Installation, Operation, and Maintenance

Packaged Climate Changer Air Handler

Model LPC
"FO" and later design sequence
1,500 to 15,000 cfm

July 2006

LPC-SVX01C-EN

general information

About This Manual

Literature Change History

Use this manual for Packaged Climate Changer air handlers, model LPC. This is the first revision of this manual. It provides specific installation, operation, and maintenance instructions for "DO" and later design sequences. For previous design sequence information, contact your local Trane representative.

Warnings and Cautions

Warnings and cautions appear at appropriate sections throughout this manual. Read these carefully.

WARNING
Indicates a potentially hazardous situation, which could result in death or serious injury if not avoided.

CAUTION
Indicates a potentially hazardous situation, which may result in minor or moderate injury if not avoided. Also, it may alert against unsafe practices.

CAUTION
Indicates a situation that may result in equipment or property-damage-only accidents.

Sample Warnings and Cautions

WARNING
Hazardous Voltage w/Capacitors!
Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

CAUTION
Use Copper Conductors Only!
Unit terminals are not designed to accept other types of conductors. Failure to use copper conductors may result in equipment damage.

Special Note on Refrigeration Emissions

World environmental scientists have concluded that ozone in our upper atmosphere is being reduced due to the release of CFC fully halogenated compounds.

Trane urges all HVAC service personnel to make every effort to prevent any refrigerant emissions while installing, operating, or servicing equipment. Always conserve refrigerants for continued use.

Additional specific information on refrigerant handling is included in this manual where applicable.

Common HVAC Acronyms
For convenience, a number of acronyms and abbreviations are used throughout this manual. These acronyms are alphabetically listed and defined below.

BAS = Building automation systems
cfm = Cubic-feet-per-minute
ewt = entering water temperature
F/A = Fresh air
HVAC = Heating, ventilation and air conditioning
I/O = Inputs/outputs
IOM= Installation, operation, and maintenace manual
LH = Left-hand
O/A = Outside air
R/A = Return air
RH = Right-hand
rpm = Revolutions-per-minute
S/A = Supply air
w.c. = Water column
ZSM = Zone sensor module

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Cross reference to related publications/information for model LPC units with Tracer AH540 controls:

- *Installation, Operation, and Programming Guide for Tracer AH540 Unit Controller, CNT-SVX05B-EN*
- *Packaged Climate Changer Air Handler Catalog, CLCH-PRC007-EN*

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general information

General

Packaged Climate Changer units are draw-through air handlers that are designed for cooling and/or heating conditions of 1,500 to 15,000 nominal cfm.

Basic unit components consist of coil(s), condensate drain pan, filter, one fan wheel, motor and drive.

Unit control options range from the simple control interface for field-mounted controllers to the sophisticated Tracer AH540. For more information on the Tracer AH540 controls, see the Operation section of this manual.

Refrigerant Handling Procedures

Environmental Accountability Policy
Trane urges that all HVAC servicers to make every effort to eliminate, if possible, or vigorously reduce the emission of CFC, HCFC, and HFC refrigerants to the atmosphere. Always act in a responsible manner to conserve refrigerants for continued usage even when acceptable alternatives are available.

Recover and Recycle Refrigerants
Never release refrigerant to the atmosphere! Always recover and/or recycle refrigerant for reuse, reprocessing (reclaimed), or properly dispose if removing from equipment. Always determine the recycle or reclaim requirements of the refrigerant before beginning the recovery procedure. Obtain a chemical analysis of the refrigerant if necessary. Questions about recovered refrigerant and acceptable refrigerant quality standards are addressed in ARI Standard 700.

Refrigerant Handling and Safety
Consult the manufacturer's material safety data sheet (MSDS) for information on refrigerant handling to fully understand health, safety, storage, handling, and disposal requirements. Use the approved containment vessels and refer to appropriate safety standards. Comply with all applicable transportation standards when shipping refrigerant containers.

Service Equipment and Procedures
To minimize refrigerant emissions while recovering refrigerant, use the manufacturer's recommended recycling equipment per the MSDS. Use equipment and methods which will pull the lowest possible system vacuum while recovering and condensing refrigerant. Equipment capable of pulling a vacuum of less than 1,000 microns of mercury is recommended.

Do not open the unit to the atmosphere for service work until refrigerant is fully removed/recovered. When leak-testing with trace refrigerant and nitrogen, use HCFC-22 (R-22) rather than CFC-12 (R-12) or any other fully-halogenated refrigerant . Be aware of any new leak test methods which may eliminate refrigerants as a trace gas. Perform evacuation prior to charging with a vacuum pump capable of pulling a vacuum of 1,000 microns of mercury or less. Let the unit stand for 12 hours and with the vacuum not rising above 2,500 microns of mercury.

A rise above 2,500 microns of mercury indicates a leak test is required to locate and repair any leaks. A leak test is required on any repaired area.

Charge refrigerant into the equipment only after equipment does not leak or contain moisture. Reference proper refrigerant charge requirements in the maintenance section of this manual to ensure efficient machine operation. When charging is complete, purge or drain charging lines into an approved refrigerant container. Seal all used refrigerant containers with approved closure devices to prevent unused refrigerant from escaping to the atmosphere. Take extra care to properly maintain all service equipment directly supporting refrigerant service work such as gauges, hoses, vacuum pumps, and recycling equipment .

When cleaning system components or parts, avoid using CFC-11 (R-11) or CFC-113 (R-113). Use only cleaning-solvents that do not have ozone depletion factors. Properly dispose of used materials. Refrigeration system cleanup methods using filters and driers are preferred. Check for leaks when excessive purge operation is observed.

Keep abreast of unit enhancements, conversion refrigerants, compatible parts, and manufacturer's recommendations that will reduce refrigerant emissions and increase equipment operating efficiencies.

Access section option
- with or without preheat coil
- one or two-row hot water (9, 12, or 14 fpi) or
- one-row steam distributing coil (6 fpi)

Internal filter frame accommodates two-inch filters

Galvanized steel cabinet
- matt-faced insulation
- foil face insulation optional
- double wall insulation optional
- 2-inch flat filter option on main section

Sizes: 03, 06, 09, 10, 12, 14, 17, 21, 25 or 30 square feet
- 1,500 to 15,000 cfm (708 to 4956 l/s)
- UL/CUL listing
- ARI 410 and 430 listed
- Meets ARI 260 acoustic ratings

Face & bypass option
helps control preheat

Filter section option
- 2-inch, MERV 7, angle filters
- 4-inch, MERV 7, flat filters
- 4-inch, MERV 12, flat filters

Other options include:
- electric heat with single-point power connections, reheat position
- factory mounted and wired disconnect with motor overloads
- variable frequency drive factory mounted and wired

Up to 8 rows of coil
- 4 or 6 row DX coil with 9, 12, or 14 fpi
- 4, 6, or 8-row chilled water with 9, 12, or 14 fpi
- 1 or 2-row hot water coil, reheat or preheat with 9, 12, or 14 fpi
- 1-row steam coil, 6 fpi, reheat or preheat

Belt-driven motor
- Internal spring isolation optional
- $^1/_2$ to 20 hp
- 650 to 1900 rpm

Forward-curved fan
- fixed pitch or variable pitch sheaves
- constant volume or variable air volume

Control options
- control interface
- Tracer AH540 DDC controller

Figure I-GI-1. Packaged Climate Changer air handler unit components. Horizontal unit is shown.

Ultraviolet (UV) Germicidal Irradiation Lights

The United States Environmental Protection Agency (EPA) believes that molds and bacteria inside buildings have the potential to cause health problems in sensitive individuals (Note 1). If specified, Trane provides ultraviolet lights (UV-C) as a factory-engineered and installed option in select commercial air handling products for the purpose of reducing microbiological growth (mold and bacteria) within the equipment. When factory provided, polymer materials that are susceptible to deterioration by the UV-C light will be substituted or shielded from direct exposure to the light. In addition, UV-C radiation can damage human tissue, namely eyes and skin. To reduce the potential for inadvertent exposure to the lights by operating and maintenance personnel, electrical interlocks that automatically disconnect power to the lights are provided at all unit entry points to equipment where lights are located

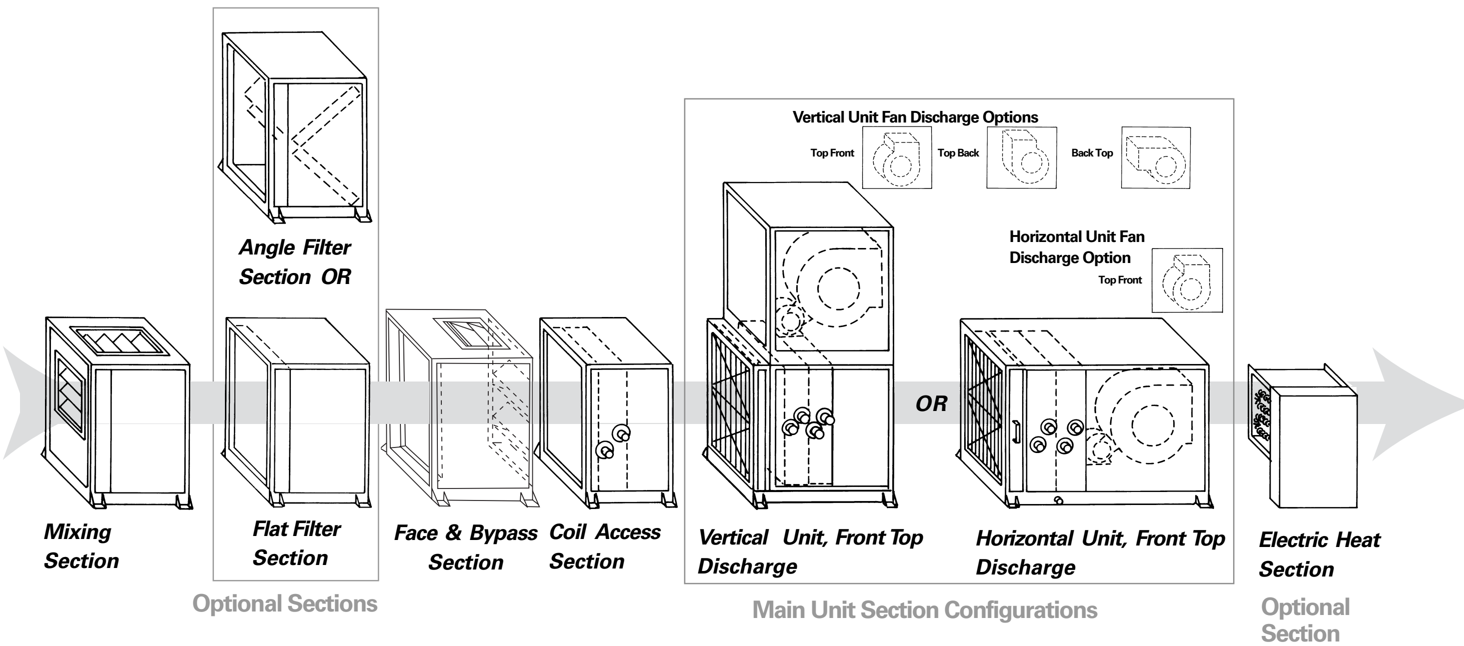
Note:
1. United States Environmental Protection Agency; A Brief Guide to Mold, Moisture and your Home; *Brochure EPA 402-K-02-003. It's available online, at www.epa.gov. Enter "guide to mold" in the search box to view.*

⚠ WARNING

Equipment Damage From Ultraviolet (UV) Lights!

Trane does not recommend field installation of ultraviolet lights in its air handling equipment for the intended purpose of improving indoor air quality. High intensity C-band ultraviolet light is known to severely damage polymer (plastic) materials and poses a personal safety risk to anyone exposed to the light without proper personal protective equipment (can cause damage to eyes and skin). Polymer materials commonly found in HVAC equipment that may be susceptible include insulation on electrical wiring, fan belts, thermal insulation, various fasteners and bushings. Degradation of these materials can result in serious damage to the equipment. Trane accepts no responsibility for the performance or operation of our air handling equipment in which ultraviolet devices were installed outside of the Trane factory.

Packaged Climate Changer Unit Configurations and Optional Sections



Available Fan Discharge Configurations Detail

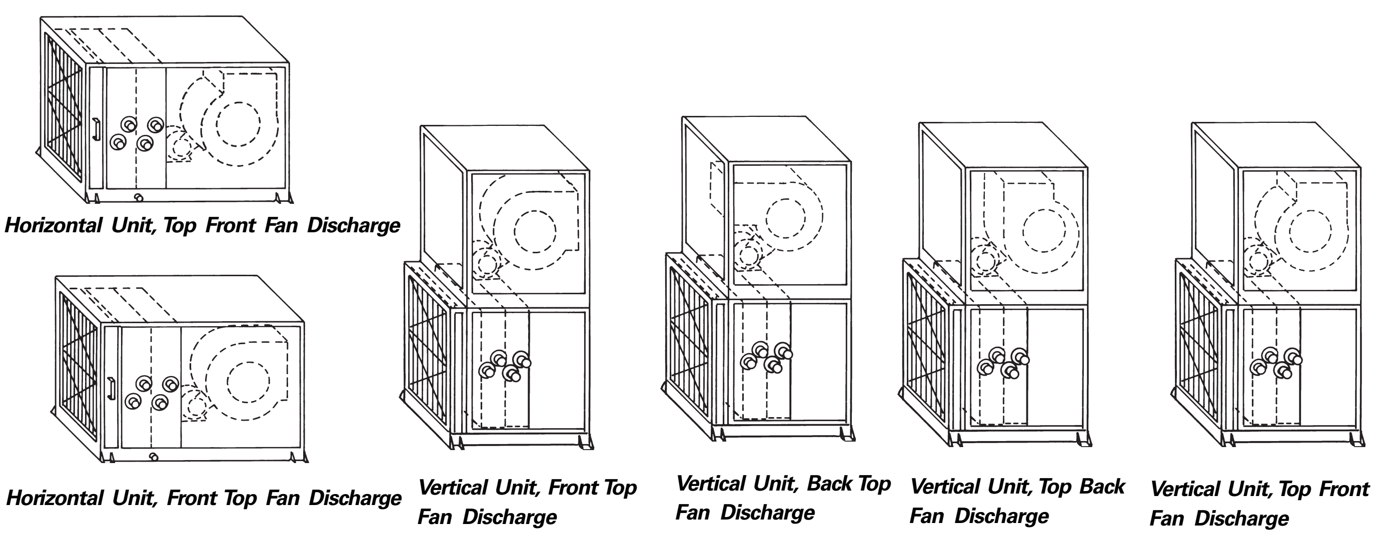


Table I-GI-1. Packaged Climate Changer General Data

Unit size	3	6	8	10	12	14	17	21	25	30
Unit nominal airflow, cfm	1500	3000	4000	5000	6000	7000	8500	10500	12500	15000
Hydronic & DX coil										
coil area, ft^2	2.8	5.6	7.5	9.7	12.4	14.3	16.9	20.6	24.2	28.8
width, in.	17.5	22.5	27.5	27.5	35.0	35.0	45.0	45.0	51.2	51.2
length, in.	23.0	36.0	39.0	51.0	51.0	59.0	54.0	66.0	68.0	81.0
velocity, ft./min.	536.7	533.3	537.1	513.3	484.0	488.1	503.7	509.1	516.5	520.3
dry weight, lbs. [Note 10]										
1-row	23.5	35.0	41.8	51.5	66.2	72.1	82.8	93.2	109.7	122.5
2-row	29.5	46.3	56.8	70.8	91.0	100.5	116.6	134.2	168.5	190.2
4-row	46.6	75.8	94.7	120.5	152.8	170.7	207.3	240.7	276.3	317.0
6-row	58.6	98.5	124.7	159.3	202.4	227.8	274.9	322.8	372.7	431.2
8-row	73.6	125.4	159.5	204.7	259.4	292.9	351.3	414.5	479.5	556.8
wet weight, lbs. [Note 10]										
1-row	29.2	43.6	52.5	64.0	85.8	93.2	108.2	121.5	141.9	158.2
2-row	37.7	59.0	73.0	90.5	119.9	132.4	161.1	184.4	226.6	255.4
4-row	59.8	97.6	123.1	155.7	201.6	225.4	279.1	323.9	373.1	427.8
6-row	76.9	129.4	165.2	210.0	271.2	305.3	374.0	438.9	508.2	587.7
8-row	96.9	165.5	212.2	271.0	348.2	393.3	477.6	563.5	653.7	759.0
waterflow limits										
1-row										
min. gpm [Note 3]	6.1	7.9	9.6	9.6	12.2	12.2	15.7	15.7	17.5	17.5
max. gpm [Note 4]	32.6	42.0	51.3	51.3	65.3	65.3	83.9	83.9	93.3	93.6
2, 4, 6, & 8-row										
min. gpm [Note 3]	6.1	14.9	18.4	18.4	23.6	23.6	30.6	30.6	35.0	35.0
max. gpm [Note 4]	32.6	79.3	51.3	51.3	65.3	125.9	163.2	163.2	186.6	186.6
volume, gallons										
1-row	0.7	1.0	1.3	1.5	2.3	2.5	3.1	3.4	3.9	4.3
2-row	1.0	1.5	2.0	2.4	3.5	3.8	5.3	6.0	7.0	7.8
4-row	1.6	2.6	3.4	4.2	5.9	6.6	8.6	10.0	11.6	13.3
6-row	2.2	3.7	4.9	6.1	8.3	9.3	11.9	13.9	16.3	18.8
8-row	2.8	4.8	6.3	7.9	10.6	12.0	15.2	17.9	20.9	24.3
Steam coil										
area, ft^2	1.9	4.5	6.5	8.5	11.7	13.5	6.8	8.4	11.0	13.2
width, in. [Note 5]	12.0	18.0	24.0	24.0	33.0	33.0	18.0	18.0	24.0	24.0
length, in. [Note 6]	23.0	36.0	39.0	51.0	51.0	59.0	54.0	67.0	66.0	79.0
area, ft^2 [Note 7]	–	–	–	–	–	–	9.0	11.2	11.0	13.2
width, in. [Notes 5 & 7]	–	–	–	–	–	–	24.0	24.0	24.0	24.0
length, in. [Notes 6 & 7]	–	–	–	–	–	–	54.0	67.0	66.0	79.0
weight, lbs.	31.7	54.8	74.8	86.0	114.1	123.3	157.6	179.9	200.0	224.2
Fan/motor data										
fan wheel size, in.	9x7	12x9	12x12	15x15	18x15	18x18	20x15	20x20	20x18	22x20
max rpm	2000	1500	1700	1400	1200	1200	1100	1000	1300	1150
motor HP	1/2 - 2	1/2 - 3	3/4 - 5	1 - 5	1 - 7 1/2	1 - 7 1/2	1 -10	2 - 15	3 - 20	3 - 20
min. design cfm [Note 8]	1050	2100	2800	3500	4200	4900	5950	7350	8750	10500
max. design cfm [Note 9]	1800	3600	4800	6000	7200	8400	10200	12600	15000	18000
2 and 4-in. Flat filter data										
quantity - size in.	1 - 20x25	2 - 20x25	2 - 20x25	1 - 16x25 2 - 20x25	2 - 16x20 1 - 16x25 2 - 20x20 1 - 20x25	2 - 16x20 1 - 16x25 2 - 20x20 1 - 20x25	2 - 16x20 2 - 16x25 2 - 20x20 2 - 20x25	2 - 16x20 2 - 16x25 2 - 20x20 2 - 20x25	2 - 16x25 6 - 20x25	6 - 16x25 4 - 20x25
area, ft^2	3.5	6.9	6.9	9.7	16.3	16.3	22.5	22.5	26.4	30.6
nominal air velocity, ft./min.	432.0	432.0	576.0	514.3	369.2	430.8	377.8	466.7	473.5	490.2
2-in. Angle filter section data										
quantity - size in.	2 - 16x25	4 - 20x20	4 - 20x20	4 - 20x20 2 - 16x20	9 - 20x20	9 - 20x20	6 - 16x25 6 - 20x25	6 - 16x25 6 - 20x25	4 - 16x20 12 - 20x20	12 - 16x20 8 - 20x20
area, ft^2	5.6	11.1	11.1	15.6	25.0	25.0	37.5	37.5	42.2	48.9
velocity, ft./min.	270.0	270.0	360.0	321.3	240.0	280.0	226.7	280.0	296.2	306.7
Mixing section										
nominal air velocity, ft./min.	966.4	1066.3	1123.4	1120.4	1184.1	1161.7	1171.1	1120.1	1218.5	1247.1

Notes: 1. Coil width = length in the direction of a coil header, typically vertical. 2. Coil length = length of coil in direction of the coil tubes, typically horizontal and perpendicular to airflow. 3. Unit sizes 17-30 have two stacked steam coils. 4. To prevent erosion/noise problems. 5. Coil width = length in the direction of a coil header, typically vertical. 6. Coil length = length of coil in direction of the coil tubes, typically horizontal and perpendicular to airflow. 7. The minimum waterflow is to assure self venting of the coil. There is no minimum water flow limit for coils that do not require self venting. 8. Minimum airflow limit is for units with hot water, steam, or electric heat. There is no minimum airflow for cooling only units. 9. Due to moisture carryover limits. 10. Coil weight based on 12 fpi coil.

Table I-GI-2. Available motor horsepower and unit voltage

	motor horsepower										
unit voltage	1/2	3/4	1	1 1/2	2	3	5	7 1/2	10	15	20
208/60/1	●	●	●								
230/60/1	●	●	●								
277/60/1	●	●	●								
208/60/3	●	●	●	●	●	●	●	●	●	●	●
230/60/3	●	●	●	●	●	●	●	●	●	●	●
460/60/3	●	●	●	●	●	●	●	●	●	●	●
575/60/3			●	●	●	●	●	●	●	●	●
380/50/3			●	●	●	●	●	●	●	●	
415/50/3			●	●	●	●	●	●	●	●	

Table I-GI-3. Available motor horsepower by unit size

	motor horsepower										
unit size	1/2	3/4	1	1 1/2	2	3	5	7 1/2	10	15	20
3	●	●	●	●	●						
6	●	●	●	●	●	●					
8		●	●	●	●	●	●				
10			●	●	●	●	●				
12			●	●	●	●	●	●			
14			●	●	●	●	●	●			
17			●	●	●	●	●	●	●		
21					●	●	●	●	●		
25						●	●	●	●	●	●
30						●	●	●	●	●	●

Dx Coil Options

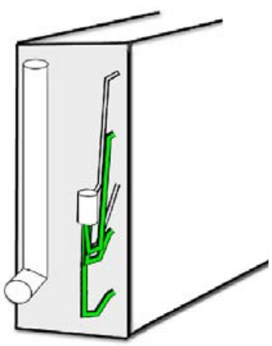


Figure I-GI-1. Single Circuit DX Coil

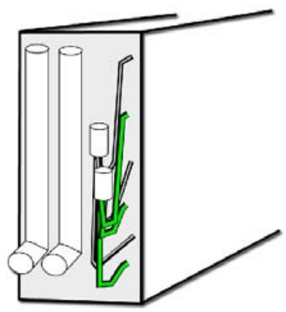


Figure I-GI-2. Intertwined DX Coil

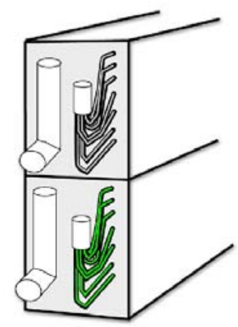


Figure I-GI-3. Horizontal Face Split DX Coil

Table I-GI-5. Packaged Climate Changer DX Coil Configuration Options

Coil Configuration	Single				Horizontal Face Split				Intertwined			
Unit Size	# Dist.	# Circuits	Coil Fin Width	Coil Fin Length	# Dist.	# Circuits	Coil Fin Width	Coil Fin Length	# Dist.	# Circuits	Coil Fin Width	Coil Fin Length
3	1	3	17.5	23.0	–	–	–	–	–	–	–	–
6	1	5	22.5	36.0	–	–	–	–	–	–	–	–
8	1	7	27.5	39.0	2	7	27.5	39.0	2	7	27.5	39.0
10	1	10	27.5	51.0	2	10	27.5	51.0	2	10	27.5	51.0
12	–	–	–	–	2	13	35.0	51.0	2	13	35.0	51.0
14	–	–	–	–	2	13	35.0	59.0	2	13	35.0	59.0
17	–	–	–	–	2	17	45.0	54.0	4	17	45.0	54.0
21	–	–	–	–	2	17	45.0	66.0	4	17	45.0	66.0
25	–	–	–	–	2	20	51.3	68.0	4	20	51.5	68.0
30	–	–	–	–	4	40	51.3	81.0	4	40	51.3	81.0

Note: 4-row coils have a 3/16" distributor. 6-row coils have a 1/4" distributor.

TRANE

Installation general information

Packaged Climate Changer Model Number Description

Following is a complete description of the Packaged Climate Changer model number. Each digit in the model number has a corresponding code that identifies specific unit options.

LPC	A	A	08	F	2	F0	L	L	B	0	0	000	0	0	A	F	B	H	B	0	0	0	0	0	0	0	0	0	0	0
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	28	29	30	31	32	33	34	35	36	37

Digit 1, 2, 3 - Unit model
LPC = Packaged Climate Changer

Digit 4 - Development sequence
A = “A” development sequence

Digit 5 - Configuration
A = horizontal/front top
B = horizontal/top front
C = vertical/front top
D = vertical/top front
E = vertical/back top
F = vertical/top back

Digit 6, 7 - Unit size
03 = 3 square feet of coil
06 = 6 square feet of coil
08 = 8 square feet of coil
10 = 10 square feet of coil
12 = 12 square feet of coil
14 = 14 square feet of coil
17 = 17 square feet of coil
21 = 21 square feet of coil
25 = 25 square feet of coil
30 = 30 square feet of coil

Digit 8 - Unit voltage
0 = no motor, controls, electric heat
A = 208/60/1
B = 230/60/1
C = 277/60/1
D = 208/60/3
E = 230/60 /3
F = 460/60/3
G = 575/60/3
H = 380/50/3
J = 415/50/3

Digit 9 - Insulation & Isolation
1 = 1 inch, matt faced
2 = 1 inch, foil faced
3 = 1 inch, double-wall with field provided external isolaiton
4 = 1 inch, double-wall with internal isolation

Digit 10,11 - Design sequence

Digit 12 - Drain pan type, coil & motor connection location
R = polymer drain pan, RH coil & motor
L = polymer drain pan, LH coil & motor
C = polymer drain pan, RH coil & LH motor
D = polymer drain pan, LH coil & RH motor
E = SS drain pan, RH coil & motor
F = SS drain pan, LH coil & motor
G = SS drain pan, RH coil & LH motor
H = SS drain pan, LH coil & RH motor

Digit 13 - Unit Coil #1 Type (1st in Air Stream)
0 = no unit coil #1
hydronic heat coils
A = 1-row, 9 fpi
B = 1-row, 12 fpi
C = 1-row, 14 fpi
D = 2-row, 9 fpi
E = 2-row, 12 fpi
F = 2-row, 14 fpi
chilled hydronic coils
G = 4-row, 9 fpi
H = 4-row,12 fpi
J = 4-row, 14 fpi
K = 6-row, 9 fpi
L = 6-row, 12 fpi
M = 6-row, 14 fpi
N = 8-row, 9 fpi
P = 8-row, 12 fpi
R = 8-row, 14 fpi
DX coils, 3/16” distributor
T = 4-row, 9 fpi
U = 4-row, 12 fpi
V = 4-row, 14 fpi
Steam Coil
1 = 1-row, 6 fpi
DX coils, 1/4” distributor
5 = 6-row, 9 fpi
6 = 6-row DX, 12 fpi
7 = 6-row DX, 14 fpi

Digit 14 - Unit coil #2 type (2nd in air stream)
0 = no unit coil #1
hydronic reheat coils
A = 1-row, 9 fpi
B = 1-row, 12 fpi
C = 1-row, 14 fpi
D = 2-row, 9 fpi
E = 2-row, 12 fpi
F = 2-row, 14 fpi
chilled hydronic coils
G = 4-row, 9 fpi
H = 4-row,12 fpi
J = 4-row, 14 fpi
K = 6-row, 9 fpi
L = 6-row, 12 fpi
M = 6-row, 14 fpi
DX coils, 3/16” distributor
N = 4-row, 9 fpi
P = 4-row, 12 fpi
R = 4-row, 14 fpi
steam coil
W = 1-row, 6 fpi
DX coils, 1/4” distributor
2 = 6-row, 9 fpi
3 = 6-row, 12 fpi
4 = 6-row, 14 fpi

Digit 15 - Access section (preheat)
0 = none
hydronic coils
A = 1-row, 9 fpi
B = 1-row, 12 fpi
C = 1-row, 14 fpi
D = 2-row, 9 fpi
E = 2-row, 12 fpi
F = 2-row, 14 fpi
G = 1-row steam coil, type NS, 6 fpi
R = no coil, matt face insulation

Digit 16 - Electric heat, factory mounted only
0 = none
1 = electric heat with 1 stage
2 = electric heat with 2 stages
4 = electric heat with 4 stages

Digit 17, 18, 19 - Electric heater kW
006 - 018 = 1 kW increments
020 - 038 = 2 kW increments
041 - 059 = 3 kW increments
063 - 095 = 4 kW increments
95 and < = 5 kW increments
Digit 17, 18, 19 - Electric heater kW

Digit 20 - Control type
0 = none
1 = control interface
2 = Tracer AH540 zone temp. control
3 = Tracer AH540 discharge temp. control

Digit 21 = Electric heater options
0 = none
A = line fuse
B = door interlocking disconnect switch
C = air flow switch
combined options
D = A and B
E = A and C
F = B and C
G = A, B, and C

Digit 22 – Refrigerant circuit options
0 = none
1 = single circuit with one stage DX
2 = face split circuit with 2 stage DX
3 = intertwined circuit with 2 stage DX
5 = single circuit with 2 stage DX
6 = face split circuit with 4 stage DX
7 = intertwined circuit with 4 stage DX

Digit 23 - Motor horsepower (hp)
0 = none
A = 1/2 hp
B = 3/4 hp
C = 1 hp
D = 1 1/2 hp
E = 2 hp
F = 3 hp
G = 5 hp
H = 7 1/2 hp
J = 10 hp
K = 15 hp
L = 20 hp

Digit 24 - Volume control
A = CV with variable pitch sheaves
B = CV with fixed pitch sheaves
C = VFD with fixed pitch sheaves

Digit 25 – Drives, fixed/variable
0 = none
A = 650 rpm/600 – 700 rpm
B = 700 rpm/650 – 750 rpm
C = 750 rpm/700 – 800 rpm
D = 800 rpm/750 – 850 rpm
E = 850 rpm/800 – 900 rpm
F = 900 rpm/850 – 950 rpm
G = 950 rpm/900 – 1000 rpm
H = 1000 rpm/950 – 1050 rpm
J = 1050 rpm/1000 – 1100 rpm
K = 1100 rpm/1050 – 1150 rpm
L = 1150 rpm/1100 – 1200 rpm
M = 1200 rpm/1150 – 1250 rpm
N = 1250 rpm/ 1200 – 1300 rpm
P = 1300 rpm/1250 – 1350 rpm
R = 1350 rpm/1300 – 1400 rpm
T = 1400 rpm/1350 – 1450 rpm
U = 1450 rpm/1400 – 1500 rpm
V = 1500 rpm/1450 – 1550 rpm
W = 1550 rpm/1500 – 1600 rpm
Y = 1600 rpm/1550 – 1650 rpm
Z = 1650 rpm/1600 – 1700 rpm
1 = 1700 rpm/1650 – 1750 rpm
2 = 1750 rpm/1700 – 1800 rpm
3 = 1800 rpm/1750 – 1850 rpm
4 = 1850 rpm/1800 – 1900 rpm
5 = 1900 rpm/1850 – 1950 rpm
6 = 1950 rpm/1900 – 2000 rpm
7 = 2000 rpm/1950 – 2050 rpm

Digit 26 - Filter type/filter/mixing section
0 = none
A = flat unit filter
B = flat unit filter & mixing section
C = angle filter section
D = flat filter section
E = angle filter section & mixing section
F = flat filter section & mixing section

Digit 27 – Face & bypass section (F & B, preheat position)
0 = none
A = F & B w/ NC actuator
B = F & B w/ NO actuator
C = F & B w/ field-supplied NO actuator
D = F & B w/ field-supplied NC actuator

Digit 28 - Control option
0 = none
1 = dehumidification w/RH sensor
2 = dehumidification w/comm.RH
3 = 2-pipe changeover w/EWT sensor
4 = 2-pipe changeover w/comm. EWT
5 = CO_2 sensor
6 = 1 & 4

Digit 29 - Control options 1, factory mounted
0 = none
A = low limit switch
B = condensate overflow switch
C = dirty filter switch
D = fan status switch
combined options
E = A and B
F = A and C
G = A and D
H = B and C
J = B and D
K = C and D
L = A, B, and, C
M = A, B, and D
N = A, C, and D
P = B, C, and D
R = A, B, C, and D

Digit 30 - Control options 2
0 = none
A = discharge air sensor (DAS)
B = mixed air sensor (MAS)
D = NO mixing box act.
E = NC mixing box act.
combined options
F = A and B
H = A and D
J = A and E
L = B and D
M = B and E
R = A, B, and D
T = A, B, and E
1 = field mounted, NO, mixing box act.
2 = field mounted, NC, mixing box act.
3 = DAS & field sup. NO mixing box act.
4 = DAS & field sup. NC, mixing box act.
5 = MAS & field sup. NO mixing box act.
6 = MAS & field sup. NC mixing box act.
7 = DAS, MAS field sup. NO mix. box act.
8 = DAS, MAS field sup. NC mix. box act.

Digit 31 - Control function
0 = none
1 = mixed air ctrl.
2 = mixed air preheat ctrl.
3 = economizing with mixed air ctrl.
4 = economizing with mixed air preheat ctrl.

