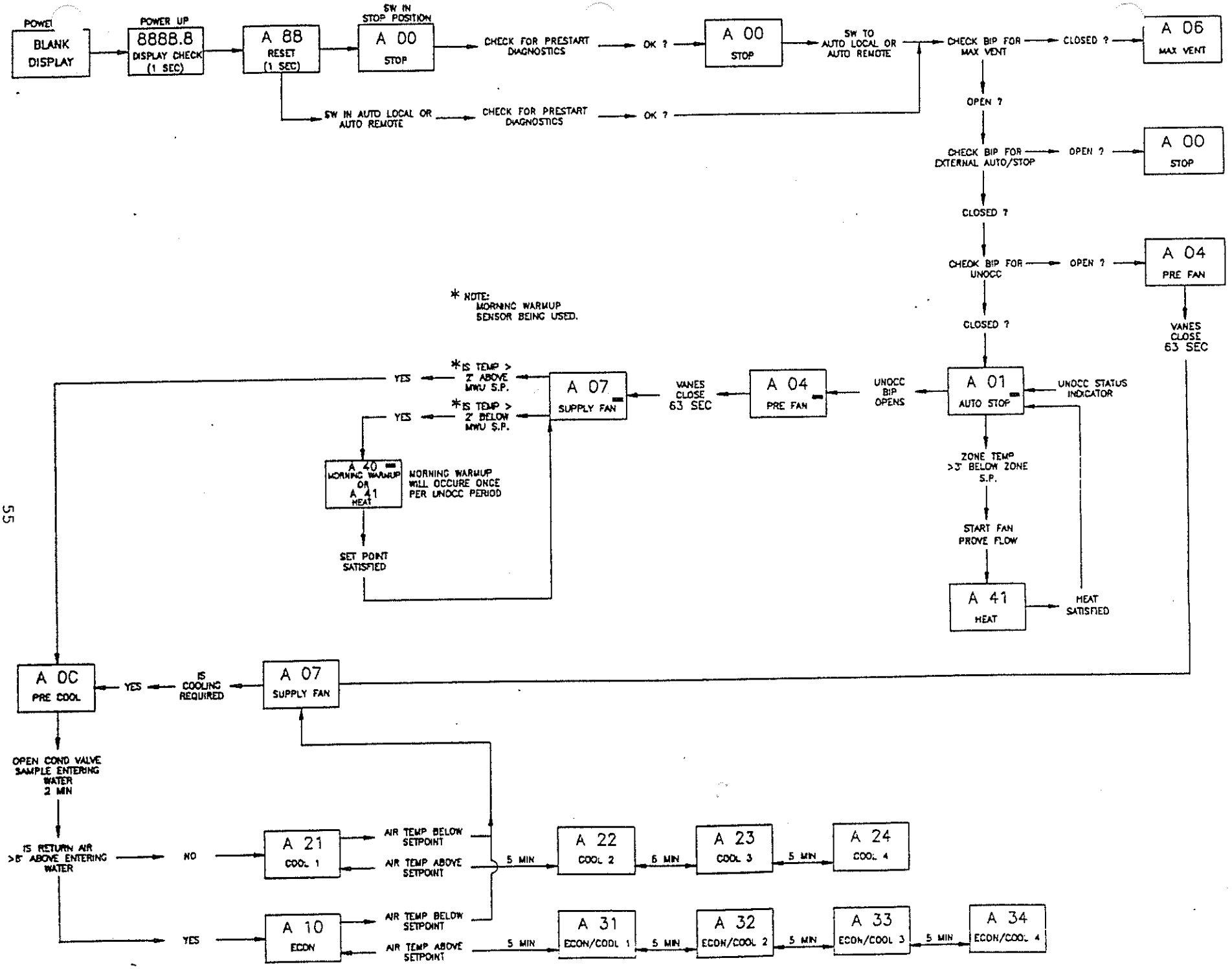
SYSTEM LEVEL COMMAND AND SETPOINT HIERARCHY

The UCM with communications and reset functions form a hierarchal system with internal logic set such that at any one time one and only one source of command information is presented to the unit control for operation.

A building automation computer can directly download setpoints to the operating unit, and can download default setpoints to be used in the event that the communications link fails. The unit switch allows the user to select between BAS active control/BAS default(REMOTE switch position), and front panel/reset functions (LOCAL switch position). Setpoint reset functions can be switched on or off via service switches on the UCM.
The building automation computer can download active setpoints directly or use the setpoint reset function for temperature sensor based reset.



# O P E R A T I O N A L  M O D E S


POWER
BLANK DISPLAY
POWER UP
8888.8
DISPLAY CHECK (1 SEC)
A 88
RESET (1 SEC)
SW IN STOP POSITION
A 00
STOP
CHECK FOR PRESTART DIAGNOSTICS
OK ?
A 00
STOP
SW TO AUTO LOCAL OR AUTO REMOTE
CHECK BIP FOR MAX VENT
CLOSED ?
A 06
MAX VENT
SW IN AUTO LOCAL OR AUTO REMOTE
CHECK FOR PRESTART DIAGNOSTICS
OK ?
OPEN ?
CHECK BIP FOR EXTERNAL AUTO/STOP
OPEN ?
A 00
STOP
CLOSED ?
CHECK BIP FOR UNOCC
OPEN ?
A 04
PRE FAN
VANES CLOSE 63 SEC
CLOSED ?
* NOTE:
MORNING WARMUP
SENSOR BEING USED.
A 01
AUTO STOP
UNOCC STATUS INDICATOR
UNOCC BIP OPENS
A 04
PRE FAN
VANES CLOSE 63 SEC
A 07
SUPPLY FAN
*IS TEMP > 2° ABOVE MWU S.P.
YES
*IS TEMP > 2° BELOW MWU S.P.
YES
A 40
MORNING WARMUP
OR
A 41
HEAT
MORNING WARMUP WILL OCCURE ONCE PER UNOCC PERIOD
SET POINT SATISFIED
ZONE TEMP >3° BELOW ZONE S.P.
START FAN PROVE FLOW
A 41
HEAT
HEAT SATISFIED
A 0C
PRE COOL
YES
IS COOLING REQUIRED
A 07
SUPPLY FAN
OPEN COND VALVE SAMPLE ENTERING WATER 2 MIN
IS RETURN AIR >5° ABOVE ENTERING WATER
NO
A 21
COOL 1
AIR TEMP BELOW SETPOINT
AIR TEMP ABOVE SETPOINT
5 MIN
A 22
COOL 2
5 MIN
A 23
COOL 3
5 MIN
A 24
COOL 4
YES
A 10
ECON
AIR TEMP BELOW SETPOINT
AIR TEMP ABOVE SETPOINT
5 MIN
A 31
ECON/COOL 1
5 MIN
A 32
ECON/COOL 2
5 MIN
A 33
ECON/COOL 3
5 MIN
A 34
ECON/COOL 4

## OPERATING STATES

| Operating States | Code |
|---|---|
| STOP | 00 |
| AUTO | 01 |
| | |
| PRE-FAN | 04 |
| LOW ENT. AIR TEMP. PROTECTION | 05 |
| MAXIMUM VENTILATION | 06 |
| SUPPLY FAN ON | 07 |
| PRE-COOL | 0C |
| | |
| ECONOMIZING | 10 |
| COOLING LEVEL 1 | 21 |
| COOLING LEVEL 2 | 22 |
| COOLING LEVEL 3 | 23 |
| COOLING LEVEL 4 | 24 |
| | |
| ECON/COOLING LEVEL 1 | 31 |
| ECON/COOLING LEVEL 2 | 32 |
| ECON/COOLING LEVEL 3 | 33 |
| ECON/COOLING LEVEL 4 | 34 |
| | |
| MORNING WARMUP | 40 |
| HEAT | 41 |
| RESET | 88 |

The display is always lit when power is on. All 8's will be displayed as a display test when the unit is initially powered up.

Operating State Description

Stop

All outputs are de-energized upon entry except for the actuator outputs. The actuator outputs are driven to initial positions and the associated outputs are then de-energized.

Auto

All the outputs are de-energized with the exception of the alarm, and any actuator outputs. The alarm output remains energized if an alarm condition exists. The actuators may be driving to initial positions.

Pre-Fan

The UCM has a fan on command and is waiting 60 seconds before the fan contactor is energized.

## LOW ENTERING AIR TEMPERATURE PROTECTION

The machine is driven to this state when low entering air temperature exist, $37^{o}$ $+0^{o}/-2^{o}$ F, reset > $39^{o}$ F. The unit is shut down and special conditions are set up to try to prevent freezing of any unit parts.

When the machine is driven to this state due to low entering air temperature, all compressors and the supply air fan are shut off. The optional cooling tower/condenser water pump interlock output is energized, all water valves are positioned for full water flow through the economizer and machine. The common alarm output is energized. The optional inlet guide vanes are closed, the optional unoccupied output is energized, and the airside economizer outdoor air dampers are closed when present.

ENTRY TO THIS STATE:

a. From STOP

EXIT FROM THIS STATE:

a. To AUTO when the unit switch had been in the Auto position all during the period of time the machine was in the LOW ENTERING AIR TEMPERATURE PROTECTION state and entering air temperature is warm enough
b. To STOP if the unit switch is in the stop position and the entering air temperature is warm enough
c. To RESET if the unit switch has transitioned from Stop/Reset to Auto during the period of time the machine was in the LOW ENTERING AIR TEMPERATURE PROTECTION state and entering air temperature is warm enough

## MAXIMUM VENTILATION

The maximum ventilation mode is initiated when the Fan-on/Ventilate input signal switches from open to closed. The supply fan is turned on, the optional ventilation output is energized, and if an airside economizer is installed, it is driven to its full open position. The water valves are driven to initial positions.

The supply fan is on and the duct pressure control loop is made active by enabling the inlet guide vanes/inverter speed reference outputs. The common alarm output is or remains energized if an alarm condition exists. The optional unoccupied output is energized. The optional ventilation output is energized. No change is made in the optional heat/cool mode output; it remains energized or de-energized as it had been prior to entering the state. All water valves are driven to initial positions. An airside economizer is driven to its maximum open position. The optional dirty filter output is energized if the dirty filter input is true.

ENTRY TO THIS STATE:

a. Immediate from all states when the Fan-on/Ventilate input is closed

EXIT FROM THIS STATE:

a. To SUPPLY FAN ON upon the opening of the Fan-on/Ventilate input
b. To STOP

SUPPLY FAN ON

The supply fan is on and the optional VAV duct pressure control loop is made active by enabling the inlet guide vanes, inverter ready, or inverter options.

PRE-COOL

The optional cooling tower/condenser water pump interlock is energized if it had not been previously. Entering air temperature and entering economizer water temperature are being sampled to determine whether the economizing or cooling level 1 path is to be taken. The unit also reverts to this state when a call for cooling exists with no compressors or economizer available.

ECONOMIZING

The unit entering economizer water temperature is $8^{\circ}$ F or more below the entering air temperature and is providing cooling using the waterside economizer. For airside economizer, if enthalpy is good, the airside economizer damper is modulated to provide cooling.

COOLING LEVEL 1 - 4

Compressors are cycled based on the need for cooling.

ECONOMIZING/COOLING LEVEL 1 - 4

There is full water flow through the waterside economizer or maximum outdoor airflow through the airside economizer. Compressors are cycled based on the need for cooling. The optional cooling tower/condenser water pump interlock output is energized whenever mechanical cooling is required if an airside economizer is used.

## HEAT

The optional heat output is energized on the need for heat. The full bank of unit electric heaters will be turned on if installed. The duct pressure control loop is active.

## MORNING WARMUP

Optional morning warmup is initiated when the unoccupied input signal switches from closed to open. The optional heat output is energized and the unit stays in the morning warmup until the morning warmup temperature setpoint is satisfied.

## HISTORY REGISTER

The UCM will retain a diagnostic code history register. Status of the last diagnostic code detected and each malfunction diagnostic code that is detectable by the machine will be stored in volatile memory. The codes can be read on the display by using the Advance Display button. The code list explanation is printed on a label on the front of the unit.

There are two different types of diagnostics reset: one for current diagnostic conditions, and one for resetting history diagnostics. The current failure diagnostic codes are reset when the unit switch is moved from the Stop/Reset position to the Auto Local or Auto Remote position. All historical diagnostics are retained until the Advance Display button is depressed when the Unit Switch is moved from the Auto Local to the Stop/Reset position.

## DIAGNOSTIC CONDITIONS

The machine is protected from possible damage due to the limits or conditions noted below being exceeded or violated. The diagnostic specified (see diagnostic section) is indicated when the machine or portion of the machine is taken out of service for the reason stated. The action specified is taken by the unit control module to prevent or minimize personnel or machine damage. Operator action, if any, required to restore full machine operation is specified. The common alarm output will be energized whenever any diagnostic occurs unless otherwise stated.

## CONTROL STATES AND SEQUENCES

Major control sequences for the UCM are governed by equipment interlocks, occupied/unoccupied status, cooling or heating demand, economizing conditions, unit operating limit conditions, detected sensor or equipment failures, and the front panel UNIT SWITCH.

The UNIT SWITCH can be placed in either the AUTO/LOCAL or AUTO/REMOTE position. This results in different setpoints and unit operating commands, according to what may be present from the BAS communication. Transitions in unit commands are handled as if the unit switch position was changed. Setpoint transitions are limited and handled by the control algorithms, and are not normally expected to result in a mode change.

Diagnostic conditions are detected and reported using a hexadecimal code format. Diagnostic conditions may:

1) Result in an operating mode change
2) Lockout or shutdown all compressors
3) Shutdown the entire unit
4) Shutdown or lockout an affected compressor
5) Present information without change in unit status

GENERAL 24 HOUR OPERATING SEQUENCES, WITH CONTROL SETPOINT & SENSOR
FOR ALL CONTROL CONFIGURATION VARIATIONS

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **1. VAV COOL ONLY** | OCCUPIED COOL | AUTO (UNIT NOT RUNNING) | | |
| SETPOINT | SUPPLY AIR | | | |
| SENSOR | SUPPLY AIR | | | |

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **2. VAV COOL W/ NH/MWUP** | OCCUPIED COOL | UNOCC HEAT / MORNING WARMUP | | OCCUPIED HEAT |
| SETPOINT | SUPPLY AIR | NIGHT HEAT | MORNING WARMUP | MORNING WARMUP |
| SENSOR | SUPPLY AIR | NIGHT HEAT | MORNING WARMUP | MORNING WARMUP |

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **3. CV COOL ONLY** | OCCUPIED COOL | AUTO (UNIT NOT RUNNING) | | |
| SETPOINT | DAY COOLING | | | |
| SENSOR | ZONE | | | |

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **4. CV COOL W/ NH/MWUP** | OCCUPIED COOL | UNOCC HEAT / MORNING WARMUP | | OCCUPIED HEAT |
| SETPOINT | DAY COOLING | NIGHT HEAT | MORNING WARMUP | MORNING WARMUP |
| SENSOR | ZONE | ZONE | ZONE | ZONE |

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **5. CV HEAT/COOL** | OCCUPIED HEAT/COOL | AUTO (UNIT NOT RUNNING) | | |
| SETPOINT | DAY COOLING<br>DAY HEATING | | | |
| SENSOR | ZONE | | | |

| | DAY OPERATION | NIGHT OPERATION / TRANSITION TO DAY | | |
|---|---|---|---|---|
| **6. CV HEAT/COOL W/ NH/MWUP** | OCCUPIED HEAT/COOL | UNOCC HEAT / MORNING WARMUP | | OCCUP HEAT/COOL |
| SETPOINT | DAY COOLING<br>DAY HEATING | NIGHT HEAT | MORNING WARMUP | DAY COOLING<br>DAY HEATING |
| SENSOR | ZONE | ZONE | ZONE | ZONE |

## BASIC UNIT CONTROL OPERATING SEQUENCES

Unit control sequences are described by major operations, with transitions between static states identified as entry procedures or conditions. Additional detail is provided by the listing for diagnostic codes/conditions, and control sequence timing parameters.

Sequence descriptions are in the form:

Entry Procedures: Static control conditions held throughout unit operation
Mode Operation: Dynamic control sequences and conditions occuring during the unit operation.
Exit conditons: The unit operations which may become the next unit operation if exit criteria are met.

### CONSTANT VOLUME AND VAV UNIT POWER OFF

Entry Procedures: From all states, power down sequences.
Mode Operations: No power available, no controlled actions possible. No front panel display is present.
Exit to mode:
To INTERNAL INITIALIZATION when unit power applied.

## CONSTANT VOLUME AND VAV UNIT INTERNAL INITIALIZATION

Entry Procedures: Unit power on, DC power up and processor reset/start hardware procedures

Mode operations:
- Internal initialization of all parameters
- Internal processing system test
- Front panel display test (88888)
- Exit is made to a stop mode if all internal tests and initializations are complete
- If an internal failure is detected, and the microprocessor is able, the controller failure diagnostic (FF) will appear on the front panel display, and no exit occurs

Exit to mode:

If VAV system,
VAV STOP
If Constant Volume system,
CONSTANT VOLUME STOP

**CONSTANT VOLUME STOP**

Entry Procedures: Stop all compressors (Unstaged stop)
Stop fan
Unoccupied mode output: OFF
Ventilation output: OFF
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: operate to close completely

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
Condenser water valve: Fully closed

w/UNIT ID DIAGNOSTIC (F8)
Economizer water valve: Fully open
Condenser water valve: Fully open

Mode operations: Monitor sensor inputs.

Valid operating modes

| | |
|---|---|
| Stop | 00 |

STOP operation is maintained if:
- -Unit switch remains in the STOP position unless overridden by LOW ENTERING AIR TEMPERATURE PROTECTION.
- -EXTERNAL INTERLOCK is in the DISABLE condition, unless overridden by LOW ENTERING AIR TEMPERATURE PROTECTION or MAXIMUM VENTILATION.

Exit to an active mode is made if STOP operation is not maintained by any of the above conditions.

Exit to mode:

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING
C.V. OCCUPIED COOLING
C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING

If FAN ON/VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME LOW ENTERING AIR TEMPERATURE PROTECTION

Entry Procedures:
- Stop all compressors (Unstaged stop)
- Stop fan
- Unoccupied mode output: From prior mode
- Ventilation output: OFF
- Cooling tower/Cond Water Pump Interlock: ON
- Heat output: ON
- Heat/Cool output: Heat

w/AIRSIDE ECONOMIZER
- Airside economizer: operate to close completely
- (Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: Fully open
- Condenser water valve: Fully closed

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: Fully open
- Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
- Condenser water valve: Fully open
- (Airside economizer outputs in closed position)

w/UNIT ID DIAGNOSTIC (F8)
- Economizer water valve: Fully open
- Condenser water valve: Fully open

Mode operations: Maintain water flow through condenser and waterside economizer if present and stop all airflow through unit to inhibit condenser water freeze. Heat output is turned on to active external heat source, if present. This mode is initiated and maintained by the diagnostic (CF) entering air sensor low temperature. BAS override of Heat 1 and Ventilation outputs are not allowed.

Exit is made when the diagnostic (CF) is reset.
Exit is made to maximum ventilation, which takes precedence, unless unit switch is in STOP position.

Valid operating modes
- Low Entering Air Temperature Protection 05

Exit to mode:

If OCCUPIED, & Night Heat/Morning Warmup option installed,
- C.V. MORNING WARMUP

If OCCUPIED,
- C.V. OCCUPIED SUPPLY FAN ON
- C.V. OCCUPIED HEATING
- C.V. OCCUPIED COOLING
- C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
- C.V. UNOCCUPIED
- C.V. UNOCCUPIED HEATING

If FAN ON/VENTILATE,
- C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME MAXIMUM VENTILATION

Entry Procedures:
- Stop all compressors (Unstaged stop)
- Fan start or continue to run (display 06)
- Unoccupied mode output: OFF
- Ventilation output: OFF
- Cooling tower/Cond Water Pump Interlock: OFF
- Heat output: OFF
- Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
- Airside economizer: operate to OPEN completely
- (Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: Fully closed
- Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: Fully closed
- Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL
- Condenser water valve: Fully closed
- w/ Air. economizer - Airside econ.: fully open
- w/o Air. economizer - Air. econ.: from prior state

w/UNIT ID DIAGNOSTIC (F8)
- Economizer water valve: Fully open
- Condenser water valve: Fully open

Mode operations: Provide ventilation to the occupied space.

Valid operating modes:

| | |
|---|---|
| Maximum ventilation | 06 |

THIS MODE IS MAINTAINED BY THE FAN-ON/VENTILATE INPUT, UNLESS OVERRIDDEN BY THE UNIT SWITCH IN THE STOP POSITION OR A UNIT SHUTDOWN DIAGNOSTIC: dA, E6, CE, FE.

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- C.V. OCCUPIED SUPPLY FAN ON
- C.V. OCCUPIED HEATING
- C.V. OCCUPIED COOLING
- C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
- C.V. UNOCCUPIED
- C.V. UNOCCUPIED HEATING

**CONSTANT VOLUME OCCUPIED SUPPLY FAN ON**

Entry Procedures: Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: open to minimum position
(Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o airside econ.)
Condenser water valve: Fully closed

Mode operations: Ventilation of occupied space.

Valid operating modes:

| | |
|---|---|
| Supply Fan On | 07 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
C.V. OCCUPIED HEATING
C.V. OCCUPIED COOLING
C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING

If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED HEATING

Entry Procedures:
- Fan start (04) or continue to run (07)
- Unoccupied mode output: OFF
- Ventilation output: ON
- Cooling tower/Cond Water Pump Interlock: OFF
- Heat output: OFF
- Heat/Cool output: ON

w/AIRSIDE ECONOMIZER
- Airside economizer: open to minimum position

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o airside econ.)
- Condenser water valve: close

Mode operations: Heating capacity control according to zone temperature to meet day heating temperature setpoint.

Valid operating modes:

| | |
|---|---|
| Supply Fan On | 07 |
| Heating Level 1 | 41 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- C.V. OCCUPIED SUPPLY FAN ON
- C.V. OCCUPIED COOLING
- C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
- C.V. UNOCCUPIED
- C.V. UNOCCUPIED HEATING

If FAN ON VENTILATE,
- C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED COOLING

Entry Procedures:
Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Heat output: OFF
Heat/Cool output: OFF
Pre-cool procedure (0C):
Cooling tower/Cond Water Pump Interlock: ON

w/CONDENSER HEAD PRESSURE CONTROL
Condenser water valve: Fully open

Mode operations:
Cooling capacity control according to zone temperature to meet day cooling temperature setpoint. If condenser head pressure control is present, it is active.

Valid operating modes:

| | |
|---|---|
| Cooling Level 1 | 21 |
| Cooling Level 2 | 22 |
| Cooling Level 3 | 23 |
| Cooling Level 4 | 24 |

Exit to mode:
If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING
If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING
If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED COOLING W/AIRSIDE ECONOMIZER

Entry Procedures: Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Heat output: OFF
Heat/Cool output: OFF
Airside economizer: open to minimum position

Mode operations: IF ECONOMIZING:
Cooling tower/cond wtr pump interlock: OFF
Condenser water valve: close
Modulate airside economizer damper according to zone temperature to meet day cooling setpoint
Valid operating modes:
Economizing 10
OR IF ECONOMIZING WITH MECHANICAL COOLING:
Pre-cool procedure (10):
Cooling tower/cond wtr pump interlock: ON
W/CONDENSER HEAD PRESSURE CONTROL:
Condenser water valve: fully open
Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint; head pressure control active if present; maintain airside economizer damper fully open (low temperature limit may cause damper to modulate).
Valid operating modes:
Pre-Cool/Economizing 10
Econ/Cooling level 1,2,3,4 31,32,33,34
OR IF NOT ECONOMIZING:
Pre-cool procedure (0C):
Cooling tower/cond wtr pump interlock: ON
W/CONDENSER HEAD PRESSURE CONTROL:
Condenser water valve: fully open
Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint; head pressure control active if present; maintain airside economizer at minimum position.
Valid operating modes:
Pre-cool 0C
Cooling level 1,2,3,4 21,22,23,24

Exit to mode:
If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING
If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING
If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED COOLING W/STANDARD WATERSIDE ECONOMIZER

Entry Procedures: Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Heat output: OFF
Heat/Cool output: OFF
If call for economizing due to $3^{o}$ F zone error (07):
Cooling tower/Cond Water Pump Interlock: ON
Condenser water valve: open
Economizer water valve: close

Mode operations:

IF ECONOMIZING:

Open economizer water valve, close condenser water valve, then modulate economizer water valve according to zone temperature to meet day cooling setpoint.

Valid operating modes:

Economizing 10

OR

Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint and maintain economizer water valve open, condenser water valve closed.

Valid operating modes:

Econ/cooling level 1,2,3,4 31,32,33,34

In both cases when the economizer water valve is being modulated, the condenser water valve is modulated in opposite direction to maintain constant water flow.

IF NOT ECONOMIZING:

Pre-cool procedure (0C):
Cooling tower/cond water pump interlock: ON
Condenser water valve: open
Economizer water valve: close

Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint and maintain condenser water valve open; economizer water valve is closed.

Valid operating modes:

Cooling level 1,2,3,4 21,22,23,24

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING

If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING

If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED COOLING W/ENERGY SAVING WATERSIDE ECON.

Entry Procedures: Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Heat output: OFF
Heat/Cool output: OFF
If call for economizing due to $3^{o}$ F zone error (07):
Cooling tower/Cond Water Pump Interlock: ON
Condenser water valve: open
Economizer water valve: close

Mode operations:

IF ECONOMIZING:

Open economizer water valve, close condenser water valve, then modulate economizer water valve according to zone temperature to meet day cooling setpoint.

Valid operating modes:

| | |
|---|---|
| Economizing | 10 |

OR

Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint and maintain economizer water valve open, condenser water valve closed.

Valid operating modes:

| | |
|---|---|
| Econ/cooling level 1,2,3,4 | 31,32,33,34 |

IF NOT ECONOMIZING:

Pre-cool procedure (0C):
Cooling tower/cond water pump interlock: ON
Condenser water valve: open
Economizer water valve: close

Modulate mechanical cooling capacity according to zone temperature to meet day cooling setpoint and maintain condenser water valve open; economizer water valve is closed.

Valid operating modes:

| | |
|---|---|
| Cooling level 1,2,3,4 | 21,22,23,24 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING

If UNOCCUPIED,
C.V. UNOCCUPIED
C.V. UNOCCUPIED HEATING

If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME UNOCCUPIED (STOP)

Entry Procedures:
- Stop all compressors (Unstaged stop)
- Stop fan
- Unoccupied mode output: ON
- Ventilation output: OFF
- Cooling tower/Cond Water Pump Interlock: OFF
- Heat output: OFF
- Heat/Cool output: ON

w/AIRSIDE ECONOMIZER
- Airside economizer: close

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
- Condenser water valve: Fully closed

Mode operations: Unit is stopped until another operation is initiated.

Valid operating modes

| | |
|---|---|
| Auto | 01 |

Exit to mode:

If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- C.V. OCCUPIED SUPPLY FAN ON
- C.V. HEATING
- C.V. OCCUPIED COOLING
- C.V. OCCUPIED COOLING W/ECONOMIZER

If FAN ON/VENTILATE,
- C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME UNOCCUPIED HEATING (NIGHT HEAT)

Entry Procedures:

Fan start (04) or continue to run (07)
Unoccupied mode output: ON
Ventilation output: OFF
Heat output: OFF
Heat/Cool output: ON
Cooling tower/cond water pump interlock: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: close

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
Condenser water valve: Fully closed

Mode operations:

Fan is cycled on and off with heat according to demand by heating control algorithm to satisfy night heat setpoint according to zone temperature sensor.

Valid operating modes

| | |
|---|---|
| Auto | 01 |
| Pre-fan | 04 |
| Supply fan on | 07 |
| Heating level 1 | 41 |

Exit to mode:

If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED, & Night heat/morning warmup option installed,
C.V. MORNING WARMUP

If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED COOLING
C.V. OCCUPIED COOLING W/ECONOMIZER

If FAN ON/VENTILATE,
C.V. MAXIMUM VENTILATION

**CONSTANT VOLUME MORNING WARMUP**

Entry Procedures:
Fan start (04) or continue to run (07)
Unoccupied mode output: From prior mode
(normally ON, as entry is from unoccupied)
Ventilation output: OFF
Heat output: From prior mode
Heat/Cool output: ON
Cooling tower/cond water pump interlock: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: close

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

Mode operations:
Maintain heat on until zone temperature satisfies morning warmup setpoint, then exit. Upon any exit, further morning warmup is locked out unless another unoccupied/occupied cycle or low entering air temperature protection occurs.

Valid operating modes

| | |
|---|---|
| Morning warmup | 40 |

Exit to mode:
If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED HEATING/MORNING WARMUP TERMINATION
If UNOCCUPIED,
C.V. UNOCCUPIED HEATING
If FAN ON/VENTILATE,
C.V. MAXIMUM VENTILATION

## CONSTANT VOLUME OCCUPIED HEATING/MORNING WARMUP TERMINATION

Entry Procedures:

Fan start (04) or continue to run (07)
Unoccupied mode output: OFF
Ventilation output: ON
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: ON

w/AIRSIDE ECONOMIZER
Airside economizer: open to minimum position
(Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o airside econ.)
Condenser water valve: fully closed

Mode operations:

Heating capacity control according to zone temperature to meet morning warmup setpoint. Upon any exit, further morning warmup is locked out unless another unoccupied/occupied cycle or low entering air temperature protection occurs.