Digit 32 - Control options 3, factory provided, field installed
0 = none
A = outdoor air temperature sensor
B = duct static pressure sensor
C = A & B
D = outdoor air temperature communicated
E = duct static pressure communicated
F = D & E

Digit 33 – Preheat control valve options
0 = none
A = 3/4" 2-way, NO 7.3 Cv
B = 3/4" 2-way, NC 7.3 Cv
C = 3/4" 3-way, NO 7.3 Cv
D = 3/4" 3-way, NC 7.3 Cv
E = 1" 2-way, NO 11.6 Cv
F = 1" 2-way, NC 11.6 Cv
G = 1" 3-way, NO 11.6 Cv
H = 1" 3-way, NC 11.6 Cv
J = 1 1/4" 2-way, NO 18.5 Cv
K = 1 1/4" 2-way, NC 18.5 Cv
L = 1 1/4" 3-way, NO 18.5 Cv
M = 1 1/4" 3-way, NC 18.5 Cv
N = 1 1/2" 2-way, NO 28.9 Cv
P =1 1/2" 2-way, NC 28.9 Cv
Q = 1 1/2" 3-way, NO 28.9 Cv
R =1 1/2" 3-way, NC 28.9 Cv
T = 2" 2-way, NO 46.2 Cv
U = 2" 2-way, NC 46.2 Cv
V = 2" 3-way, NO 46.2 Cv
W = 2" 3-way, NC 46.2 Cv
X = 2 1/2" 2-way, NO 54 Cv
Y = 2 1/2" 2-way, NC 54 Cv
Z = 2 1/2" 3-way, NO 54 Cv
1 = 2 1/2" 3-way, NC 54 Cv
2 = field supplied 2-way NO
3 = field supplied 2-way NC
6 = field supplied 3-way NO
7 = field supplied 3-way NC

Note: NO = Normally open & NC = Normally closed in the valve's de-energized state

Digit 34 – Cooling control valve options
0 = none
A = 3/4″ 2-way, NO 7.3 Cv
B = 3/4″ 2-way, NC 7.3 Cv
C = 3/4″ 3-way, NO 7.3 Cv
D = 3/4″ 3-way, NC 7.3 Cv
E = 1″ 2-way, NO 11.6 Cv
F = 1″ 2-way, NC 11.6 Cv
G = 1″ 3-way, NO 11.6 Cv
H = 1″ 3-way, NC 11.6 Cv
J = 1 1/4″ 2-way, NO 18.5 Cv
K = 1 1/4″ 2-way, NC 18.5 Cv
L = 1 1/4″ 3-way, NO 18.5 Cv
M = 1 1/4″ 3-way, NC 18.5 Cv
N = 1 1/2″ 2-way, NO 28.9 Cv
P = 1 1/2″ 2-way, NC 28.9 Cv
Q = 1 1/2″ 3-way, NO 28.9 Cv
R =1 1/2″ 3-way, NC 28.9 Cv
T = 2″ 2-way, NO 46.2 Cv
U = 2″ 2-way, NC 46.2 Cv
V = 2″ 3-way, NO 46.2 Cv
W = 2″ 3-way, NC 46.2 Cv
X = 2 1/2″ 2-way, NO 54 Cv
Y = 2 1/2″ 2-way, NC 54 Cv
Z = 2 1/2″ 3-way, NO 54 Cv
1 = 2 1/2″ 3-way, NC 54 Cv
2 = field supplied, 2-way NO
3 = field supplied, 2-way NC
6 = field supplied, 3-way NC
7 = field supplied, 3-way NC

Note: NO = Normally open & NC = Normally closed in the valve's de-energized state

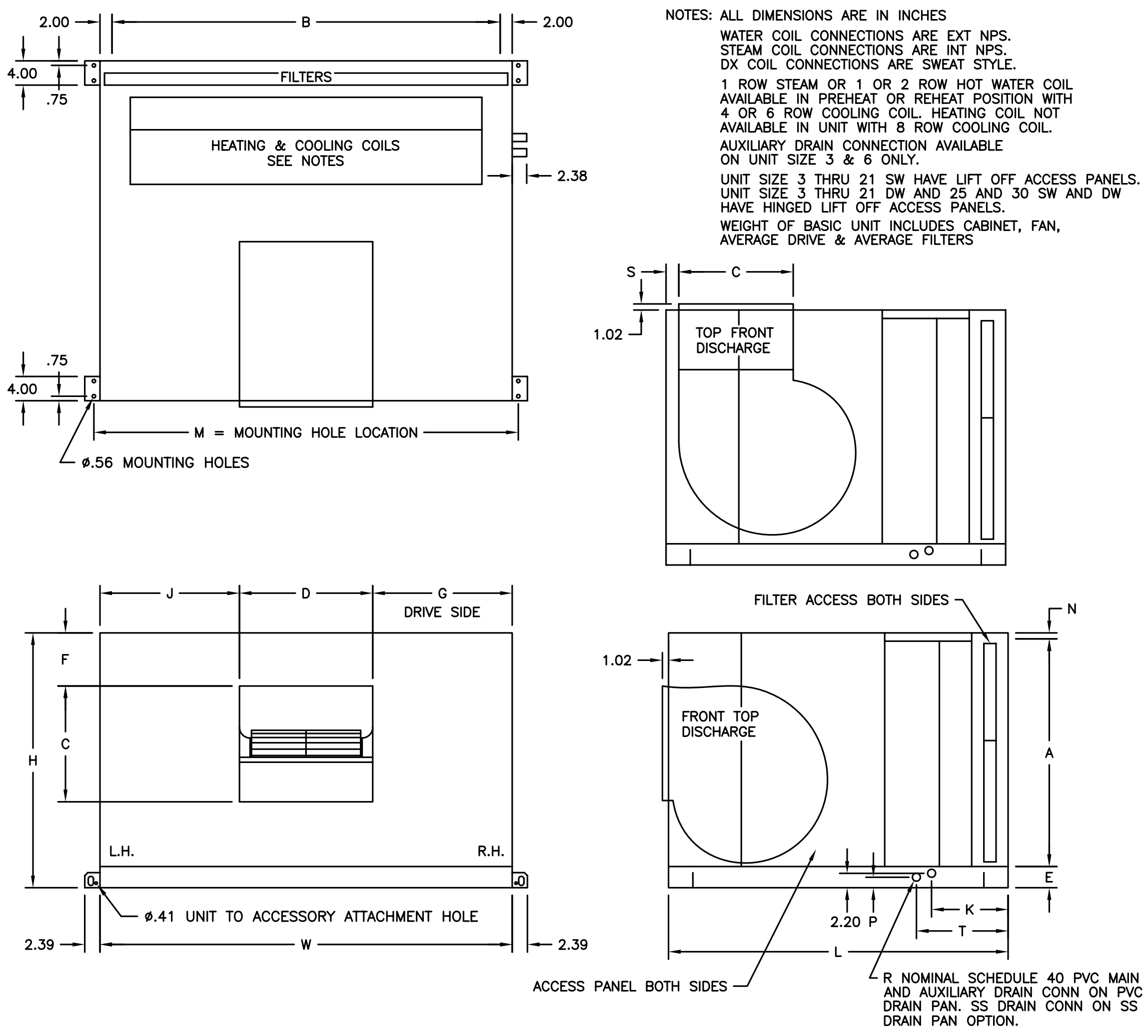
Digit 35 – Reheat control valve options
0 = none
A = 3/4″ 2-way, NO 7.3 Cv
B = 3/4″ 2-way, NC 7.3 Cv
C = 3/4″ 3-way, NO 7.3 Cv
D = 3/4″ 3-way, NC 7.3 Cv
E = 1″ 2-way, NO 11.6 Cv
F = 1″ 2-way, NC 11.6 Cv
G = 1″ 3-way, NO 11.6 Cv
H = 1″ 3-way, NC 11.6 Cv
J = 1 1/4″ 2-way, NO 18.5 Cv
K = 1 1/4″ 2-way, NC 18.5 Cv
L = 1 1/4″ 3-way, NO 18.5 Cv
M = 1 1/4″ 3-way, NC 18.5 Cv
N = 1 1/2″ 2-way, NO 28.9 Cv
P = 1 1/2″ 2-way, NC 28.9 Cv
Q = 1 1/2″3-way, NO 28.9 Cv
R = 1 1/2″ 3-way, NC 28.9 Cv
T = 2″ 2-way, NO 46.2 Cv
U = 2″ 2-way, NC 46.2 Cv
V = 2″ 3-way, NO 46.2 Cv
W = 2″ 3-way, NC 46.2 Cv
X = 2 1/2″ 2-way, NO 54 Cv
Y = 2 1/2″ 2-way, NC 54 Cv
Z = 2 1/2″ 3-way, NO 54 Cv
1 = 2 1/2″ 3-way, NC 54 Cv
2 = field supplied, 2-way NO
3 = field supplied, 2-way NC
6 = field supplied 3-way NO
7 = field supplied 3-way NC

Note: NO = Normally open & NC = Normally closed in the valve's de-energized state

Digit 36 – External exhaust fan support
0 = none
1 = configure for control
2 = configure for exhaust fan start/stop & status support
3 = generic temperature thermistor

Digit 37 – Zone sensor options
0 = none
1 = sensor w/off, auto, Fahrenheit knob, on/cancel and comm jack
2 = sensor w/Fahrenheit knob, on/cancel and comm jack
4 = sensor only
5 = field supplied zone sensor
F = standalone operator display
G = 1 & F
H = 2 & F
J = 4 & F
K = 5 & F

Horizontal Unit, in.

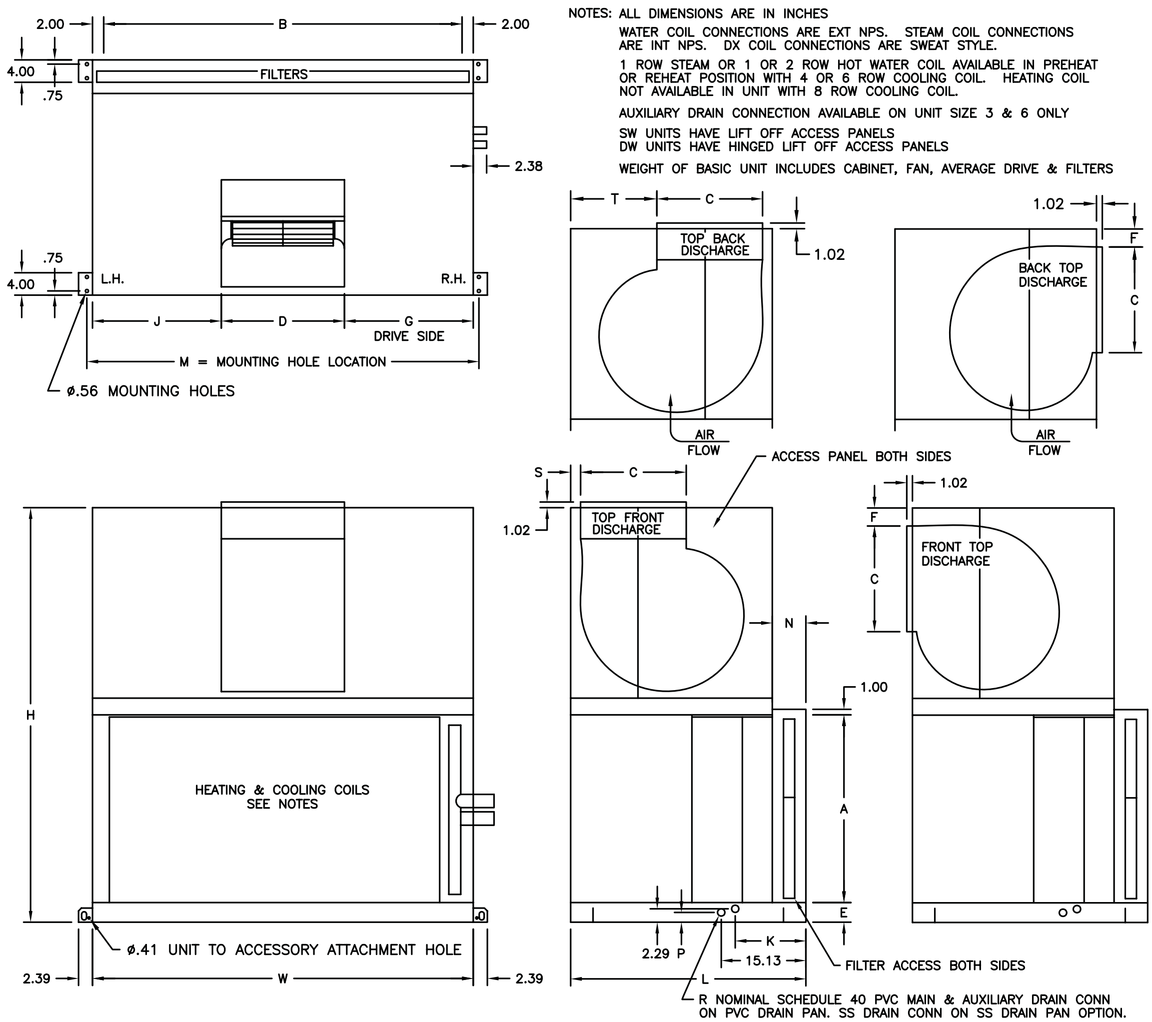


HorizontalPackagedClimateChangerdimensions&weights,in-lbs.

unit size	H	W	L	A	B	C	D	E	F	G	J	K(RH)	K(LH)	M	N	P	R	S	T	weights SW	weights DW
3	24.5	31.2	54.0	20.5	27.2	10.6	9.4	3.0	2.3	10.9	10.9	12.6	17.6	33.0	1.0	1.6	0.8	2.7	15.1	164	231
6	30.5	44.2	57.0	26.5	40.2	13.8	12.5	3.0	3.3	15.9	15.9	12.6	17.6	46.0	1.0	1.6	0.8	2.0	15.1	232	323
8	34.5	48.2	48.0	30.0	44.2	13.8	15.9	3.5	8.7	18.6	13.6	—	—	50.0	1.0	1.6	1.0	2.4	15.1	240	337
10	34.5	60.2	52.0	30.0	56.2	16.2	18.9	3.5	3.8	20.6	20.6	—	—	62.0	1.0	1.6	1.0	2.0	15.1	277	398
12	42.0	68.2	56.0	37.5	64.2	19.2	19.2	3.5	5.4	24.5	24.5	—	—	70.0	1.0	1.6	1.0	2.1	15.1	462	607
14	42.0	68.2	56.0	37.5	64.2	19.2	22.2	3.5	5.4	23.0	23.0	—	—	70.0	1.0	1.6	1.0	2.1	15.1	476	619
17	52.0	76.2	62.0	47.5	72.2	25.1	20.1	3.5	8.9	28.1	28.1	—	—	78.0	1.0	1.6	1.0	2.1	15.1	594	775
21	52.0	76.2	62.0	47.5	72.2	25.1	25.1	3.5	8.9	25.6	25.6	—	—	78.0	1.0	1.6	1.0	2.1	15.1	636	819
25	59.5	78.2	67.0	53.0	74.2	25.5	23.5	4.5	15.7	27.4	27.4	—	—	80.0	2.0	2.8	1.3	2.0	18.1	771	1000
30	59.5	91.2	72.0	53.0	87.2	28.5	26.5	4.5	11.3	32.4	32.4	—	—	93.0	2.0	2.8	1.3	2.0	18.1	967	1233

Notes: 1. Weight of basic unit includes: cabinet, fan, average drive and filter. Add 9 pounds to basic weight for control box, if applicable
2. For units with factory installed VFD, an additional 11.26 inches needs to be added to the width of the unit to accomadote VFD
3. SW = Single Wall
4. DW = Double Wall

Vertical Unit, in.



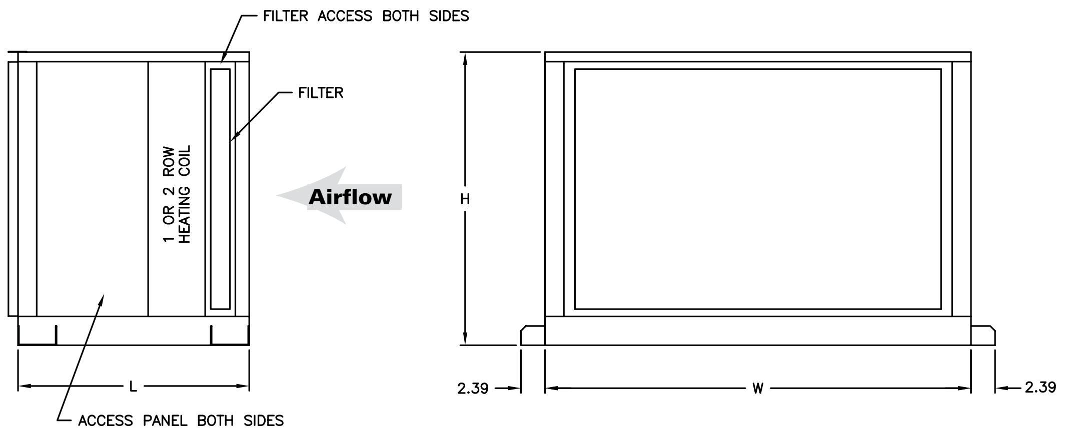
Vertical Packaged Climate Changer dimensions & weights, in-lbs.

unit												K			N					Weights	
size	H	W	L	A	B	C	D	E	F	G	J	LH	RH	M	SW	DW	P	R	S	T	SW	DW
3	47.0	31.2	40.0	20.5	27.2	10.6	9.4	3.0	2.3	10.9	10.9	17.6	12.6	33.0	6.0	6.0	1.6	.75	2.67	21.0	189	287
6	59.0	44.2	46.0	26.5	40.2	13.8	12.5	3.0	2.3	15.9	15.9	17.6	12.6	46.0	6.0	6.0	1.6	.75	2.03	24.4	275	419
8	66.5	48.2	34.0	30.0	44.2	13.8	15.9	3.5	8.7	18.6	13.6	—	—	50.0	6.0	6.0	1.7	1.0	2.38	12.1	286	428
10	66.5	60.2	38.0	30.0	56.2	16.2	18.9	3.5	3.8	20.6	20.6	—	—	62.0	6.0	6.0	1.7	1.0	1.96	14.0	316	493
12	82.0	68.2	42.0	37.5	64.2	19.2	19.2	3.5	5.4	24.5	24.5	—	—	70.0	6.0	6.0	1.7	1.0	2.07	15.0	526	751
14	82.0	68.2	42.0	37.5	64.2	19.2	22.2	3.5	5.4	23.0	23.0	—	—	70.0	6.0	6.0	1.7	1.0	2.07	13.0	539	769
17	102.5	76.2	45.0	47.5	72.2	25.1	20.1	3.5	8.9	28.1	28.1	—	—	78.0	6.0	5.0	1.7	1.0	2.06	13.0	709	998
21	102.5	76.2	45.0	47.5	72.2	25.1	25.1	3.5	8.9	25.6	25.6	—	—	78.0	6.0	5.0	1.7	1.0	2.06	13.0	750	1041

Notes: 1. Vertical units are only available in sizes 3 – 21.
2. For units with factory installed VFD, an additional 11.26 inches needs to be added to the width of the unit to accomadote VFD
3. SW = Single Wall
4. DW = Double Wall

Access Section, in.

Note: This is a flanged edge to secure section to either the main unit or another section.



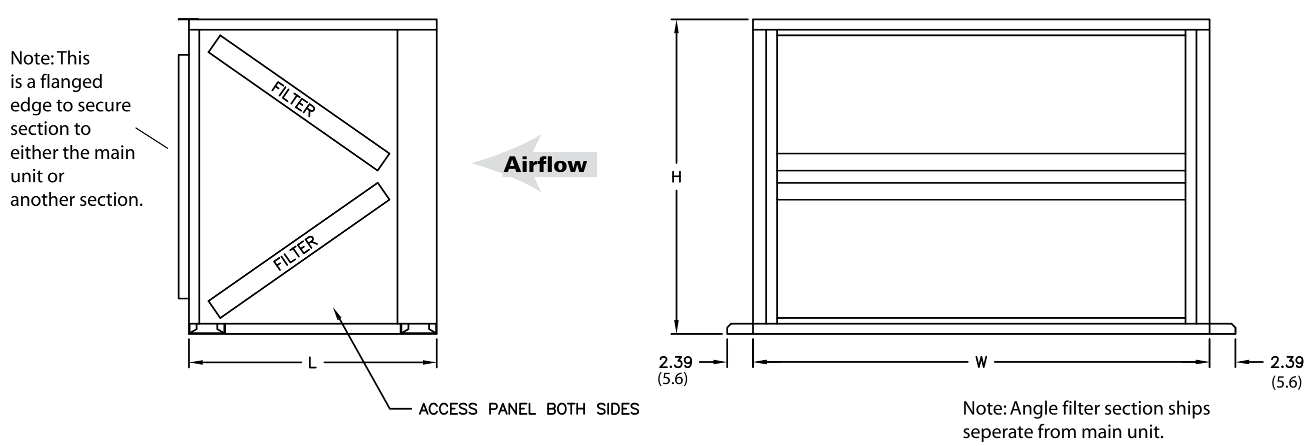
Note: Access section is only available with a 1 or 2-row heating coil and ships seperate from main unit.

Access section dimensions & weights, in-lbs.

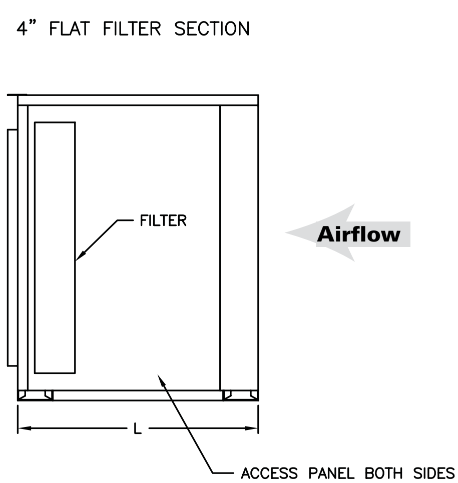
unit size	H	L	W	weight SW	weight DW
3	24.5	24.3	31.2	69	97
6	30.5	24.3	44.2	100	137
8	34.5	24.3	48.2	106	148
10	34.5	24.3	60.2	119	169
12	42.0	24.3	68.2	162	218
14	42.0	24.3	68.2	157	213
17	52.0	24.3	76.2	204	267
21	52.0	24.3	76.2	196	259
25	59.5	28.3	78.2	248	336
30	59.5	28.3	91.2	271	370

Notes: 1. SW = Single Wall
2. DW = Double Wall

Angle Filter Section in.



Flat Filter Section in.



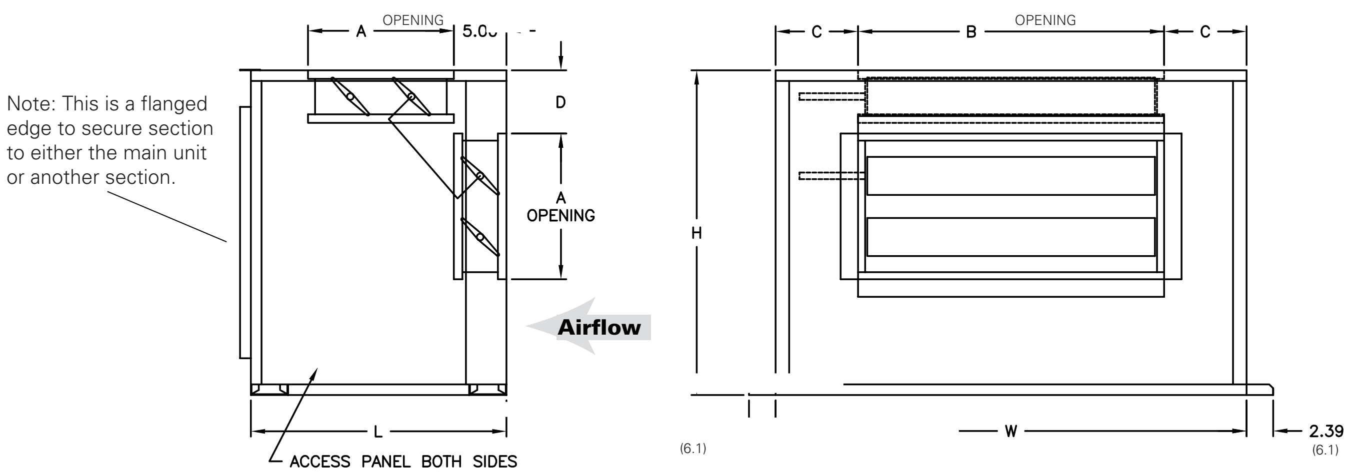
Angle & flat filter section dimensions & weights, in-lbs.

unit size	H	L	W	flat filter SW	flat filter DW	angle filter SW	angle filter DW
3	24.5	21.5	31.2	46	60	50	64
6	30.5	24.0	44.2	64	86	68	90
8	34.5	27.3	48.2	78	107	82	111
10	34.5	25.5	60.2	83	115	89	121
12	42.0	27.3	68.2	112	151	126	165
14	42.0	27.3	68.2	112	151	126	165
17	52.0	29.3	76.2	164	209	179	224
21	52.0	29.3	76.2	164	209	179	224
25	59.5	35.0	78.2	184	250	200	266
30	59.5	35.0	91.2	201	275	217	291

Notes: 1. SW = Single Wall
2. DW = Double Wall

NOTES:
ALL DIMENSIONS ARE IN INCHES.
SIZE 3 THRU 21 SW HAVE LIFT OFF ACCESS PANELS.
SIZE 3 THRU 21 DW AND 25 AND 30 SW AND DW HAVE HINGED LIFT OFF ACCESS PANELS.

Damper Section, in.



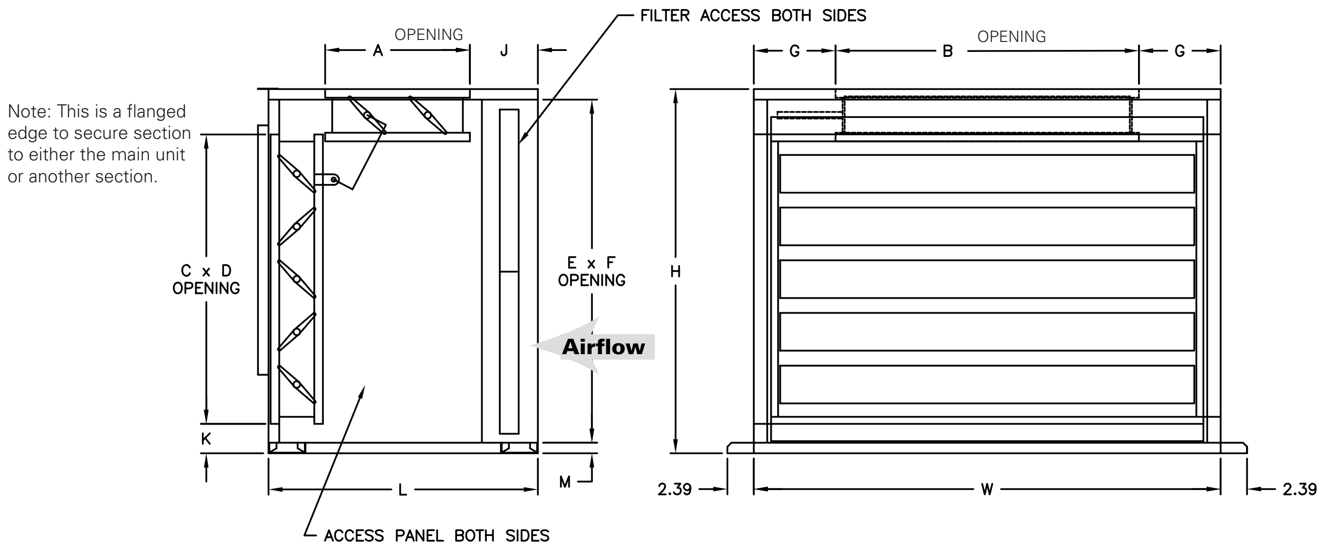
Notes:
All dimensions are in inches.
Damper section ships seperate from main unit.
Linkage between dampers factory installed inside mixing box on drive side.

Damper section dimensions & weights, in-lbs.

unit size	H	L	W	A	B	C	D	damper qty. - size	weights SW	weights DW
3	24.5	21.5	31.2	14.0	16.0	7.6	5.8	2 - 14.0 x 16.0	80	98
6	30.5	24.0	44.2	14.0	29.0	7.6	5.8	2 - 14.0 x 29.0	119	147
8	34.5	27.3	48.2	19.7	26.0	11.1	5.8	2 - 19.7 x 26.0	135	170
10	34.5	25.5	60.2	14.0	46.0	7.1	5.8	2 - 14.0 x 46.0	168	208
12	42.0	27.3	68.2	19.7	37.0	15.6	5.8	2 - 19.7 x 37.0	186	237
14	42.0	27.3	68.2	19.7	44.0	12.1	5.8	2 - 19.7 x 44.0	199	248
17	52.0	29.3	76.2	19.7	53.0	11.6	5.8	2 - 19.7 x 53.0	274	340
21	52.0	34.0	76.2	25.5	53.0	11.6	5.8	2 - 25.7 x 53.0	309	376
25	59.5	35.0	78.2	25.5	58.0	10.1	6.0	2 - 25.7 x 58.0	318	399
30	59.5	35.0	91.2	25.5	68.0	11.6	6.0	2 - 25.7 x 68.0	355	447

Notes: 1. SW = Single Wall
2. DW = Double Wall

Face & Bypass Section, in.



Notes:
All dimensions are in inches.
Damper section ships seperate from main unit.
Linkage between dampers factory installed inside mixing box on drive side.

Face & bypass section dimensions & weights, in-lbs.

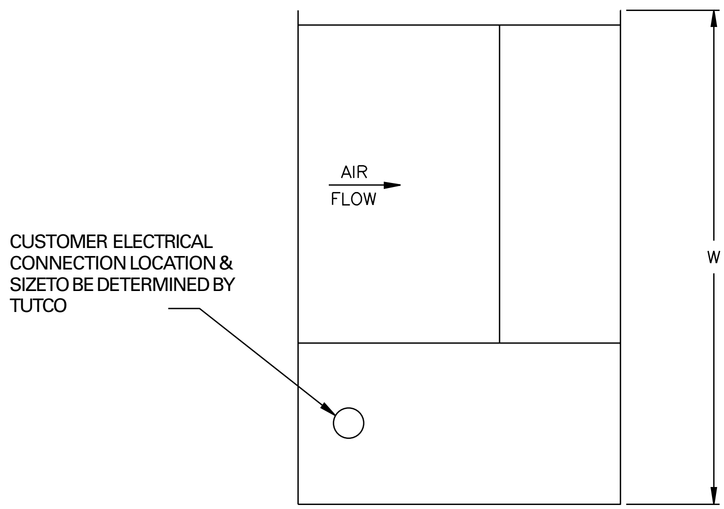
unit size	H	L	W	A	B	C	D	E	F	G	J	K	M	face damper	bypass damper	weights SW	weights DW
3	24.5	23.5	31.2	14.0	16.0	14.0	26.0	22.5	28.7	7.6	5.6	5.3	1.0	14.0 x 27.0	14.0 x 16.0	94	111
6	30.5	26.0	44.2	14.0	29.0	19.7	39.0	28.5	41.7	7.6	7.4	4.6	1.0	19.7 x 40.0	14.0 x 29.0	140	165
8	34.5	28.3	48.2	19.7	26.0	25.5	43.0	32.5	45.6	11.1	4.6	3.8	1.0	25.5 x 44.0	19.7 x 26.0	159	188
10	34.5	26.5	60.2	14.0	46.0	25.5	55.0	32.5	57.6	7.1	7.6	3.8	1.0	25.5 x 56.0	14.0 x 49.0	198	231
12	42.0	28.3	68.2	19.7	37.0	31.2	63.0	40.0	65.7	15.6	4.6	4.6	1.0	31.2 x 64.0	19.7 x 37.0	220	260
14	42.0	28.3	68.2	19.7	44.0	31.3	63.0	40.0	65.7	12.1	4.6	4.6	1.0	31.2 x 64.0	19.7 x 44.0	235	274
17	52.0	32.3	76.2	19.7	53.0	42.7	71.0	50.0	73.6	11.6	7.6	3.9	1.0	42 x 72.0	19.7 x 53.0	323	371
21	52.0	35.0	76.2	25.5	53.0	42.7	71.0	50.0	73.6	11.6	4.6	3.9	1.0	42.72 x 72.0	25.5 x 53.0	365	417
25	59.5	37.0	78.2	25.5	58.0	48.5	74.0	53.0	74.0	10.1	5.2	6.4	4.5	48.47 x 74.0	25.5 x 58.0	375	437
30	59.5	37.0	91.2	25.5	68.0	48.5	87.0	53.0	87.0	11.6	5.2	6.4	4.5	48.47 x 87.0	25.5 x 68.0	419	489

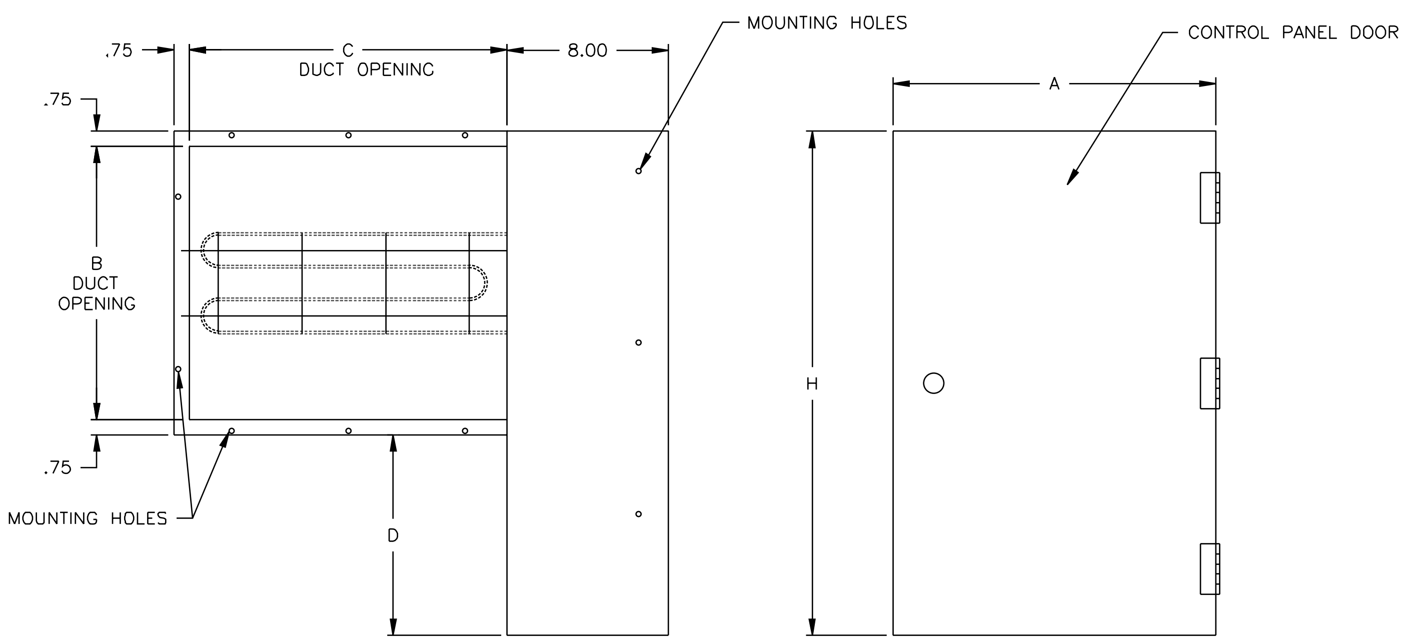
Notes: 1. SW = Single Wall
2. DW = Double Wall

Electric Heat Section

Electric Heat Section Dimensions & Weights, in-lbs.

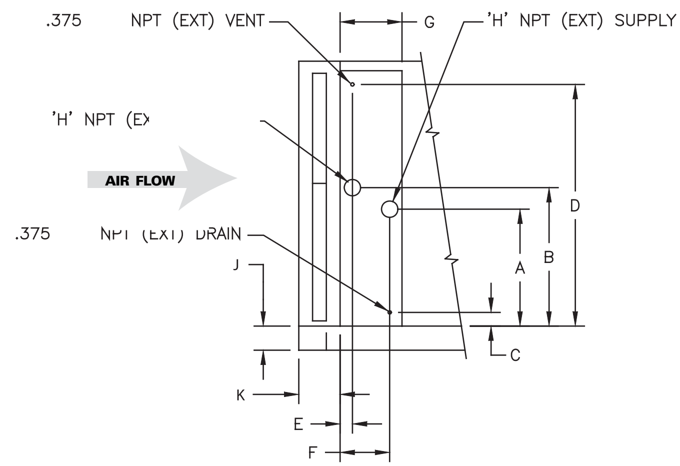
Unit Size	H	W	A	B	C	D	Weight
3	24.5	18.0	12.0	10.4	9.3	12.1	34.0
6	30.5	21.0	16.0	13.6	12.3	8.9	38.0
8	34.5	24.5	16.0	13.6	15.8	9.9	44.0
10	34.5	27.5	20.0	16.0	18.8	11.5	62.0
12	42.0	27.8	20.0	19.0	19.0	13.5	66.0
14	42.0	30.8	20.0	19.0	22.0	13.5	69.0
17	52.0	28.6	20.0	24.9	19.9	7.6	73.0
21	52.0	33.6	20.0	24.9	24.9	7.6	77.0
25	59.5	32.0	20.0	25.3	23.3	7.3	79.0
30	59.5	35.1	20.0	28.3	26.4	4.2	82.0





Water Coil Connections

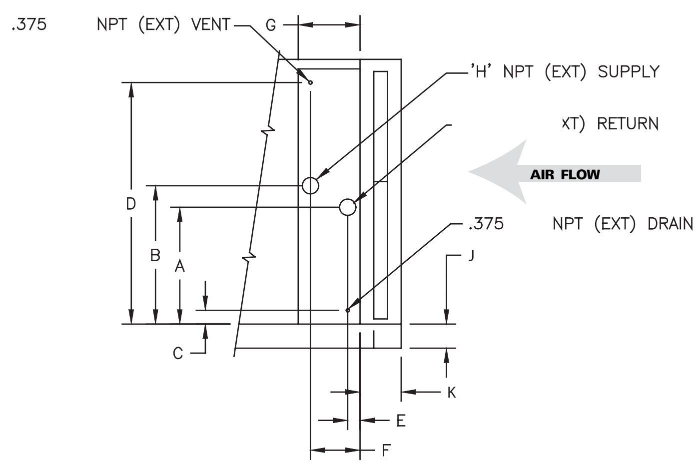
left hand



Note: J = 3.1" on unit sizes 3 and 6
= 3.6" on unit sizes 8–21
= 4.6" on unit sizes 25 & 30

K = 6.1" on unit sizes 3–21
= 8.1" on unit sizes 25 & 30

right hand



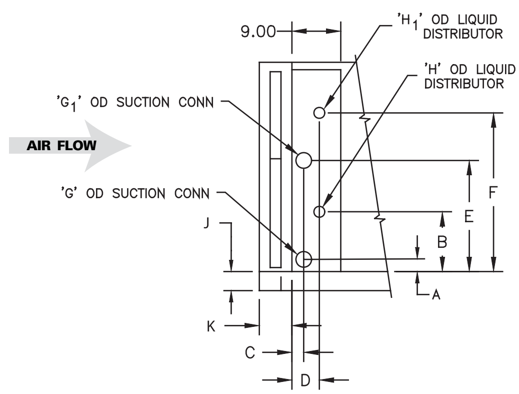
Water coil connections, in.

	left hand connections only				right hand connections only							
unit size	A	B	C	D	A	B	C	D	E	F	G	H
one-row coil												
3	8 5/8	11 11/16	2	18 5/16	7 7/8	11 1/8	1 3/8	17 5/8	1 11/16	3 11/16	5 3/8	1 1/2
6	11 1/8	14 3/16	2	23 5/16	10 3/8	13 5/8	1 3/8	22 5/8	1 11/16	3 11/16	5 3/8	1 1/2
8, 10	13 5/8	16 11/16	2	28 5/16	12 7/8	16 1/8	1 3/8	27 5/8	1 11/16	3 11/16	5 3/8	1 1/2
12, 14	17 5/16	20 3/8	2	35 13/16	16 11/16	19 13/16	1 3/8	35 1/8	1 1/2	3 7/8	5 3/8	2
17, 21	22 5/16	25 3/8	2	45 13/16	21 11/16	24 13/16	1 3/8	45 1/8	1 1/2	3 7/8	5 3/8	2
25, 30	25 3/8	28 5/8	2 5/8	51 3/8	24 13/16	27 7/8	2	50 13/16	2	4 1/2	6 1/2	2
two-row coil												
3	7 5/8	10 13/16	1 3/8	17	8 7/8	12	2 5/8	18 5/16	1 13/16	3 5/8	5 3/8	1 1/2
6	10 13/16	13 7/8	2	22 5/8	10 13/16	13 7/8	2	22 5/8	1 13/16	3 5/8	5 3/8	1 1/2
8, 10	13 5/16	16 3/8	2	27 5/8	13 5/16	16 3/8	2	27 5/8	1 13/16	3 5/8	5 3/8	1 1/2
12, 14	17	20 1/8	2	35 1/8	17	20 1/8	2	35 1/8	1 1/2	3 13/16	5 3/8	2
17, 21	22	25 1/8	2	45 1/8	22	25 1/8	2	45 1/8	1 1/2	3 13/16	5 3/8	2
25, 30	25 1/8	28 3/16	2	51 3/8	25 1/8	28 5/16	2	51 3/8	1 7/8	4 5/8	6 1/2	2 1/2
four-row coil												
3	7 5/8	10 13/16	2 5/8	18 5/16	8 7/8	12	2 5/8	18 5/16	4	7 3/16	9	1 1/2
6	10 13/16	13 7/8	2	22 5/8	10 13/16	13 7/8	2	22 5/8	4	7 3/16	9	1 1/2
8, 10	13 5/16	16 3/8	2	27 5/8	13 5/16	16 3/8	2	27 5/8	4	7 3/16	9	1 1/2
12, 14	17	20 1/8	2	35 1/8	17	20 1/8	2	35 1/8	4	7 3/16	9	2
17, 21	22	25 1/8	2	45 1/8	22	25 1/8	2	45 1/8	4	7 3/16	9	2 1/2
25, 30	25 1/8	28 3/16	2	51 3/8	25 1/8	28 5/16	2	51 3/8	4	7 3/16	9	2 1/2
six-row coil												
3	7 5/8	10 13/16	2 5/8	18 5/16	8 7/8	12	2 5/8	18 5/16	1 13/16	7 3/16	9	1 1/2
6	10 13/16	13 7/8	2	22 5/8	10 13/16	13 7/8	2	22 5/8	1 13/16	7 3/16	9	1 1/2
8, 10	13 5/16	16 3/8	2	27 5/8	13 5/16	16 3/8	2	27 5/8	1 13/16	7 3/16	9	1 1/2
12, 14	17	20 1/8	2	35 1/8	17	20 1/8	2	35 1/8	1 13/16	7 3/16	9	2
17, 21	22	25 1/8	2	45 1/8	22	25 1/8	2	45 1/8	1 13/16	7 3/16	9	2 1/2
25, 30	25 1/8	28 3/16	2	51 3/8	25 1/8	28 5/16	2	51 3/8	1 13/16	7 3/16	9	2 1/2
eight-row coil												
3	7 5/8	10 13/16	2 5/8	18 5/16	8 7/8	12	2 5/8	18 5/16	1 13/16	9 3/8	11 3/16	1 1/2
6	10 13/16	13 7/8	2	22 5/8	10 13/16	13 7/8	2	22 5/8	1 13/16	9 3/8	11 3/16	1 1/2
8, 10	13 5/16	16 3/8	2	27 5/8	13 5/16	16 3/8	2	27 5/8	1 13/16	9 3/8	11 3/16	1 1/2
12, 14	17	20 1/8	2	35 1/8	17	20 1/8	2	35 1/8	1 13/16	9 3/8	11 3/16	2
17, 21	22	25 1/8	2	45 1/8	22	25 1/8	2	45 1/8	1 13/16	9 3/8	11 3/16	2 1/2
25, 30	25 1/8	28 5/16	2	51 3/8	25 1/8	28 5/16	2	51 3/8	1 13/16	9 3/8	11 3/16	2 1/2

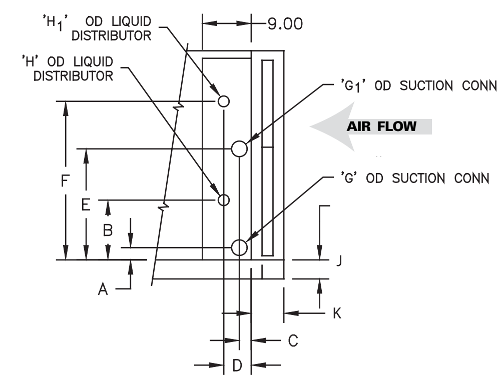
DX Coil Connections

single circuit coils for unit sizes 3 –10 and horizontal face split coils for unit sizes 12 – 25

left hand



right hand



NOTE: DX COIL CONNECTIONS ARE SWEAT STYLE

Single circuit DX coil connections, unit sizes 3 - 10, in.

unit size	A	B	C	D (LH)	D (RH)	G	H	J	K
four-row coil, 3/16" distributor									
3	2 3/8	10 5/16	4	5 1/8	7 3/16	1 3/8	5/8	3 1/8	6 1/8
6	2 3/8	17 11/16	4	5 1/8	7 3/16	1 3/8	7/8	3 1/8	6 1/8
8	2 3/8	18 13/16	4	5 1/8	7 3/16	1 3/8	7/8	3 5/8	6 1/8
10	2 1/2	18 3/16	4	5 1/8	7 3/16	1 5/8	7/8	3 5/8	6 1/8
six-row coil, 1/4" distributor									
3	2 3/8	11	1 13/16	2 7/8	5	1 3/8	7/8	3 1/8	6 1/8
6	2 3/8	17 11/16	1 13/16	2 7/8	5	1 3/8	7/8	3 1/8	6 1/8
8	2 3/8	19 5/16	1 13/16	2 7/8	5	1 3/8	1 1/8	3 5/8	6 1/8
10	2 1/2	19	1 13/16	2 7/8	5	1 5/8	1 3/8	3 5/8	6 1/8

Note: Single circuit DX coils on unit sizes 3 – 10 have one distributor.

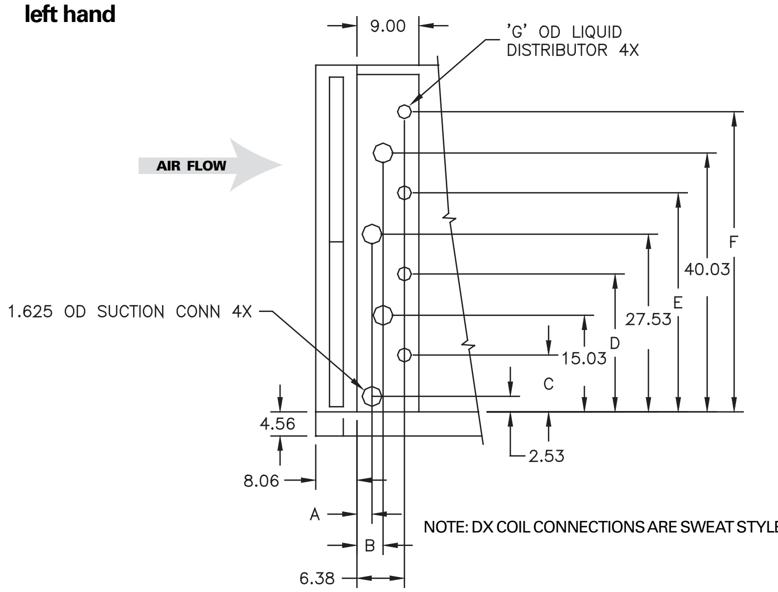
Horizontal face split circuit DX coil connections, unit sizes 8 – 25, in.

unit size	A	B	C	D (LH)	D (RH)	E	F	G	G_1	H	H_1	J	K
four-row coil, 3/16" distributor													
8	2 3/8	8 1/8	4	5 1/8	7 3/16	17 3/8	22 13/16	1 3/8	1 3/8	5/8	5/8	3 5/8	6 1/8
10	2 3/8	8 1/8	4	5 1/8	7 3/16	14 7/8	22 3/8	1 3/8	1 3/8	7/8	7/8	3 5/8	6 1/8
12, 14	1 7/8	12 5/8	4	5 1/8	7 3/16	19 7/8	31 1/8	1 3/8	1 3/8	7/8	7/8	3 5/8	6 1/8
17, 21	1 7/8	17 5/8	4	5 1/8	7 3/16	25	41 3/8	1 5/8	1 5/8	7/8	7/8	3 5/8	6 1/8
25	1 7/8	18 5/16	4	5 5/16	7 3/16	27 1/2	43 5/16	1 5/8	1 5/8	7/8	7/8	4 5/8	8 1/8
six-row coil, 1/4" distributor													
8	2 3/8	8 13/16	1 13/16	2 7/8	5	17 3/8	22 3/8	1 3/8	1 3/8	7/8	7/8	3 5/8	6 1/8
10	2 3/8	13/16	1 13/16	2 7/8	5	14 7/8	22 3/8	1 3/8	1 5/8	7/8	7/8	3 5/8	6 1/8
12, 14	2 3/8	13	1 13/16	2 7/8	5	19 7/8	31 3/8	1 3/8	1 3/8	1 1/8	7/8	3 5/8	6 1/8
17, 21	2 3/8	18 3/16	1 13/16	2 7/8	5	25	42	1 5/8	1 5/8	1 1/8	1 1/8	3 5/8	6 1/8

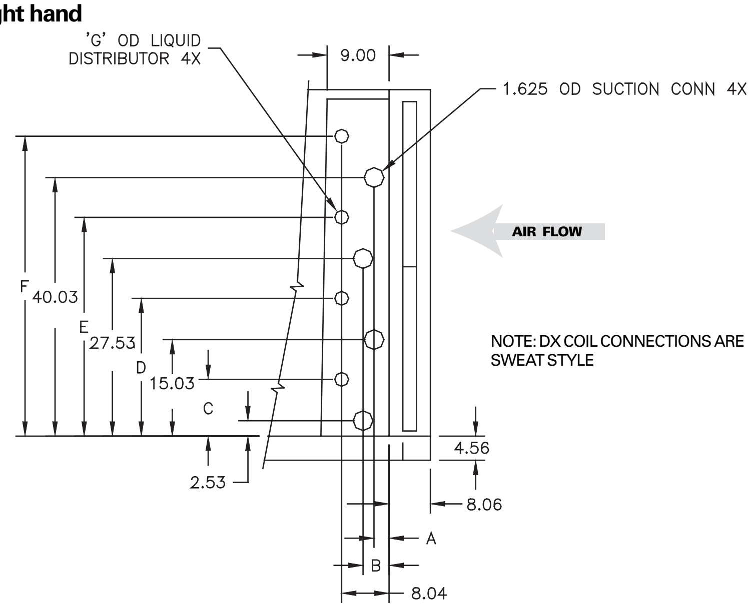
DX Coil Connections

horizontal face split circuit coils for unit size 30

left hand



right hand



Horizontal face split circuit DX coil connections, unit size 30, in.

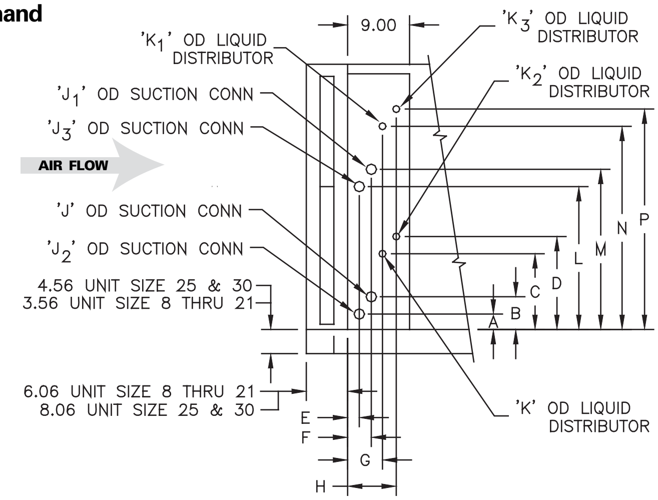
A	B	C	D	E	F	G
four-row coil, 3/16" distributor						
3 1/8	4 13/16	11 1/8	23 5/8	36 1/8	48 5/8	7/8
six-row coil, 1/4" distributor						
1	2 5/8	11 7/8	24 3/8	36 7/8	49 3/8	1 3/8

Note: Horizontal face split circuit DX coils on unit size 30 has four distributors.

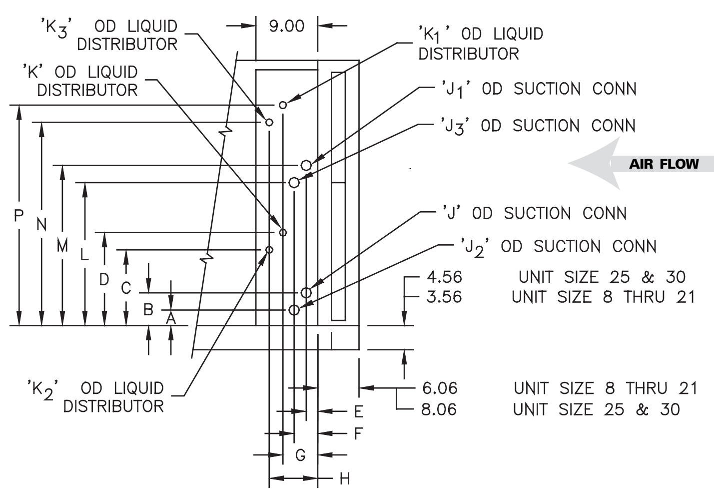
DX Coil Connections
intertwined coils unit sizes 8 – 30

NOTE: DX COIL CONNECTIONS ARE SWEAT STYLE

left hand



right hand



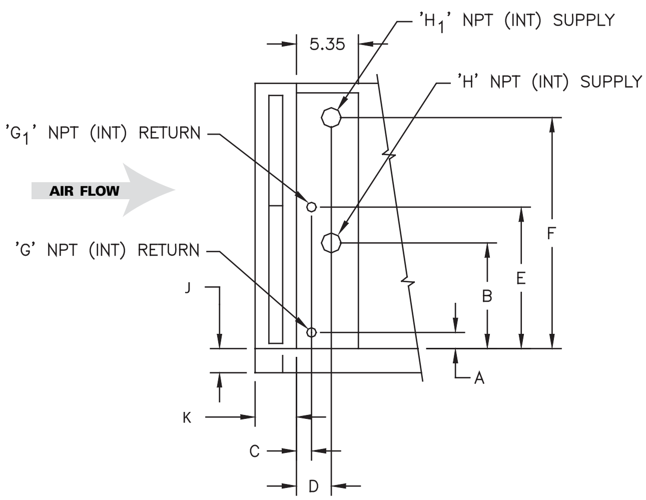
Intertwined circuit DX coil connections, unit sizes 8 – 30, in.

unit size	A	B	C	D	E	F	G	H	J	J_1	J_2	J_3	K	K_1	K_2	K_3	L	M	N	P
four-row coil, 3/16" distributor																				
8	2 3/8	6 3/16	18 3/16	14 1/8	3 3/16	4 11/16	5 5/16	7 5/16	1 3/8	--	1 3/8	--	5/8	--	5/8	--	--	--	--	-
10	2 3/8	4 7/8	20 1/8	22 5/8	3 3/16	4 11/16	5 5/16	7 5/16	1 3/8	--	1 3/8	--	7/8	--	7/8	--	--	--	--	--
12,14	2 3/8	4 7/8	22 13/16	19 11/16	3 3/16	4 11/16	5 5/16	7 5/16	1 3/8	--	1 3/8	--	7/8	--	7/8	--	--	--	--	--
17, 21	2 3/8	4 7/8	17 1/2	14 7/8	3 3/16	4 11/16	5 5/16	7 5/16	1 3/8	1 3/8	1 3/8	1 3/8	5/8	5/8	7/8	5/8	24 7/8	27 3/8	36 1/8	38 5/8
25	2 3/8	4 7/8	17 1/2	20	3 3/16	4 11/16	5 5/16	7 5/16	7/8	1 3/8	1 3/8	1 3/8	7/8	7/8	7/8	7/8	27 3/8	29 7/8	42 1/2	45
30	2 1/2	3 13/16	18 7/8	20 1/8	3 1/8	4 7/8	6 3/16	8 3/16	1 5/8	1 5/8	1 5/8	1 5/8	7/8	7/8	7/8	7/8	27 1/2	28 13/16	43 7/8	45 1/8
six-row coil, 1/4" distributor																				
8	2 3/8	6 3/16	18 5/8	14 7/8	1	2 5/8	3 3/16	5 3/16	1 3/8	--	1 3/8	--	7/8	--	7/8	--	--	--	--	--
10	2 3/8	4 7/8	20 1/8	22 5/8	1	2 5/8	3 3/16	5 3/16	1 3/8	--	1 3/8	--	7/8	--	7/8	--	--	--	--	--
12,14	2 3/8	4 7/8	23 3/16	19 13/16	1	2 5/8	3 3/16	5 3/16	1 3/8	--	1 3/8	--	7/8	--	1 1/8	--	--	--	--	--
17, 21	2 3/8	4 7/8	17 1/2	15 5/16	1	2 5/8	3 3/16	5 3/16	1 3/8	1 3/8	1 3/8	1 3/8	7/8	7/8	7/8	7/8	24 7/8	27 3/8	36 1/2	39
25	2 3/8	4 7/8	17 1/2	20	1	2 5/8	3 3/16	5 3/16	1 3/8	1 3/8	1 3/8	1 3/8	7/8	7/8	7/8	7/8	27 3/8	29 7/8	42 1/2	45
30	2 1/2	3 13/16	19 11/16	20 7/8	1	2 5/8	6 3/16	8 3/16	1 5/8	1 5/8	1 5/8	1 5/8	1 3/8	1 3/8	1 3/8	1 3/8	27 1/2	28 13/16	44 11/16	45 7/8

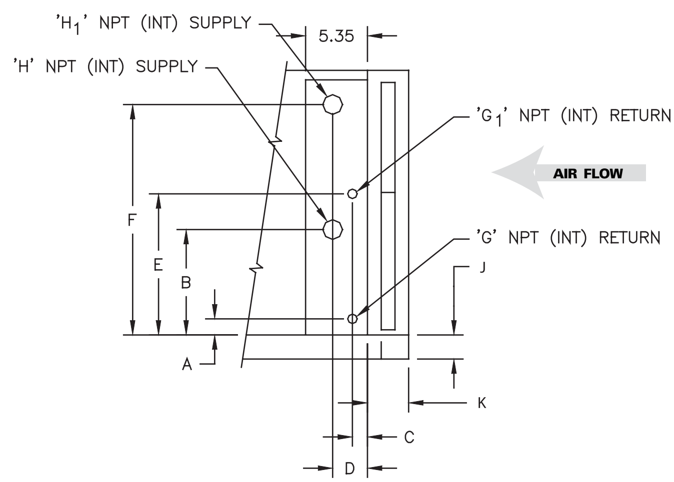
Note: DX intertwined coils, on unit sizes 8 – 14 have two distributors. Unit sizes 17 – 30 have four distributors.

Steam Coil Connections

left hand



right hand



Steam coil connections, in.

unit size	A	B (LH)	B (RH)	C	D	E	F (LH)	F (RH)	G	G_1	H	H_1	J	K
3	4 1/2	10 7/8	7 7/8	1 5/16	2 13/16	--	--	--	1	--	1 1/2	--	3 1/8	6 1/8
6	4	13 3/8	10 3/8	1 5/16	2 1/2	--	--	--	1	--	2	--	3 1/8	6 1/8
8, 10	3 3/16	15 7/8	12 7/8	1 5/16	2 1/2	--	--	--	1 5/16	--	2 1/2	--	3 5/8	6 1/8
12, 14	2 3/8	18 3/16	18 3/16	1 5/16	2 1/2	--	--	--	1 5/16	--	3	--	3 5/8	6 1/8
17, 21	2 3/16	14 7/8	11 7/8	1 5/16	2 1/2	28	37 3/8	34 3/8	1 5/16	1	2 1/2	2	3 5/8	6 1/8
25, 30	2 5/16	15	12	1 5/16	2 1/2	27 13/16	40 1/2	37 1/2	1 5/16	1 5/16	2 1/2	2 1/2	4 5/8	8 1/8

Note: Unit sizes 17 – 30 with steam coils are two stacked coils.

WARNING

Hazardous Voltage w/Capacitors!
Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Receiving and Handling

Upon delivery, inspect all components for possible shipping damage. See the Receiving Checklist section for detailed instructions. Trane recommends leaving units and accessories in their shipping packages/skids for protection and ease of handling until installation.

Shipping Package

Packaged Climate Changer air handlers ship assembled on skids with protective coverings over the coil and discharge openings. Optional accessory sections ship attached to one another on a separate skid for unit sizes except 25 and 30. For those sizes, up to two accessory sections may ship on one skid.

Ship-Separate Accessories

Field-installed sensors ship separately inside the unit's main control panel.

Receiving Checklist

Complete the following checklist immediately after receiving unit shipment to detect possible shipping damage.

- Inspect individual cartons before accepting. Check for rattles, bent carton corners, or other visible indications of shipping damage.
- If a unit appears damaged, inspect it immediately before accepting the shipment. Manually rotate the fan wheel to ensure it turns freely. Make specific notations concerning the damage on the freight bill. Do not refuse delivery.
- Inspect the unit for concealed damage before it is stored and as soon as possible after delivery. Report concealed damage to the freight line within the allotted time after delivery. Check with the carrier for their allotted time to submit a claim.
- Do not move damaged material from the receiving location. It is the receiver's responsibility to provide reasonable evidence that concealed damage did not occur after delivery.
- Do not continue unpacking the shipment if it appears damaged. Retain all internal packing, cartons, and crate. Take photos of damaged material.
- Notify the carrier's terminal of the damage immediately by phone and mail. Request an immediate joint inspection of the damage by the carrier and consignee.
- Notify your Trane representative of the damage and arrange for repair. Have the carrier inspect the damage before making any repairs to the unit.
- Compare the electrical data on the unit nameplate with the ordering and shipping information to verify the correct unit is received.

Table I-PC-1. Service Requirements, in. (cm)

Unit Size	Dimension A
3	43 (109)
6	56 (142)
8	59 (150)
10 & 12	71 (180)
14	79 (201)
17	74 (188)
21	86 (218)
25	
30	

Installation Preparation

Before installing the unit, consider the following unit location recommendations to ensure proper unit operation.

1. Verify the floor or foundation is level. Shim or repair as necessary. To ensure proper unit operation, install the unit level (zero tolerance) in both horizontal axes. Failure to level the unit properly can result in condensate management problems, such as standing water inside the unit.
2. Allow adequate service and code clearances as recommended in "Service Access" section. Position the unit and skid assembly in its final location.
3. Consider coil piping and condensate drain requirements. Allow room for proper ductwork and electrical connections. Support all piping and ductwork independently of the unit to prevent excess noise and vibration.

Service Access

See Table I-PC-1 below and Figure I-PC-1 for recommended service and code clearances.

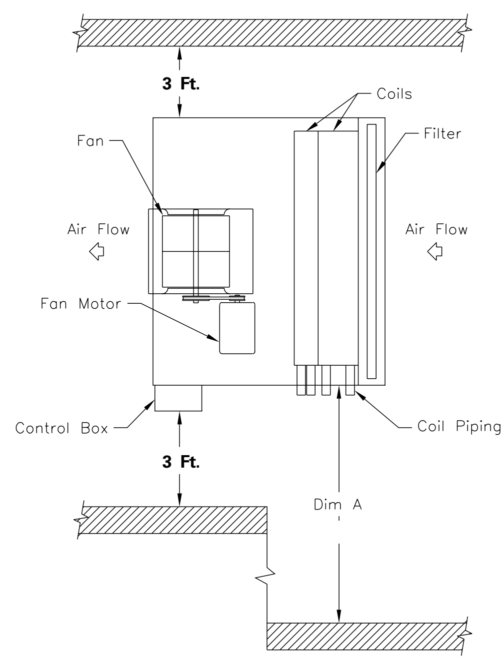


Figure I-PC-1. Top view of Packaged climate changer unit showing recommended service and code clearances.

Rigging and Handling

Before preparing the unit for lifting, estimate the approximate center of gravity for lifting safety. Unit weight may be unevenly distributed with more weight in the coil area. Approximate unit weights are given in the Dimensions and Weights section and on the unit nameplate.

Before hoisting the unit into position, use a proper rigging method such as straps, slings, or spreader bars for protection and safety. Always test-lift the unit (at least 24 inches) to determine the exact unit balance and stability before hoisting it to the installation location.

⚠ WARNING

Improper Unit Lift!

Test lift unit approximately 24 inches to verify proper center of gravity lift point. To avoid dropping unit, reposition lifting point if unit is not level. Failure to properly lift unit could result in death, serious injury, or possible equipment or property-only damage.

Unit Location Recommendations

When selecting and preparing the installation location, follow these recommendations.

1. Consider the unit weight. Reference the unit weight on the unit nameplate or in the Dimensions and Weights section.
2. Allow sufficient space for recommended clearances, access panel removal, and maintenance access. Refer to Figure I-PC-1.
3. The installer must provide threaded suspension rods for ceiling mounted units. All units must be installed level.
4. Coil piping and condensate drain requirements must be considered. Allow room for proper ductwork and electrical connections. Support all piping and ductwork independently of unit to prevent excess noise and vibration.

Skid Removal

The unit ships on skids that provide forklift locations from the front or rear. The skid allows easy maneuverability of the unit during storage and transportation. Remove the skids before placing the unit in its permanent location.

Remove the skids using a forklift or jack. Lift one end of the unit off of the skids. Vibration isolators for external isolation are field supplied. See Figure I-PC-1 for installation recommendations.

Rotating Filter Door Swing

The unit ships with the fillter doors in a downstream configuration. To allow the doors to swing in an upstream configuration, follow the steps listed in the figure below.

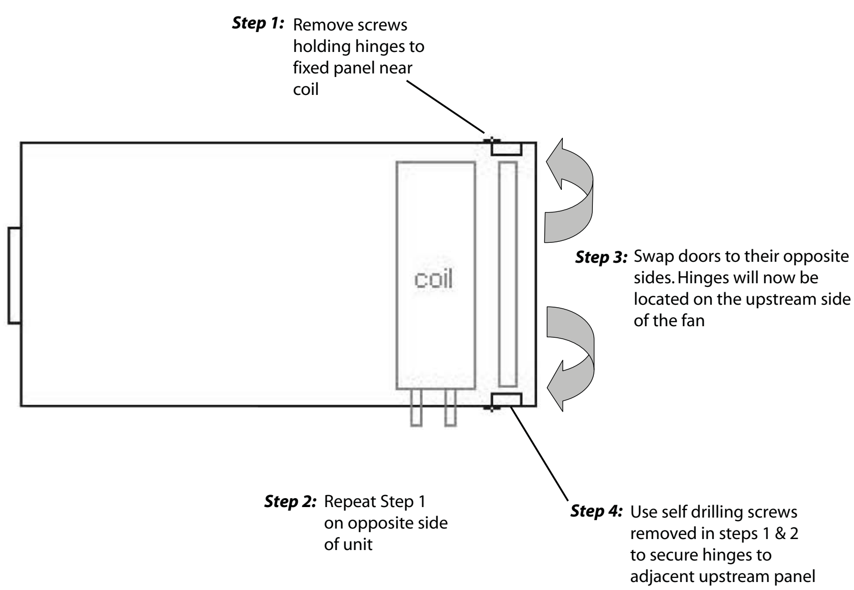


Figure I-PC-2. Rotating Filter Door Swing

Fan Discharge Conversion

The LPC Vertical Unit can be ordered in four discharge configurations: Top/Front, Front/Top, Top/Back, and Back/Top Figure I-PC-4. Discharge Configurations. Field conversions from one configuration to another can be made for sizes 8 through 21 by modifying certain parts of the cabinet and by rotating the fan. Also, if changing from a front or back discharge to a top discharge configuration, a duct extension will need to be added.

For sizes 3 and 6 a new fan assembly will be needed.

There are some differences between single-wall construction cabinets with fiberglass insulation and double-wall construction cabinets with foam insulation that will drive some minor differences in some of the steps required for a field conversion.

But overall the basic steps are the same for both.

1. Disconnect power from the unit
2. Remove access doors.
3. Remove the screws inside the cabinet along the top of the coil that secure the coil to the cabinet roof

4a. If top discharge and no internal isolation remove screws securing duct that connects the fan to the roof
b. If top discharge with internal isolation, duct is not mechanically secured to the fan so roof & duct can be removed as one piece.
c. Remove roof

5a. If horizontal (front or back) discharge and no internal isolation, remove screws securing fan housing to cabinet
b. If horizontal (front or back) discharge with internal isolation loosen and remove j-bolt securing fan housing to cabinet.
c. Remove front and back panel.