Valid operating modes:

| | |
|---|---|
| Supply Fan On | 07 |
| Heating Level 1 | 41 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
C.V. STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
C.V. LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
C.V. OCCUPIED SUPPLY FAN ON
C.V. OCCUPIED COOLING
C.V. OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
C.V. UNOCCUPIED HEATING

If FAN ON VENTILATE,
C.V. MAXIMUM VENTILATION

**VARIABLE AIR VOLUME STOP**

Entry Procedures: Stop all compressors (Unstaged stop)
Stop fan
Inlet guide vanes: close completely
/Inverter speed signal: min. speed reference
Unoccupied mode output: OFF
Ventilation output: OFF
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: operate to close completely

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
Condenser water valve: Fully closed

w/UNIT ID DIAGNOSTIC (F8)
Economizer water valve: Fully open
Condenser water valve: Fully open

Mode operations: Monitor sensor inputs.

Valid operating modes

| | |
|---|---|
| Stop | 00 |

STOP operation is maintained if:
- -Unit switch remains in the STOP position, unless overridden by LOW ENTERING AIR TEMPERATURE PROTECTION.
- -EXTERNAL INTERLOCK is in the DISABLE condition, unless overridden by LOW ENTERING AIR TEMPERATURE PROTECTION or MAXIMUM VENTILATION.

Exit to an active mode is made if STOP operation is not maintained by any of the above conditions.

Exit to mode:

If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON
VAV OCCUPIED COOLING
VAV OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
VAV UNOCCUPIED
VAV UNOCCUPIED HEATING

If FAN ON/VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME LOW ENTERING AIR TEMPERATURE PROTECTION

Entry Procedures:
- Stop all compressors (Unstaged stop)
- Stop fan
- Inlet guide vanes: close completely
- /Inverter speed signal: min. speed reference
- Unoccupied mode output: ON
- Ventilation output: OFF
- Cooling tower/Cond Water Pump Interlock: ON
- Heat output: ON
- Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
- Airside economizer: operate to close completely
- (Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: Fully open
- Condenser water valve: Fully closed

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: Fully open
- Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
- Condenser water valve: Fully open
- (Airside economizer outputs in closed position)

w/UNIT ID DIAGNOSTIC (F8)
- Economizer water valve: Fully open
- Condenser water valve: Fully open

Mode operations: Maintain water flow through condenser and waterside economizer if present and stop all airflow through unit to inhibit condenser water freeze. Heat output is turned on to active external heat source, if present. This mode is initiated and maintained by the diagnostic (CF) entering air sensor low temperature. BAS override of Heat 1 and Ventilation outputs are not allowed.

Exit is made when the diagnostic (CF) is reset.
Exit is made to maximum ventilation, which takes precedence, unless unit switch is in STOP position.

Valid operating modes

| | |
|---|---|
| Low Entering Air Temperature Protection | 05 |

Exit to mode:

If OCCUPIED, & Night Heat/Morning Warmup option installed,
- VAV MORNING WARMUP

If OCCUPIED,
- VAV OCCUPIED COOLING
- VAV OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
- VAV UNOCCUPIED
- VAV UNOCCUPIED HEATING

If FAN ON/VENTILATE,
- VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME MAXIMUM VENTILATION

Entry Procedures:

Stop all compressors (Unstaged stop)
Fan start or continue to run (display 06)
Inlet guide vanes: operate to close completely prior to fan start
/Inverter speed signal: minimum speed reference prior to fan start
Unoccupied mode output: OFF
Ventilation output: ON
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: operate to OPEN completely
(Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: Fully closed
Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL
Condenser water valve: Fully closed
w/ Air. economizer - Airside econ.: fully open
w/o Air. economizer - Air. econ.: from prior state

w/UNIT ID DIAGNOSTIC (F8)
Economizer water valve: Fully open
Condenser water valve: Fully open

Mode operations:

Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint. Provide ventilation to the occupied space.

Valid operating modes:

Maximum ventilation 06

THIS MODE IS MAINTAINED BY THE FAN-ON/VENTILATE INPUT, UNLESS OVERRIDDEN BY THE UNIT SWITCH IN THE STOP POSITION OR A UNIT SHUTDOWN DIAGNOSTIC: dA, E6, CE, FE.

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON
VAV OCCUPIED COOLING
VAV OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
VAV UNOCCUPIED HEATING

## VARIABLE AIR VOLUME OCCUPIED SUPPLY FAN ON

Entry Procedures:
- Fan start (04) or continue to run (07)
- Inlet Guide Vanes: operate to close completely prior to fan start
- /Inverter speed signal: minimum speed reference prior to fan start
- Unoccupied mode output: OFF
- Ventilation output: ON
- Cooling tower/Cond Water Pump Interlock: OFF
- Heat output: OFF
- Heat/Cool output: OFF

w/AIRSIDE ECONOMIZER
- Airside economizer: open to minimum position
- (Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: Fully closed
- Condenser water valve: Fully open

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: Fully closed
- Condenser water valve: Fully closed

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o airside econ.)
- Condenser water valve: Fully closed

Mode operations: Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint. Ventilation of occupied space.

Valid operating modes:

| | |
|---|---|
| Supply Fan On | 07 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- VAV OCCUPIED COOLING
- VAV OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
- VAV UNOCCUPIED
- VAV UNOCCUPIED HEATING

If FAN ON VENTILATE,
- VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME OCCUPIED COOLING

Entry Procedures:
- Fan start (04) or continue to run (07)
- Inlet guide vanes: operate to close completely prior to fan start
- /Inverter speed signal: minimum speed reference prior to fan start
- Unoccupied mode output: OFF
- Ventilation output: ON
- Heat output: OFF
- Heat/Cool output: OFF

Pre-cool procedure (0C):
- Cooling tower/Cond Water Pump Interlock: ON

w/CONDENSER HEAD PRESSURE CONTROL
- Condenser water valve: Fully open

Mode operations: Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint. Cooling capacity control according to supply air temperature to meet supply air temperature setpoint. If condenser head pressure control is present, it is active.

Valid operating modes:

| | |
|---|---|
| Cooling Level 1 | 21 |
| Cooling Level 2 | 22 |
| Cooling Level 3 | 23 |
| Cooling Level 4 | 24 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- VAV OCCUPIED SUPPLY FAN ON

If UNOCCUPIED,
- VAV UNOCCUPIED
- VAV UNOCCUPIED HEATING

If FAN ON VENTILATE,
- VAV MAXIMUM VENTILATION

**VARIABLE AIR VOLUME OCCUPIED COOLING W/AIRSIDE ECONOMIZER**

Entry Procedures: Fan start (04) or continue to run (07)
Inlet guide vanes: operate to close completely prior to fan start
/Inverter speed signal: minimum speed reference prior to fan start
Unoccupied mode output: OFF
Ventilation output: ON
Heat output: OFF
Heat/Cool output: OFF
Airside economizer: open to minimum position

Mode operations: Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint.

IF ECONOMIZING:
Cooling tower/cond wtr pump interlock: OFF
Condenser water valve: close
Modulate airside economizer damper according to supply air temperature to meet supply air temperature setpoint
Valid operating modes:

| | |
|---|---|
| Economizing | 10 |

OR IF ECONOMIZING WITH MECHANICAL COOLING:
Pre-cool procedure (10):
Cooling tower/cond wtr pump interlock: ON
W/CONDENSER HEAD PRESSURE CONTROL:
Condenser water valve: fully open
Modulate mechanical cooling capacity according to supply air temperature to meet supply air setpoint; head pressure control active if present; maintain airside economizer damper fully open (low temperature limit may cause damper to modulate).
Valid operating modes:

| | |
|---|---|
| Pre-Cool/Economizing | 10 |
| Econ/Cooling level 1,2,3,4 | 31,32,33,34 |

OR IF NOT ECONOMIZING:
Pre-cool procedure (0C):
Cooling tower/cond wtr pump interlock: ON
W/CONDENSER HEAD PRESSURE CONTROL:
Condenser water valve: fully open
Modulate mechanical cooling capacity according to supply air temperature to meet supply air setpoint; head pressure control active if present; maintain airside economizer at minimum position.
Valid operating modes:

| | |
|---|---|
| Pre-cool | 0C |
| Cooling level 1,2,3,4 | 21,22,23,24 |

Exit to mode:
If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON
If UNOCCUPIED,
VAV UNOCCUPIED
VAV UNOCCUPIED HEATING
If FAN ON VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME OCCUPIED COOLING W/STANDARD WATERSIDE ECON.

Entry Procedures:
- Fan start (04) or continue to run (07)
- Inlet guide vanes: operate to close completely prior to fan start
- /Inverter speed signal: minimum speed reference prior to fan start
- Unoccupied mode output: OFF
- Ventilation output: ON
- Heat output: OFF
- Heat/Cool output: OFF

Pre-cool procedure (0C):
- Cooling tower/Cond Water Pump Interlock: ON
- Condenser water valve: open
- Economizer water valve: close

Mode operations: Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint

IF ECONOMIZING:

Open economizer water valve, close condenser water valve, then modulate economizer water valve according to supply air temperature to meet supply air temperature setpoint.

Valid operating modes:

| | |
|---|---|
| Economizing | 10 |

OR

Modulate mechanical cooling capacity according to supply air temperature to meet supply air temperature setpoint and maintain economizer water valve open, condenser water valve closed.

Valid operating modes:

| | |
|---|---|
| Econ/cooling level 1,2,3,4 | 31,32,33,34 |

In both cases when the economizer water valve is being modulated, the condenser water valve is modulated in opposite direction to maintain constant water flow.

IF NOT ECONOMIZING:

Modulate mechanical cooling capacity according to supply air temperature to meet supply air temperature setpoint and maintain condenser water valve open; economizer water valve is closed.

Valid operating modes:

| | |
|---|---|
| Cooling level 1,2,3,4 | 21,22,23,24 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON

If UNOCCUPIED,
VAV UNOCCUPIED HEATING

If FAN ON VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME OCC. COOLING W/ENERGY SAVING WATERSIDE ECON.

Entry Procedures:
- Fan start (04) or continue to run (07)
- Inlet guide vanes: operate to close completely prior to fan start
- /Inverter speed signal: minimum speed reference prior to fan start
- Unoccupied mode output: OFF
- Ventilation output: ON
- Heat output: OFF
- Heat/Cool output: OFF

Pre-cool procedure (0C):
- Cooling tower/Cond Water Pump Interlock: ON
- Condenser water valve: open
- Economizer water valve: close

Mode operations: Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint.

IF ECONOMIZING:

Open economizer water valve, close condenser water valve, then modulate economizer water valve according to supply air temperature to meet supply air setpoint.

Valid operating modes:

| | |
|---|---|
| Economizing | 10 |

OR

Modulate mechanical cooling capacity according to supply air temperature to meet supply air temperature setpoint and maintain economizer water valve open, condenser water valve closed.

Valid operating modes:

| | |
|---|---|
| Econ/cooling level 1,2,3,4 | 31,32,33,34 |

IF NOT ECONOMIZING:

Modulate mechanical cooling capacity according to supply air temperature to meet supply air temperature setpoint and maintain condenser water valve open; economizer water valve is closed.

Valid operating modes:

| | |
|---|---|
| Cooling level 1,2,3,4 | 21,22,23,24 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON

If UNOCCUPIED,
VAV UNOCCUPIED
VAV UNOCCUPIED HEATING

If FAN ON VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME UNOCCUPIED (STOP)

Entry Procedures:
- Stop all compressors (Unstaged stop)
- Stop fan
- Inlet guide vanes: operate to close completely prior to fan start
- /Inverter speed signal: minimum speed reference prior to fan start
- Unoccupied mode output: ON
- Ventilation output: OFF
- Heat output: OFF
- Heat/Cool output: ON
- Cooling tower/cond water pump interlock: OFF

w/AIRSIDE ECONOMIZER
- Airside economizer: close
- (Condenser water valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
- Economizer water valve: close
- Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
- Condenser water valve: Fully closed
- (Airside economizer outputs in closed position)

Mode operations: Unit is stopped until another operation is initiated.

Valid operating modes

| | |
|---|---|
| Auto | 01 |

Exit to mode:

If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
- VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
- VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
- VAV OCCUPIED SUPPLY FAN ON
- VAV OCCUPIED COOLING
- VAV OCCUPIED COOLING W/ECONOMIZER

If FAN ON/VENTILATE,
- VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME UNOCCUPIED HEATING (NIGHT HEAT)

Entry Procedures:
Fan stop
Inlet guide vanes: operate to close completely
/Inverter speed signal: minimum speed reference
Unoccupied mode output: ON
Ventilation output: OFF
Heat output: OFF
Heat/Cool output: ON
Cooling tower/cond water pump interlock: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: close
(Condenser valve outputs in closed position)
w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o air. econ.)
Condenser water valve: Fully closed
(Airside economizer outputs in closed position)

Mode operations:
Fan is cycled on and off with heat according to demand by heating control algorithm to satisfy night heat setpoint according to zone temperature sensor. During fan run, duct pressure is controlled by fan speed or inlet guide vanes to satisfy duct pressure setpoint.

Inlet guide vanes: close completely prior to fan start
/Inverter speed signal: min. speed reference prior to fan start

Valid operating modes

| | |
|---|---|
| Auto | 01 |
| Pre-fan | 04 |
| Supply fan on | 07 |
| Heating level 1 | 41 |

Exit to mode:
If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
VAV MORNING WARMUP
If FAN ON/VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME MORNING WARMUP

Entry Procedures:

Fan start (04) or continue to run (07)
Inlet guide vanes: operate to close
completely prior to fan start
/Inverter speed signal: minimum speed
reference prior to fan start
Unoccupied mode output: From prior mode
(normally ON, as entry is from unoccupied)
Ventilation output: OFF
Heat output: OFF
Heat/Cool output: ON
Cooling tower/cond water pump interlock: OFF

w/AIRSIDE ECONOMIZER
Airside economizer: close
(Condenser water valve outputs in closed position)
w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

Mode operations:

Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint. Maintain heat on until morning warmup temperature satisfies morning warmup setpoint, then exit. Upon any exit, further morning warmup is locked out unless another unoccupied/occupied cycle or low entering air temperature protection occurs.

Valid operating modes
Morning warmup 40

Exit to mode:
If EXTERNAL INTERLOCK is in DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP
If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION
If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON
VAV OCCUPIED HEATING/MORNING WARMUP TERMINATION
If UNOCCUPIED,
VAV UNOCCUPIED HEATING
If FAN ON/VENTILATE,
VAV MAXIMUM VENTILATION

## VARIABLE AIR VOLUME OCCUPIED HEATING/MORNING WARMUP TERMINATION

Entry Procedures:
Fan start (04) or continue to run (07)
Inlet guide vanes: operate to close completely prior to fan start
/Inverter speed signal: minimum speed reference prior to fan start
Unoccupied mode output: OFF
Ventilation output: ON
Cooling tower/Cond Water Pump Interlock: OFF
Heat output: OFF
Heat/Cool output: ON

w/AIRSIDE ECONOMIZER
Airside economizer: open to minimum position
(Condenser valve outputs in closed position)

w/STANDARD WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: open

w/ENERGY SAVING WATERSIDE ECONOMIZER
Economizer water valve: close
Condenser water valve: close

w/CONDENSER HEAD PRESSURE CONTROL (w/ or w/o airside econ.)
Condenser water valve: fully closed

Mode operations:
Control duct pressure by fan speed or inlet guide vanes to satisfy duct pressure setpoint. Heating capacity control according to morning warmup temperature to meet morning warmup setpoint. Upon any exit, further morning warmup is locked out unless another unoccupied/occupied cycle or low entering air temperature protection occurs.

Valid operating modes:

| | |
|---|---|
| Supply Fan On | 07 |
| Heating Level 1 | 41 |

Exit to mode:

If EXTERNAL INTERLOCK is in the DISABLE condition,
or if UNIT SWITCH is in the STOP position,
or if a DIAGNOSTIC EXISTS CAUSING UNIT SHUTDOWN,
VAV STOP

If Entering Air Sensor Low Temperature diagnostic (CF),
VAV LOW ENTERING AIR TEMP PROTECTION

If OCCUPIED,
VAV OCCUPIED SUPPLY FAN ON
VAV OCCUPIED COOLING
VAV OCCUPIED COOLING W/ECONOMIZER

If UNOCCUPIED,
VAV UNOCCUPIED HEATING

If FAN ON VENTILATE,
VAV MAXIMUM VENTILATION

CONSTANT VOLUME UNOCCUPIED COOLING

No mechanical cooling is allowed in the unoccupied mode; no unit operation is defined.

CONSTANT VOLUME UNOCCUPIED ECONOMIZING

No unit operation is defined.

VARIABLE AIR VOLUME UNOCCUPIED COOLING

No mechanical cooling is allowed in the unoccupied mode; no unit operation is defined.

VARIABLE AIR VOLUME UNOCCUPIED ECONOMIZING

No unit operation is defined.

# DIAGNOSTICS AND DIAGNOSTIC MODES

## Diagnostic Code List

In the table below, a "LATCHING" diagnostic is a condition which causes the machine or a portion of the machine as noted to shut down and requires a manual reset to restore operation. A diagnostic that is not latching resets automatically when the condition causing the diagnostic goes away. A non-latching diagnostic will shut down the machine or a part of the machine if so indicated. If no indication is made, the diagnostic is informative only.

| DIAGNOSTIC DESCRIPTION | CODE | LATCHING |
|---|---|---|
| Zone Sensor | A0 | N |
| Supply Air Sensor | A2 | N |
| Morning Warmup Sensor | 97 | N |
| Temp Reset Sensor | 98 | N |
| Entr Cond Water Temp Sensor | 9A | N |
| Leaving Cond Water Temp Sensor | 9b | N |
| Entr Econ Water Temp Sensor | 99 | N |
| Evap Suction Temp Circuit 1 | 9C | N-Ckt 1 |
| Evap Suction Temp Circuit 2 | 9d | N-Ckt 2 |
| Evap Suction Temp Circuit 3 | 9E | N-Ckt 3 |
| Evap Suction Temp Circuit 4 | 9F | N-Ckt 4 |
| Low Pressure Cutout Circuit 1 | b5 | Y-Ckt 1 |
| Low Pressure Cutout Circuit 2 | b6 | Y-Ckt 2 |
| Low Pressure Cutout Circuit 3 | b7 | Y-Ckt 3 |
| Low Pressure Cutout Circuit 4 | b8 | Y-Ckt 4 |
| High Pressure Cutout Circuit 1 | F5 | Y-Ckt 1 |
| High Pressure Cutout Circuit 2 | F6 | Y-Ckt 2 |
| High Pressure Cutout Circuit 3 | bE | Y-Ckt 3 |
| High Pressure Cutout Circuit 4 | bF | Y-Ckt 4 |
| Overload Trip Compressor A | bA | Y-Ckt 1 |
| Overload Trip Compressor B | bb | Y-Ckt 2 |
| Overload Trip Compressor C | bC | Y-Ckt 3 |
| Overload Trip Compressor D | bd | Y-Ckt 4 |
| Hi Mot/Rfgt Disch Temp Cprsr A | C1 | Y-Ckt 1 |
| Hi Mot/Rfgt Disch Temp Cprsr B | C2 | Y-Ckt 2 |
| Hi Mot/Rfgt Disch Temp Cprsr C | C3 | Y-Ckt 3 |
| Hi Mot/Rfgt Disch Temp Cprsr D | C4 | Y-Ckt 4 |
| Dirty Filter | d0 | N |
| Heat | d1 | Y-Heat |
| Supply Fan High Duct Pressure | dA | Y-Machine |
| Supply Fan/Low Duct Pressure | E0 | N |
| Supply Fan Overload Trip | CE | Y-Machine |
| Phase Reversal/Phase Loss | E6 | Y-Machine |
| Condenser Water Flow | F7 | N-CKT -1-4 |
| Condenser Water Low Temp | C9 | N |

| | | |
|---|---|---|
| Entering Air Low Temperature | CF | N-Machine |
| Entering Air High Temperature | FE | Y-Machine |
| Improper Cprsr Config Unit ID | F8 | Y-Machine |
| Controller | FF | Y-Machine |
| Unit Communication | dF | Y-Machine |
| | | |
| Contactor Compressor A | CA | Y-Ckt 1 |
| Contactor Compressor B | Cb | Y-Ckt 2 |
| Contactor Compressor C | CC | Y-Ckt 3 |
| Contactor Compressor D | Cd | Y-Ckt 4 |

| Code | Diagnostic Description | Latching | Operation Locked Out |
|---|---|---|---|
| 97 | Morning Warmup Sensor<br>Sensor out of range: <10° or >150° | No | VAV - MWUP, occ. heat<br>CV - None |
| 98 | Temperature Reset Sensor<br>Sensor out of range: <14° or >140° | No | None - continue w/reset |
| 99 | Entering Econ Water Temp Sensor<br>Sensor out of range: <14° or >123° | No | Waterside Economizer |
| 9A | Entering Cond Water Temp Sensor<br>Sensor out of range: <14° or >123° | No | Circuits 1 - 4 |
| 9b | Leaving Cond Water Temp Sensor<br>Sensor out of range: <14° or >123° | No | W/head pressure control:<br>Circuits 1 - 4 |
| 9C | Evap Suction Temp Circuit 1<br>Sensor out of range: <0° or >140° | No | Circuit 1 |
| 9d | Evap Suction Temp Circuit 2<br>Sensor out of range: <0° or >140° | No | Circuit 2 |
| 9E | Evap Suction Temp Circuit 3<br>Sensor out of range: <0° or >140° | No | Circuit 3 |
| 9F | Evap Suction Temp Circuit 4<br>Sensor out of range: <0° or >140° | No | Circuit 4 |
| A0 | Zone Sensor<br>Sensor out of range: <10° or >150° | No | VAV - Unoccupied heat<br>CV - Heat, cool, & econ. |
| A2 | Supply Air Sensor<br>Sensor out of range: <14° or >160° | No | VAV - all cooling<br>CV - economizing |
| b5 | Low Pressure Cutout Circuit 1<br>Suction pressure <20 ± 4 PSI for > 2-3 min after comp. start, or switch open > 1 sec w/comp on/off; switch closes > 35 ± 5 PSI | Yes | Circuit 1 |
| b6 | Low Pressure Cutout Circuit 2<br>Description: same as B5 | Yes | Circuit 2 |
| b7 | Low Pressure Cutout Circuit 3<br>Description: same as B5 | Yes | Circuit 3 |
| b8 | Low Pressure Cutout Circuit 4<br>Description: same as B5 | Yes | Circuit 4 |
| bA | Overload Trip Compressor A<br>Motor amps >132% for >102 sec, motor amps >LRA for >1.6 sec, or phase loss | Yes | Circuit 1 |

| | | | |
|---|---|---|---|
| bb | Overload Trip Compressor B | Yes | Circuit 2 |
| | Description: same as bA | | |
| bC | Overload Trip Compressor C | Yes | Circuit 3 |
| | Description: same as bA | | |
| bd | Overload Trip Compressor D | Yes | Circuit 4 |
| | Description: same as bA | | |
| bE | High Pressure Cutout Circuit 3 | Yes | Circuit 3 |
| | Loss of input to UCM, or discharge pressure > 360 $\pm$ 10 PSI; switch closes < 270 $\pm$ 20 PSI | | |
| bF | High Pressure Cutout Circuit 4 | Yes | Circuit 4 |
| | Description: same as bE | | |
| C1 | Hi Mot/Rfgt Disch Temp Cprsr A | Yes | Circuit 1 |
| | Motor winding temp > $221^{\circ} \pm 9^{\circ}$, switch closes < $181^{\circ} \pm 20^{\circ}$; refrig. discharge temp > $302^{\circ} \pm 9^{\circ}$, switch closes < $202^{\circ} \pm 20^{\circ}$ | | |
| C2 | Hi Mot/Rfgt Disch Temp Cprsr B | Yes | Circuit 2 |
| | Description: same as C1 | | |
| C3 | Hi Mot/Rfgt Disch Temp Cprsr C | Yes | Circuit 3 |
| | Description: same as C1 | | |
| C4 | Hi Mot/Rfgt Disch Temp Cprsr D | Yes | Circuit 4 |
| | Description: same as C1 | | |
| C9 | Condenser Water Low Temp | No | Circuits 1 - 4 |
| | w/o Head Pressure Control: lockout @ water temp $<54^{\circ}$, reset $>58^{\circ}$ | | |
| | w/Head Pressure Control: lockout @ water temp $<34^{\circ}$, reset $>38^{\circ}$ | | |
| CA | Contactor A | Yes | Circuit 1 |
| | Current > 8% detected when compressor is not required to run | | |
| Cb | Contactor B | Yes | Circuit 2 |
| | Description: same as CA | | |
| CC | Contactor C | Yes | Circuit 3 |
| | Description: same as CA | | |
| Cd | Contactor D | Yes | Circuit 4 |
| | Description: same as CA | | |
| CE | Supply Fan Overload Trip | Yes | Unit |
| | Motor amps >118% for >1638 sec, motor amps >LRA for >19 sec, contactor failure, or single phasing | | |
| CF | Entering Air Low Temperature | No | Unit |
| | Sensor $<37^{\circ}$, reset $>39^{\circ}$; 6S26 switch $<35^{\circ}$, reset $>45^{\circ}$ | | |

| | | | |
|---|---|---|---|
| d0 | Dirty Filter<br>Filter pressure drop >.9" | No | Information only/no alarm |
| d1 | Heat<br>No current 13 sec after output energized or 3 sec current dropout | Yes | All heat |
| dA | Supply Fan High Duct Pressure<br>Supply duct pressure >1" WC + Supply Air Pressure setpoint | Yes | Unit |
| dF | Unit Communication<br>Internal UCM module to module microprocessor communications lost w/unit switch in AUTO REMOTE | Yes | Unit |
| E0 | Supply Fan Low Duct Pressure<br>Supply duct pressure <0.4" WC >100 sec from fan start | No | Information only |
| E6 | Phase Reversal/Phase Loss<br>Phase reversal or loss on unit power supply | Yes | Unit |
| F5 | High Pressure Cutout Circuit 1<br>Loss of input to UCM, or discharge pressure > 360 $\pm$ 10 PSI; switch closes < 270 $\pm$ 20 PSI | Yes | Circuit 1 |
| F6 | High Pressure Cutout Circuit 2<br>Description: same as F5 | Yes | Circuit 2 |
| F7 | Condenser Water Flow<br>No water flow at end of precool mode or loss of flow for >3 sec | No | Circuits 1 - 4 |
| F8 | Improper Cprsr Config/Unit ID<br>UCM DIP switches improperly set for unit type | Yes | Unit |
| FE | Entering Air High Temperature<br>Entering air temperature >135$^{o}$ | Yes | Unit |
| FF | Controller<br>Internal UCM problem detected | Yes | Unit |

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| A0 | **ZONE SENSOR** |
| Cause: | a. Resistance out of range - high (temp low)<br>b. Resistance out of range - low (temp high) |
| UCM Action: | a1. Disable heating, cooling, and economizing on Constant Volume units<br>a2. Disable night heating on VAV units<br>b. Clear diagnostic and enable heating and cooling when resistance returns to normal range |
| Operator action: | None required |
| A2 | **SUPPLY AIR SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a1. Disable all cooling (including economizing) on VAV units<br>a2. Disable economizing on CV units |
| Operator action: | None required |
| 97 | **MORNING WARMUP SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Bypass morning warmup and occupied heat on VAV units with night heat/morning warmup, default to cooling and night heat only<br>b. Clear diagnostic and enable morning warmup when resistance returns to normal range |
| Operator action: | None required |
| 98 | **TEMPERATURE RESET SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Display diagnostic, energize common alarm output, continue with reset |
| Operator action: | None required |
| 9A | **ENTERING CONDENSER WATER TEMPERATURE SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Disable compressors for item a only. For condensing pressure control, shut unit off. |
| Operator action: | None required |

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| **9b** | **LEAVING CONDENSER WATER TEMPERATURE SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Disable compressors for units with condensing pressure control option |
| Operator action: | None required |

| | |
|---|---|
| **99** | **ENTERING ECONOMIZER WATER TEMPERATURE SENSOR** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Disable waterside economizer |
| Operator action: | None required |

| | |
|---|---|
| **9C** | **EVAPORATOR SUCTION TEMPERATURE CIRCUIT 1** |
| Cause: | a. Resistance out of range - high (low temp)<br>b. Resistance out of range - low (high temp) |
| UCM Action: | a. Disable associated compressor for timed period |
| Operator action: | None required |