6. Loosen nuts/bolts securing sliding motor base in place and loosen nuts on belt tensioning bolt.
7. Remove v-belt(s)
8. Detach fan from the base and rotate to the desired discharge position.

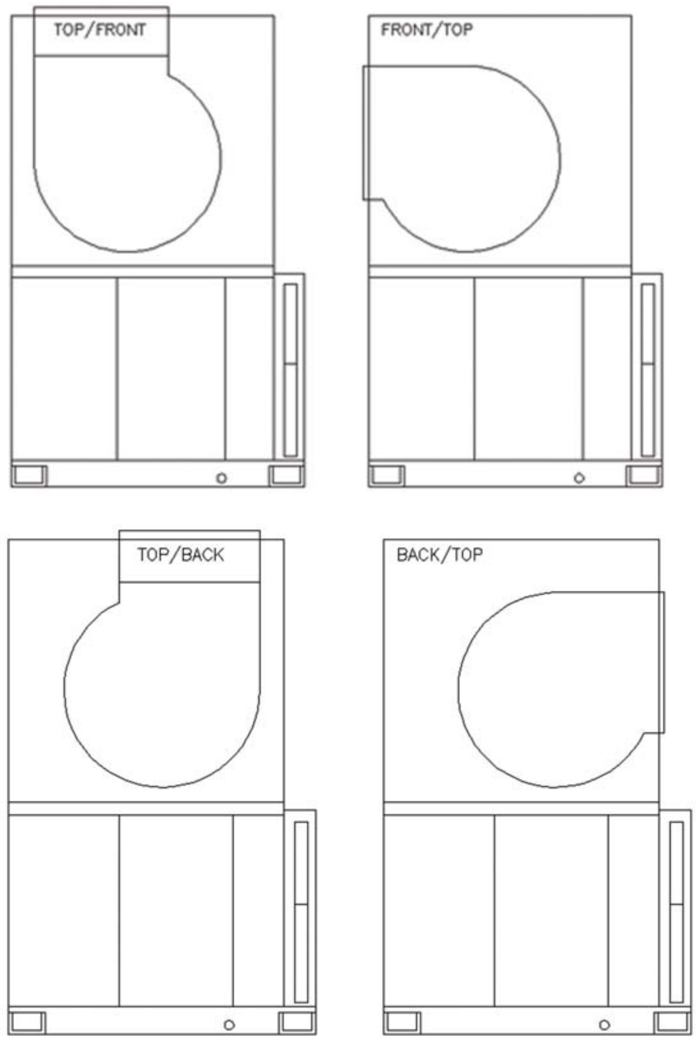


Figure I-PC-4. Discharge Configurations

9. It may be necessary to remove and reinstall the fan shaft on the opposite side depending on the new discharge position. Loosen set screws on the fan bearings that hold the shaft in place. Loosen set screw holding fan in place. Remove shaft from the fan and reinstall so that the driven end is on the opposite side.
10. Reattach fan to the base
11. Reattach v-belt, tighten, and secure sliding motor base in place. Because the distance between the motor shaft and the fan shaft may change, it may be necessary to purchase a new v-belt.
12. Cut a hole in the discharge panel for the air discharge. For double wall units cover the exposed foam insulation at the inside edges of the hole using the insulation cover channels installed on the other discharge panel.

13a. If changing from horizontal discharge to vertical (such as front/top to top/front) then a duct extension will need to be added to join the fan to the roof.

b. On units without internal isolation the duct extension is secured to the fan housing with screws. The duct can be purchased from Service Parts or can be fabricated in the field.

c. On units with internal isolation the duct extension is wider at the bottom to form a gap between and the fan housing, which is bridged by a flexible foam gasket. Contact Service Parts for a duct extension kit. (See Fig. 1)

14a. If changing from vertical to horizontal (such as top/front to front/top) then the duct extension will need to be replaced by mounting angles to join the fan to the cabinet.

b. On units without internal isolation the mounting angles can be secured to the fan and to the cabinet with screws. The angles can be purchased from Service Parts or can be fabricated in the field.

c. On units with internal isolation the mounting angles do not extend as far and do not reach the cabinet panel. The gap is bridged by a flexible foam gasket. Also the gasket stays compressed using a thrust restraint assembly. Contact Service parts for angle/gasket kit. (See Fig. 2)

15. Reattach roof
16. Reattach coil to roof support.
17. Reattach front/back panels
18. Reattach access doors.

Pre-Installation Checklist

Complete the following checklist before beginning unit installation.

- Verify the unit size and tagging with the unit nameplate.
- Make certain the floor or foundation is level, solid, and sufficient to support the unit and accessory weights. See the Dimensions and Weights section. Level or repair the floor before positioning the unit if necessary.
- Allow minimum recommended clearances for routine maintenance and service. Refer to unit submittals for dimensions.
- Allow one and one half fan diameters above the unit for the discharge ductwork.

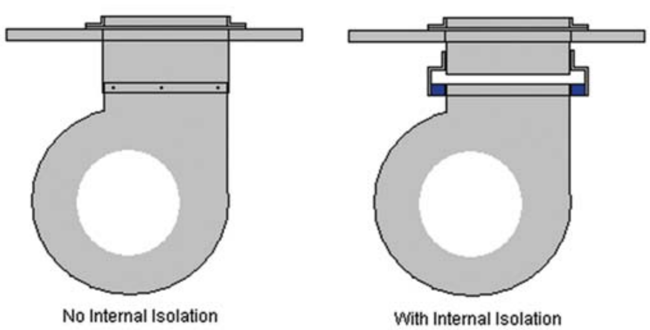


Figure I-PC-5. Contact Service Parts for a Duct Extension Kit

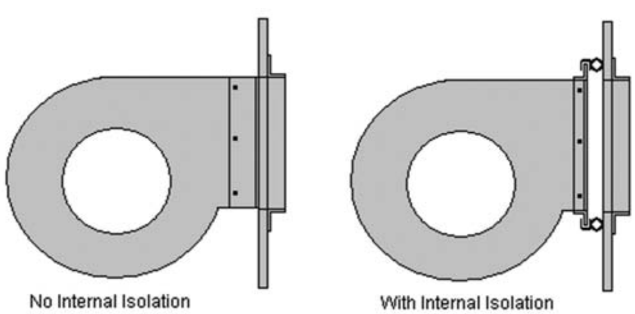


Figure I-PC-6 Service PArts for Angle/Access Kits

Duct Connections

WARNING

Hazardous Voltage w/Capacitors!
Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Install all air ducts according to the National Fire Protection Association standards for the "Installation of Air Conditioning and Ventilation Systems other than Residence Type (NFPA 90A) and Residence Type Warm Air Heating and Air Conditioning Systems (NFPA 90B).

For units without internal isolation, inlet and discharge air duct connections to the unit should be made with a flexible material minimizing noise and vibration. Typically, about three inches is needed for this connection to rigid ductwork.

For units with internal isolation, flexible material is not required on the inlet and discharge air duct connections.

Inlet and discharge air duct connections to the unit should be made with a flexible material minimizing noise and vibration. Typically, about three inches is needed for this connection to rigid ductwork.

Duct turns and transitions must be made carefully to minimize air friction losses. Avoid sharp turns and use splitters or turning vanes when elbows are necessary. Make turns in the same direction of rotation of the fan. Discharge ductwork should run in a straight line, unchanged in size or direction, for at least a distance of 1-1/2 fan diameters

Condensate Drain Connections

The main drain line and the trap must be the same size as the drain connection. Refer to Table I-MR-1 for drain line sizes. Refer to Figure I-MR-1 for a guide to trap sizing.

Drain traps must be primed. If they are not, the trap is essentially non-existent and the drain will likely overflow.

Plug or trap the auxiliary drain connection, if applicable. If the auxiliary drain connection is left open, air can be drawn in through the opening. This drawn in air can cause moisture carryover.

All drain lines downstream of the trap **must** flow **continuously** downhill. If segments of the line are routed uphill, this can cause the drain line to become pressurized. With a pressurized drain line, the trap can back up into the drain pan, causing it to overflow.

See Figure I-MR-1 for drain trap recommendations.

CAUTION

Water Damage!
Failure to make adequate condensate piping may result in water damage to the equipment or building.

Coil Connections

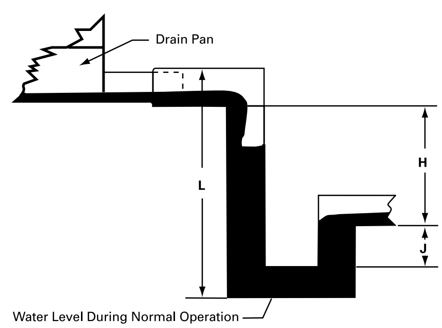
Hydronic Coils

Hydronic coil options are either one, two, four, six or eight-row coils with high efficiency Delta-Flo™ fins. Aluminum fins are mechanically bonded to ½ inch O.D. seamless copper tubes. All coils are specifically designed and circuited for chilled and hot water use only. All coils are pressure tested at 450 psi. Threaded connections are standard.

Proper installation and piping is necessary to enure satisfactory coil operation and prevent operational damage. Water inlet and outlet connections protrude through the coil access panel. Follow standard piping practices when piping to the coil.

Steam Coils

Packaged Climate Changer units fitted with steam coils have labeled holes for piping penetrations. Check that the coil is installed correctly and that the unit installation agrees with the submittals. Refer to Figure I-MR-2 for typical steam coil piping.



H = 1" Of Length for Each 1" Of Negative Pressure + 1" Additional
J = ½ of H
L = H + J + Pipe Dia. + Insulation

Figure I-MR-1. Recommended drain trap installation for draw-thru units.

Table I-MR-1. Condensate Piping Sizes

Unit Size	3	6	8	10	12	14	17	21	25	30
Main Drain (in)	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.25	1.25
Main Drain (cm)	1.905	1.905	2.54	2.54	2.54	2.54	2.54	2.54	3.175	3.175
Auxiliary Drain (in.)	0.75	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Auxiliary Drain (cm)	1.905	1.905	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Coil Connection Recommendations
Follow these recommendations to prevent possible damage when making coil connections:

1. Install a ½″15 swing-check vacuum breaker in the unused condensate return connection at the top of the coil. Install this vacuum breaker as close to the coil as possible.
2. Vent the vacuum breaker to the atmosphere or pipe it to the return main at the discharge side of the steam trap.

Note: A vacuum breaker is mandatory when the coil is controlled by a modulating steam supply or two-position (on/off) automatic steam supply valve.

⚠ WARNING
Hazardous Pressures!

If a heat source is required to raise the tank pressure during removal of refrigerant from cylinders, use only warm water or heat blankets to raise the tank temperature. Do not exceed a temperature of 150˚F. Do not, under any circumstances apply direct flame to any portion of the cylinder. Failure to follow these safety precautions could result in a violent explosion, which could result in death or serious injury.

The condensate return line must be piped full size of the condensate trap connection, except for a short nipple screwed directly into the coil headers condensate return trapping. Do not bush or reduce the coil return tapping size.

Proper Steam Trap Installation
Proper steam trap selection and installation is necessary for satisfactory coil performance and service life. For installation, use the following steps:

1. Install the steam trap discharge 12 inches below the condensate return connection to provide sufficient head pressure to overcome trap losses and ensure complete condensate removal. Use float and themostatic traps with atmospheric pressure gravity condensate return, with automatic controls or when there is a possibility of low pressure steam. Float and thermostatic traps are recommended because gravity drain and continuous discharge operation.
2. Trap each coil separately to prevent holding up condensate in one or more of the coils.
3. Install strainers as close as possible to the inlet side of the trap.
4. Use a V-Port modulating valve to obtain gradual modulation of the coil steam supply.
5. Do not modulate systems with overhead or pressurized returns unless the condensate is drained by gravity into a receiver, vented to atmosphere, and returned to the condensate pump.
6. Slowly turn the steam on full for at least ten minutes before opening the fresh air intake on units with fresh air dampers.
7. Pitch all supply and return steam piping down 1-inch per 10 feet in the direction of the steam or condensate flow.
8. Do not drain the steam mains or take-offs through the coils. Drain the mains ahead of the coil through a steam trap to the return line.
9. Assure continuous condensate removal. Overhead returns require one psig of pressure at the steam trap discharge for each two feet of elevation.

Code of System Components in Piping Diagram

FT	Float and thermostatic steam trap
BT	Bucket steam trap
GV	Gate valve
OV	Automatic two-position (on-off) control valve
TV	Automatic three-way control valve
VB	Vacuum breaker
CV	Check valve
ST	Strainer
AV	Automatic or manual air vent

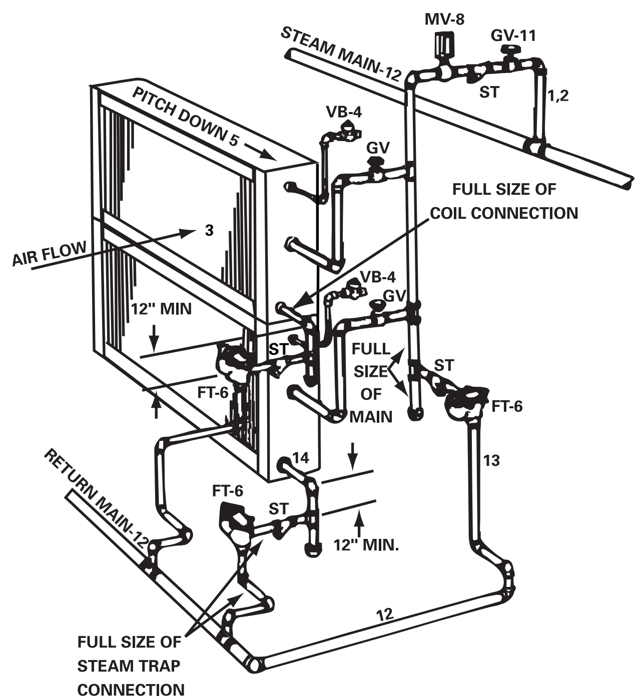


Figure I-MR-2. Typical Piping for Steam Coils

Refrigerant Coil Piping

Units that are UL listed shall not have refrigerant temperatures and pressures exceeding that listed on the unit nameplate.

For unit-installed refrigerant coils, packed elbows are provided. Make pipe connections as shown in Figure I-MR-2.

Note: DX coils ship dehydrated and charged with a dry air holding charge. To prevent leaks and system contamination, do not break the seal until the coil is installed. All liquid lines have a 5/8" process tube attached. Use only a pipe cutter to cut the process tube.

Ensure the coil is installed correctly with airflow in the same direction as indicated on the coil nameplate or casing (field installed coils). The suction connection must be at the bottom of the suction header.

Follow accepted refrigeration piping practices and safety precautions for typical refrigerant coil piping and components. Specific recommendations are provided with the highside components, including instructions for pressure-testing, evacuation, and system charging. Follow the general recommendations for component selection and line sizing below. Leak test the entire refrigerant system after all piping is complete.

Charge the unit according to approximate weight requirements, operating pressures and superheat/subcooling measurements. Adjust the thermal expansion valve setting if necessary.

General Refrigerant Piping Recommendations

Note: Refer to the note on page two of this manual regarding the handling of refrigerants. ***Line Sizing:*** Properly sizing the liquid line is critical to a successful application. If provided, use the liquid line size recommended by the manufacturer of the compressor unit. The selected tube diameter must be as small as possible, while still providing at least 5°F [2.7°C] of subcooling at the expansion valve throughout the operating envelope.

Routing: Install the liquid line with a slight slope in the direction of flow so that it can be routed with the suction line. Minimize tube bends and reducers because these items tend to increase pressure drop and reduce subcooling at the expansion valve.

Insulation: The liquid line is generally warmer than the surrounding air, so it does not require insulation.

Components: Liquid-line refrigerant components necessary for a successful job include an expansion valve, moisture-indicating sight glass, filter drier, manual ball shutoff valves, access port, and possibly a solenoid valve. Position these components as close to the evaporator as possible.

- **Thermal expansion valve (TEV):** Select the TEV based on the actual evaporator capacity, considering the full range of loadings. Verify that the valve will successfully operate at the lightest load condition, considering if hot gas bypass is to be used. For improved modulation, choose a TEV with balanced port construction and an external equalizer connection. The valve must be designed to operate against a back pressure of 20 psi higher than actual evaporator pressure. Install the TEV directly on the coil liquid connection (distributor provided).

The remote expansion-valve bulb should be firmly attached to a straight, well-drained, horizontal section of the suction line. The external equalizer line should be inserted downstream of the remote bulb.

- **Moisture-indicating sight glass**: Install a moisture-indicating sight glass in the liquid line between the expansion valve and filter drier. The sight glass should be sized to match the size of the liquid line.
- **Filter drier:** Install a properly sized liquid line filter-drier upstream from the expansion valve and as close to the evaporator coil as possible. Select the filter-drier for a maximum pressure drop of 2 psi at the design condition.

Manual, ball-type shutoff valves on either side of the filter drier allows replacement of the core without evacuating the entire refrigerant charge.

- **Access port:** The access port allows the unit to be charged with liquid refrigerant and is used to determine subcooling. This port is usually a Schraeder valve with a core.
- **Solenoid valve:** If required by the compressor unit, install the solenoid valve between the filter drier and sight glass.

CAUTION
Valve Damage!
Disassemble the thermal expansion valve before completing the brazing connections. If necessary, wrap the valve in a cool wet cloth while brazing. Failure to protect the valve from high temperatures may damage internal components.

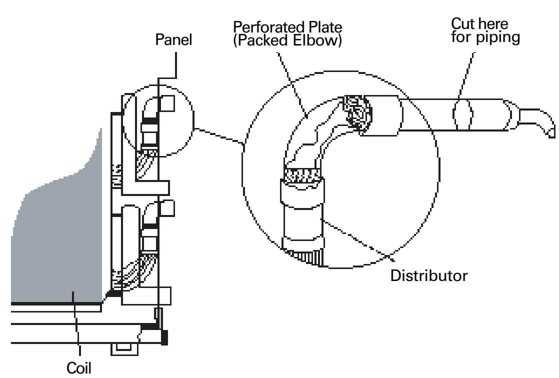


Figure I-MR-3. Refrigerant Coil with Packed Elbow

Installation — mechanical requirements

Suction Line

Line sizing: Properly sizing the suction line is critical for ensuring that the oil returns to the compressor throughout the system operating envelope. If provided, use the suction line size(s) recommended by the manufacturer of the compressor unit. The selected tube diameter(s) must maintain adequate refrigerant velocities at all operating conditions.

Routing: To prevent residual or condensed refrigerant from "free-flowing" toward the compressor, install the suction line so it slopes slightly — 1 inch per 10 feet of run [1 cm per 3 m] — toward the evaporator. Avoid putting refrigerant lines underground. Refrigerant condensation, installation debris inside the line, service access, and abrasion/corrosion can quickly impair system reliability.

Insulation: After operating the system and testing all fittings and joints to verify the system is leak-free, insulate the suction lines to prevent heat gain and unwanted condensation.

Components: Installing the suction line requires field installation of these components: an access port and possibly a suction filter. Position them as close to the compressor as possible.

- **Access port:** The access port is used to determine suction pressure and adjust the TEV. It should be located near the external equalizer line connection. This port is usually a Schraeder valve with a core.
- **Suction filter:** If required by the compressor unit, a replaceable-core suction filter is installed as close to the compressor unit as possible. Adding manual, ball-type shutoff valves upstream and downstream of the filter simplifies replacement of the filter core.

CAUTION

High Temperatures While Brazing!
Disassemble the thermal expansion valve before completing the brazing connections. If necessary, wrap the valve in a cool wet cloth while brazing. Failure to protect the valve from high temperatures may result in damage to internal components.

Unit Wiring Diagrams

Specific unit wiring diagrams are provided on the inside of the control panel door. Use these diagrams for connections or trouble analysis.

WARNING
Hazardous Voltage w/Capacitors!
Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Supply Power Wiring

It is the installer's responsibility to provide power supply wiring to the unit. Wiring should conform to NEC and all applicable code requirements. When units are ordered without controls, the contractor must also furnish an on/off switch, thermostat, and a fused disconnect switch in compliance with national and local electrical codes.

Bring supply wiring through the knockout in the unit control box. Connect the three phase wires to the power terminal block or the non-fused disconnect switch in the control box terminals. Refer to specific wiring diagrams and fuse information in the unit's control panel.

Refer to unit specific wiring diagrams for specific wiring connections. Locate unit wiring diagrams on the inside of the control box cover. Refer to the unit nameplate for unit specific electrical information, such as voltage, minimum circuit ampacity (MCA), and maximum fuse size (MFS).

CAUTION
Use Copper Conductors Only!
Unit terminals are not designed to accept other types of conductors. Failure to use copper conductors may result in equipment damage.

Caution
Motor Winding Damage!
Do not use a megohm meter or apply voltage greater than 50 DVC to a compressor motor winding while it is under a deep vacuum. Voltage sparkover may cause damage to the motor windings.

Electrical Grounding Restrictions

All sensor and input circuits are normally at or near ground (common) potential. When wiring sensors and other input devices to the Tracer AH540 controller, avoid creating ground loops with grounded conductors external to the unit control circuit. Ground loops can affect the measurement accuracy of the controller.

All input/output circuits (except isolated relay contacts and optically isolated inputs) assume a grounded source, either a ground wire at the supply transformer to control panel chassis, or an installer supplied ground.

Note: Do not connect any sensor or input circuit to an external ground connection.

The installer must provide interconnection wiring to connect wall mounted devices such as a zone sensor module. Refer to the unit wiring schematic for specific wiring details and point-to-point wiring connections. Dashed lines indicate field wiring on the unit wiring schematics. All interconnection wiring must conform to NEC Class 2 wiring requirements and any state and local requirements. Refer to Table 1 for the wire size range and maximum wiring distance for each device.

Power

The Tracer AH540 controller is powered by 24VAC. Three pairs of two terminals are provided for 24VAC connection to the board.

Important Recommendation
Do not bundle or run interconnection wiring in parallel with or in the same conduit with any high-voltage wires (110V or greater). Exposure of interconnection wiring to high voltage wiring, inductive loads, or RF transmitters may cause radio frequency interference (RFI). In addition, improper separation may cause electrical noise problems. Therefore, use shielded wire (Beldon 83559/83562 or equivalent) in applications that require a high degree of noise immunity. Connect the shield to the chassis ground and tape at the other end.

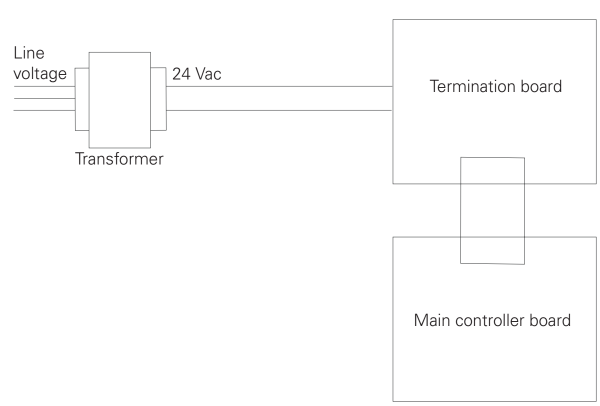


Figure I-ER-1. Tracer AH540 Power Requirement

Table ER-1. Electric heat voltage

unit voltage	heater voltage
208	208
230	240
277	277
460	480
575	600
380	380
415	415

Table ER-2. LPC Electric Heat kW Limits, Min./Max

	unit size									
voltage	3	6	8	10	12	14	17	21	25	30
208/60/1	6/9	6/18	7/18	8/28	N/A	N/A	N/A	N/A	N/A	N/A
230/60/1	6/11	6/20	7/20	8/30	N/A	N/A	N/A	N/A	N/A	N/A
277/60/1	6/13	6/24	7/24	8/38	N/A	N/A	N/A	N/A	N/A	N/A
208/60/3	6/13	6/26	7/28	8/41	10/50	12/50	14/50	17/50	20/47	20/41
230/60/3	6/13	6/26	7/32	8/41	10/53	12/59	14/59	17/59	20/56	20/50
460/60/3	6/13	6/24	7/32	8/44	10/53	12/63	14/75	17/95	20/95	20/120
575/60/3	6/13	6/26	7/34	8/44	10/53	12/63	14/75	17/95	20/95	20/120
380/50/3	6/13	6/26	7/32	8/44	10/53	12/63	14/75	17/95	20/95	20/95
415/50/3	6/13	6/26	7/32	8/44	10/53	12/63	14/75	17/95	20/95	20/95
minimum air flow										
cfm	1050	2100	2800	3500	4200	4900	5950	7350	8750	10,500

1. Units drawing less than 100 amps are available with or without door interlocking disconnect. Units drawing more than 100 amps are not available with door interlocking disconnect.
2. Units drawing less than 48 amps are available with or without line fusing. Units drawing greater than 48 amps have line fusing as standard.
3. Units with electric heat must not be run below the minimum cfm listed above.

Useful Formulas:

Single Phase Heater Amps = (kW x 1000)/Voltage

Three Phase Heater Amps = (kW x 1000)/ (Voltage x 1.73)

Minimum Circuit Ampacity = MCA
MCA = 1.25 x (heater amps + motor FLA)

Maximum Fuse Size or Maximum Overcurrent Protection = MFS
MFS = (2.25 x motor FLA) + heater amps

kW = (Air Flow x DeltaT) / K
DeltaT = (kW x K) / Air Flow
K = 3145 (English)
K = 824.7 (SI)

HACR (Heating, Air-Conditioning and Refrigeration) type circuit breakers are required in the branch circuit wiring for all fan-coils with electric heat.

See Tables ED- 3 through ED-6 for motor FLA's

Select a standard fuse size or HACR type circuit breaker equal to the MCA.
Use the next larger standard size if the MCA does not equal a standard size.

Standard fuse sizes are:
15, 20, 25, 30, 35, 40, 45, 50, 60 amps

Note:
1. Heaters available in the following kW increments:

6	14	26	44	71	110
7	15	28	47	75	115
8	16	30	50	79	120
9	17	32	53	83	
10	18	34	56	87	
11	20	36	59	91	
12	22	38	63	95	
13	24	41	67	100	

Table ER-3. Motor electrical characteristics & motor/VFD weight, lbs.

hp	utilization voltage	FLA	LRA	RPM	motor weight	motor frame size	VFD line input	VFD weight
0.5	208/60/1	3.7	17.4	1725	23	56		
	230/60/1	3.6	17.3					
	277/60/1	3.2	14.5	1725	23	56		
	208/60/3	2.1	15	1725	21	56		
	230/60/3	2.2	13	1725	23	56		
	460/60/3	1.1	6.5					
0.75	208/60/1	5	28.9	1725	33	56		
	230/60/1	4.9	29					
	277/60/1	4.2	29	1725	33	56		
	208/60/3	3.1	20.5	1725	24	56		
	230/60/3	3	20	1725	27	56		
	460/60/3	1.5	10					
1	208/60/1	5.3	32.9	1725	35	56		
	230/60/1	5	33					
	277/60/1	4.1	30	1725	35	56		
	208/60/3	3.1	20.3	1725	33	56	6.3	27
	230/60/3	2.8	20				6.3	27
	460/60/3	1.4	10				2.5	27
	575/60/3	1.1	8	1725	34	56	2.3	31
	400/50/3	2.1	16.8	1450	39	56	2.8	27
1.5	208/60/3	5	34.4	1740			6.3	27
	230/60/3	4.6	34				6.3	27
	460/60/3	2.3	17				2.5	27
	575/60/3	1.65	12.6	1740	39	56	2.3	31
	400/50/3	2.5	19.7	1450	40	56	2.8	27
2	208/60/3	5.9	42.3				7.3	27
	230/60/3	5.6	42	1725			7.3	27
	460/60/3	2.8	21				3.4	27
	575/60/3	2.2	16.8	1740	45	56	2.6	31
	400/50/3	3.6	31.6	1450	56	56	3.8	27
3	208/60/3	8.7	64.7				10.4	31
	230/60/3	8	64	1725			10.4	31
	460/60/3	4	32				4.8	27
	575/60/3	3.2	25.6	1725	56	56	3.8	31
	400/50/3	5.5	44.6	1450	74	182-4T	5.3	27
5	208/60/3	14	91.8				16.8	31
	230/60/3	13.2	91	1740			16.8	31
	460/60/3	6.6	45.5				8.3	31
	575/60/3	5.3	36.4	1740	74	182-4T	5.9	31
	400/50/3	9.5	68.1	1450	113	213-5T	9.1	31
7.5	208/60/3	22.2	139.4				23.8	76
	230/60/3	21.6	138.8	1760			23.8	76
	460/60/3	10.8	69.4				10.6	31
	575/60/3	8	49	1760	113	213-5T	9.2	31
	400/50/3	13.5	89.5	1450	129	213-5T	15.2	31
10	208/60/3	28	180				32.2	76
	230/60/3	28	180	1760			32.2	76
	460/60/3	14	90				14.2	31
	575/60/3	11	72	1760	131	213-5T	11.1	31
	400/50/3	18.5	148.7	1450	167	254T	24.0	76
15	208/60/3	40.6	301				48.3	84
	230/60/3	40.6	301	1760			48.3	84
	460/60/3	20.3	150.5				21.0	76
	575/60/3	16.2	120	1760	162	254T	16.6	76
	400/50/3	23	148	1465	235	254-6T	24.0	76
20	208/60/3	61	298	1760	198	254-6T	61.9	84
	230/60/3	50	300	1760	235	254-6T	61.9	84
	460/60/3	25	150				27.6	76
	575/60/3	20	135	1760	242	254-6T	21.4	76

Installing the Unit

Follow the procedures below to install the unit properly.

Ceiling Suspended Horizontal Units

1. Determine the unit mounting hole dimensions. Prepare the hanger rod isolator assemblies (provided by installing contractor) and install. Use threaded rods to level the unit. Consult the General Data tables and/ or the Dimensions and Weights section to determine total unit weight. See Figure I-P-1.

Note: Verify that the motor is clean and dry prior to startup.

2. Attach the unit to the suspension rods using washers and lock-nuts.
3. Level the unit for proper coil drainage and condensate removal from the drain pan. Refer to Figure I-MR-1 for proper drain trapping. Isolate piping separately.
4. Connect the ductwork to the unit. Refer to the Ductwork Recommendations section.

Floor Mounted Horizontal and Vertical Units

1. Determine the total unit weight and each corner weight before designing the vibration isolation system sizing (provided and installed by others). Refer to the following section, *Corner Weight Calculations,* and the *Dimensions and Weights* section for unit and coil weights. Isolation systems may be either spring-type or "waffle pad" isolators.
2. Both horizontal and vertical units ship with corner brackets for mounting. Prepare the floor or housekeeping pad to properly secure unit.
3. Secure the unit to the floor with anchor bolts and lock-nuts . Or if using isolators, secure them to the floor and then secure the unit to the isolators. Refer to Figure I-IP-2.
4. Remove all shipping blocking or restraints on the isolator systems.

Optional Sections

All optional sections ship fully assembled, attached to one another on a separate skid from the main unit. These sections have installation brackets on all four corners, similar to the main unit.

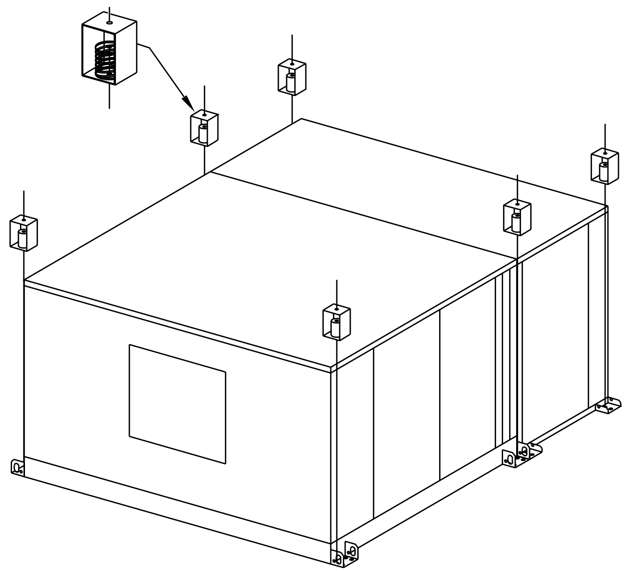


Figure I-IP-1. Ceiling installation

Notes: Vibration Isolation Hanger. Use hanger rod diameter recommended by isolator manufacturer. Vibration isolators are field-supplied.

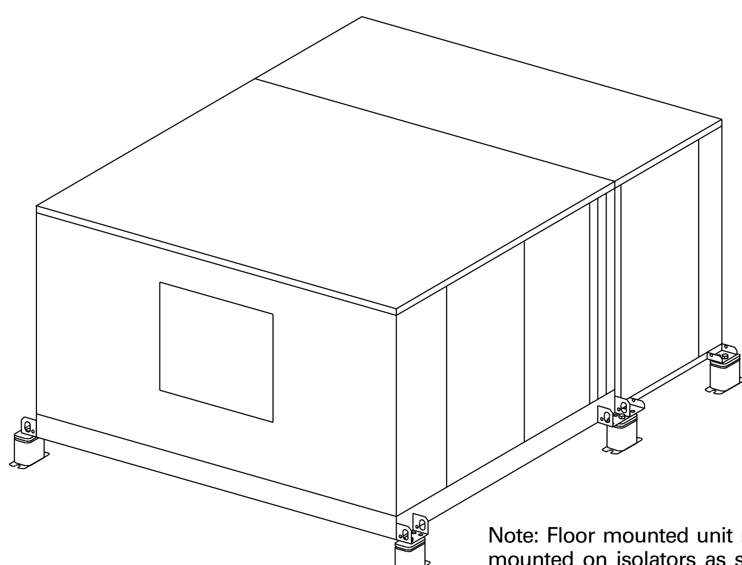


Figure I-IP-2. Floor installation

Note: Floor mounted unit may be mounted on isolators as shown or on Elasto-rib pads. Isolators or Elasto-rib pads are field-supplied.

LPC Unit Corner Weight Calculations

Calcute model LPC corner weights to ensure you size isolators correctly. Remember, units are not internally isolated and require external isolators provided at installation.

Before calculating the corner weights, you must first calculate the total unit weight. Add the coil, motor, and control box weights to the main unit weight to get the total unit weight. Weights are listed in the Dimensions & Weights section of this manual.

Example
This example uses a size 8 horizontal unit, with a right-hand motor/drive & control box.

Note: Include the wet coil weight. Motor/drive control box always = 9 lbs.

1. Calculate total LPC operating weight:

component	weight, lbs.
main unit	240
motor, 460/60/3, ½ hp	43
8-row hydronic coil	212.2
control box	9
Total operating weight =	504.2

Reference Figure I-IP-1 for a visual explanation of the following steps.

2. Calculate the "leaving air side" corner weights, labeled C & D in graphic.

- Divide the main unit weight by 4 to get main unit corner weight: 240 ÷ 4 = 60 lbs.
- Divide the motor weight by 2 to get the 2 corners. Add to the main unit corner weight to get the total corner weight: 43 ÷ 2 = 21.5 + 60 = 81.5 lbs.

Note: To get the total corner weight you must add the motor/drive control box weight to the correct unit side. See step 4.

3. Calculate the "entering air side" corner weights, labeled A & B in the graphic.

- Divide the coil weight by 2 to get the 2 coil weight corners of the entering air side. Add to the main unit corner weight of the entering air side: 212.2 ÷ 2 = 106.1 lbs. + 60 lbs. = 166.1 lbs.

Note: To get the total corner weight you must add the motor/drive control box weight to the correct unit side. See step 4.

4. Add the motor/drive control box weight to the correct unit side.
The unit can have the motor/drive control box on either the right or left-hand side. Verify this by inspecting the unit or referencing the unit model number, digit 12 .

In this example (right-hand motor/drive), we will add the control box weight to the leaving air side, corner weight C: 81.5 lbs + 9 lbs. = 90.5 lbs.

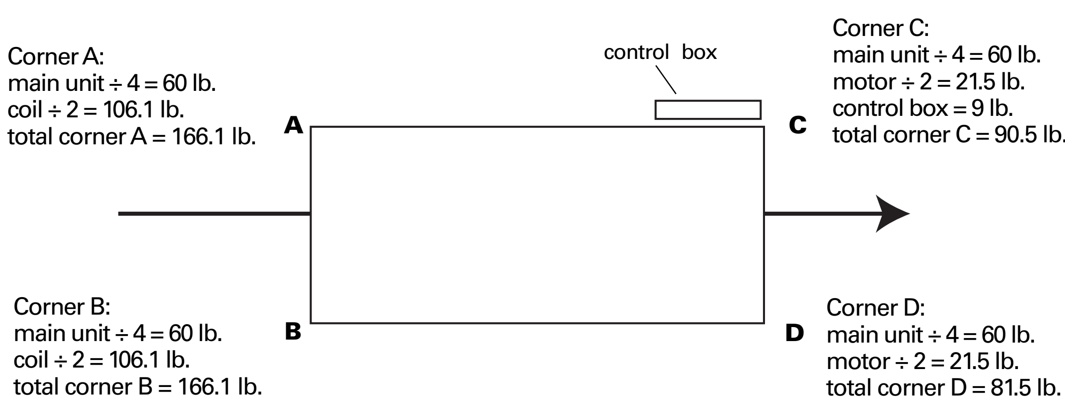
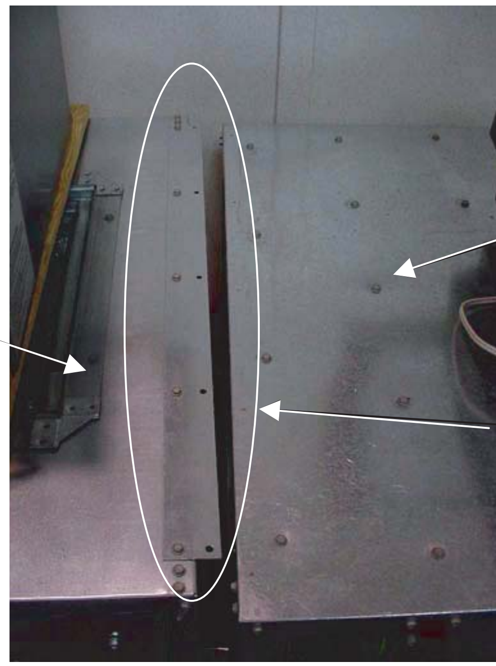
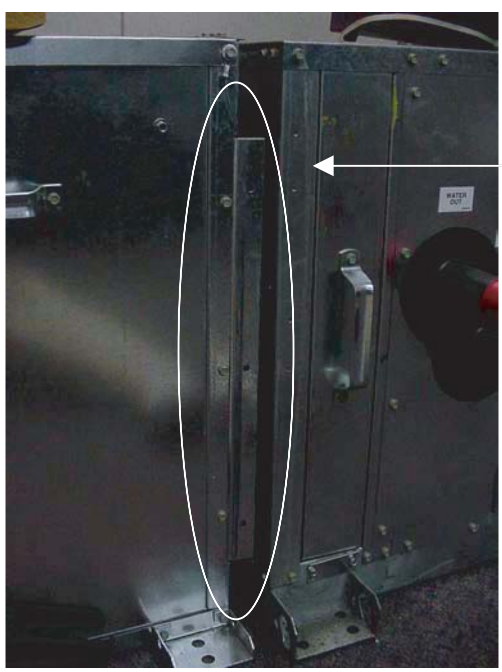


Figure I-IP-1. Corner weight calculation example: size 8 horizontal LPC with a right-hand motor/drive & control box.

Attaching optional sections to the model LPC



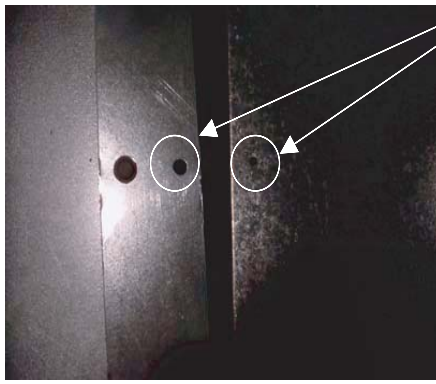
Step 1.
Connect modules to flange on top of unit.



Step 2.
Use the flange on both sides of the unit to connect modules.

Note: Gasketing is not required on this equipment. The Packaged Climate Changer was designed and tested to be used without gasketing.

Note: All screws, nuts, & bolts required for installation are field-provided.



Step 3.

Line up the holes on the unit and module and attach together using a #10 - 16 x 0.5 inch screw.

Step 4.

Line up the corner brackets on the module being joined.

Step 5.

Attach the corner brackets using a bolt and nut.

Note: Gasketing is not required on these units. The Packaged Climate Changer is designed and tested to be used without gasketing. All screws, nuts, and bolts required for installation are field supplied.

Installing Wall Mounted Controls

Wall mounted zone sensors ship taped to the control box.

Position the controller on an inside wall three to five feet above the floor and at least 18 inches from the nearest outside wall. Installing the controller at a lower height may give the advantage of monitoring the temperature closer to the zone, but it also exposes the controller to airflow obstructions. Ensure that air flows freely over the controller.

Before beginning installation, follow the wiring instructions below. Also, refer to the unit wiring schematic for specific wiring details and point connections.

Wiring Instructions

Avoid mounting the controller in an area subject to the following conditions:

- Dead spots, such as behind doors or in corners that do not allow free air circulation.
- Air drafts from stairwells, outside doors, or unsectioned hollow walls.
- Radiant heat from the sun, fireplaces, appliances, etc.
- Airflow from adjacent zones or other units.
- Unheated or uncooled spaces behind the controller, such as outside walls or unoccupied spaces.
- Concealed pipes, air ducts, or chimneys in partition spaces behind the controller.

Zone Sensor Installation

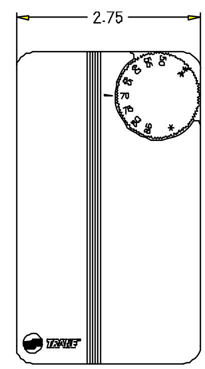
Follow the procedure below to install the zone sensor module.

1. Note the position of the setpoint adjustment knob and gently pry the adjustment knob from the cover using the blade of a small screwdriver.
2. Insert the screwdriver blade behind the cover at the top of the module and carefully pry the cover away from the base.
3. To install the zone sensor module without a junction box (directly to the wall):
   a. Using the module base as a template, mark the the rectangular cutout for the control wiring and module installation holes. Ensure the base is level.
   b. Set the base aside and make the cutout. Then, drill two 3/16" diameter holes approximately one-inch deep. Insert and fully seat the plastic anchors.
   c. Pull the control wires through the cutout and attach the module to the wall using the screws provided.
4. To install the zone sensor module to a standard junction box:
   a. Level and install a 2" x 4" junction box (installer supplied) vertically on the wall.
   b. Pull the control wires through the cutout. Attach the module to the wall using the screws provided.
5. Strip the insulation on the interconnection wires back 0.25 inch and connect to TB1. Screw down the terminal blocks.
6. Replace the zone sensor cover and adjustment knob.

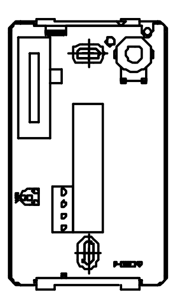
If installing a Tracer AH540 zone sensor, see the Tracer Summit Communication section for more information.

Table ER-4 Zone Sensor Maximum Wiring Distances, ft (m)

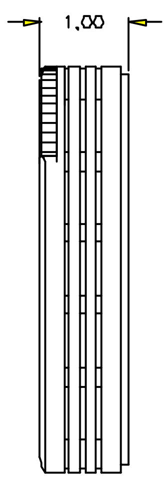
Wire Size Range	Max. Wiring Distance
16 - 22 AWG	200 (60.96)



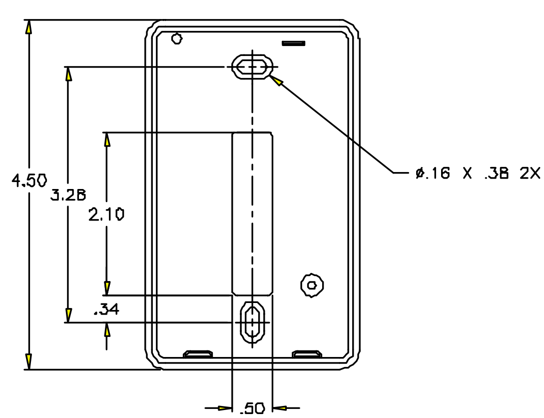
FRONT VIEW



VIEW WITH COVER REMOVED
(NOT TO SCALE)



SIDE VIEW



BACK VIEW

Figure I-IP-3. Wall mounted zone sensor dimensions.

Transition Kit Installation

The LPC was designed with the same aspect ratio as the M-Series unit. The transition kit is designed to mate up M-series modules with the LPC. The LPC mates up with the same size M-series with the exception of sizes 12 and 17. Due to fewer cabinet sizes with the LPC, these sizes mate up to the next size larger M-series unit. See figure I-IP-4 for installation istructions of the finishing kit.
The table below shows the mated sizes. The external static pressure from the M-series module needs to be included in the external static of the LPC to ensure the unit can handle the extra static.

LPC	M-Series
3	3
6	6
8	8
10	10
12	**14**
14	14
17	**21**
21	21
25	25
30	30

To install the transition kit, follow the steps listed below:

1. Apply Gasket Tape supplied in kit between the LPC and MCC Module.
2. Use Self Drilling screws supplied with the kit on the M-series side. The LPC unit will have screw holes that match the attachment brackets.

Finishing Kit Installation

The LPC was designed to be used without gasketing and to be assembled with common job site material. For circumstances where gasketing is desired, or when it is necessary to use only factory provided materials, the finishing kit is available. See Figure I-IP-5 for installation instructions of the finishing kit.
To install the Finishing Kit, follow the steps listed below:

1. Apply Gasket Tape supplied in kit between the LPC unit and accessory
2. Use screws supplied with kit to join with accessory module
3. Use supplied hardware to join feet together

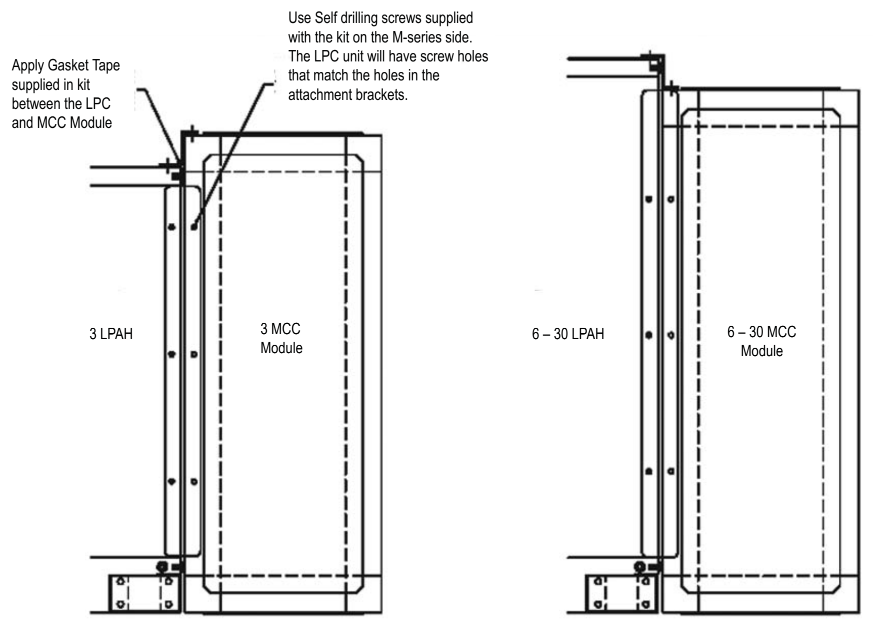


Figure I-IP-4. Transition Kit Installtion LPC

Note: LPC size 12 cannot be mated to size 12 MCC. Also, LPC size 17 cannot be mated to size 17 MCC. Size 12 LPC must be mated to size 14 MCC. Size 17 LPC must be mated to size 21 MCC.

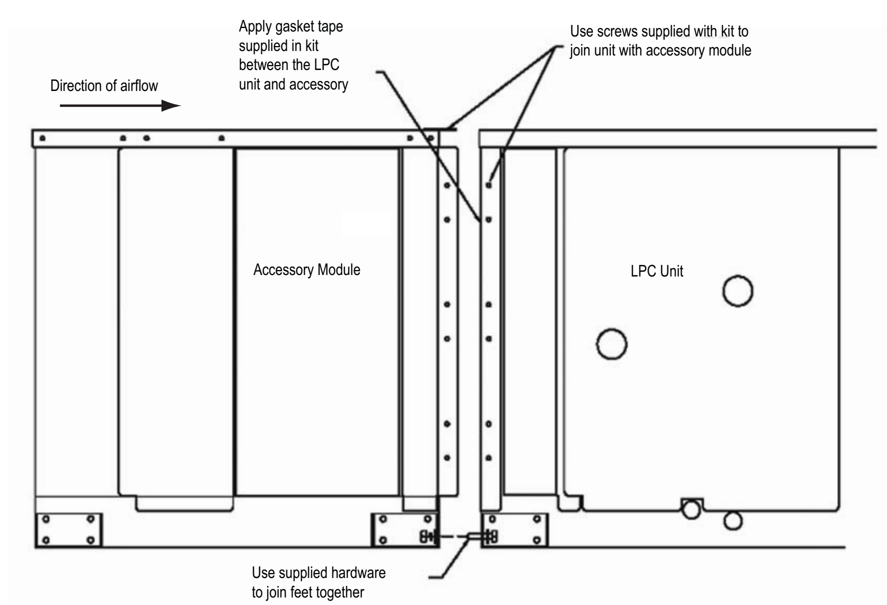


Figure I-IP-5. Finishing Kit Installation LPC

Communication Wiring

Units with Tracer AH540 Only

Communications

Tracer AH540 controllers have Comm5 communication ports. Typically, a communication link is applied between unit controllers and a building automation system. Communication also is possible via Rover™, Trane's service tool. Peer-to-peer communication across controllers is possible even when a building automation system is not present.

For example: If Tracer AH540 has a wired outdoor air temperature sensor and Tracer Summit or another Comm5 controller sends it a communicated outdoor air temperature, the communicated value is used by Tracer AH540 controller. If a communicated input value is lost, the controller reverts to using the locally wired sensor input.

The controller provides six 0.25-inch quick-connect terminals for the Comm5 communication link connections, as follows:

- Two terminals for communication to the board
- Two terminals for communication from the board to the next unit (daisy chain)
- Two terminals for a connection from the zone sensor back to the controller

Note: Communication link wiring is a shielded, twisted pair of wire and must comply with applicable electrical codes.

Follow these general guidelines when installing communication wiring on units with either a Tracer AH540 controller:

- Maintain a maximum 5000 ft. aggregate run.
- Install all communication wiring in accordance with the NEC and all local codes.
- Solder the conductors and insulate (tape) the joint sufficiently when splicing communication wire. Do not use wire nuts to make the splice.
- Do not pass communication wiring between buildings because the unit will assume different ground potentials.
- Do not run power in the same conduit or wire bundle with communication link wiring.

Note: You do not need to observe polarity for Comm5 communication links.

Device Addressing

Comm5 devices are given a unique address by the manufacturer. This address is called a Neuron ID. Each Tracer AH540 controller can be identified by its unique Neuron ID, which is printed on a label on the controller's logic board. The Neuron ID is also displayed when communication is established using Tracer Summit or Rover service tool. The Neuron ID format is 00-01-64-1C-2B-00.

Wire Characteristics

Controller communication-link wiring must be low capacitance, 18-gage, shielded, twisted pair with stranded, tinned-copper conductors. For daisy chain configurations, limit the wire run length to 5,000 ft. Truck and branch configurations are significantly shorter. Comm5 wire length limitations can be extended through the use of a link repeater.

Wire capacitance (measured in picofarads/foot [pF/ft] or picofarads/meter [pF/m]) between conductors must be 23+/-2 pF/ft (72+/-6 pF/m).

Link Configuration and Termination

Communication-link wiring must use one of the following configurations:

- Daisy chain configuration (Figure I-IP-4)
- Trunk and branch configuration (Figure I-IP-52)
- Limit total wire length to 5,000 ft. Comm5 wire length limitations can be extended through the use of a link repeater.
- See the following section on Termination resistance placement for Comm5 links.

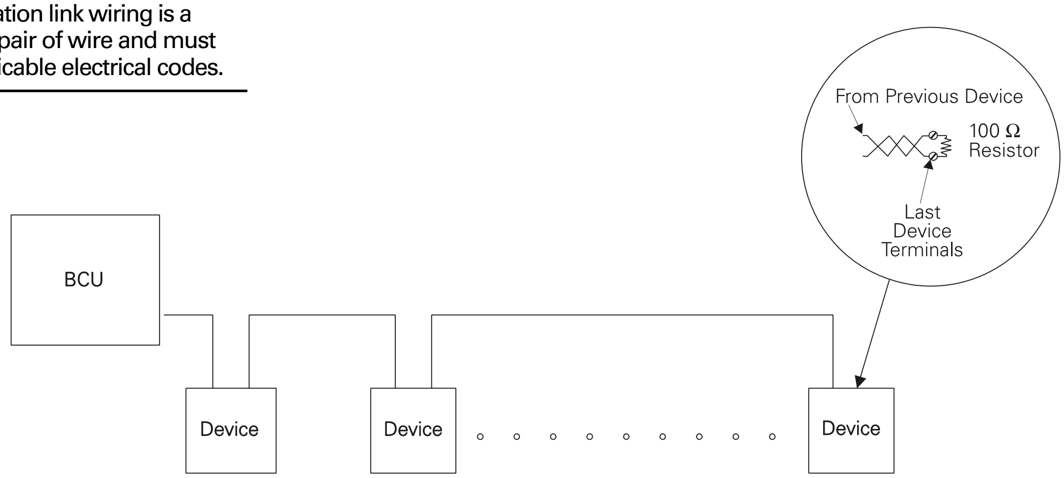


Figure I-IP-6. Daisy Chain Configuration for Communication-link Wiring (Preferred Configuration)

- Total wire length for all branches is limited to 1,600 ft. Comm5 wire length limitations can be extended through the use of a link repeater.
- The maximum number of branches is 10.
- See the following section on Termination Resistance Placement for Comm5 Links.

Termination Resistance Placement for Comm5 Links

To correctly install a Comm5 link, termination resistors are required. For daisy chain configurations, the termination resistance (measured in ohms) must be 100 ohms at each end. For trunk and branch configurations, the termination resistance must be 50 ohms (use two termination resistors in parallel).

For correct termination placement, follow the guidelines below:

- Terminate the daisy chain configuration with a resistor at the extreme end of each wire.
- Terminate a trunk and branch configuration with a resistor or resistors placed at one point on the link. The termination resistance for trunk and branch configuration can be achieved by using two terminating resistors in parallel. While it is not necessary that the termination resistance be placed at the controller, it may be the most convenient.
- When terminating a trunk and branch configuration, it is best to terminate at the point where the branching occurs or at a point very close to it.
- If the link contains more than one type of wire, the link will probably have to be manually tuned. Trane recommends that only one type of wire be used for the Comm5 communication link.
- A set of as-built drawings or a map of the communication wire layout should be made during installation. Any sketch of the communication layout should feature the terminating resistor placement. See Figure I-IP-6.

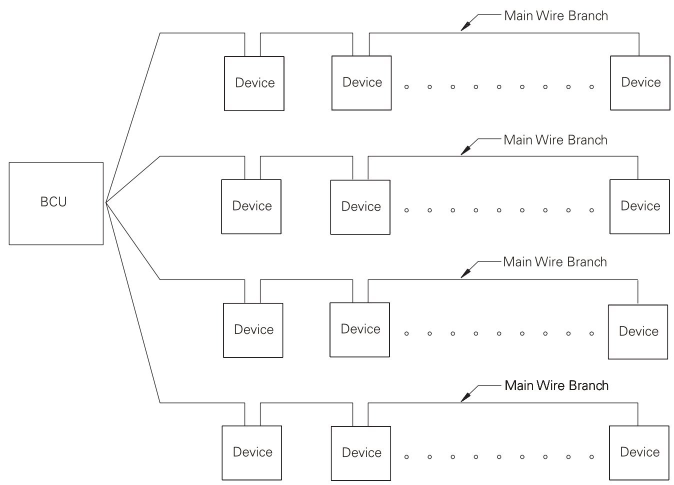


Figure I-IP-7. Trunk and Branch Configuration for Communication Link Wiring

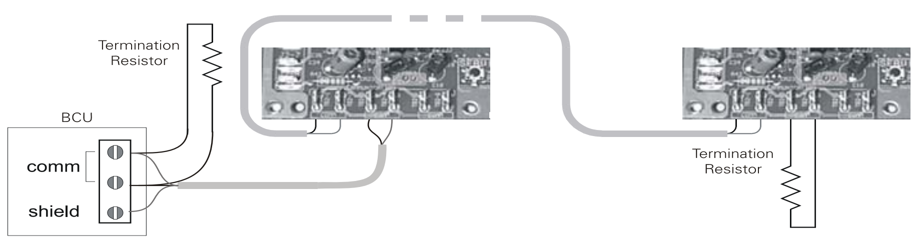


Figure I-IPR-8. Daisy Chain Resistor Placement

Recommended Wiring Practices

The following guidelines should be followed while installing communication wire.

- Comm5 is not polarity sensitive. Trane recommends that the installer keep polarity consistent throughout the site.
- Only strip away two-inches maximum of the outer conductor of shielded cable.
- Make sure that the 24VAC power supplies are consistent in how they are grounded. Avoid sharing 24VAC between Comm5 UCMs.
- Avoid over-tightening cable ties and other forms of cable wraps. A tight tie or wrap could damage the wires inside the cable.
- Do not run Comm5 cable alongside or in the same conduit as 24VAC power.
- In an open plenum, avoid lighting ballasts, especially those using 277VAC.
- Do not use a trunk and branch configuration, if possible. Trunk and branch configurations shorten the distance cable can be run.

Pre-Startup Checklist

Complete this checklist after installing the unit to verify all recommended installation procedures are complete before unit startup. This does not replace the detailed instructions in the appropriate sections of this manual. Disconnect electrical power before performing this checklist. Always read the entire section carefully to become familiar with the procedures.

⚠ WARNING

Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Receiving

- ☐ Inspect unit and components for shipping damage. File damage claims immediately with the delivering carrier.
- ☐ Check unit for missing material. Look for ship-with options and sensors that may be packaged separately from the main unit. See the "Receiving and Handling" section.
- ☐ Check nameplate unit data so that it matches the sales order requirements.

Unit Location

- ☐ Remove the shipping skid when the unit is set in its final position.
- ☐ Ensure the unit location is adequate for unit dimensions, ductwork, piping, and electrical connections.
- ☐ Ensure access and maintenance clearances around the unit are adequate.

Unit Mounting

- ☐ Place unit in its final location.
- ☐ Remove shipping skid bolts and skid.
- ☐ Properly install any field-provided isolators per instructions in Figures I-IP-1 and I-IP-2 .

Component Overview

- ☐ Inspect fan belt tension and sheave alignment. Refer to Figure M-MP-1.
- ☐ Inspect the fan motor and bearing lubrication.
- ☐ Check the bearing locking collar and sheave set screw for proper torque settings. Refer to the Appendix.
- ☐ Ensure the fan rotates freely in the correct direction.
- ☐ Verify that a clean air filter is in place.

Ductwork

- ☐ If using return ductwork to the unit, secure it with three inches of flexible duct connector.
- ☐ Extend discharge duct upward without change in size or direction for at least one and one half fan diameters.
- ☐ Use a flexible duct connection on discharge and inlet ductwork.
- ☐ Ensure trunk ductwork is complete and secure to prevent leaks.
- ☐ Verify that all ductwork conforms to NFPA 90A or 90B and all applicable local codes.

Unit Piping

- ☐ Verify the condensate drain piping is complete for the unit drain pan.
- ☐ Make return and supply water connections to the unit and/or piping package.
- ☐ Ensure the drain pan and condensate line are not obstructed. Remove any foreign matter that may have fallen into the drain pan during installation.
- ☐ Verify that piping does not leak. Drain lines should be open while performing this test.
- ☐ Treat water to prevent algae, slime, and corrosion.

Electrical

- ☐ Check all electrical connections for tightness.

Unit Panels

- ☐ Ensure all unit access panels are in place and that all screws, nuts, and bolts are tightened to their proper torques.

Packaged Climate Changer Control Options

Packaged Climate Changer units are available with two different control options:

- Control interface
- Tracer AH540

Control Interface
Model Number Digit 20 = 1
The control interface option contains a disconnect switch, fan contactor, fused transformer, and customer terminal strip. Various end device options are available factory-mounted on units with the control interface. There are four binary end device options:

1. low limit switch,
2. condensate overflow switch
3. fan status switch
4. filter status switch

Also there are three analog end device options:

1. discharge air sensor
2. mixed air sensor
3. damper actuator

Tracer AH540 Controller
Model Number Digit 20 = 2 or 3
Tracer AH540 standard control features include options available as factory-configured or field-configured (using Rover™ service software). For more detailed information on the Tracer AH540, refer to Trane publication, *CNT-SVX05B-EN.*

The Tracer AH540 controller operates as a stand-alone controller or it can communicate as part of a Trane Integrated Comfort™ System (ICS). In the stand-alone configuration, Tracer AH540 receives operation commands from the:

- space temperature and discharge air temperature for constant volume space temperature control,
- discharge air temperature for constant volume discharge air temperature control, and
- both discharge air temperature and duct static pressure for variable air volume control.

For Tracer AH540 zone sensor options, see the zone sensor section.

For optimal system performance, Packaged Climate Changer units can operate as part of an Integrated Comfort™ System (ICS) controlled by Tracer Summit®. The controller is linked directly to the Summit control panel via twisted pair communication wire, requiring no additional interface device (i.e., a command unit). The Trane ICS system can monitor or override Tracer AH540 control points. This includes such points as temperature and output positions.

Rover™ Service Software
This windows-based software package option allows field service personnel to easily monitor, save, download, and configure Tracer controllers through a communication link from a portable computer. When connected to the communication link, Rover can view any Tracer controller that is on the same communication link.

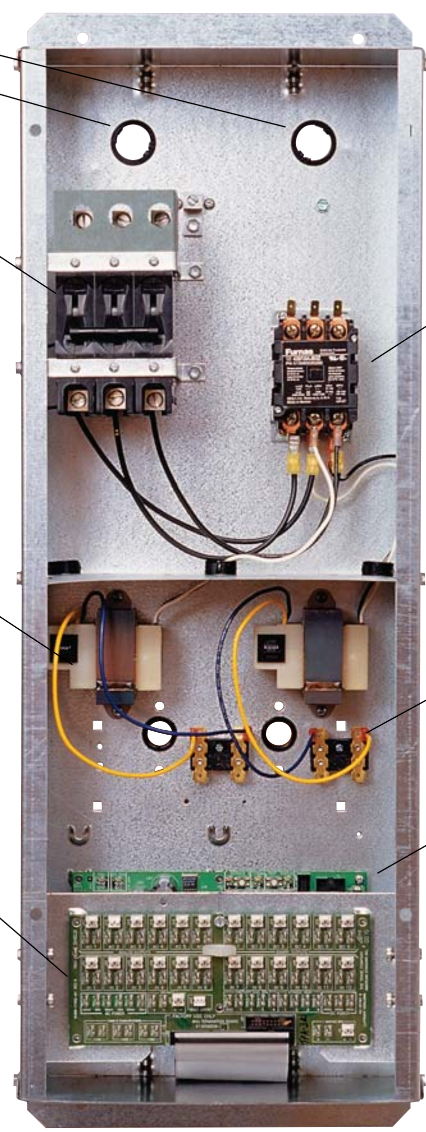


Figure O-GI-1. Packaged Climate Changer Control Panel Components

Operation general information

Tracer AH540 Zone Sensor Options

Zone sensors are available wall mounted for design flexibility. Wall-mounted zone sensors have an internal thermistor and operate on 24 VAC. Zone sensor options have a zone sensor setpoint adjustment knob, communication jack, and service pin message request. Also, an option is available without a setpoint knob. See Figures O-G1-3 through O-GI-5.

The zone sensor module is capable of transmitting the following information to the controller:

- Timed override on request
- Zone setpoint
- Current zone temperature
- Fan mode selection

Figure O-GI-2. Tracer AH540 Control Board

Figure O-GI-3. Model number digit 37 = 1 Zone sensor with off/auto fan speed switch, Farenheit setpoint knob,on/cancel, and communication jack.

Figure O-GI-4. Model number digit 37 = 2 Zone sensor with Farenheit setpoint knob,on/cancel, and communication jack.

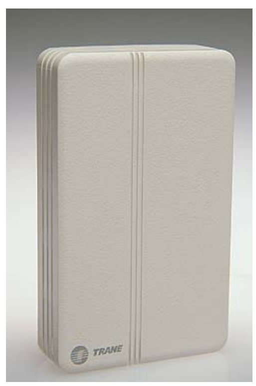


Figure O-GI-5. Model number digit 37 = 4

Figure O-GI-6. Model number digit 37 = digital zone sensor option

Figure O-GI-7. Variable frequency drive (VFD) option

Table O-GI-1. Tracer AH540 Features and Control Modes

function	space temp. control	discharge air temperature control
fan control	on/off	variable or on/off
duct static pressure		X
hydronic cooling	X	X
hydronic heating	X	X
steam heat	X	X
face & bypass heating	X	X
ventilation control	X	X
economizer damper	X	X
warmup functions	X	X
mixed air temperature control	X	X
exhaust fan (on/off)	X	X
DX cooling	X	X
electric heat	X	X
dehumidification	X	
two-pipe changeover	X	

Communication with other controllers

Tracer AH540/541 controllers operates either in stand-alone mode or as part of a building automation system. In either mode of operation, multiple controllers can be bound (bindings are configured using the Rover service tool) to other LonTalk®-based controllers so they can communicate data to one another.

Controllers that are bound as peers can share the following data:

- Setpoint
- Zone temperature
- Zone relative humidity
- Outdoor air temperature
- Occupancy mode
- Heating/cooling mode
- Fan status
- Unit capacity control

Applications having more than one unit serving a single space can benefit by using this feature; it allows multiple units to share a single space temperature sensor and prevents multiple units from simultaneously heating and cooling.