**9d** **EVAPORATOR SUCTION TEMPERATURE CIRCUIT 2**
(Identical to diagnostic 9C, except applies to circuit 2)

**9E** **EVAPORATOR SUCTION TEMPERATURE CIRCUIT 3**
(Identical to diagnostic 9C, except applies to circuit 3)

**9F** **EVAPORATOR SUCTION TEMPERATURE CIRCUIT 4**
(Identical to diagnostic 9C, except applies to circuit 4)

| | |
|---|---|
| **b5** | **LOW PRESSURE CUTOUT CIRCUIT 1** |
| Cause: | a. Low pressure switch open<br>b. Input open circuited or resistance too high |
| UCM Action: | a. Shut compressor off; lockout refrigerant circuit and associated compressor |
| Operator action: | Manual reset required to restart the circuit |

**b6** **LOW PRESSURE CUTOUT CIRCUIT 2**
(Identical to diagnostic b5, except applies to circuit 2)

**b7** **LOW PRESSURE CUTOUT CIRCUIT 3**
(Identical to diagnostic b5, except applies to circuit 3)

**b8** **LOW PRESSURE CUTOUT CIRCUIT 4**
(Identical to diagnostic b5, except applies to circuit 4)

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| **F5** | **HIGH PRESSURE CUTOUT CIRCUIT 1** |
| Cause: | a. High pressure switch open when associated compressor is operating |
| | b. Input open circuited or resistance too high |
| UCM Action: | a. Shut compressor off; lockout refrigerant circuit and associated compressor |
| Operator action: | Manual reset required to restart the circuit |
| **F6** | **HIGH PRESSURE CUTOUT CIRCUIT 2** |
| | (Identical to diagnostic F5, except applies to circuit 2) |
| **bE** | **HIGH PRESSURE CUTOUT CIRCUIT 3** |
| | (Identical to diagnostic F5, except applies to circuit 3) |
| **bF** | **HIGH PRESSURE CUTOUT CIRCUIT 4** |
| | (Identical to diagnostic F5, except applies to circuit 4) |
| **bA** | **OVERLOAD TRIP COMPRESSOR A** |
| Cause: | a. Compressor current exceeded overload time vs. trip characteristic |
| | b. No current sensed in either or both of the current transformer inputs |
| UCM Action: | a. Shut compressor off; lockout refrigerant circuit and associated compressor |
| Operator action: | Manual reset required to restart the circuit |
| **bb** | **OVERLOAD TRIP COMPRESSOR B** |
| | (Identical to diagnostic bA, except applies to circuit 2) |
| **bC** | **OVERLOAD TRIP COMPRESSOR C** |
| | (Identical to diagnostic bA, except applies to circuit 3) |
| **bd** | **OVERLOAD TRIP COMPRESSOR D** |
| | (Identical to diagnostic bA, except applies to circuit 4) |

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| **C1** | **HIGH MOTOR/REFRIGERANT DISCHARGE TEMP. COMPRESSOR A** |
| Cause: | a. Motor temperature higher than must trip value<br>b. Refrigerant discharge temperature higher than must trip value<br>c. Motor or discharge temperature sensor lead open |
| UCM Action: | a. Shut compressor off; lockout compressor |
| Operator action: | Manual reset required to restart the circuit. On a restart try when the motor temperature or refrigerant discharge switch is still open, the UCM shall keep the compressor off and display the diagnostic. Manual reset will be required again. |

**C2** **HIGH MOTOR/REFRIGERANT DISCHARGE TEMP. COMPRESSOR B**

(Identical to diagnostic C1, except applies to circuit 2)

**C3** **HIGH MOTOR/REFRIGERANT DISCHARGE TEMP. COMPRESSOR C**

(Identical to diagnostic C1, except applies to circuit 3)

**C4** **HIGH MOTOR/REFRIGERANT DISCHARGE TEMP. COMPRESSOR D**

(Identical to diagnostic C1, except applies to circuit 4)

| | |
|---|---|
| **d0** | **DIRTY FILTER** |
| Cause: | a. Dirty filter input open<br>b. Filter pressure drop > 0.9" WC |
| UCM Action: | a. Display diagnostic, do not energize common alarm output |
| Operator action: | None required |

| | |
|---|---|
| **d1** | **HEAT** |
| Cause: | a. No current sensed after 15 +0/-4 sec. following a call for heat on electric heat units only |
| UCM Action: | a. Energize common alarm output |
| Operator action: | None required |

| | |
|---|---|
| **E0** | **SUPPLY FAN LOW DUCT PRESSURE** |
| Cause: | a. Duct pressure below must prove value within 100 seconds of fan on output command |
| UCM Action: | a. Energize common alarm output |
| Operator action: | None required |

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| **CE** | **SUPPLY FAN OVERLOAD TRIP** |
| Cause: | a. Supply fan current exceeded overload time vs. trip characteristic |
| UCM Action: | a. Shut entire unit down - go to Stop mode |
| Operator action: | Manual reset required to restart the unit |

SEE VFD FAQ Doc.

• VFD External Fault ON IU1, has to have continuity
• Bad C+.

| | |
|---|---|
| **E6** | **PHASE REVERSAL/PHASE LOSS** |
| Cause: | a. Improper phase sequence at the machine power input terminal block |
| UCM Action: | a. Disable entire machine - go to Stop mode |
| Operator action: | Manual reset required to restart the unit |

- Blown Transformer 2 - Any one of them.

| | |
|---|---|
| **F7** | **CONDENSER WATER FLOW** |
| Cause: | a. Loss of condenser water flow while economizing or any stage of cooling. NOTE: no diagnostic on a shorted input. |
| UCM Action: | a. Terminate and disable all compressors |
| Operator action: | None required |

| | |
|---|---|
| **C9** | **CONDENSER WATER LOW TEMPERATURE** |
| Cause: | a. Condenser water temperature below acceptable range for machine operation |
| UCM Action: | a. Disable all compressors; re-enable when temperature returns to an acceptable range |
| Operator action: | None required |

| | |
|---|---|
| **CF** | **ENTERING AIR LOW TEMPERATURE** |
| Cause: | a. Entering air temperature is below the must trip level |
| | b. Resistance out of range - high (low temp) |
| UCM Action: | a. Go to Low Entering Air Temperature Protection mode |
| Operator action: | None required |

| | |
|---|---|
| **FE** | **ENTERING AIR HIGH TEMPERATURE** |
| Cause: | a. Entering air temperature higher than must trip value |
| | b. Resistance out of range - low (high temp) |
| UCM Action: | a. Shut entire unit down - go to Stop mode |
| Operator action: | Manual reset required to restart the machine |

| DIAGNOSTIC | DESCRIPTION |
|---|---|
| **FF** | **CONTROLLER** |
| Cause: | a. Failure detected within unit control module |
| UCM Action: | a. Shut entire unit down - go to Stop mode |
| Operator action: | Manual reset required |

| | |
|---|---|
| **dF** | **UNIT COMMUNICATION** |
| Cause: | a. Internal module to module UCM communications failure with unit switch in Auto Remote |
| UCM Action: | a. Shut entire unit down - go to Stop mode |
| Operator action: | a. Manual reset required<br>b. Move Unit switch to AUTO LOCAL for machine operation under local UCM control |

| | |
|---|---|
| **CA** | **CONTACTOR A** |
| Cause: | a. Welded compressor contactor |
| UCM Action: | a. Energize supply fan output, optional cooling tower/condenser water pump interlock output, and common alarm output; all others as in Stop mode |
| Operator action: | Manual reset required |

**Cb** **CONTACTOR B**

(Identical to diagnostic CA, except applies to contactor B)

**CC** **CONTACTOR C**

(Identical to diagnostic CA, except applies to contactor C)

**Cd** **CONTACTOR D**

(Identical to diagnostic CA, except applies to contactor D)

**LINE PHASE LOSS/PHASE ROTATION**

A circuit which accepts three phase voltage input from potential and power transformers provides a logic output indicating that all three phases of voltage are present, and have the proper phase relationship. Phase loss/phase rotation are checked prior to the first motor start in the system, and phase loss is continually monitored when running motors to protect against motor single phasing.

The purpose of reversed phasing inhibit is to prevent the initial startup of a compressor or fan if reversed phasing is detected by sensing the three phase voltage present.

# T R O U B L E S H O O T I N G

## Supply Air Pressure Measurement

A pressure transducer is used to provide a nominal .25 VDC to 4.0 VDC signal for 0 to 5" WC which allows the UCM to control system static pressure. To check the transducer for proper operation, you first must check for proper installation of the static pickup probe and connecting tubing. If tubing and pickup probe are installed and connected properly, follow the procedure below.

A. Attach a DC volt meter to 1U1, A4J4 terminals 1 and 3. Voltage on these terminals should be 4.85 to 5.15 VDC. This is a check of the power supply applied to the transducer.

B. With the unit fan stopped and no air pressure signal on the transducer, check the DC voltage between 1U1, A4J4 terminals 2 and 3. Voltage on these terminals should read approximately .25 VDC. This is a check of the 0 flow signal being sent to the UCM.

C. Start fan and again check the voltage between 1U1, A4J4 terminals 2 and 3. The voltage should be .25 to 4.0 VDC. This indicates that as system static pressure increases the VDC signal being sent to the UCM also increases.

To determine the actual voltage signal per inch of static pressure, use the following formula.

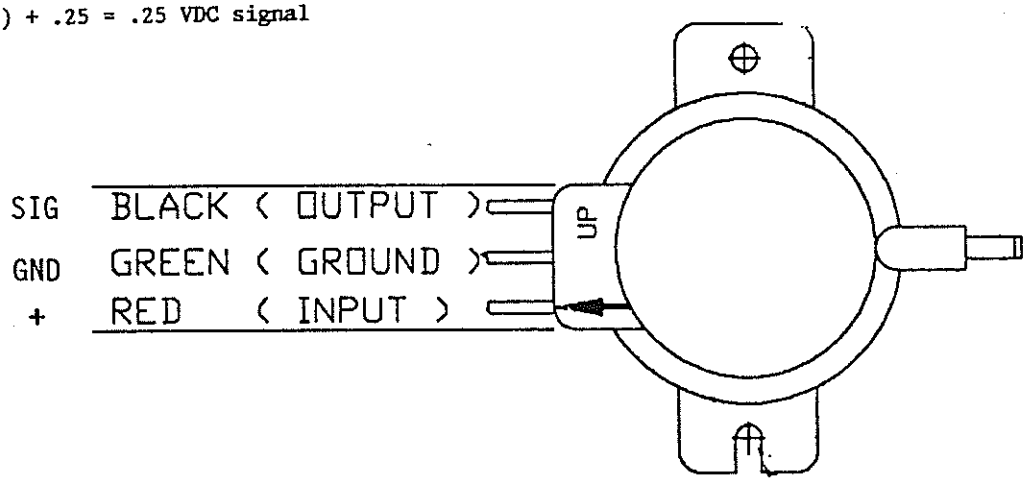
VDC = (Inches static pressure x .75) + .25

Example:

System static pressure = 5" WC
(5 x .75) + .25 = 4 VDC signal

Example:

0 Flow (Fan off)
(0 x .75) + .25 = .25 VDC signal



## COMPRESSOR CURRENT TRANSFORMER DATA & SELECTION WITH UCM BOARD A3 DIP SWITCH SETTINGS

| COMPR. TONS | VOLTAGE | CT# | PRIMARY TURNS | SW4 | SW5 |
|---|---|---|---|---|---|
| 10 | 200 | -05 | 1 | | 00110 |
| | 230 | -05 | 1 | | 01100 |
| | 460 | -01 | 1 - | | 01011 |
| | 575 | -03 | 2 | | 01011 |
| 15 | 200 | -06 | 1 | 10000 | |
| | 230 | -06 | 1 | 11100 | |
| | 460 | -02 | 1 | 11000- | |
| | 575 | -02 | 1 | 00111 | |

SWITCH SETTINGS:

1 = SWITCH IN 'ON' POSITION

0 = SWITCH IN 'OFF' POSITION

FAN CT

### CURRENT TRANSFORMER RESISTANCE TABLE (OPEN CIRCUIT)

X13580050-

| EXT. | RESISTANCE (OHMS) |
|---|---|
| 01 | 20.0 - 23.4 |
| 02 | 23.8 - 29.2 |
| 03 | 33.4 - 38.2 |
| 04 | 39.2 - 45.3 |
| 05 | 52.0 - 60.2 |
| 06 | 65.5 - 76.4 |
| 07 | 84 - 100 |
| 08 | 108 - 141 |
| 09 | 170 - 205 |

## FAN MOTOR CURRENT TRANSFORMER DATA & SELECTION WITH UCM BOARD A3 DIP SWITCH SETTINGS

| FAN H.P. | VOLTAGE | CT# | PRIMARY TURNS | STD EFFICIENCY OPEN DRIP PROOF MOTOR SW6 | HIGH EFFICIENCY OPEN DRIP PROOF MOTOR SW6 | STD EFFICIENCY TOTALLY ENCLOSED MOTOR SW6 |
|---|---|---|---|---|---|---|
| 5 | 200 | -04 | 2 | 01100 | 01001 | 01101 |
| | 230 | -03 | 2 | 01101 | 00111 | 01011 |
| | 460 | -02 | 3 | 01101 | 00111 | 01100 |
| | 575 | -02 | 4 | 10010 | 01100 | 10001 |
| 7.5 | 200 | -02 | 1 | 11011 | 10101 | 11000 |
| | 230 | -02 | 1 | 10001 | 01010 | 01101 |
| | 460 | -02 | 2 | 10001 | 01010 | 01110 |
| | 575 | -04 | 4 | 10110 | 01011 | 10011 |
| 10 | 200 | -04 | 1 | 01101 | 00111 | 01010 |
| | 230 | -03 | 1 | 01000 | 00110 | 01010 |
| | 460 | -03 | 2 | 01101 | 00110 | 01010 |
| | 575 | -02 | 2 | 10001 | 01010 | 01111 |
| 15 | 200 | -05 | 1 | 10101 | 10001 | 10101 |
| | 230 | -05 | 1 | 01011 | 00100 | 01010 |
| | 460 | -02 | 1 | 01011 | 00100 | 01010 |
| | 575 | -04 | 2 | 10001 | 01010 | 10000 |
| 20 | 200 | -06 | 1 | 10110 | 10101 | 10010 |
| | 230 | -06 | 1 | 01101 | 01010 | 01010 |
| | 460 | -06 | 2 | 01101 | 01010 | 01010 |
| | 575 | -02 | 1 | 01111 | 01010 | 01001 |
| 25 | 200 | -07 | 1 | 10100 | 10100 | 10111 |
| | 230 | -07 | 1 | 01101 | 01001 | 01101 |
| | 460 | -04 | 1 | 10001 | 01101 | 10001 |
| | 575 | -03 | 1 | 01011 | 00100 | 01011 |
| 30 | 200 | -08 | 1 | 01001 | 01001 | 01100 |
| | 230 | -07 | 1 | 11001 | 10100 | 10101 |
| | 460 | -05 | 1 | 00111 | 00000 | 00010 |
| | 575 | -04 | 1 | 01001 | 00111 | 01010 |
| 40 | 200 | -09 | 1 | 01101 | 00100 | 01101 |
| | 230 | -08 | 1 | 11101 | 10110 | 11101 |
| | 460 | -06 | 1 | 10000 | 01000 | 10000 |
| | 575 | -05 | 1 | 10000 | 01000 | 10001 |
| 50 | 200 | -09 | 1 | 11011 | 10111 | 11011 |
| | 230 | -09 | 1 | 10001 | 01100 | 10000 |
| | 460 | -07 | 1 | 01101 | 00111 | 01100 |
| | 575 | -06 | 1 | 01110 | 01000 | 01101 |

SWITCH SETTINGS:

1 = SWITCH IN 'ON' POSITION

0 = SWITCH IN 'OFF' POSITION

## DEFINITIONS

### MOTOR LINE CURRENT/ELECTRIC HEAT CURRENT

Motor line current is measured for use in motor running overload and locked rotor overcurrent protection, for both the compressor and evaporator fan motors. Two phases of line current are monitored on compressor motors, and all three phases of line current are monitored for the fan motor. One phase of line current supplying a single heater element is also monitored to provide an indication that heater control circuitry is operating properly. This phase of heater line current is run through a compressor current transformer. To provide an adjustable motor running overload setting over a wide range of line currents, a combination of current transformer selection, number of current transformer primary turns, and current signal gain is used. To determine the protection and setup for a specific motor, the motor rated load ampere value is determined. Using this value, a current transformer and primary line turns combination is selected.

A combination of UCM DIP switch setting and current transformer selection is required to allow adjustment for full range of nameplate RLA. These selections are to be factory set at time of installation in unit.

OPERATION:

Line voltage connections to the motor are made through a motor control contactor. Short circuit protection is provided by line fuses. The motor control contactor is controlled by the microcomputer via a control relay contact wired in series with the contactor coil. To provide locked rotor starting and running overload protection, motor line current is sensed by two current transformers, one in each of two motor line current conductors. Electronic circuits convert the current signals to a D.C. voltage which is multiplexed, converted to a digital value, and is then available for processing by microcomputer logic. The microcomputer scales the digitized current signal to normalize it to units of % RLA/FLA, then integrates the normalized current signal value above trip point to an integrated trip value maximum, providing a time-trip protection characteristic.

## FAN AND COMPRESSOR ELECTRICAL CIRCUIT FAILURE SEQUENCES

In the event of a failure or detected symptoms involving the motor controlling circuit of a compressor or the fan, specific sequences are invoked to retain control if possible. In all cases a diagnostic indication and alarm output is generated.

### COMPRESSOR CIRCUIT FAILURES

Note: In all cases where a UCM trip occurs, a UCM diagnostic will be generated, requiring a manual reset before a restart will be attempted.

1) Compressor line contactor held closed
   This may be detected only when the compressor is expected to be stopped, and is detected by the presence of line current, causing a UCM overload trip.
2) Compressor line contactor held open, or single phasing
   This may be detected only when the compressor is expected to be running.
   If the open line is connected to one of the current transformers, UCM trip will occur due to a detected loss of current.
   If the open line is not connected to a current transformer, the compressor may continue to run if already started. The compressor will shutdown on a detected current overload or winding temperature trip.
   If the open line occurs during a start, the compressor will trip due to locked rotor overcurrent.
   Motor shutdown may also occur due to incorrect UCM phase sense signal.
3) UCM controlling relay held closed
   This may be detected only when the compressor is expected to be stopped. UCM will trip due to sensed line current/ contactor coil voltage, and attempt to open relay via reset circuit.
4) UCM controlling relay held open
   This may be detected only when the compressor is expected to be running, and is detected by the absence of any line current, causing a UCM overload trip.

FAN CIRCUIT FAILURES

Note: In all cases where a UCM trip occurs, a UCM diagnostic will be generated, requiring a manual reset before a restart will be attempted.

1)Line contactor held closed
This may be detected only when the fan is expected to be stopped, and is detected by the presence of line current, causing a UCM overload trip.
2)Line contactor held open, or single phasing
This may be detected only when the fan is expected to be running. The fan will shutdown due to detected loss of current in any phase, causing a UCM overload trip.
Line overcurrent may also cause a UCM trip if time-current characteristics are exceeded.
If an open line occurs during a start, the UCM will trip due to locked rotor overcurrent.
Motor shutdown may also occur due to incorrect UCM phase sense signal, or loss of power to the UCM.
3)UCM controlling relay held closed
This may be detected only when the fan is expected to be stopped. UCM will trip due to sensed line current, and attempt to open relay via reset circuit.
4)UCM controlling relay held open
This may be detected only when the fan is expected to be running, and is detected by the absence of any line current, causing a UCM overload trip.

CIRCUIT FAILURE MODES/CONSIDERATIONS:

Measurement of line current is a critical function used to provide motor protection; the following general provisions exist in the design:

1)A short or open circuit of a current transformer will result in no signal to the microcomputer. Microcomputer software provides trip on a signal loss of either of the two inputs for each compressor, and a trip for any loss of the three signals for the fan motor.
2)Software tests for the presence of current in the compressor motor lines are made whenever the compressor motor control relay is not on.
3)Similar to #1, any circuit failure internally causing a loss of signal causes a trip via software. A failure causing a high reading will result in trip due to apparent overcurrent. Similar to #2, any internal failure resulting in a current signal when the motor is not running will result in a failure indication and trip.

COMPRESSOR AND FAN MOTOR LINE CURRENT MEASUREMENT & OVERLOAD PARAMETERS

(NOTE UNITS %RLA-Rated Load Amperes,%FLA-Full Load Amperes):

COMPRESSOR MOTORS-
NORMAL OPERATING RANGE: 35% TO 125% RLA
MUST TRIP: 140% RLA (RATED TRIP POINT)
MUST HOLD: 125% RLA
DESIGN OVERLOAD TRIP POINT: 132% RLA

EVAPORATOR FAN MOTOR-
NORMAL OPERATING RANGE: 35% TO 110% RLA
MUST TRIP: 125% FLA (RATED TRIP POINT)
MUST HOLD: 112% FLA
DESIGN OVERLOAD TRIP POINT: 118% FLA

LOSS OF CURRENT CRITERIA, COMPRESSOR MOTORS, FAN MOTOR, AND ELECTRIC HEAT:
DESIGN TRIP POINT(FAILURE): I(line) < 8% C.T. RATING
NOTE: Electric heater line current is sensed using the compressor A, phase A current transformer.

## EVAPORATOR FAN TIME TRIP DATA

| RANGE %FLA CURRENT | TRIP TIME (SECONDS) MINIMUM | NOMINAL | MAXIMUM |
|---|---|---|---|
| 0.0 - 118.0 | --- | NO TRIP | --- |
| 118.0 - 126.0 | 818.8 | 1638.1 | 1679.5 |
| 126.0 - 134.0 | 546.0 | 818.8 | 839.7 |
| 134.0 - 142.0 | 409.2 | 546.0 | 560.0 |
| 142.0 - 150.0 | 327.6 | 409.2 | 419.9 |
| 150.0 - 158.0 | 272.8 | 327.6 | 336.2 |
| 158.0 - 166.0 | 234.0 | 272.8 | 280.0 |
| 166.0 - 174.0 | 204.4 | 234.0 | 240.3 |
| 174.0 - 182.0 | 182.0 | 204.4 | 209.9 |
| 182.0 - 190.0 | 163.6 | 182.0 | 187.0 |
| 190.0 - 198.0 | 148.8 | 163.6 | 168.1 |
| 198.0 - 206.0 | 136.4 | 148.8 | 152.9 |
| 206.0 - 214.0 | 126.0 | 136.4 | 140.3 |
| 214.0 - 222.0 | 116.8 | 126.0 | 129.6 |
| 222.0 - 226.0 | 19.2 | 116.8 | 120.2 |
| 226.0 - LIMIT | 19.2 | 19.2 | 20.1 |

## COMPRESSOR MOTOR TIME TRIP DATA

| RANGE %RLA CURRENT | TRIP TIME (SECONDS) MINIMUM | NOMINAL | MAXIMUM |
|---|---|---|---|
| 0.0 - 132.0 | --- | NO TRIP | --- |
| 132.0 - 140.0 | 50.8 | 102.0 | 105.0 |
| 140.0 - 148.0 | 34.0 | 50.8 | 52.5 |
| 148.0 - 156.0 | 25.2 | 34.0 | 35.3 |
| 156.0 - 163.9 | 20.4 | 25.2 | 26.3 |
| 163.9 - 172.1 | 16.8 | 20.4 | 21.3 |
| 172.1 - 180.0 | 14.4 | 16.8 | 17.6 |
| 180.0 - 188.0 | 12.4 | 14.4 | 15.2 |
| 188.0 - 196.0 | 11.2 | 12.4 | 13.2 |
| 196.0 - 204.0 | 10.0 | 11.2 | 11.9 |
| 204.0 - 212.0 | 9.2 | 10.0 | 10.7 |
| 212.0 - 219.9 | 8.4 | 9.2 | 9.9 |
| 219.9 - 228.1 | 7.6 | 8.4 | 9.1 |
| 228.1 - 236.0 | 7.2 | 7.6 | 8.2 |
| 236.0 - 244.0 | 6.8 | 7.2 | 7.8 |
| 244.0 - 250.0 | 1.2 | 6.8 | 7.4 |
| 250.0 - LIMIT | 1.2 | 1.6 | 4.5 |