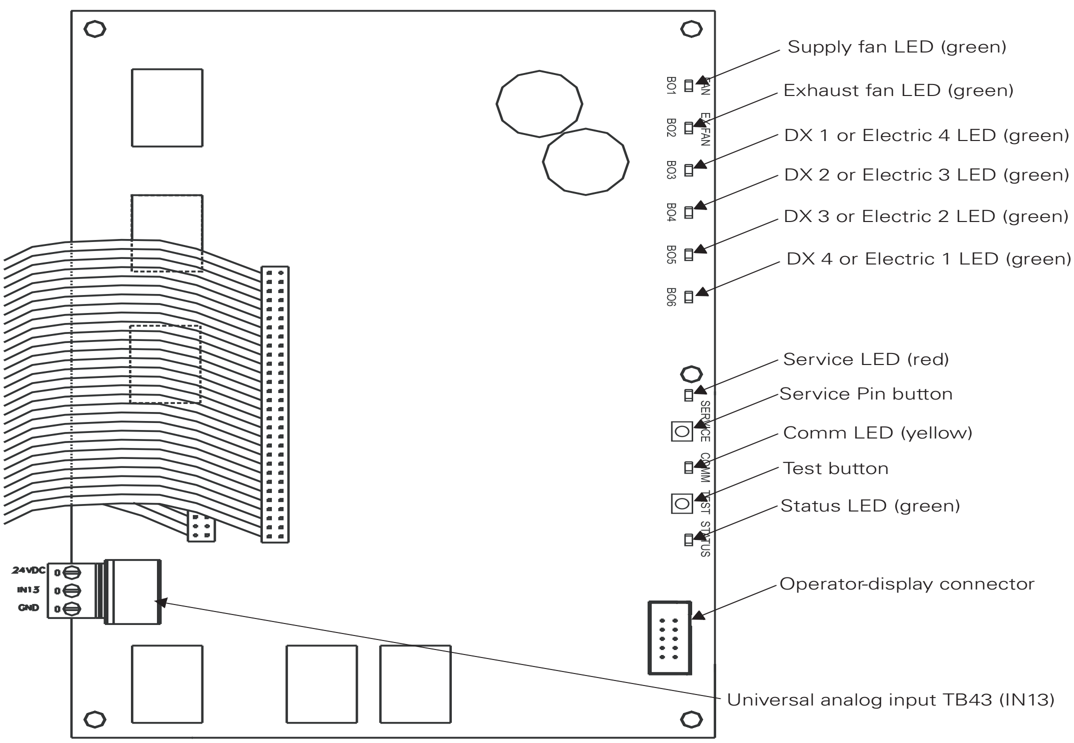


Figure O-GI-8. Tracer AH540/541 main controller board

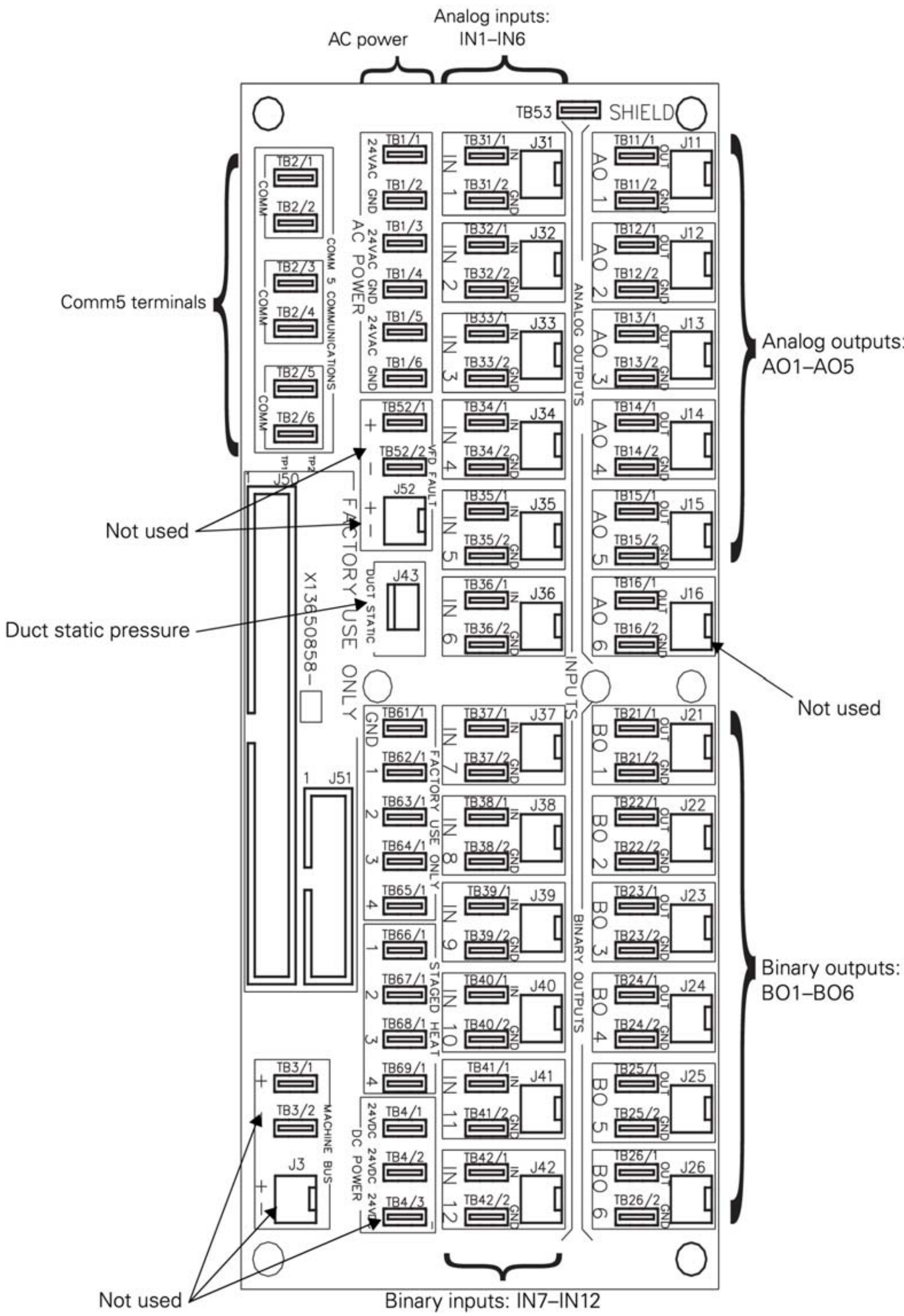


Figure O-GI-9. Tracer AH540 termination board

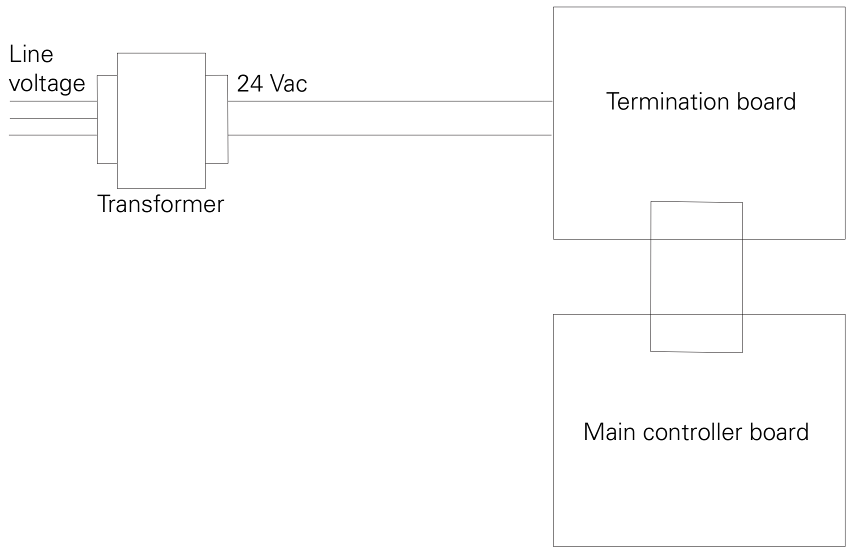


Figure O-GI-10. Power requirements

Operator display

This section explains how to install a Tracer AH540/541 operator display and set up the operator display.

Installing the stand-alone operator display

With the attached cable, the stand-alone operator display (see Figure O-GI-11) can be mounted up to 10 ft (3 m) from the Tracer AH541 controller. You can extend this distance up to 150 ft (46 m) using four-conductor wire and the included pig-tail connectors. Alternately, use three twisted-pair wires. Trane recommends the following four-conductor wires:

- Plenum 18 AWG, Trane part number 400-2059
- Plenum 22 AWG, Trane part number 400-2020
- Non-plenum, Trane part number 400-1005

CAUTION ***Avoid Equipment Damage!*** To clean the operator display, use a cloth dampened with commercial liquid glass cleaner. Spraying water or cleansers directly on the screen may result in equipment damage.

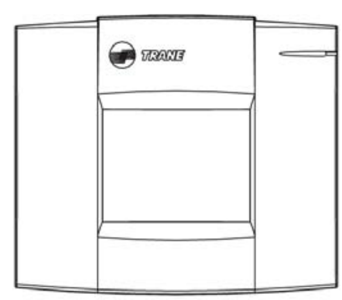


Figure O-GI-11. Tracer AH541 stand-alone operator display

To install the stand-alone operator display:

1. Unsnap the gray plastic backing from the operator display.
2. Carefully disconnect the operator-display cable from the connector inside the operator display.
3. Use the plastic backing as a template to mark the position of the four mounting holes on the mounting surface. See Figure O-GI-12.
4. Set the plastic backing aside and drill holes for #8 (4 mm) screws or #8 wall anchors.
5. Secure the plastic backing to the wall with #8 (4 mm) mounting screws (not supplied).
6. Connect the operator-display cable to the operator display, then snap the operator display to the plastic backing. The operator-display cable is keyed to the connector. If you have difficulty connecting it, make sure the key is lined up with the slot.
7. Run the operator-display cable to the Tracer AH540/541, affixing it to the wall with wiring staples or wire mold. Do not run operator-display cable in the same wire bundle with high-voltage power wires. Running input/output wires with 24 Vac power wires is acceptable.
8. Feed the cable into the Tracer AH540/541 enclosure.
9. Attach the operator-display cable to the operator-display connector on the circuit board (see Figure O-GI-13). The operator display receives power from the Tracer AH540/541 and turns on automatically when it is connected to the controller.

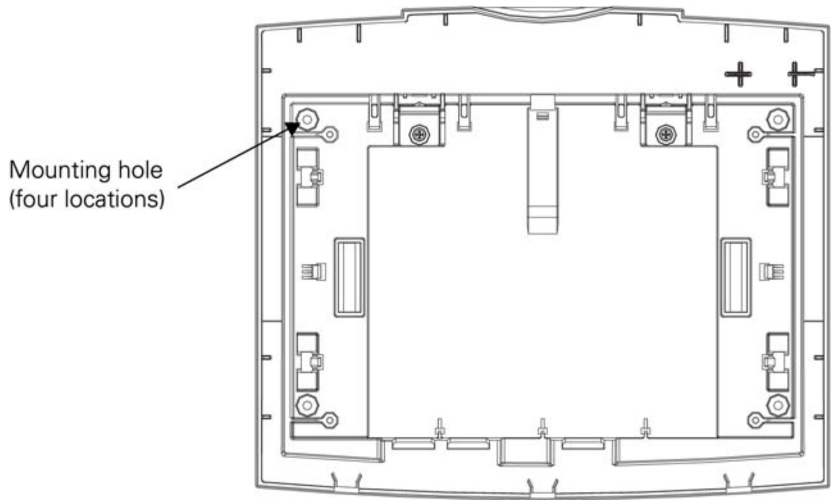


Figure O-GI-12. Stand-alone operator-display mounting holes

Connecting the portable operator display

The portable operator display is designed for temporary connections to Tracer AH541 controllers. It can be hot swapped.

CAUTION
Avoid Equipment Damage!
To clean the operator display, use a cloth dampened with commercial liquid glass cleaner. Spraying water or cleansers directly on the screen may result in equipment damage.

IMPORTANT: The portable operator display is not used for time clock scheduling. To provide scheduling, you must use a permanently-connected door mounted operator display, stand-alone operator display, or Tracer Summit system.

To connect the portable operator display:
1. Open the Tracer AH541 enclosure door.
2. Attach the operator-display cable to the operator-display connector on the circuit board (see Figure O-GI-13).

The operator display receives power from the Tracer AH541 and turns on automatically when it is connected to the controller. The operator display is hot-swappable, so there is no need to power down the controller.

Setting up the operator display
The home screen is the starting point for navigating through the screens of the operator display. The home screen is displayed when the unit is idle. The screen contains the following information from top to bottom:
- Time and date
- The controller location label: When no location is specified and the controller is a Tracer AH540, "Tracer AH540" is displayed. When no location is specified and the controller is a Tracer AH541, "Warning: Unit Config Required" is displayed.
- Operating parameters of the controller
- Push buttons: Touch one of the five buttons — View, Alarm, Schedule, Override, or Setup — to access the desired set of screens.

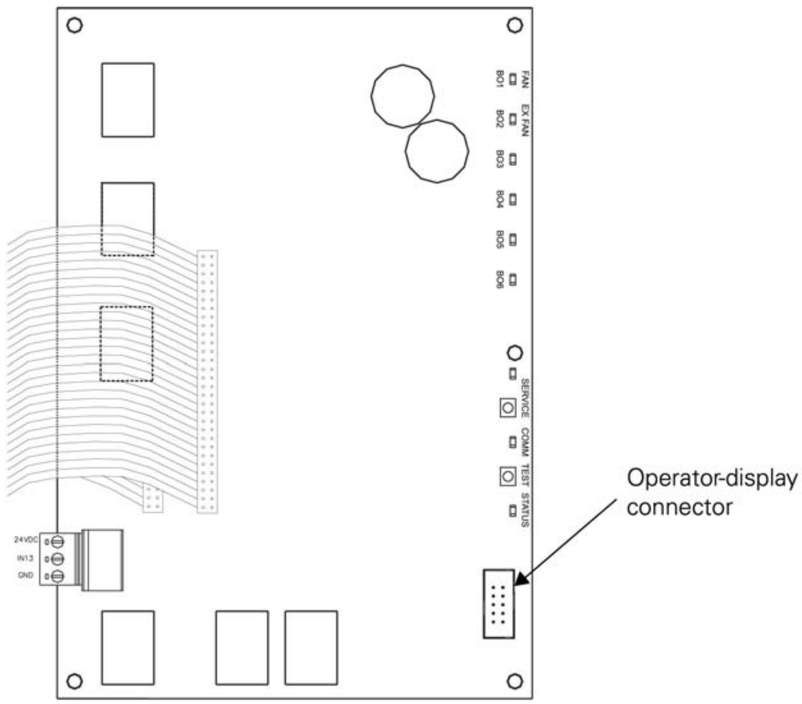


Figure O-GI-13. Operator-display connector on the Tracer AH540/541

Note: The schedule button does not appear on the Home screen when a portable operator display is connected to the controller because the portable operator display does not have a time clock and therefore cannot be used to set up schedules.

Setting up time and date
To change the time for the operator display:
1. On the home screen, press the Setup button. The Setup menu appears.
2. Press the down arrow button to go to Page 2 of 2.
3. Press the Change Time button to view the next screen.
4. Using the buttons, type the time using the format hh:mm, where *hh* is the hour and *mm* is the minute. Press either the AM or PM button, as appropriate.
5. To correct an error, press clear and start again. To accept the changes, press the OK button.

To change the date for the operator display:
1. On the home screen, press the Setup button. The Setup menu appears.
2. Press the down arrow button to go to page 2 of 2.
3. Press the Change Date button to view the next screen.
4. Press the forward and back arrows to move the cursor from day to month to year. Use the buttons to type the appropriate date.
5. To correct an error, press the reset button. To accept the changes, press the OK button.

Calibrating the operator display
To calibrate the operator display:
1. On the home screen, press the Setup button. The Setup menu appears.
2. Press the page down button to go to Page 2 of 2.
3. Press the Display Setup button. The Display Setup menu appears.
4. Press the Calibrate Touch Screen button. A screen with a target appears.

CAUTION

Avoid Equipment Damage!
Do not allow the operator display to come in contact with sharp objects.

5. Touch the target using a small, pliable, blunt object, such as a pencil eraser. Hold until the beeping stops. A second calibration screen appears.
6. Again, touch the target with the object. Hold until the beeping stops. The Setup menu appears.
7. Press the Home button. The home screen appears. Adjusting brightness and contrast.

To adjust the brightness and contrast of the operator display:

1. On the home screen, press the Setup button. The Setup menu appears.
2. Press the page down button to go to Page 2 of 2.
3. Press the Display Setup button. The Display Setup menu appears.
4. Press the Adjust Brightness and Contrast button. The Brightness and Contrast screen appears.
5. To increase the brightness, press the buttons along the top row, in sequence, from left to right.
   To decrease the brightness, press the buttons from right to left.
6. To increase the contrast, press the buttons along the bottom row, in sequence, from left to right. To decrease the contrast, press the buttons from right to left.
7. Press the Home button. The home screen appears.

Setting up, changing, or disabling the security password
To set up or change a security password or to disable its use:

Note: If security is enabled, the logon screen will display whenever you try to change a value that is security protected. To log on, type the password using the numeric type pad. You will remain logged on while you continue to work. After 20 minutes, the system will log you off.

1. On the home screen, press the Setup button. The Setup menu appears.
2. Press the page down button to go to page 2 of 2.
3. Press the Display Setup button. The Display Setup menu appears.
4. Press the page down button to go to page 2 of 2.
5. Press the Setup Security Password button. The Setup Security Password screen appears.
6. To set up or change the password, use the number keys to enter 4 to 8 numbers. Press OK. Security is enabled.

Note: If a password was previously set up, a Disable Security button appears on the Setup Security Password screen. Press the Disable Security button to disable security.

Input and Outputs

This chapter provides information about the function of inputs and outputs of the Tracer AH540/541 controller. The Tracer AH540 is configured at the factory per unit configuration and order information. The field-installed Tracer AH541 must be configured using a Rover service tool (refer to the *Rover Operation and Programming* guide, EMTX-SVX01E-EN, for more information).

Binary outputs
The Tracer AH540/541 controller has six binary outputs that are assigned to the specific functions shown in Table O-GI-2. The binary outputs are normally-open, form A relays. The relays act as a switch by either completing or breaking the circuit between the load (the end device) and the 24 Vac power. For example, when binary input BO1 is energized, 24 Vac is supplied to terminal BO1, which in turn energizes the supply fan start/stop relay (see Figure O-GI-14).

Each binary output has a green status LED on the Tracer AH540/541 controller board. The LED is off when the relay contacts are open. The LED is on when the relay contacts are closed.

When the binary output relay is Off (contact is open), a multimeter should measure 0 Vac across the output terminals. When the binary output relay is On (contacts are closed), a multimeter should measure 24 Vac across the output terminals.

Analog outputs
The Tracer AH540/541 controller has five analog outputs that are assigned to the specific functions shown in Table O-GI-3

Table O-GI-2. Binary outputs functions & locations

output label	Tracer AH540 terminal label	factory terminal label	Tracer AH541 field terminal label	function	power function	maximum output rating
BO1	TB21/1 OUT TB21/2 GND	J21	BO1	supply fan start/stop	24 Vac ground	12 VA
BO2	TB22/1 OUT TB22/2 GND	J22	BO2	exhaust fan start/stop	24 Vac ground	12 VA
BO3	TB23/1 OUT TB23/2 GND	J23	BO3	DX stage 1 or electric stage 4	24 Vac ground	12 VA
BO4	TB24/1 OUT TB24/2 GND	J24	BO4	DX stage 2 or electric stage 3	24 Vac ground	12 VA
BO5	TB25/1 OUT TB25/2 GND	J25	BO5	DX stage 3 or electric stage 2	24 Vac ground	12 VA
BO6	TB26/1 OUT TB26/2 GND	J26	BO4	DX stage 4 or electric stage 1	24 Vac ground	12 VA

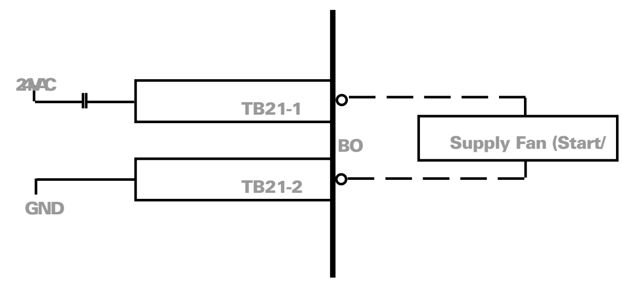


Figure O-GI-14. Tracer AH540 Termination Board Example

Table O-GI-3. Analog output functions & locations

output label	Tracer AH540 terminal label	factory terminal label	Tracer AH541 field terminal label	function	output range default value[1]	maximum output rating
AO1	TB11/1 OUT TB11/2 GND	J11	AO1	supply fan speed	0 to 10 Vdc ground	20 mA
AO2	TB12/1 OUT TB12/2 GND	J12	AO2	cool valve output or 2-pipe changeover	2 to 10 Vdc ground	20 mA
AO3	TB13/1 OUT TB13/2 GND	J13	AO3	heat output (water, steam, or electric heat sequencer)	2 to 10 Vdc ground	20 mA
AO4	TB14/1 OUT TB14/2 GND	J14	AO4	face & bypass damper	2 to 10 Vdc ground	20 mA
AO5	TB15/1 OUT TB15/2 GND	J15	AO5	outdoor air damper	2 to 10 Vdc ground	20 mA
AO6	TB16/1 TB16/2	J16	AO4	not used	2 to 10 Vdc ground	20 mA

1 Each analog output can be configured for 0–10 Vdc or 2–10 Vdc operation, and normally open or normally closed.

Analog inputs

The Tracer AH540/541 controller has eight analog inputs. Table O-GI-4 describes the function of each of the analog inputs. Each function is described in the following paragraphs.

IN1: Space temperature

Analog input IN1 measures space temperature only. The space temperature is measured with a 10kW thermistor that is included with Trane zone sensors. The Tracer AH540/541 receives the space temperature from either a wired zone sensor or as a communicated value. A communicated value has precedence over a locally wired sensor input. Therefore, the communicated value, when present, is automatically used by the controller.

If a Tracer AH540/541 is operating in constant-volume space temperature control mode and the space temperature fails or does not receive a communicated value, the controller generates a Space Temperature Failure diagnostic.

The space temperature input may also be used to generate timed override On/Cancel requests to the controller. If a momentary short in the space temperature signal occurs, the Tracer AH540/541 interprets the signal as a timed override On request.

The Tracer AH540/541 uses the timed override On request (while the zone is in unoccupied mode) as a request to go to the occupied bypass mode (occupied bypass). The occupied bypass mode lasts for the duration of the occupied bypass time, typically 120 minutes. The occupied bypass time can be changed using the Rover service tool.

Press the Cancel button on the zone sensor to cancel the override request and return the controller to unoccupied mode. This creates a momentary fixed resistance (1.5 Ω), which sends a Cancel request to the space temperature input.

IN2: Local setpoint

Analog input IN2 functions as the local (hard-wired) temperature setpoint for applications using a Trane zone sensor with a temperature setpoint thumbwheel (see "Zone sensors"). The local setpoint input is configurable (as enabled or disabled) using the Rover service tool.

Table O-GI-4. Analog input functions & locations

output label	Tracer AH540 terminal label	factory terminal label	Tracer AH541 field terminal label	function	sensor type[1]	valid ranges
IN 1	TB31/1 IN TB31/2 GND	J31	IN1	space temperature	10 kΩ thermistor	5 to 122°F
IN 2	TB32/1 IN TB32/2 GND	J32	IN2	local setpoint	1 kΩ potentiometer	50 to 85°F
IN 3	TB33/1 IN TB33/2 GND	J33	IN3	fan mode switch[2]	switched resistance	off (4870Ω± 5%) auto (2320Ω± 5%)
IN 4	TB34/1 IN TB34/2 GND	J34	IN4	discharge air temperature	10 kΩ thermistor	-40 to 212°F
IN 5	TB35/1 IN TB35/2 GND	J35	IN5	outdoor air temperature	10 kΩ thermistor	-40 to 212°F
IN 6	TB36/1 IN TB36/2 GND	J36	IN4	mixed air temperature	RTD[3]	-40 to 212°F
IN 13[4]	TB43			space relative humidity	current: 4-20 mA	0 to 100%
				CO_2 sensor	current: 4-20 mA	0 to 2000 ppm
				entering water temperature	10 kΩ thermistor	-40 to 212°F
				evaporator refrigerant temperature	10 kΩ thermistor	-40 to 212°F
				generic temperature	10 kΩ thermistor	-40 to 212°F
duct static		J43	duct static	duct static pressure	duct static pressure sensor	0 to 1250 Pa 0 to 5.02 in. water

Notes: 1 See Appendix for analog input sensor curves .
2 Sensor type: Switched resistance fan auto = 2320Ω , ±5%, fan off = 4870Ω , ±5%.
3 Sensor type RTD averaging sensor, 1000Ω at 0°C, platinum 385 curve.
4 This input is located on the main control board.

A setpoint value communicated by means of a Comm5 link can also be used for controllers operating on a building automation system. If both hard-wired and communicated setpoint values are present, the controller uses the communicated value. If neither a hard-wired nor a communicated setpoint value is present, the controller uses the stored default setpoints (configurable using the Rover service tool). If a valid hard-wired or communicated setpoint value is established and then is no longer present, the controller generates a Setpoint Failure diagnostic.

IN3: Fan mode switch

Analog input IN3 responds to specific resistances corresponding to a fan mode switch provided with certain Trane zone sensors. The fan modeswitch on a Trane zone sensor generates the fan mode signal.

The Tracer AH540/541 controller detects the unique resistance corresponding to each position of the fan mode switch. By measuring this resistance, the controller determines the requested fan mode. See Table O-GI-5.

If the Tracer AH540/541 controller does not receive a hard-wired or communicated request for fan mode, the unit recognizes the fan input as Auto.

Table O-GI-5. Determining fan mode (IN3)

Fan modes	Tracer AH540/541 operation
off	fan off (4870Ω ±1%)
auto	occupied mode: the fan runs unoccupied mode: the fan cycles off when no heating or cooling is required (2320Ω ±5%)

IN4: Discharge air temperature
The Tracer AH540/541 controller cannot operate if the controller does not sense a valid discharge air temperature input. If the sensor returns to a valid input, the controller automatically allows the unit to resume operation.

The Tracer AH540/541 controller uses analog input IN4 as the discharge air temperature input with a 10kΩ thermistor only. This sensor is hardwired and located downstream from all unit heating/cooling capacity at the unit discharge area. The discharge air temperature is used as a control input to the controller which is used for control modes of operation: space temperature control and discharge air temperature control.

Any time the discharge air temperature signal is not present, the controller generates a Discharge Air Temp Failure diagnostic and performs a unit shutdown. If the sensor returns to a valid input, the controller automatically clears the diagnostic and allows the unit to resume operation.

IN5: Outdoor air temperature
Analog input IN5 measures the outdoor air temperature. Analog input IN5 measures outdoor air temperature only. The outdoor air temperature is measured with a 10kΩ thermistor.

The controller uses the IN5 value to determine if economizing (free cooling) is feasible. For economizing to be allowed, economizing must be enabled and the outdoor air temperature must be below the economizer enable point (default 60°F, configurable). If the outdoor air temperature is equal to or above the economizer enable point, or if there is no value is present, economizing is not allowed. If both hard-wired and communicated outdoor air temperature values are present, then the controller uses the communicated value.

If a valid hard-wired or communicated outdoor air temperature value is established and then is no longer present, the controller generates an Outdoor Air Temp Failure diagnostic and economizing is no longer enabled. If the sensor returns to a valid input, the controller automatically clears the diagnostic and allows economizer operation.

IN6: Mixed-air temperature
Analog input IN6 is used for mixed-air temperature, with an averaging 1000 (at 32°F [0°C]) RTD sensor only. The input is used for mixed-air tempering and outdoor air economizing operations.

The Tracer AH540/541 controller does not allow economizing if the controller does not sense a valid mixed-air temperature input. If the sensor returns to a valid input, the controller automatically checks to see if economizer operation is possible.

If a valid mixed-air temperature signal has been established by the RTD sensor, but then the value is no longer present, the controller generates a Mixed Air Temperature Failure diagnostic and disallows economizer operation. When the sensor returns to a valid input, the controller automatically clears the diagnostic and checks to see if economizer operation is possible.

IN13: Universal analog input
The universal analog input IN13 (TB43) can be configured for a variety of sensors using the Rover service tool (see "Configuration" sectiuon). The input must be configured properly for the sensor wired to the input. The input can be used for only one sensor at a time. The following sensors are supported:
- Space relative humidity (4–20 mA)
- CO_2 sensor (4–20 mA)
- Entering water temperature (10kΩ thermistor)
- Evaporator refrigerant temperature (10kΩ thermistor)
- Generic temperature (10kΩ thermistor)

Relative humidity
When using the universal analog input with a relative humidity sensor first configure the controller input using the Rover service tool, and then make the wiring connections. The sensor must provide a 4–20 mA and allows two-pipe changeover operation where 20 mA is equal to 100% relative humidity.

A space relative humidity input is required for space dehumidification control. If valid space relative humidity input does not exist, space dehumidification control will be disabled. The controller will accept a valid hard-wired sensor input or a communicated value for space relative humidity. If both a hard-wired and a communicated value exist, the controller will use the communicated value for control. The communicated value has priority over the hard-wired input.

When a space relative humidity input is established (either hard-wired or communicated), the controller generates a Humidity Input Failure diagnostic if the signal is no longer valid, and disables space dehumidification. If the sensor or communicated value returns to a valid input, the controller automatically clears the diagnostic and allows space dehumidification operation.

CO_2 sensor
When using the universal analog input with a CO_2 sensor first configure the controller input using the Rover service tool for CO_2 and then make the wiring connections. The sensor must provide a 4–20 mA signal, where 20 mA is equal to 2000 ppm.

The CO_2 input, reported in parts per million, is not used for any AH540/541 control purposes. Instead the input is reported to the building automation system using Comm5 or other devices as a data point. When a CO_2 sensor input is established, the controller generates a CO_2 Sensor Failure diagnostic if the signal is no longer valid, but the diagnostic has no effect on controller operation. If the sensor returns to a valid input, the controller automatically clears the diagnostic.

Entering water temperature
The universal analog input configured as entering water temperature accepts a 10kΩ thermistor input. A valid entering water temperature value (hard-wired or communicated) is required for two-pipe changeover operation for space temperature control air-handling units with one hydronic coil. If both a hard-wired and a communicated value exist, the controller will use the communicated value for two-pipe changeover operation. The communicated value has priority over the hard-wired input.

When valid entering water temperature input is available to the controller it is used to determine if hot or cold water capacity is available for space heating and cooling operation. If the entering water temperature input is not valid, the controller assumes hot water exists and disables hydronic cooling operation.

When an entering water temperature input is established (either hardwired or communicated), the controller generates an Entering Water Temp Failure diagnostic, if the signal is no longer valid, and assumes a cold entering water temperature. If the sensor or communicated value returns to a valid input, the controller automatically clears the diagnostic and allows two-pipe changeover operation.

Evaporator refrigerant temperature
The universal analog input configured as evaporator refrigerant temperature accepts a 10Ω thermistor input. A valid evaporator refrigerant temperature is not required for DX cooling operation but does aid in protecting condensing unit compressors.

When a valid evaporator refrigerant temperature input is available to the controller, it is used to determine if the DX cooling capacity should be decreased to prevent low refrigerant temperatures. This function is referred to as defrost operation (see "Defrost operation"). Low refrigerant temperatures indicate frost conditions on the evaporator and therefore cooling capacity must be reduced to defrost the coil.

When the evaporator refrigerant temperature input is established, the controller generates an Evap Refrigerant Temp Failure diagnostic if the signal is no longer valid, but the diagnostic has no affect on controller operation. If the sensor returns to a valid input, the controller automatically clears the diagnostic.

Generic temperature input
The universal analog input configured as generic temperature accepts a 10Ω thermistor input. The input can be used in a variety of applications using Tracer Summit. This input has no effect on the controller operation but will report a Generic Temperature Failure diagnostic message if the input becomes invalid or out or range. The diagnostic automatically reset when the input is valid or in range.

J43: Duct static pressure
The duct static pressure input (terminal J43) interfaces with a specialized pressure transducer only. When a valid duct static pressure value (either hardwired or communicated) exists and a variable-air-volume supply fan is present, the controller uses this value for duct static pressure control.

When a duct static pressure is established, the controller generates a Duct Static Press Failure diagnostic if the signal is no longer valid, and shuts down the unit. When the sensor returns to a valid input, the controller automatically clears the diagnostic and allows the unit to resume operation.

The Tracer AH540/541 controller, if configured for variable-air-volume control, cannot operate without a valid duct static pressure input. When the sensor returns to a valid input, the controller resumes unit operation. The controller is not required to have a duct static pressure input for constant-volume space temperature or constant-volume discharge air temperature control.

ON/CANCEL buttons on the zone sensor

Momentarily pressing the ON button on the zone sensor during unoccupied mode places the controller in occupied bypass mode for 120 minutes. You can adjust the number of minutes the Tracer AH540/541 is placed in the occupied bypass mode by using the Rover service tool. The controller remains in occupied bypass mode until the override time expires or until you press the CANCEL button on the zone sensor.

If the building automation system sends an unoccupied mode command to the controller and ON button on the zone sensor is pressed, the controller goes to occupied bypass and communicates back to the building automation system that its effective occupancy mode is occupied bypass.

If the controller is in the unoccupied mode, regardless of the source (the building automation system or a hard-wired occupancy binary input), pressing the ON button causes the controller to go into the occupied bypass mode for the duration of the configured occupied bypass time.

Binary inputs

The Tracer AH540/541 controller has six binary inputs. Each binary input associates an input signal of 0 Vdc with closed contacts and 24 Vdc with open contacts. If the wired binary device has closed contacts, a multimeter should measure less than 1.0 Vdc across the binary input terminals. If the binary input has opened, a multimeter should measure greater than 20 Vdc across the binary input terminals.

Table O-GI-6 describes the function of each of the binary inputs. For an explanation of the diagnostics generated by each input, see the "Diagnostics" section.

Table O-GI-6. Binary input functions & locations

input label	Tracer AH540 terminal label	Tracer AH541 factory terminal label	Tracer AH541 field terminal label	function	power function
IN 7	TB37-1 IN TB37-2 GND	J37	IN7	low-temp detection or coil defrost	24 Vdc ground
IN 8	TB38-1 OUT TB38-2 GND	J38	IN8	run/stop	24 Vdc ground
IN 9	TB39-1 OUT TB39-2 GND	J39	IN9	occupancy or generic[1]	24 Vdc ground
IN 10	TB40-1 OUT TB40-2 GND	J40	IN10	supply fan status	24 Vdc ground
IN 11	TB41-1 OUT TB41-2 GND	J41	IN11	filter status	24 Vdc ground
IN 12	TB42-1 OUT TB42-2 GND	J42	IN12	exhaust fan status or coil defrost	24 Vdc ground

Note 1 When configured as a generic binary input, it has no direct effect on controller operation.

IN7: Low-temperature detection or coil defrost

Binary input IN7 can be configured either as a low-temperature detection input or a coil defrost input.

Low-temperature detection

When configured as a low-temperature detection input, IN7 protects the coils of hydronic units. A low-temperature-detection device (freezestat) connected to the input detects the low temperature. The Tracer AH540/541 controller can protect the coil using one binary input. When the controller detects the low-temperature-detection signal, the controller generates a Low Temp Detect diagnostic, which disables the fan, opens all unit water or steam valves, and closes the outdoor air damper (when present).

The low-temperature detection device can be automatically or manually reset. However, you must manually reset the Low Temperature Detect diagnostic to clear the diagnostic and restart the unit. See "Resetting diagnostics" for instructions on clearing controller diagnostics.

Coil defrost

Binary input IN7 can be configured as a coil defrost input in direct expansion (DX) cooling applications when a binary device is used to detect low evaporator refrigerant temperatures. When the DX coil refrigerant temperature drops below the detecting device threshold and the device output changes states, the Tracer AH540/541 controller disables all DX cooling until the frost condition is cleared. DX cooling operation automatically resumes when the binary input is normal. For more information regarding coil defrost operation, see "Coil defrost binary input."

Note: Binary input IN12 can also be configured as a coil defrost input.

Table O-GI-8. Coil defrost binary input configuration

Configuration	Contact closed	Contact open
not used	normal	normal
normally closed disabled	normal	DX cooling
normally open	DX cooling disabled	normal

Table O-GI-7. Low Temperature Detection Controller Operation

Diagnostic	Fan	Cool Output	Heat Output	Face & Bypass	Outdoor Air Damper
Low Temperature Detection	Off		Open (Note 1)	Face	Closed

Note 1: When steam is the source of heat, the heat valve is cycled open and closed when the controller is shut down on a Low Temp Detect latching diagnostic. Cycling the steam valve helps prevent excessive cabinet temperatures. See steam valve cycling in the Sequence of Operation section for further details.