# TYPICAL OPERATING ENVELOPE

FIGURE 3

## 20 - 80 TONS COMMERCIAL SELF-CONTAINED

## FULL LOAD

58 TON UNIT SHOWN
(W/SLIGHTLY FOULED CONDENSER)

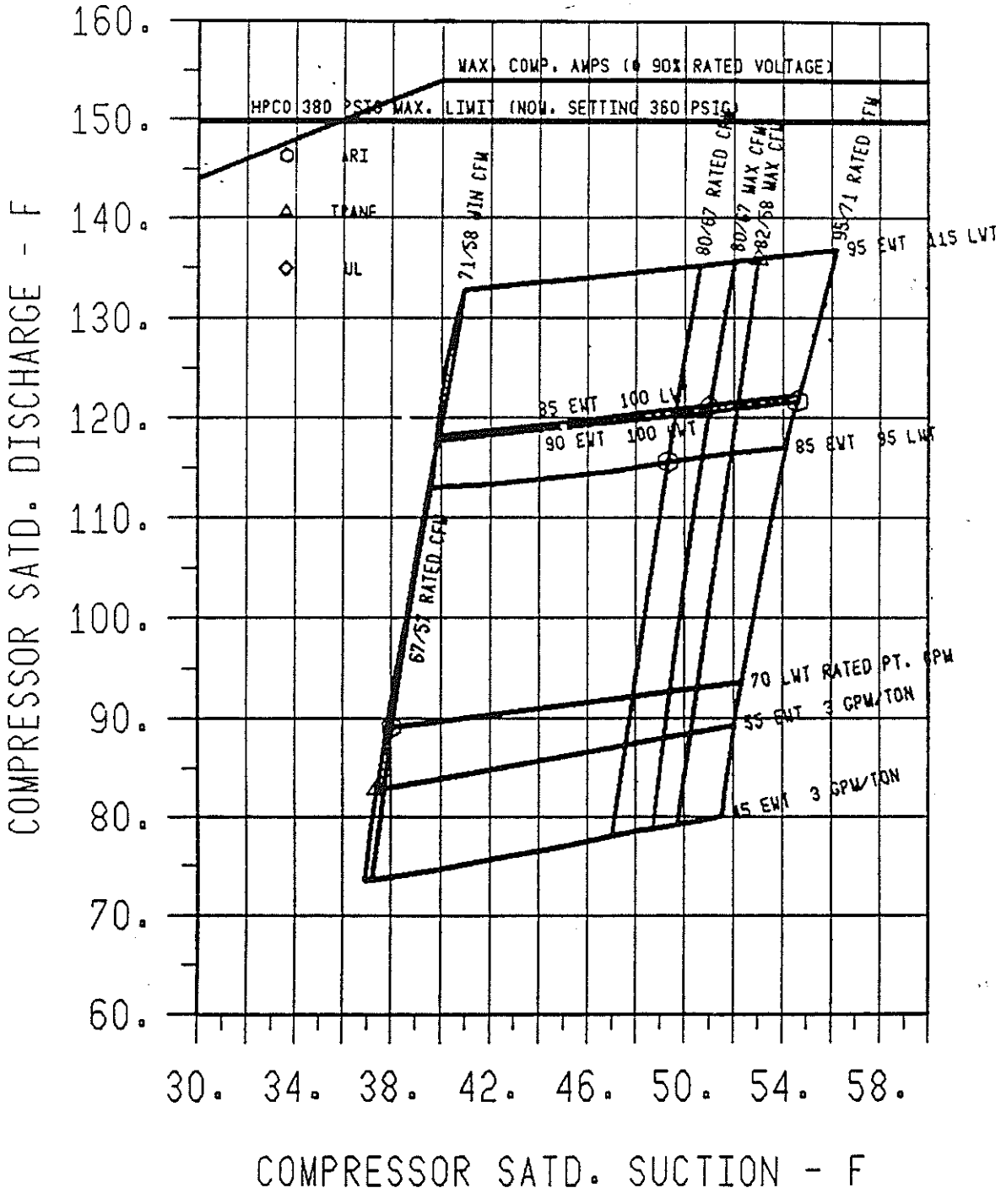


FIG. 4

DATE 7/22/87

# AIR FLOW AND ESP PERFORMANCE
# COMMERCIAL SELF CONTAINED
# VAV UNITS

FAN PERFORMANCE INCLUDES:
-CABINET LOSS
-WET EVAP COIL
FILTER LOSS IS ESP
ECONOMIZER LOSS IS ESP

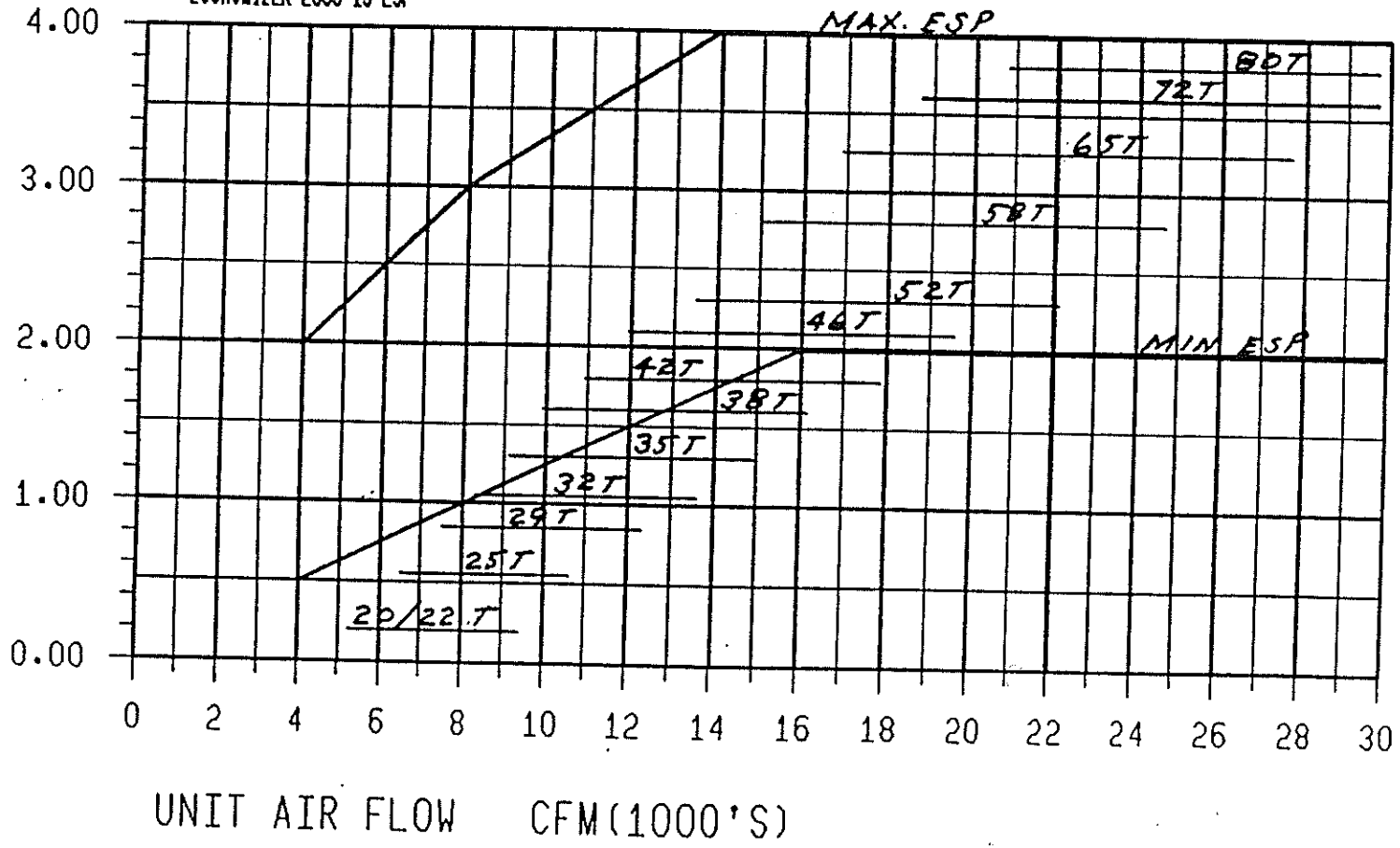
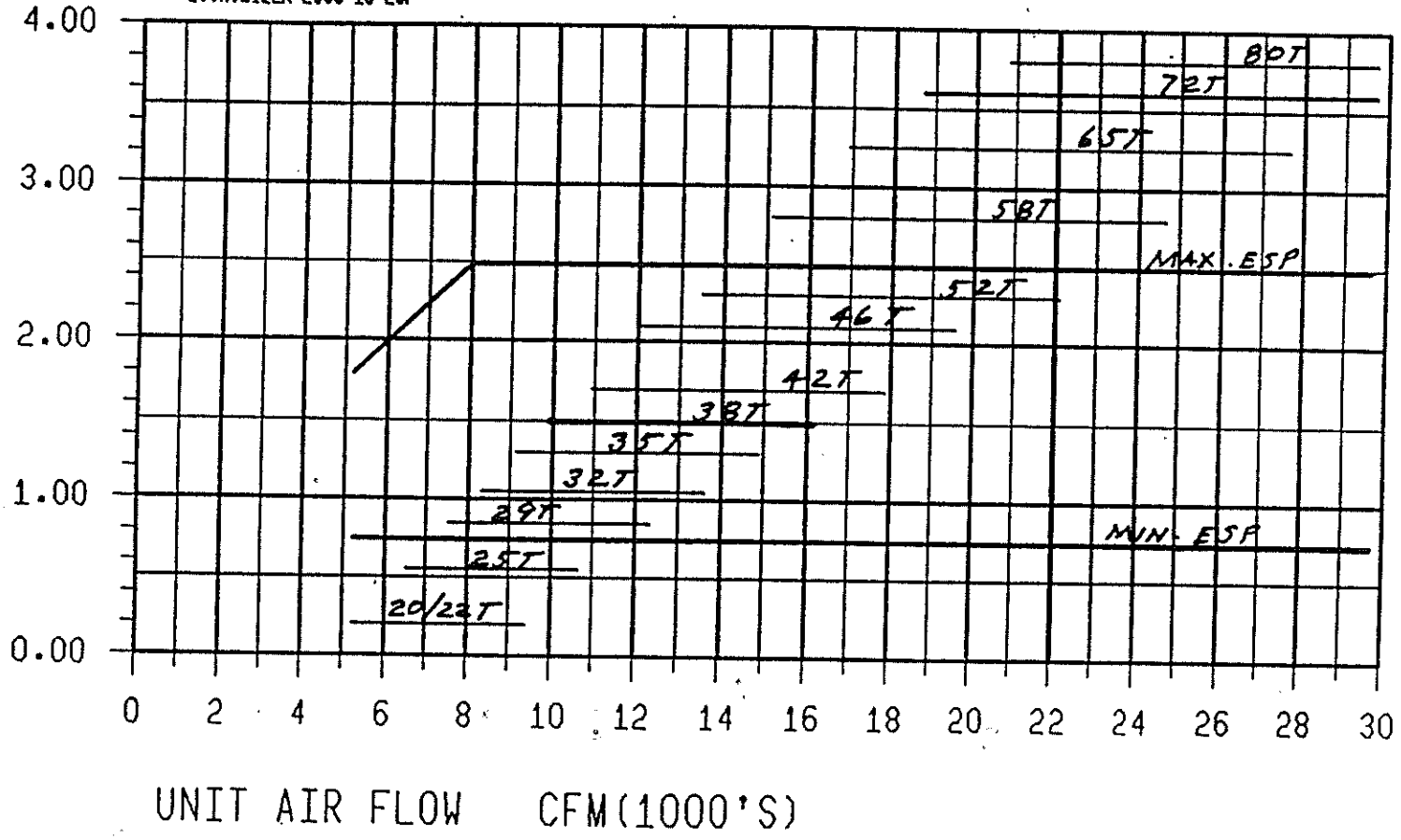


FIG. 5

DATE 7/22/87

# AIR FLOW AND ESP PERFORMANCE
# COMMERCIAL SELF CONTAINED
# NON-VAV UNITS

FAN PERFORMANCE INCLUDES:
-CABINET LOSS
-WET EVAP COIL
FILTER LOSS IS ESP
ECONOMIZER LOSS IS ESP



# ECONO COIL PRESSURE DROP
## 4-ROW COIL
## COMMERCIAL SELF CONTAINED

FIG- 6

DATE 7-30-87

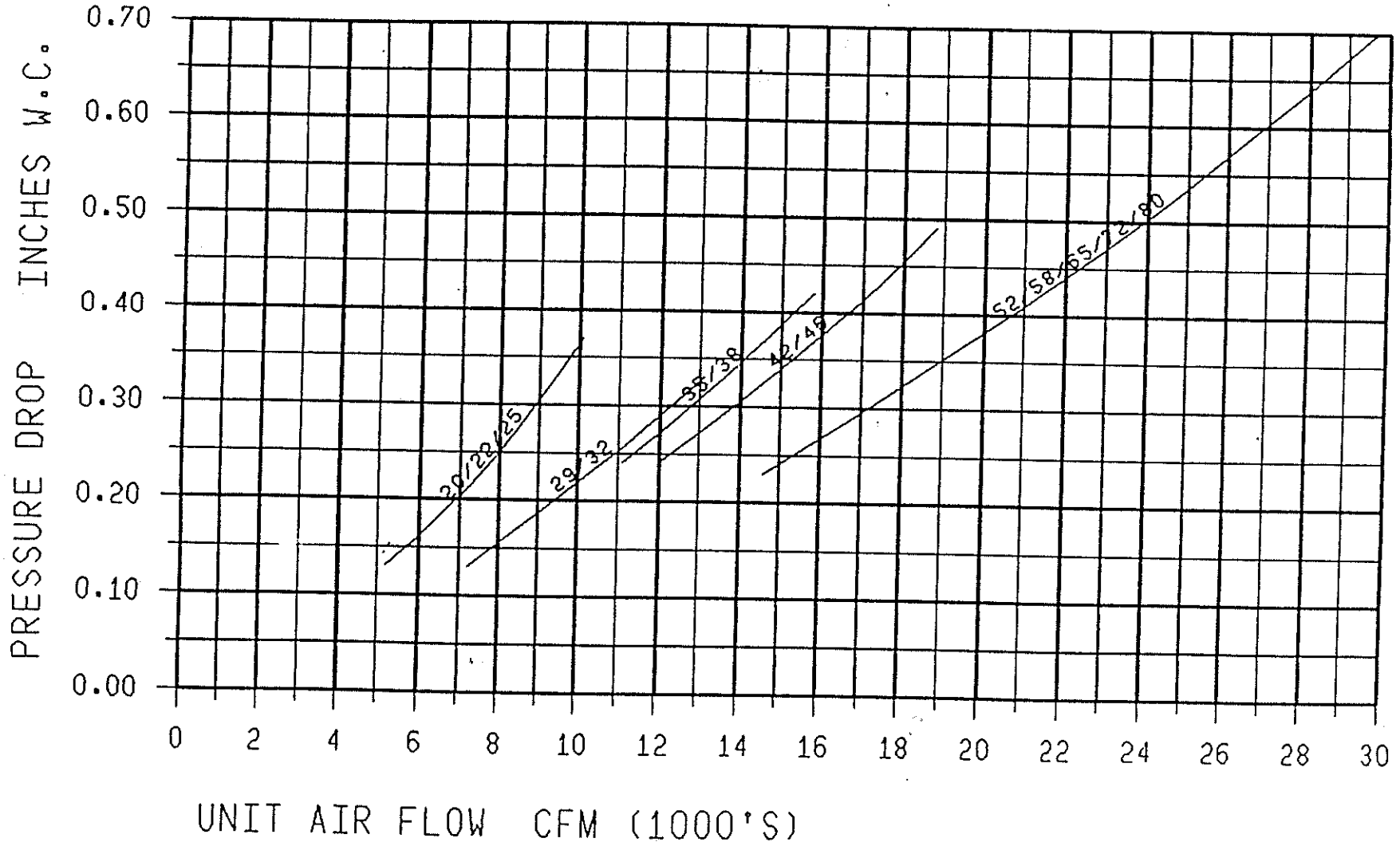
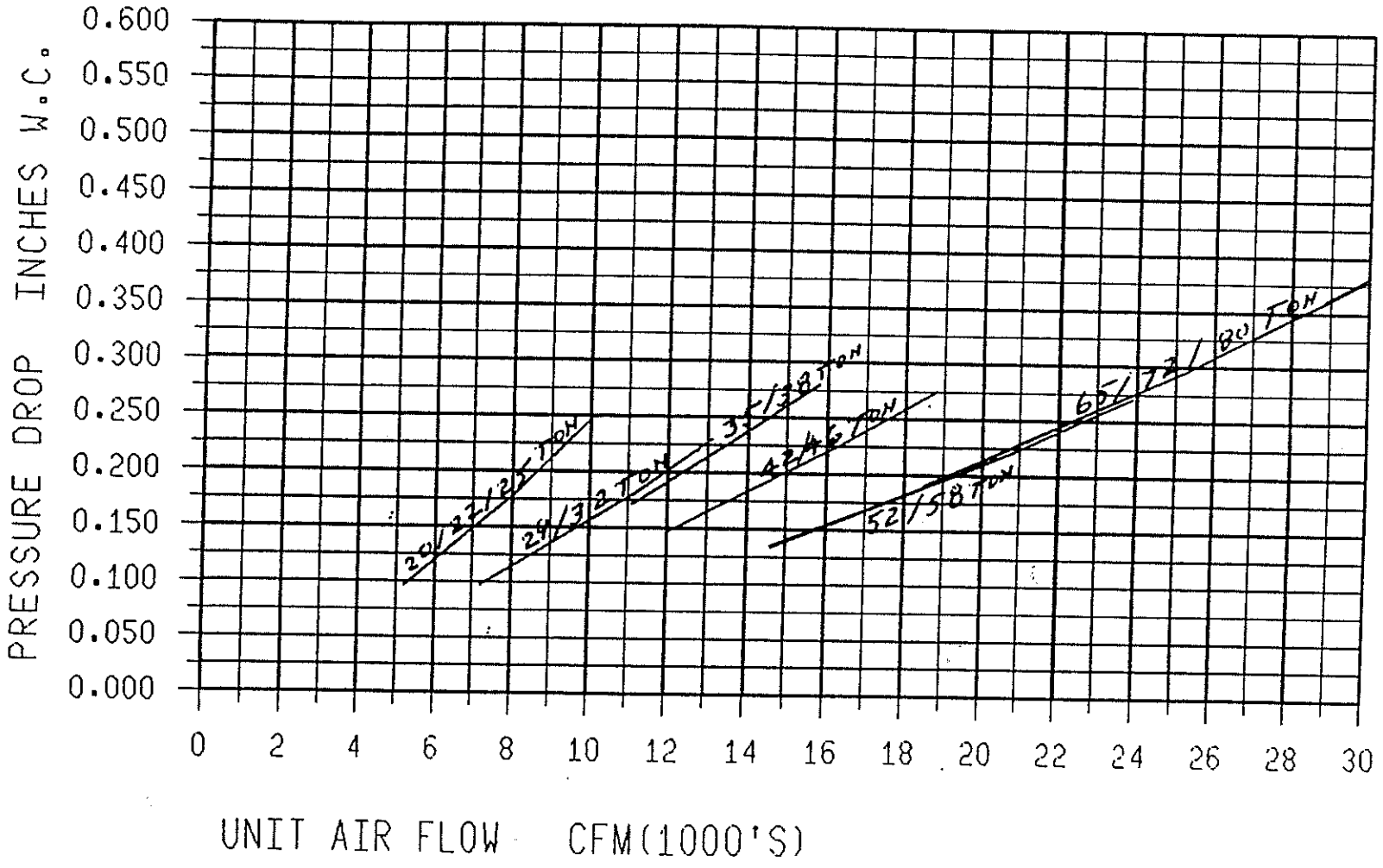


FIG. 8

# ECONO COIL PRESSURE DROP
# TWO ROW COIL
# COMMERCIAL SELF CONTAINED

DATE 6/19/87



## CONDENSING PRESSURE CONTROL OPTION
## 20 - 80 TON COMMERCIAL SELF-CONTAINED

Condensing pressure control is an option used on units without a waterside economizer. It allows mechanical cooling for entering condenser water temperatures 20 degrees below the normal compressor lockout temperature of 55 degrees F.