IN8: Run/stop

This hard-wired binary input IN8 can be used for a variety of functions to shut down the unit. The Tracer AH540/541 controller systematically shuts down unit operation and reports a Unit Shutdown diagnostic upon detecting a stop input. For example, a condensate overflow sensor or a smoke detector can be connected to the run/stop input to shut down unit operation.

The run/stop input can be configured as a latching or non-latching Unit Shutdown diagnostic. If the input is configured as non-latching, the unit will be returned to normal operation when the input is in the run state. If the run/stop input is configured as latching, the input must first be returned to the run state, and the diagnostic must be reset in the controller before the unit is allowed to run. See Table O-GI-9.

Table O-GI-9. Run/Stop IN 8 Binary Input Configuration

Configuration	Contact Closed	Contact Open
Not used	Run	Run
Normally closed	Run	Stop
Normally open	Stop	Run

IN9: Occupancy or generic

The Tracer AH540/541 controller uses the occupancy binary input IN9 for two occupancy-related functions or as a generic binary input.

Local occupancy mode request

For controllers not receiving a communicated occupancy mode request, the local occupancy binary input determines the unit occupancy based on the hard-wired signal (see Table O-GI-10). Normally, the signal is hard-wired to a binary switch or clock.

If the occupancy input is configured as normally open and a hard-wired occupancy signal on binary input IN9 is open, then the unit switches to occupied mode. If the hard-wired occupancy signal is closed, the controller switches to unoccupied mode (only if the occupied bypass timer = 0; see "Occupied bypass mode").

Table 11. Occupancy IN9 binary input

Configuration	Contact closed	Contact open
normally closed	occupied	unoccupied
normally open	unoccupied	occupied

Generic binary input

Binary input IN9 can be configured as a generic binary input for a variety of applications with a Tracer Summit system only. The binary input does not affect controller operation. A generic binary input can be monitored only from Tracer Summit.

IN10: Supply fan status

The fan status binary input IN10 indicates the presence of air flow through the supply fan of an air-handling unit. For Tracer AH540/541 applications, a differential pressure switch detects fan status, with the high side of the differential being supplied at the unit outlet and the low side supplied inside the unit. During fan operation, differential pressure closes the normally open switch and confirms that the fan is operating properly.

A Low Supply Fan Air Flow diagnostic is detected during the following two conditions:

- The controller is commanding the fan On and the fan status switch is not in the closed position.
- The fan status switch does not close the binary input within the configurable fan On delay time limit of the controller commanding the fan On. Although the fan status switch is normally open, it is configurable (see Table O-GI-11).

IN11: Filter status

The filter status switch connected to binary input IN11 detects a dirty air filter and indicates a need for maintenance. For Tracer AH540/541 applications, a differential pressure switch detects filter status, with the high side of the differential being supplied at the filter inlet and the low side supplied at the filter outlet. During fan operation, filter differential pressure increases as the filter becomes increasingly dirty.

A normally open filter status switch closes when the differential pressure reaches a set threshold. This is a non-latching, informational diagnostic; the controller will continue normal unit operation.

Although the filter status switch is normally open, it is configurable (see Table O-GI-12).

Table O-GI-11. Fan Status Binary IN 10 Configuration

IN 10 Configuration	Contact Closed	Contact Open
Not used	Normal	Normal
Normally closed	Latching diagnostic (Note 1)	Normal
Normally open	Normal	Latching diagnostic (Note 1)

Note 1: A Low Supply Fan Air Flow diagnostic is generated when the controller turns on the supply fan output, but the supply fan status binary input indicates the supply fan is not running after the configurable fan delay time.

Table O-GI-12. Filter Status Configuration

IN 11 Configuration	Contact Closed	Contact Open
Not used	Clean	Clean
Normally closed	Clean	Dirty
Normally open	Dirty	Clean

Table O-GI-13. Exhaust Fan Status Binary IN 12 Configuration

IN 12 Configuration	Contact Closed	Contact Open
Not used	Normal	Normal
Normally closed	Exhaust fan diagnostic (Note 1)	Normal
Normally open	Normal	Exhaust fan diagnostic (Note 1)

Note 1: A Low Exhaust Fan Air Flow diagnostic is generated when the controller turns on the exhaust fan output, but the exhaust fan status binary input indicates the exhaust fan is not running after a 2 minute time delay. This diagnostic is

IN12: Exhaust fan status or coil defrost
Binary input IN12 can be configured either as an exhaust fan status input or a coil defrost input.

Exhaust fan status
When configured as an exhaust fan status binary input, IN12 indicates the presence of air flow through an exhaust fan associated with the controlled air-handling unit. For Tracer AH540/541 applications, a differential pressure switch detects exhaust fan status, with the high side of the differential being supplied at the outlet. During exhaust fan operation, differential pressure closes the normally open switch and confirms that the fan is operating properly.

A Low Exhaust Fan Air Flow diagnostic is detected during the following two conditions:

1. The controller is commanding the exhaust fan On and the status switch is not in the closed position.
2. The fan status switch does not close the binary input within two minutes of the controller commanding the exhaust fan On.

Although the fan status switch is normally open, it is configurable (see Table O-GI-13).

Coil defrost
Binary input IN12 can be configured as a coil defrost input.
See the "Coil defrost" section.

Zone sensors

The controller accepts the following zone sensor inputs:

- Space temperature measurement (10kW thermistor)
- Zone sensor setpoint thumbwheel (either internal or external on the zone sensor module)
- Fan mode switch
- Timed override On request
- Timed override Cancel request
- Communication jack
- Service pin message request

Space temperature measurement
Trane zone sensors use a 10kΩ thermistor to measure the space temperature. Typically, zone sensors are wall-mounted in the room and include a space temperature thermistor. A valid space temperature input is required for the controller to operate in space temperature control. If both a hard-wired and communicated space temperature value exist, the controller ignores the hard-wired space temperature input and uses the communicated value.

Zone sensor setpoint thumbwheel
Zone sensors with an internal or external setpoint thumbwheel (1kΩ) provide the Tracer AH540/541 controller with a local setpoint (50°F to 85°F [10°C to 29.4°C]). An internal setpoint thumbwheel is concealed under the front cover of the zone sensor. To access it, remove the zone sensor cover. An external setpoint thumbwheel (when present) is accessible from the front cover of the zone sensor.

See “Zone sensor setpoint thumb wheel” section for an explanation of how the controller determines the setpoint.

Fan mode switch
The zone sensor fan mode switch provides the controller with a fan request signal (Off, Auto). If the fan control request is communicated to the controller, the controller ignores the hard-wired fan mode switch input and uses the communicated value. The zone sensor fan mode switch input can be enabled or disabled through configuration using the Rover service tool. If the zone sensor switch is disabled, the controller resorts to the Auto fan mode.

When the fan mode switch is placed in the Off position, the controller does not control any unit capacity. The unit remains powered and all outputs are driven Closed or Off.

Upon a loss of signal on the fan speed input, the controller reports a diagnostic and reverts to using the Auto fan mode of operation.

ON/CANCEL buttons
Some Trane zone sensor modules include timed override ON and CANCEL buttons. Use the timed override ON and CANCEL buttons to place the controller in override (occupied bypass mode) and to cancel the override request.

The controller always recognizes the timed override ON button. If someone presses the zone sensor timed override ON button, the controller initializes the bypass timer to 120 minutes (adjustable).

If the controller is unoccupied when someone presses the ON button for two seconds, the controller immediately changes to occupied bypass mode and remains in the mode until either the timer expires or someone presses the zone sensor’s timed override CANCEL button. If the ON button is pressed during occupied bypass mode before the timer expires, the controller re-initializes the bypass timer to 120 minutes.

If the controller is in any mode other than unoccupied when someone presses the ON button, the controller initializes the bypass time to 120 minutes. As time expires, the bypass timer continues to decrement. During this time, if the controller changes from its current mode to unoccupied (perhaps due to a change based on the system time-of-day schedule), the controller switches to occupied bypass mode for the remainder of the bypass time or until someone presses the zone sensor timed override CANCEL button.

Zone sensor communication jack
Use the RJ-11 communication jack (present on some zone sensor modules) as the connection point from the Rover service tool to the communication link when the communication jack is wired to the communication link at the controller. By accessing the communication jack via Rover, you gain communication access to any controller on the link.

Service Pin message request
Pressing the zone sensor ON button for ten seconds and then releasing it causes the controller to transmit a Service Pin message. The Service Pin message can be useful for installing the controller on a communication network. (See the *Rover Operation and Programming* guide, EMTX-SVX01E-EN, for more information).

Zone sensor wiring connections
Typical Trane zone sensor wiring connections *with* a fan mode switch are as follows:

- 1: Space temperature
- 2: Common
- 3: Setpoint
- 4: Fan mode
- 5: Communications
- 6: Communications

Typical Trane zone sensor wiring connections *without* a fan mode switch are as follows:

- 1: Space temperature
- 2: Common
- 3: Setpoint
- 5: Communications
- 6: Communications

Sequence of Operation

The Tracer AH540/541 is a configurable controller. All of the controller sequences of operation are predefined with no need for programming the controller. Configurable parameters are provided to allow the user to adjust the controller operation. For example, the minimum occupied outdoor air damper position can be changed.

All configuration parameters are set to defaults predetermined through extensive air-handling unit testing in several different operating conditions. The factory default settings are also based on the air-handling unit configuration and order information.

Control modes

The Tracer AH540/541 controller is configurable to operate in one of two air-handling temperature control modes:

1. Space temperature control
2. Discharge air temperature control

When the AH540/541 is configured for space temperature control, it conforms to the LonMark® Space Comfort Controller (SCC) profile. When theAH540/541 is configured for discharge air temperature control, it conforms to the LonMark® Discharge Air Controller (DAC) profile.

Note: Some sequences in this chapter are specific to the space temperature control mode and some are specific to the discharge air temperature control mode. Some sequences are common to both modes, but operate differently. Where mode-dependent differences exist, they are explained in this chapter.

Space temperature control

The Tracer AH540/541 controller requires both a space temperature and discharge air temperature sensor to be present for space temperature control operation (also called cascade control). In this control mode, the Tracer AH5405/541 uses the space temperature and the measured discharge air temperature to maintain the space temperature at the active space cooling setpoint or the active space heating setpoint. The controller modulates its heating or cooling outputs to control the discharge air temperature to the discharge air temperature setpoint. This calculated discharge air temperature setpoint is the desired discharge air temperature (supply air temperature) that the unit must deliver to maintain space temperature at the space heating or cooling setpoint.

The space temperature can be hard-wired to analog input IN1 on the termination board (10kΩ thermistor only) or can be communicated to the controller via Comm5. Similarly, a setpoint can be provided with either a hard-wired setpoint thumbwheel to analog input IN2 on the controller, with a communicated value, or by using the stored default setpoints in the controller. The discharge air temperature must be a hard-wired analog input IN4 to the termination board (10kΩ thermistor only).

The controller heat/cool mode is determined by either a communicated request or by the controller itself, when the heat/cool mode is Auto. When the heat/cool mode is Auto, the controller compares the active space setpoint and the active space temperature and decides if the space needs heating or cooling.

The Tracer AH540/541 controller must have a valid space temperature and discharge air temperature input to operate space temperature control.

When the controller is configured for a supply fan and space temperature control, the controller will not operate the unit if the space temperature or discharge air temperature sensors are missing or have failed.

The space temperature control algorithm uses two control loops: a space temperature loop and a discharge air temperature loop. The space temperature control loop compares the active heat/cool space setpoint and the space temperature and calculates a discharge air temperature setpoint. The calculated discharge air temperature setpoint range is bound by configurable heating (maximum) and cooling (minimum) limits.

The discharge air temperature loop compares the discharge air temperature to the calculated discharge air temperature setpoint (calculated by the space temperature loop), and calculates a heat or cool capacity to respond to the discharge air temperature setpoint.

The capacity calculation, as a result of the discharge air temperature control loop, is used to drive the air-handling unit actuators to maintain space temperature at the space temperature setpoint.

Control gains
Figure O-SO-1 illustrates the separate control for the space temperature control loop and discharge air temperature control loop. The gain parameter values that control the different loops have been determined through extensive testing of different types of heating or cooling capacities and at operating conditions of the air-handling unit.

Heating/cooling mode control
The heating or cooling mode of the controller can be determined two ways:
1. Communicated request
2. Automatically by the controller

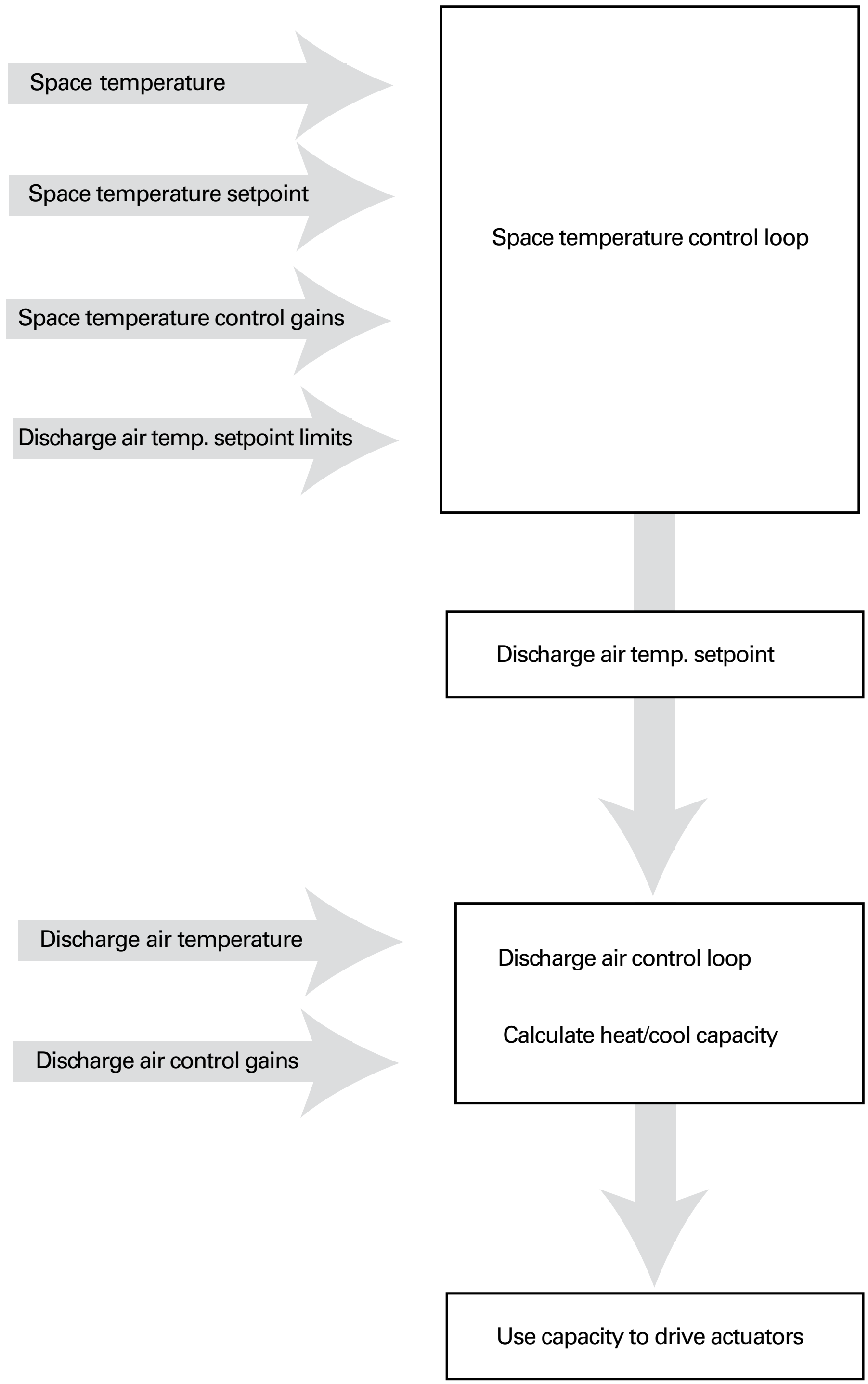


Figure O-SO-1. Space Temperature Control Block Diagram

Communicated request
A building automation system or peer controller may communicate the heating or cooling mode to the controller via network variables nviHeat- Cool and/or nviApplicMode. Heating mode commands the controller to heat only. Cooling mode commands the controller to cool only. The Auto mode allows the controller to automatically change from heating to cooling or vice versa.

Auto mode
A communicated request of Auto or the controller default operation (Auto) can place the unit into heating or cooling mode. When the controller automatically determines the heating or cooling mode while in Auto mode, the unit switches to the desired mode based on the control algorithm.

If the Tracer AH540/541 controller is operating space temperature control, it uses the space temperature and space temperature setpoint to automatically determine heat or cool mode of operation. When the controller first powers up or after a reset, it makes an initial determination if the heat/cool mode should be heat or cool. If the controller is configured as heating and cooling, the controller determines the appropriate mode.

For example, if the initial space temperature is less than the occupied space heat setpoint then the initial heat/cool mode is heating. The heat/cool mode for a cool-only unit is always cool. The heat/cool mode for a heat-only unit is always heat.

When the controller is allowed to automatically determine its space heating and cooling mode, the unit changes from cool to heat or from heat to cool, when the integrated error between the active space setpoint and the active space temperature is 900°F seconds or greater. The integrated error is calculated once every ten seconds.

See Figure O-SO-2 for an example of the controller changing from space cooling (unit mode = cool) to space heating (unit mode = heat). In this example, the initial unit mode is cool because the space temperature is above the cool setpoint, and the cooling capacity is greater than 0%.

Following the curve from left to right, the space temperature falls below the cool setpoint, and the controller reacts by lessening its cooling capacity. When the space temperature reaches 1, the cooling capacity is 0%. The rate at which the controller reaches 0% capacity depends on the space temperature rate of change.

Point 1 on the curve in Figure O-SO-2 indicates the point at which the cooling capacity equals 0%, space temperature is less than 0.5°F below the cooling setpoint, and the error integrator starts to add up. Error integration does not begin until the capacity is 0%. See the "Heat/cool changeover: error integration example".

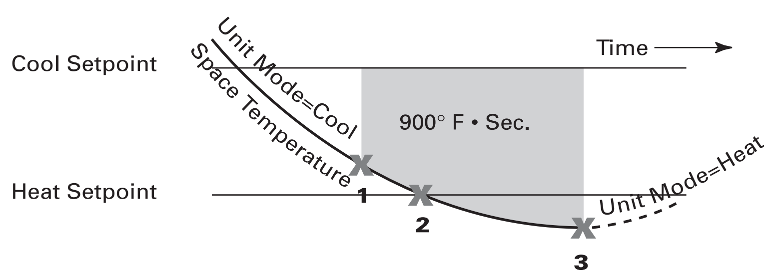


Figure O-SO-2. Automatic Heat/Cool Changeover Logic Example

Table O-SO-3. Space temperature control based on communicated request

Request[Note 1]	Supply Fan	Mechanical Heating	Mechanical Cooling	Outdoor Air Damper	Exhaust Fan
Auto	Enabled	Enabled	Enabled	Enabled	Enabled
Heat	Enabled	Enabled	Disabled	Enabled	Enabled
Morning warmup	Enabled	Enabled	Disabled	Closed	Disabled
Cool	Enabled	Disabled	Enabled	Enabled	Enabled
Night purge	Enabled	Disabled	Disabled	Ventilation disabled Economizer enabled	Enabled
Pre-cool	Enabled	Disabled	Enabled	Ventilation disabled Economizer enabled	Disabled
Off	Disabled	Disabled	Disabled	Disabled	Disabled
Test	Enabled	Enabled	Enabled	Enabled	Enabled
Emergency heat[Note 2]	Enabled	Enabled	Enabled	Enabled	Enabled
Fan only	Enabled	Disabled	Disabled	Disabled[Note 3]	Enabled

Note 1: Enabled means that the controller can use it if needed. Disabled means that the controller cannot use it.
Note 2: The Tracer AH540 controller does not support emergency heat. Emergency heat is treated as Auto.
Note 3: Fan-only operation allows the outdoor air damper to open to its minimum position based on occupancy. Economizing is not allowed.

Point 2 on the curve indicates the active heat setpoint. The space temperature must fall below the active heat setpoint before the controller can change to heating. Conversely, the space temperature must rise above the active cooling setpoint before the controller can change to cooling.

Point 3 on the curve indicates the point at which the controller switches to heat (from cool) after the error integrator exceeds 900°F • seconds.

The controller must be able to heat before it will switch to heat. A unit that cannot heat will not switch to heat. A unit that cannot cool will not switch to cool.

Heat/cool changeover: error integration example

If the active space temperature is 66.5°F, the current mode is cooling, the cooling capacity is 0°F, and the space cooling setpoint is 70°F. The error calculation is 70 – 0.5 – 66.5 = 3°F. If the same error exists for 60 seconds, the error integration term is (3°F • 60 seconds = 180°F seconds). Therefore, after five minutes (3°F • 300 seconds = 900°F seconds), the controller will switch from cooling to heating mode if the space temperature is below the occupied heating setpoint.

Cooling operation

The heating and cooling space setpoint high and low limits are always applied to the occupied and occupied standby setpoints. During the cooling mode, the Tracer AH540/541 controller attempts to maintain the active space temperature at the active space cooling setpoint. Based on the controller occupancy mode, the active space cooling setpoint is one of the following:

- Occupied cooling setpoint
- Occupied standby cooling setpoint
- Unoccupied cooling setpoint

Cooling outputs are controlled based on unit configuration and required machine cooling capacity. At 0% machine cooling capacity, the cooling valve closes and the outdoor air damper is at its minimum position. As the required machine cooling capacity increases, the cooling valve and/or the outdoor air damper opens above their minimum positions.

The discharge air temperature control algorithm calculates a desired discharge air temperature to maintain the space cooling setpoint. Cool capacity is controlled to achieve the desired discharge air setpoint. Heat capacity can also be used to temper cold outdoor air conditions to maintain ventilation and the discharge air setpoint.

The outdoor air damper provides cooling whenever economizing is possible and there is a need for cooling. If economizing is not possible, it will not be used in cooling. If economizing is possible, it is always the first stage of cooling. See "Outdoor air damper operation" section for more information.

Heating operation

In the heating mode, the Tracer AH540/541 controller attempts to maintain the space temperature at the active heating setpoint. Based on the controller occupancy mode, the active space heating setpoint is one of the following:

- Occupied heating setpoint
- Occupied standby heating setpoint
- Unoccupied heating setpoint

The outputs are controlled based on the unit configuration and the required machine heating capacity. At 0% machine heating capacity, heating capacity is at its minimum position. As the required machine heating capacity increases, heating capacity opens above its minimum position. At 100% machine heating capacity, heating capacity opens to its maximum position.

The economizer outdoor air damper is never used as a source of heating. It is used only for ventilation when the unit is heating. For more information, see "Outdoor air damper operation" section.

Space temperature setpoint arbitration

The space temperature setpoint is communicated by a building automation system or peer-to-peer using a binding (see "Communication with other controllers"). When the Tracer AH540/541 is in occupied mode, occupied standby mode, or occupied bypass mode, a communicated setpoint takes precedence over a local (hard-wired) setpoint.

When neither a communicated nor a local (hard-wired) setpoint is present, the controller uses the locally stored default heating and cooling setpoints.

The exception is when the controller is in unoccupied mode. Then the controller always uses locally stored default unoccupied setpoints. These setpoints are configured at the factory prior to shipment. Use the Rover service tool to modify these default unoccupied setpoints.

Zone sensor setpoint thumbwheel

Zone sensors with an internal or external setpoint thumbwheel (1Ω) provide the Tracer AH540/541 controller with a local setpoint (50°F to 85°F [10°C to 29.4°C]). An internal setpoint thumbwheel is concealed under the front cover of the zone sensor. To access it, remove the zone sensor cover. An external setpoint thumbwheel (when present) is accessible from the front cover of the zone sensor.

When the local (hard-wired) setpoint thumbwheel is used to determine the setpoints, all unit setpoints are calculated based on the local setpoint value, the configured setpoints, and the active mode of the controller.

For example, assume the controller is configured with the following default setpoints:

- Unoccupied cooling setpoint 85°F (29.4°C)
- Occupied standby cooling setpoint 76°F (24.4°C)
- Occupied cooling setpoint 74°F (23.3°C)
- Occupied heating setpoint 70°F (21.1°C)
- Occupied standby heating setpoint 66°F (18.9°C)
- Unoccupied heating setpoint 60°F (15.6°C)

Absolute Setpoint Offset = Setpoint Input – Mean Setpoint

From the default setpoints in this example, the mean setpoint is the mean of the occupied cooling and heating setpoints, which is 72°F [(74+70) / 2]. The absolute setpoint offset is the difference between the setpoint input and the mean setpoint.

Operation

Assume a thumbwheel setpoint input of 73°F, resulting in an absolute setpoint offset of 1°F (73–72=1). The controller adds the absolute setpoint offset (1°F) to occupied and occupied standby default setpoints to derive the effective setpoints, as follows.

- Unoccupied cooling setpoint 85°F (same as default)
- Occupied standby cooling setpoint 77°F (default+1=77)
- Occupied cooling setpoint 75°F (default+1=75)
- Occupied heating setpoint 71°F (default+1=71)
- Occupied standby heating setpoint 67°F (default+1=67)
- Unoccupied heating setpoint 60°F (same as default)

When a building automation system or other controller communicates a setpoint to the controller, the controller ignores the hard-wired setpoint input and uses the communicated value. The exception is the unoccupied mode, when the controller always uses the stored default unoccupied setpoints.

After the controller completes all setpoint calculations based on the requested setpoint, the occupancy mode, the heating and cooling mode, and other factors, the calculated setpoint is validated against the following setpoint limits:

- Heating setpoint high limit
- Heating setpoint low limit
- Cooling setpoint high limit
- Cooling setpoint low limit

These setpoint limits only apply to the occupied and occupied standby heating and cooling setpoints. These setpoint limits do not apply to the unoccupied heating and cooling setpoints stored in the controller configuration.

Unit configuration also exists to enable or disable the local (hard-wired) setpoint at the zone sensor module. This parameter provides additional flexibility to allow you to apply communicated, hard-wired, or default setpoints without having to make physical wiring changes to the controller.

Discharge air temperature control

The controller requires a discharge air temperature sensor (10Ω thermistor only) to operate in the discharge air temperature control mode.

Discharge air temperature control modulates the heating or cooling outputs to maintain discharge air temperature at the discharge air temperature setpoint regardless of the entering air conditions of the air-handling unit.

Figure O-SO-4 shows the steps the Tracer AH540/541 controller takes to control discharge air. First the controller determines if a communicated discharge-air heating setpoint and discharge-air cooling setpoint are present. The communicated setpoint has precedence over the configured (default) setpoint. If no communicated value is present, the controller uses the configured discharge air temperature setpoint.

Discharge air temperature setpoint minimum and maximum limits are placed on the discharge air setpoint depending on the effective heat or cool mode. If the effective heat/cool mode is cool, the maximum discharge air cooling setpoint limit and minimum discharge-air cooling setpoint limit the discharge-air cooling setpoint.

The effective discharge air temperature setpoint is determined from:

- Communicated or configured discharge air temperature setpoint value
- Minimum and maximum heat/cool setpoint limits
- Effective heat/cool mode

See Table O-SO-4 and Table O-SO-5 for an example of how the controller determines the effective discharge air temperature setpoint.

Table O-SO-4. Example of configuration parameters

Dishcharge-air cooling setpoint	55°F (18.2°C)
Maximum discharge-air cooling setpoint	68°F (20.0°C)
Minimum discharge-air cooling setpoint	50°F (10.0°C)
Discharge-air heating setpoint	100°F (37.8°C)
Maximum discharge-air heating setpoint1	104°F (40.0°C)
Minimum discharge-air heating setpoint	86°F (30.0°C)

Note1. When the controller is applied to an air-handling unit with a draw-through supply fan, the maximum discharge-air heating setpoint should be set to 104°F (default setpoint). This prevents the discharge air temperature from exceeding the high temperature limit of the supply fan motor. Exceeding the motor temperature limit can cause premature failures.

Table O-SO-5. Example of communicated values

Discharge-air cooling setpoint input	50°F (10.0°C)
Discharge-air heating setpoint input	None
Effective heat cool mode	Cool

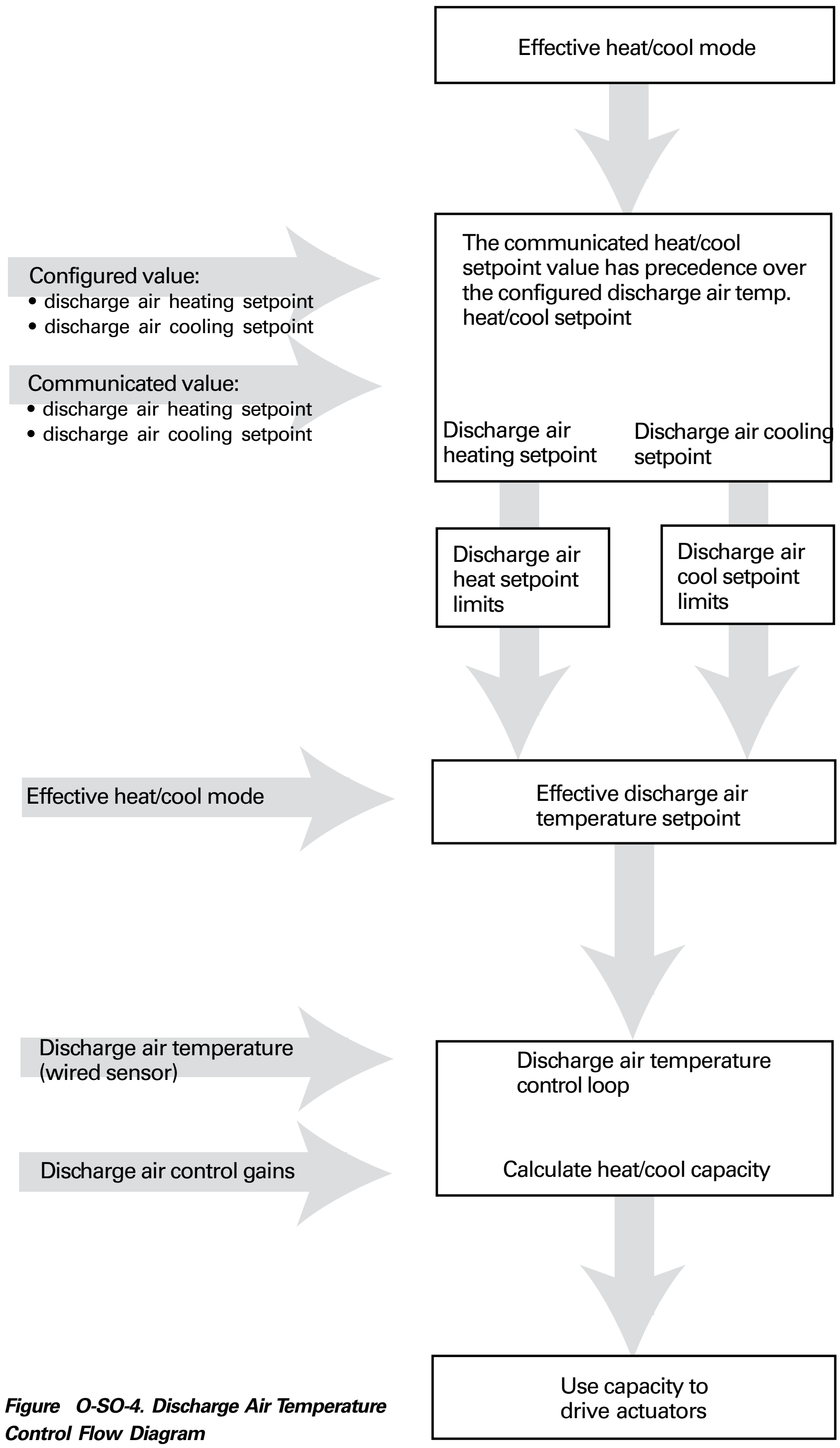


Figure O-SO-4. Discharge Air Temperature Control Flow Diagram

Operation

Because the effective heat cool mode is cool and the communicated value has precedence over the local configuration value, the discharge-air cooling setpoint is 50°F. The maximum and minimum discharge-air cooling setpoint limits are then applied to determine an effective discharge-air temperature setpoint of 53°F, from Table O-SO-4.

In this example, if the effective heat cool mode is Heat, the effective discharge air temperature setpoint would be 100°F.

The discharge air temperature control loop uses the effective discharge air temperature setpoint, discharge air temperature (from the wired sensor), and the configured control gains to calculate an output capacity for the end devices.

Heating/cooling mode control
The heating or cooling control mode of the controller can be determined in two ways:
1. Communicated request
2. Automatically by the controller

Communicated request
A building automation system or peer controller may communicate the heating or cooling mode to the controller using network variable nviApplicMode. Heating mode commands the controller to heat only. Cooling mode commands the controller to cool only. The Auto mode allows the controller to automatically change from heating to cooling or cooling to heating.

Auto mode
A communicated request of Auto or the controller default operation (Auto) can place the unit into cooling mode. A zone temperature input is required for discharge air temperature control when auto heat/cool changeover is desired. When the controller automatically determines the heating or cooling mode using auto mode, the unit switches to the desired mode based on the control algorithm and the relationship between zone temperature to the configured daytime warm up start and stop setpoints. See daytime warm up in configuration section of this manual.

When the controller first powers up or after a reset, it makes an initial determination if the discharge air temperature control mode should be heating or cooling. The discharge demand for a cooling-only unit is always cooling. The discharge demand for a heating only unit is always heating. A unit that can heat or cool initially starts in cooling mode.

Power-up sequence
This sequence applies to both space temperature control and discharge air temperature control. When 24 Vac power is initially applied to the AH540/541 controller, the following sequence occurs:
1. Green Status LED turns On.
2. All binary outputs are controlled to their de-energized state, and analog outputs are set to the normally closed output voltage.
3. The controller reads the inputs to determine initial values.
4. Power-up control wait feature is applied. The controller waits 300 seconds to allow ample time for the communicated control data to arrive. If after 300 seconds, the controller has not received any communicated control data, the unit assumes stand-alone operation.
5. Normal operation begins assuming no diagnostics have been generated.

Manual output test can be initiated at any time in the power-up sequence or during normal operation. Refer to the "Performing a manual output test" section.