The condensing pressure is affected by the entering or supply water temperature, the water flowrate, and the temperature of the refrigerant gas. For SWUD, condensing pressure is controlled by modulating the water flow rate based on temperature rise across the condensers. The main point is that control is based on water temperature, not refrigerant pressure.

Whenever a compressor is turned on, there is a predictable rise in water temperature from condenser inlet to outlet. This temperature rise is caused by the heat exchange between the condenser water and refrigerant. This predictable temperature rise or differential is a function of entering condenser water temperature, unit size, and number of compressors running. The head pressures will range anywhere from 125 to 136 PSIG at 35 degree entering water to a range of 222 to 248 PSIG at 90 degree entering water. Figure 1 shows the relationship of discharge pressure to entering water temperature.

For the SWUD condensing pressure control, a motorized ball valve on the unit water inlet regulates condenser capacity by modulating condenser water flow. Regulating condenser capacity maintains head pressure by holding the leaving condenser water temperature at the predicted or precalculated value. Reducing the water flow rate decreases the condenser capacity and causes an increase in condensing pressure. As supply water temperature increases, the flow is increased to increase condenser capacity and reduce condensing pressure.

The water flow in the unit is divided between the number of "circuits" in the unit; anywhere from two to four. Each circuit has its own condenser, expansion valve, evaporator section and compressor. For a three compressor unit with only one compressor running, the operating condenser has a predictable temperature rise. The water from all three condensers mixes together and produces a predictable total leaving water temperature. When the second compressor turns on, the added temperature rise again increases the total leaving water temperature by a predictable amount. The Unit Control Module monitors unit entering and leaving water temperature and positions the valve to hold the predetermined water temperature rise depending on the number of compressors operating. The sensors used to measure entering and leaving water temperatures are a matched pair.

HEAD PRESSURES WITH AND WITHOUT
HEAD PRESSURE CONTROL
CSC

PRODUCT CODE 267

# DISCHARGE PRESSURE VS ENTERING WATER TEMP. COMMERCIAL SELF CONTAINED

FIGURE 1

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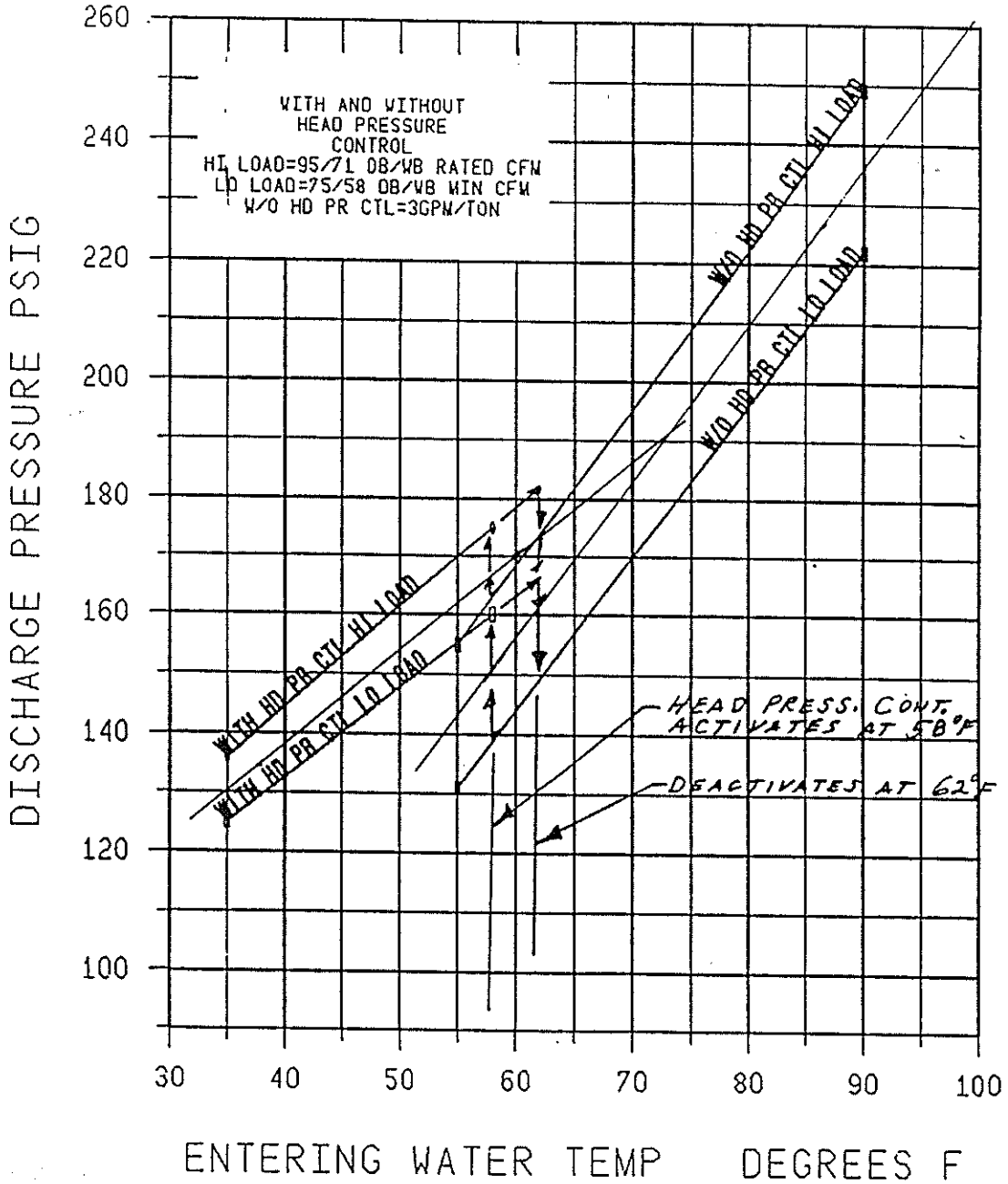


For example, a 22 ton unit with one compressor running has a rise across the operating condenser of 15 degrees. The warmer water discharge mixes with the water from the condenser that's off and establishes a lower average leaving water temperature of approximately 7 - 9.4 degrees. When the second compressor comes on, it's condenser differential also rises to 15 degrees. The leaving water from the two combine and the total drop across the condenser bank is actually 15 degrees with 60 degree entering water as required. The following table lists the water temperature rise as a function of unit size and cooling level. The range of rise covers the entering water temperature control range from 34 to 62 degrees.

| Unit Size | Cooling level | Range of Condenser water temp rise |
|---|---|---|
| 20/22/25 | 1 | 7.0 - 9.4 |
| | 2 | 15.0 - 19.0 |
| 29/32 | 1 | 6.0 - 7.6 |
| | 2 | 9.0 - 11.4 |
| | 3 | 15.0 - 19.0 |
| 35/38 | 1 | 5.0 - 6.6 |
| | 2 | 10.0 - 12.4 |
| | 3 | 15.0 - 19.0 |
| 42/46 | 1 | 5.0 - 5.8 |
| | 2 | 7.0 - 7.8 |
| | 3 | 11.7 - 13.3 |
| | 4 | 15.0 - 19.0 |
| 52/58 | 1 | 10.0 - 12.4 |
| | 2 | 10.0 - 12.4 |
| | 3 | 15.0 - 19.0 |
| 65/72 | 1 | 5.5 - 7.4 |
| | 2 | 7.6 - 9.8 |
| | 3 | 12.9 - 15.4 |
| | 4 | 16.0 - 20.0 |
| 80 | 1 | 5.5 - 7.4 |
| | 2 | 7.6 - 9.8 |
| | 3 | 12.9 - 15.4 |
| | 4 | 16.0 - 20.0 |

Head pressure control is enabled and active whenever the entering water temperature falls to or below 58±2 deg. F. The control will be disabled and inactive when the temperature rises to 62±2 deg. F or above. This provides hysteresis to avoid rapid cycling between states. When the condensing pressure control valve is used, the unit is locked out of mechanical cooling at a minimum entering water temperature of 34±2 deg. F. If the temperature rises back to 38±2 deg. F or above, mechanical cooling will be re-enabled. This again prevents rapid cycling between states. The valve will be closed whenever the unit is shut down or not providing mechanical cooling.

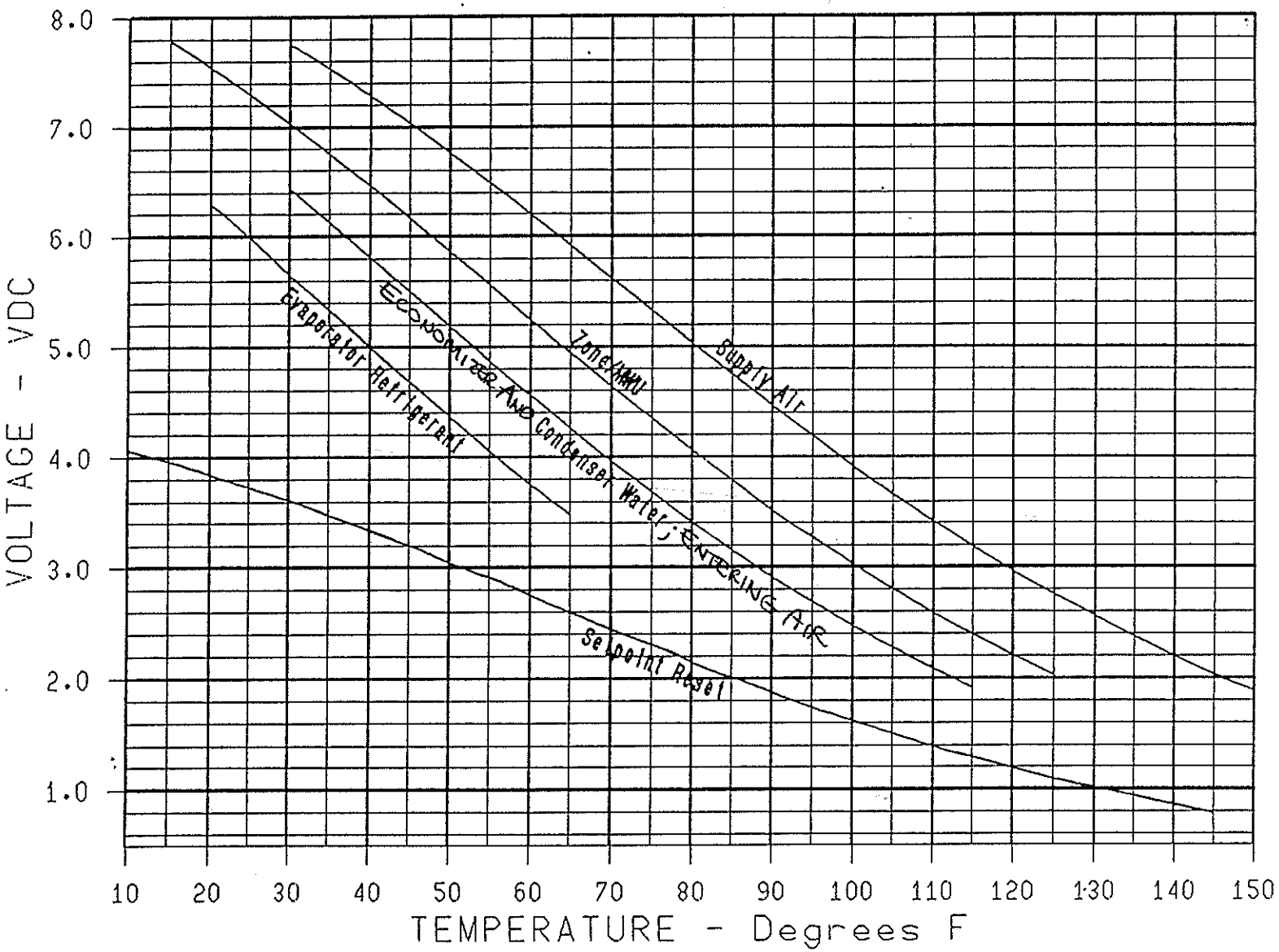
The unit capacity is based on a water flow rate of 3 GPM/Ton. A condenser valve position greater than or equal to 35% is maintained during active condensing pressure control to protect against possible nuisance compressor shutdown due to low condenser water flow rate. The minimum flow rate is also required to help minimize condenser fouling. Under some operating conditions, the valve may be driven to minimum position, 35%, which causes the leaving condenser water temperature to be below the desired value. The condensing pressure will then follow the system conditions during this limit condition. Also, once the valve is wide open, no further control is possible and condensing pressure again follows system conditions.

Permissible extremes of condenser water flow are:

| Unit Nominal Tons | Total Max GPM | Max Total GPM/Nom. Ton | Total Min GPM | Min Total GPM/Nom Ton |
|---|---|---|---|---|
| 20/22 | 80 | 3.6 | 36 | 1.6 |
| 25 | 80 | 3.2 | 36 | 1.4 |
| 29 | 102 | 3.5 | 46 | 1.6 |
| 32 | 102 | 3.2 | 46 | 1.4 |
| 35 | 119 | 3.4 | 54 | 1.5 |
| 38 | 119 | 3.1 | 54 | 1.4 |
| 42 | 142 | 3.4 | 64 | 1.5 |
| 46 | 142 | 3.1 | 64 | 1.4 |
| 52 | 186 | 3.6 | 84 | 1.6 |
| 58 | 186 | 3.2 | 84 | 1.4 |
| 65 | 226 | 3.5 | 102 | 1.6 |
| 72 | 226 | 3.1 | 102 | 1.4 |
| 80 | 248 | 3.1 | 112 | 1.4 |

**Sensor Voltage Scale for SWUD 20-80 Units**

(9.9 VDC indicates sensor open circuit)



**Sensor Resistance Scale for SWUD 20-80 Units**

Note: Resistance curve applies to unit air, water, frost protection and wall-mount thermostat sensors.