Occupancy modes

The occupancy mode can be either communicated to the controller or hard-wired using the occupancy binary input IN9+. The valid occupancy modes for space temperature control are:
- Occupied
- Unoccupied
- Occupied standby
- Occupied bypass

The valid occupancy modes for discharge air temperature control are:
- Occupied
- Unoccupied
- Occupied bypass

Occupied mode

The occupied mode is the normal operating mode for occupied spaces or daytime operation. The Tracer AH540/541 controller operates this sequence according to the configured control mode.

Space temperature control: Occupied mode
If configured for space temperature control, the controller attempts to maintain the space temperature at the active occupied heating or cooling space setpoint, based on the measured space temperature, the discharge air temperature, the active setpoint, and the proportional/integral control algorithm. Additional information related to controller setpoints can be found in "Space temperature setpoint arbitration" section.

Discharge air temperature control: Occupied mode
If configured for discharge air temperature control, the controller maintains the discharge air temperature at the configured discharge air heating or cooling setpoint. The default occupied mode of the controller is cooling. In the occupied mode, the controller communicated application mode input (nviApplicMode) and heat/cool mode input (nviHeatCool) determine the controller heating and cooling setpoint.

Unoccupied mode

The unoccupied mode is the normal operating mode for unoccupied spaces or nighttime operation. When the controller is in the unoccupied mode, the controller attempts to maintain the space temperature between the configured unoccupied heating and cooling setpoints, based on the measured space temperature. The Tracer AH540/541 controller operates according to the configured control mode.

Space temperature control: Unoccupied mode
In unoccupied mode, if configured for space temperature control, the supply fan is Off whenever the space temperature is between the unoccupied heating and cooling setpoints. If the space temperature rises above the unoccupied cooling setpoint the Tracer AH540/541 turns On the supply fan and provides cooling at the unoccupied cooling setpoint.

If the space temperature drops below the unoccupied heating setpoint the controller turns On the supply fan and provides heating at the unoccupied heating setpoint.

Discharge air temperature control: Unoccupied mode
In unoccupied mode, if configured for discharge air temperature control, the controller must have either a hard-wired or communicated space temperature input from the Tracer Summit building automation system. In unoccupied mode, the supply fan is Off whenever the space temperature is between the unoccupied heating and cooling setpoints. If the space temperature rises above the unoccupied cooling setpoint the Tracer AH540/541 turns On the supply fan and provides cooling at the discharge air cooling setpoint.

If the space temperature drops below the unoccupied heating setpoint the controller turns On the supply fan and provides heating at the discharge air heating setpoint.

Note that primary heating or cooling capacity is defined by unit type and whether heating or cooling is enabled or disabled. For example, if the economizer is enabled and possible, it will be the primary cooling capacity. If hydronic heating is possible, it will be the primary heating capacity.

Occupied standby mode
If configured for space temperature control, the controller uses the occupied standby mode to reduce heating and cooling demands during occupied hours when a space is vacant or unoccupied. For example, the controller may use occupied standby mode for a classroom while the studentsare out of the room. In the occupied standby mode, the controller uses the occupied standby cooling and heating setpoints. Because the occupied standby setpoints typically cover a wider range than the occupied setpoints, the Tracer AH540/541 controller reduces the demand for heating and cooling the space. Also, the outdoor air economizer damper uses the economizer standby minimum position to reduce the heating and cooling demands.

Occupied standby is a mode in which the controller has received an occupied request from Tracer Summit, but has also received a local unoccupied binary input IN9 signal. For example, an unoccupied conference room (as sensed by a local occupancy sensor) in an occupied building (as commanded by a Tracer Summit system) is in occupied standby mode. When the conference room becomes occupied with people, the local occupancy sensor changes the controller mode to occupied.

The controller can be placed into the occupied standby mode when a communicated occupancy request is combined with the local (hard-wired) occupancy binary input signal. When the communicated occupancy request is unoccupied, the occupancy binary input (if present) does not affect the controller occupancy. When the communicated occupancy request is occupied, the controller uses the local occupancy binary input to switch between the occupied and occupied standby modes.

During occupied standby mode, the controller economizer damper position goes to the economizer standby minimum position. The economizer standby minimum position can be changed using the Rover service tool.

When no occupancy request is communicated, the occupancy binary input switches the controller operating mode between occupied and unoccupied. When no communicated occupancy request exists, the unit cannot switch to occupied standby mode.

Occupied bypass mode
If configured for either space temperature control or discharge air temperature control, the controller uses occupied bypass mode for timed override conditions. For example, if the controller is in unoccupied mode and someone presses the ON button on the zone sensor, the controller is placed in occupied bypass mode for 120 minutes (adjustable) or until someone presses the CANCEL button on the zone sensor. The controller can be placed in occupied bypass mode by either communicating an occupancy request of Bypass to the controller or by using the timed override ON button on the Trane zone sensor.

When the controller is in unoccupied mode, you can press the ON button on the zone sensor to place the controller into occupied bypass mode for the duration of the bypass time (typically 120 minutes).

If the controller is in the occupied standby mode, you can press the ON button on the zone sensor to place the controller into occupied bypass mode for the duration of the configured bypass time. Typically, the controller is in occupied standby mode rather than occupied mode because of the local binary occupancy input.

Sources of occupancy mode control
There are four ways to control the occupancy mode (see Table O-SO-4):

- Communicated request (usually provided by the building automation system or peer device)
- Pressing the zone sensor timed override ON button (or CANCEL button)
- Occupancy binary input (see "Occupancy binary input" for more information)
- Default operation of the controller (occupied mode)

A communicated request from a building automation system or another peer controller can change the controller occupancy. However, if communication is lost, the controller reverts to the default operating mode (occupied) after 15 minutes (configurable, specified by the "receive heartbeat time"), if no local hard-wired occupancy signal exists.

Occupancy binary input
The Tracer AH540/541 controller uses the occupancy binary input IN9 for two occupancy-related functions. For controllers not receiving a communicated occupancy request, the occupancy binary input determines the occupancy of the unit based on the hard-wired signal. Normally, the signal is hard-wired to a binary switch or time clock.

When a hard-wired occupancy signal is open, the unit switches to occupied mode (if the occupancy input is configured as normally open). When a hard-wired occupancy signal is closed, the controller switches to unoccupied mode.

For controllers that receive a communicated occupancy request from a building automation system, the hard-wired occupancy binary input is used with a communicated occupancy request to place the controller in either occupied mode or occupied standby mode.

In occupied mode, the controller operates according to the occupied setpoints. In occupied standby mode, the unit controller operates according to the occupied standby setpoints. When the controller receives a communicated unoccupied request, the controller operates according to the unoccupied setpoints regardless of the hard-wired occupancy input state.

If neither the hard-wired binary input nor a communicated request is used to select the occupancy mode, the controller defaults to occupied mode because the occupancy binary input (if present) typically is configured as normally open and no occupancy device is connected.

Determining the occupancy mode
The occupancy of the controller is determined by evaluating the combination of three potential communicating inputs, as well as the hard-wired occupancy input and the occupied bypass timer (see Table O-SO-4).

Three different communicating inputs affect controller occupancy mode:
1. Occupancy – manual command
2. Occupancy – schedule
3. Occupancy – sensor

These inputs provide maximum flexibility, but the number of inputs you decide to use varies with the application and the features available in your building automation system.

Occupancy – manual command
Some communicating devices may request occupancy based on the information communicated in the network variable (nvoOccManCmd). Trane systems and zone sensors do not communicate this information to the controller, but the Tracer AH540/541 controller accepts this network variable as communicated input (nviOccManCmd).

Occupancy – schedule
Building automation systems normally communicate an occupancy request to the Tracer AH540/541 controller using a network variable input (nviOccSchedule).

Occupancy – sensor
Some occupancy sensors may be equipped with the ability to communicate an occupancy mode to the controller. In such devices, network variable input (nviOccSensor) is used to communicate occupancy to the controller. Trane systems and zone sensors do not currently send this variable. The hard-wired occupancy input of this controller is handled as if it is a communicated occupancy sensor input. When both a hard-wired input and a communicated input exist, the communicated input is used.

Table O-SO-6. Effective occupancy arbitration for Tracer AH540/541 with operator display

Manual override[1] (nviOccManCmd)	Communicated schedule (nviOccSchedule)	Local schedule	Occupancy sensor (nviOccSensor[3])	Local occupancy binary input	Bypass timer[4]	Result (nvoEffectOccup)
Occupied	—	—	—	—	—	Occupied
Unoccupied	—	—	—	—	zero	Unoccupied
					not zero	Bypass
Bypass	Occupied	—	—	—	—	Occupied
	Unoccupied	—	—	—	zero	Unoccupied
					not zero	Bypass
	Standby	—	—	—	zero	Standby
					not zero	Bypass
	Null[2]	Occupied	—	—	—	Occupied
		Unoccupied	—	—	zero	Unoccupied
					not zero	Bypass
		Null	Occupied	—	—	Occupied
			Unoccupied	—	zero	Unoccupied
					not zero	Bypass
			Null	Occupied	—	Occupied
				Unoccupied	zero	Unoccupied
					not zero	Bypass
				Not present	—	Occupied

1 This value is the last enumeration received. It can come from either the nviOccManCmd network variable or the operator display schedule override.
2 Null = any other value.
3 The variable nviOccSensor is used with the SCC profile only. Refer to the Null rows in this column for the DAC profile.
4 This value represents whether or not the bypass timer is at zero or not. When a bypass request is made, the timer is set to the value specified in the Occupied Bypass Timer field, and it begins to count down. While it is counting down, the value is not zero. When the count down is complete, the value is zero.

continued Table O-SO-6 Effective occupancy arbitration for Tracer AH540/541 with operator display

Manual override[1] (nviOccManCmd)	Communicated schedule (nviOccSchedule)	Local schedule	Occupancy sensor (nviOccSensor[3])	Local occupancy binary input	Bypass timer[4]	Result (nvoEffectOccup)
Standby	—	—	—	—	zero	Standby
					not zero	Bypass
Null	Occupied	—	Occupied	—	—	Occupied
			Unoccupied	—	zero	Standby
					not zero	Bypass
			Null	Occupied	—	Occupied
				Unoccupied	zero	Standby
					not zero	Bypass
				Not present	—	Occupied
	Unoccupied	—	—	—	zero	Unoccupied
					not zero	Bypass
	Standby	—	—	—	zero	Standby
					not zero	Bypass
	Null	Occupied	Occupied	—	—	Occupied
			Unoccupied	—	zero	Standby
					not zero	Bypass
			Null	Occupied	—	Occupied
				Unoccupied	zero	Standby
					not zero	Bypass
				Not present	—	Occupied
		Unoccupied	—	—	zero	Unoccupied
					not zero	Bypass
		Null	Occupied	—	—	Occupied
			Unoccupied	—	zero	Unoccupied
					not zero	Bypass
			Null	Occupied	—	Occupied
				Unoccupied	zero	Unoccupied
					not zero	Bypass
				Not present	—	Occupied

1 This value is the last enumeration received. It can come from either the nviOccManCmd network variable or the operator display schedule override.
2 Null = any other value.
3 The variable nviOccSensor is used with the SCC profile only. Refer to the Null rows in this column for the DAC profile.
4 This value represents whether or not the bypass timer is at zero or not. When a bypass request is made, the timer is set to the value specified in the Occupied Bypass Timer field, and it begins to count down. While it is counting down, the value is not zero. When the count down is complete, the value is zero.

Timed override control
This sequence applies to both space temperature control and discharge air temperature control, with differences as noted.

If the zone sensor has a timed override option (ON/CANCEL buttons), pushing the ON button initiates a timed override request. A timed override request changes the occupancy mode from unoccupied mode to occupied bypass mode. In occupied bypass mode, the controller controls the zone temperature based on the occupied heating or cooling setpoints. The occupied bypass time, which resides in the Tracer AH540/541 and defines the duration of the override, is configurable from 0 to 240 minutes. The default value is 120 minutes for space temperature control; the default value is 0 minutes (disabled) for discharge air temperature control. When the occupied bypass time expires, the unit transitions from occupied bypass mode to unoccupied mode. Pushing the CANCEL button cancels the timed override request. A timed override cancel request will end the timed override before the occupied bypass time has expired and will transition the unit from occupied bypass mode to unoccupied mode.

If the controller is in any mode other than unoccupied when the ON button is pressed, the controller still starts the occupied bypass timer without changing the mode to occupied bypass. If the controller is placed in unoccupied mode before the occupied bypass timer expires, the controller will be placed in occupied bypass mode and remain in that mode until either the CANCEL button is pressed on the Trane zone sensor or the occupied bypass time expires.

Morning warmup
The morning warm-up function initiates a special heating sequence to raise space temperature to occupied conditions. This sequence is especially useful for a building occupancy transition from unoccupied to occupied.

The Tracer AH540/541 controller operates this sequence according to the configured control mode.

Space temperature control: Morning warmup
The controller keeps the outdoor air damper closed (when a mixing box is present) anytime during a occupied, occupied bypass, or occupied standby mode when the space temperature is 3ºF or more below the heating setpoint. The damper remains closed indefinitely (no time limit). As the space temperature increases above this threshold, the outdoor damper progressively opens toward the minimum position setpoint. When the space temperature is within 2ºF of the effective heating setpoint, the outdoor air damper will be at the minimum position setpoint.

The outdoor air damper normally is open to a minimum position during the occupied mode when the controller turns On the supply fan. The damper normally is closed during:

- Warmup/cool-down mode
- Unoccupied mode
- Certain diagnostic conditions
- Low ambient damper lockout
- Anytime the supply fan is Off

Morning warmup can also be a communicated request from a Trane Tracer Summit building automation system. When the Tracer AH540/541 controller receives a communicated morning warm-up request, heating mode is enabled and the outdoor air damper closes. The controller remains in morning warmup until a different request is communicated.

Discharge air temperature control: Morning warmup
If the controller is configured for discharge air temperature control, the controller requires a space temperature input (hard-wired or communicated) and setpoint input (local, communicated, or default value) to initiate the morning warmup sequence of operation. The space temperature and setpoint inputs are used by the controller to determine if heating or cooling air should be supplied to the space.

On a transition from unoccupied to occupied, occupied bypass, or occupied standby, the controller compares the space temperature to the heating setpoint. If the space temperature is 1.5°F below the heating setpoint, morning warmup is initiated. The outdoor air damper closes (or remains closed) and heat/cool mode is heating. The morning warmup control sequence has no time limit upon a transition from unoccupied to occupied, when the controller is configured for discharge air temperature control.

Morning warmup can also be a communicated request from a building automation system. When the Tracer AH540/541 controller receives a communicated morning warmup request, heating mode is enabled and the outdoor air damper closes. The controller remains in morning warmup until a different request is communicated.

Daytime warmup
This sequence applies to controllers configured for discharge air temperature control. The air-handling units must have heating capacity (hydronic or steam) and a communicated or wired space temperature must exist.

Daytime warmup allows the controller to automatically change to heating if the space temperature is below the effective heating setpoint by a temperature that is more than the configured daytime warmup enable differential. Daytime warmup coordinates the controller heat/cool to heating, as well as communicates the controller mode of operation to the duct system for changeover.

The daytime warmup start setpoint is a configurable temperature below the effective space heating setpoint. When the space temperature drops to below the start setpoint, the daytime warmup function is initiated by the controller.

The daytime warmup terminate setpoint is a configurable temperature above the start setpoint. When the space temperature rises above the stop setpoint, the warmup function is terminated by the controller.

Unlike morning warmup, the outdoor air damper is at the configured minimum position or at the communicated minimum damper position according to the effective occupancy.

Operation

Cool-down
In cool-down operation the controller closes the outdoor air damper eliminating any additional cooling load due to warm outdoor temperatures. Normally the outdoor air damper is closed in this mode of operation and hydronic or mechanical cooling is provided to cool-down the space. However if the outdoor air temperature is suitable economizer cooling is allowed.

The Tracer AH540/541 controller operates this sequence according to the configured control mode.

Space temperature control: Cool-down
If configured for space temperature control, the controller provides an automatic cool-down function on a transition from unoccupied to occupied or occupied standby mode of operation. Cool-down is initiated and the outdoor air damper remains closed if space temperature is greater than 3ºF above the active cooling setpoint. As the space temperature decreases below this threshold, the outdoor damper progressively opens toward the minimum position setpoint. When the space temperature is within 2ºF of the effective cooling setpoint, the outdoor damper will be at the occupied or occupied-standby minimum position setpoint.

Cool-down can also be initiated by a building automation system with a mode command of pre-cool (optimal-start). The controller will stay in the pre-cool until the mode is removed by the system. A heating-only air-handling-unit configuration, with no cooling capacity, disables the automatic cool-down function. The outdoor air damper (if present) will open to minimum position and provide economizing, if enabled.

Discharge air temperature control: Cool-down
If configured for discharge air temperature control, the controller enters a cool-down mode only when coordinated by a building automation system (optimal-start). In cool-down, the controller's heat-cool mode is reported as pre-cool. The controller will stay in the pre-cool until the mode is removed by the automation system.

Supply fan operation
The controller determines fan operation based on the selected control mode. If the controller is configured for space temperature control, the supply fan operates in constant-volume. If configured for discharge air temperature control, the supply fan can be configured to operate either with constant-volume or variable-air-volume.

With both constant-volume and variable-air volume supply fan operation, the controller turns the supply fan binary output (BO1) On continuously during occupied, occupied standby, and occupied bypass modes.

During the unoccupied heating and cooling modes of operation, the supply fan will cycle Off when the space temperature is between the heating and cooling setpoints. If electric heat is energized during unoccupied heating periods of operation, the supply fan will run for an additional 120 seconds after electric heat capacity is de-energized. The supply fan is normally Off during air-handler operation with the following exceptions:

- During unoccupied mode when there is no requirement for heating and cooling
- When entering water temperature sampling is initiated
- As a result of certain diagnostic conditions
- During manual or system overrides

If a supply fan status binary input sensor is wired to the controller (at IN10) it is used to verify fan operation before heating and cooling start.

Upon energizing the supply fan output BO1, the Tracer AH540/541 controller waits a configurable time period (fan status delay) to allow the fan time to reach a desired air flow. Then the controller verifies fan operation (fan status).

A Low Supply Fan Air Flow diagnostic is generated if the controller powers the fan On and the fan status switch is not in the fan running position, or if the fan status switch is not set to make the fan run within the configured time limit after the controller commands the fan On. This latching diagnostic discontinues unit operation until the diagnostic is cleared from the controller. Fan operation can also be affected by other diagnostic conditions that cause the controller to shut down the unit.

Constant-volume supply fan operation
For constant-volume supply fan operation, the controller must be configured either for space temperature control or for discharge air temperature control with constant-volume.

In constant-volume operation, the fan runs continuously during occupied, occupied standby, and occupied bypass modes of operation, except when the controller is in occupied mode and turns the fan Off during entering water sampling periods. During unoccupied periods, the supply fan binary output BO1 controls the supply fan Off and On depending on heating or cooling requirements. The supply fan is normally Off during unoccupied modes of operation when space temperature is between the unoccupied heating and cooling setpoints.

If the controller is wired to a Trane zone sensor, the user can change the supply fan operation through the fan mode switch (when present). When the fan mode switch is in the Off position, the controller shuts down the unit. If the fan mode switch is moved to the Auto position, the controller operates the fan On and Off according to heat and cool demands and the active occupancy mode.

Variable-air-volume supply fan operation: Duct static pressure
For variable-air-volume supply fan operation, the controller must be configured for both discharge air temperature control and for variable-air-volume fan operation. When configured for variable-air-volume operation, the controller uses a duct static pressure control routine.

Variable-air-volume operation always maintains duct static pressure control in all modes of operating with the supply fan On.The air-handling unit duct static pressure is maintained by a duct static pressure control sequence.

The supply fan variable frequency drive in a variable-air-volume system is controlled to maintain the duct static pressure setpoint. When the fan is On, the controller reads and compares the duct static pressure input to the duct static pressure setpoint and adjusts the supply fan speed analog output signal (AO1) to the variable frequency drive.

The duct static pressure signal can be from a wired sensor or communicated via a network variable. If the controller does not have a valid duct static pressure from a wired sensor or communicated, the controller generates a Duct Static Press Failure diagnostic and shuts down the unit. The controller does not operate duct static pressure control without a valid duct static pressure input.

If the controller has both a hard-wired and communicated duct static pressure input, the communicated value is used for duct static pressure control. The greater of the two values, local (hard-wired) or communicated, is used for duct static pressure high limit shutdown.

The Tracer AH540/541 controller has a configurable duct static pressure high limit setpoint. If the duct static pressure exceeds the duct static pressure high limit setpoint, the controller shuts down the unit and generates a Duct Static Press High Limit diagnostic. This latching diagnostic must be cleared from the controller before the unit is allowed to operate.

Valve Operation
This sequence applies to both space temperature control and discharge air temperature control.

The controller uses analog modulating (0–10 Vdc or 2–10 Vdc) valves for heating or cooling operation. The controller supports one or two modulating valves for hydronic heating, steam heat, and hydronic cooling operation.TheTracer AH540/541 controller supports both one- and two-valve unit configurations.

Heating only, cooling only, and heating and cooling controller configurations will always use the heating analog output for valve heating and cooling analog output for valve cooling. For two-pipe changeover configurations with only one hydronic coil installed, use the cooling analog output for heating/cooling valve operation.

Normally, heating and cooling valves remain closed any time the supply fan is Off. Valves can open when the supply fan is Off during:
- Entering water temperature sampling
- Freeze avoidance
- Certain diagnostic conditions
- Valve override open

The Tracer AH540/541 controller operates with either normally open or normally closed valves. The normal state of the valve is the position of the valve when power is not applied. When power is applied, the controller has full control of the valve. For example, if the fan mode switch on the zone sensor is in the Off position, the controller closes the valve, regardless if it is configured normally open or normally closed.

Freeze-avoidance valve cycling
During low-temperature detect or freeze-avoidance diagnostic conditions that cause the unit to shutdown, the controller opens all heating and cooling valves 100% to prevent the coil from freezing. When hydronic or steam heat is present, the controller cycles the heat valve output On, then Off, over a period of five minutes (configurable) to prevent excessive unit cabinet temperatures. The heat valve output open position is configurable from 0 to 100%.

For example, if valve cycling, duty cycle is configured for 25% (default), the controller opens the valve for 75 seconds (25% of 5 minutes) and closes it for 225 seconds.

Two-pipe changeover

This sequence applies only space temperature control.The controller provides a two-pipe changeover function when an air-handling unit has one hydronic coil for heating and cooling operation.Two-pipe changeover allows the controller to provide heating or cooling to the space depending on the entering water temperature.

When a two-pipe changeover unit has secondary electric heat the controller uses the electric heat if the entering water temperature is not appropriate for heating. If entering water temperature is appropriate for heating, the controller uses hydronic heating and disables electric heat operation.

Two-pipe changeover units without an auxiliary source of heat, like electric heat, determine their mode based on the following sequence:

1. If the controlled space requires heating or cooling, the controller changes from heating to cooling and cooling to heating based on the space temperature, active setpoint, and integrated error between the two. Once the controller changes modes, it verifies the entering water temperature.

2. If the controller does not have a valid entering water temperature (hard-wired or communicated), the controller assumes hot water is present.

3. When the entering water temperature is not appropriate for the desired capacity (either heating or cooling), the controller remains at 0% hydronic capacity. Economizer cooling would remain available if needed regardless of the entering water conditions.

4. If the entering water temperature is appropriate for heating or cooling, the controller energizes the appropriate output to control the space temperature at the heating setpoint in heating mode or cooling setpoint in cooling mode.

Entering water temperature sampling

This sequence applies to controllers configured for space temperature control.

If configured for space temperature control, the controller can sample the entering water condition for air-handling units with a single hydronic coil. The entering water temperature is important for reliable heating and cooling control. The entering water temperature must be at least 5ºF above the space temperature for hydronic heating and 5ºF below the space temperature for hydronic cooling for satisfactory capacity control.

Three-way valve applications
When using three-way control valves, the central water supply flows continuously to the unit valve and is either directed through the coil or bypassed around the coil. Because water flow is continuous, the entering water temperature sensor can be installed on the pipe where the flow rate is constant. For both three-way valves and bleed lines, continuous water flow when combined with proper sensor location gives a continuous and reliable measurement of the entering water temperature.

Note: Entering water sampling (also referred to as purge) is not required for three-way valve applications.

Two-way valve applications
The AH540/541 controller offers a control solution for two-way valve applications. The entering water temperature sampling function (purge) periodically opens the two-way valve to allow temporary water flow, producing a reliable entering water temperature measurement.

When water flows normally and frequently through the coil, the controller does not initiate the entering water temperature sampling function because the water temperature measurement is valid for determining the entering water condition. During unit startup or changeover, the controller determines its ability to deliver heating or cooling. The controller initiates the entering water temperature function to determine if the entering water temperature is adequate for delivering the desired heating or cooling. The measurement must indicate that the water is warm enough to heat the space or cool enough to cool the space.

When the controller initiates the entering water temperature sampling function, the controller turns Off the supply fan and opens the hydronic valve for no more than the maximum sampling time while measuring entering water temperature. An initial stabilization period is allowed to open the valve to a configured position (50% default) and to flush the piping.

When this temperature stabilization period has expired, the controller compares the entering water temperature to the effective space temperature (either hard-wired or communicated) to determine if it can be used for the desired mode. The controller continues to compare the entering water temperature to the effective space temperature for the maximum sampling time.

Whenever the entering water temperature is warmer than 110°F, the controller assumes the entering water temperature is hot because it is unlikely the coil would drift to a high temperature unless the actual temperature was very high. If the entering water temperature is not usable for the required space demand, the controller closes the water valve and starts the supply fan until the next sampling period (configurable). If the controller determines the entering water temperature is adequate for heat or cooling, it resumes normal heating/cooling control and effectively disables entering water sampling until it is required.

Entering water temperature sampling is disabled when:

- Unit configuration is dedicated heating and cooling or two-pipe changeover without purge (three-way valve application).
- Entering water temperature is communicated to the controller.
- For cooling, entering water temperature is less than five degrees colder than the space temperature or greater than 110°F.
- For heating, entering water temperature is greater than 5° warmer than the space temperature.

Face-and-bypass damper operation

This sequence applies to both space temperature control and discharge air temperature control.

The face-and-bypass damper modulates a percentage of air to the face of the heat coil and around the coil (bypass) to maintain the supply air temperature setpoint. The air passing through the hot water coil is mixed with the air bypassing the coil to produce a desired discharge air temperature.

The Tracer AH540/541 controller supports face-and-bypass operation for low outdoor temperature heating modes of operation only. During low outdoor temperatures, when the outdoor air temperature is lower than the face-and-bypass heat modulation setpoint, the heating valve is fully opened and the face-and-bypass damper is used for heating to prevent the coil from freezing. During economizer cooling operation, when outdoor temperature is less than the face and bypass heat modulation setpoint, the face-and-bypass damper is full bypass.

The face-and-bypass heat modulation setpoint is the outdoor air temperature (40°F default, configurable) at which the controller changes over to face and bypass heating operation. The face-and-bypass heat modulation setpoint can be changed using the Rover service tool.

When the outdoor air temperature is greater than 3°F above the face-andbypass heating modulation setpoint, the hydronic heating valve is modulated to maintain discharge air temperature. The face-and-bypass damper is positioned for full face air flow. When the outdoor air temperature is less than the face and bypass heating modulation setpoint, the controller fully opens the heating valve and uses the heat face-and-bypass damper to modulate heating capacity to maintain the desired discharge air temperature.

During diagnostic and fan Off conditions, when the controller shuts down unit operation, the face-and-bypass damper is in the full bypass position. During freeze avoidance operation or a Low Temp Detect diagnostic, the face-and-bypass damper is driven to full face.

Outdoor air damper operation

This sequence applies to both space temperature control and discharge air temperature control. The controller operates the modulating outdoor air damper according to effective occupancy, outdoor air temperature (communicated or hardwired sensor), space temperature, effective space temperature setpoint, discharge air temperature, and discharge air temperature setpoint. Default minimum damper positions are provided and can be changed using the Rover service tool for occupied and occupied standby ventilation.

The controller can also receive a communicated outdoor air damper minimum position setpoint. A communicated minimum position setpoint has priority over all configured minimum position setpoints. When a communicated minimum position setpoint is not present, the controller uses the configured minimum setpoints (see Table O-SO-8). During occupied modes, the damper remains at a minimum damper position, whether it is configured or communicated.

Mixed-air temperature control

The Tracer AH540/541 controller provides minimum ventilation requirements according to the effective occupancy mode. Ventilation requirements are maintained by mixed-air temperature control depending on available heating and cooling sources, unit configuration, and mixed-air temperature control type (configurable). Low mixed-air temperatures can be a concern for units with hydronic heating and cooling.

Table O-SO-7. Face-and-bypass damper operation based upon outdoor air temperature

Outdoor air temperature	Hydronic heating valve	Face-and-bypass damper
Outdoor air temperature is greater than face-and-bypass heat modulation setpoint[1]	Modulated to maintain desired setpoint	Full coil face (operation disabled)
Outdoor air temperature is less than-face and-bypass heat modulation setpoint	100% open	Modulated to maintain desired setpoint (operation enabled)

1 The outdoor air temperature must rise 3°F above the face and bypass heating enable point before face-and bypass-heating operation is disabled.

Table O-SO-8. Determining the outdoor air damper minimum position setpoint

Occupancy	nviOAMinPos communicated value	Active outdoor air damper minimum position setpoint
Unoccupied	Present or not present	Zero
Occupied	Present	Communicated value
	Not present	Occupied minimum
Occupied bypass	Present	Communicated value
	Not present	Occupied minimum
Occupied standby	Present	Communicated value
	Not present	Occupied standby minimum

Mixed-air temperature control is used to maintain the mixed-air temperature above the mixed-air low-limit setpoint (configurable). See Table O-SO-9. If the air-handling unit does not have a mixing box section, then mixed-air temperature control is not required.

Heat only, cool only, preheat cool, or cool reheat air-handling configurations with a mixing box can be configured for mixed-air temperature control. If cold outdoor air conditions exist, depending on ventilation requirements, the mixed-air temperature can create freezing conditions. Mixed-air temperature control reduces the outdoor air damper below the minimum position to maintain mixed-air temperature above the mixedair low-limit setpoint.

Air-handling units with preheat can use mixed-air preheat control to maintain mixed-air temperature before reducing ventilation. Cold entering air conditions from the mixing box can be heated with the preheat capacity to maintain the mixed-air temperature above the mixed-air low limit setpoint. Mixed-air preheat control attempts to use preheat until it has reached 100% capacity. At 100% preheat capacity, if mixed-air temperature is below the low-limit temperature, the mixed-air preheat control then lowers the outdoor air damper below the minimum position to maintain mixed air above the mixed-air low-limit setpoint.

If ventilation is not a concern, the Tracer AH540/541 controller can be configured for mixed-air temperature control when preheat capacity is available. Mixed-air preheat control is the best choice for preheat air-handling units with ventilation requirements.

Mixed-air temperature sensor location

It is important to mount the mixed-air temperature sensor in the proper location according to the mixed-air temperature control configuration.

Economizing

This sequence applies to both space temperature control and discharge air temperature control.

Economizing is a mode in which outdoor air is used as a source of cooling capacity before hydronic cooling. With a valid outdoor air temperature (either hard-wired or communicated) or a communicated Enable command from the Tracer Summit system, the Tracer AH540/541 controller uses the modulating economizer damper as the highest priority source of free cooling.

Economizing is possible during the occupied, occupied standby, unoccupied, and occupied bypass modes. It requires a mixed-air temperature sensor and an air-handling unit equipped with a mixing box. The mixed-air temperature sensor is used as a low-temperature limit, to keep mixed-air temperatures above freezing. It also requires an outdoor air temperature value to be present. If an outdoor temperature is not available, a communicated request can enable economizing.

The controller initiates the economizer function if the outdoor air temperature is cold enough to be used as free cooling capacity. If the outdoor air temperature is less than the economizer enable setpoint (absolute dry bulb), the controller modulates the outdoor air damper (between the active minimum damper position and 100%) to control the amount of outdoor air cooling capacity. When the outdoor air temperature rises 5°F above the economizer enable point, the controller disables economizing and moves the outdoor air damper back to its predetermined minimum position based on the current occupancy mode or communicated minimum damper position (see Table O-SO-10).

Table O-SO-9. Mixed-air temperature control

Air-handling unit configuration	Mixed-air temperature control type (configurable)	Controller action
No mixing box present	None	None
Heat only unit Cool only unit Cool reheat unit Preheat cool unit	Mixed-air temperature control	Reduce ventilation. Mixed-air temperature is maintained above the mixed-air low-limit setpoint (48°F default, configurable) by reducing the outdoor air ventilation below minimum position. The lower percent of outdoor air raises the mixed-air temperature.
Preheat cool unit	Mixed-air preheat control	Preheat before reducing ventilation. Preheat capacity is used to maintain the mixed-air temperature above the mixed-air low-limit setpoint (48°F default, configurable). If 100% preheat capacity does not maintain the mixed-air temperature above the mixed-air low-limit setpoint, outdoor air ventilation is reduced below minimum position.

Table O-SO-10. Relationship between outdoor temperature sensors & damper position

	Outdoor air damper		
Outdoor air temperature	**Occupied or Occupied bypass**	**Occupied standby**	**Unoccupied**
No or invalid outdoor air temperature	Open to occupied minimum position	Open to occupied standby minimum position	Closed
Failed outdoor air sensor	Open to occupied minimum position	Open to occupied standby minimum position	Closed
Outdoor air temperature less than the low ambient damper lockout setpoint[1]	Closed	Closed	Closed
Outdoor air temperature present and economizing feasible	Economizing, damper controlled between occupied minimum position and 100%	Economizing, damper controlled between occupied standby minimum position and 100%	Open and economizing during unit operation, otherwise closed
Outdoor air temperature present and economizing not feasible[2]	Open to occupied minimum position	Open to occupied standby minimum position	Closed

1 The low ambient damper lockout setpoint is a configurable temperature setpoint used to close the outdoor air damper, regardless of occupancy, when extreme outdoor air temperatures are present.
2 The Tracer AH540/541 controller disables economizing if the mixed-air temperature sensor is not present or is not valid.

Low ambient damper lockout

The controller closes the outdoor air damper during any heating, cooling, or economizer mode of operation or occupancy when extreme outdoor air temperatures exist. This condition disables outdoor air damper ventilation and economizing functions, but low ambient damper lockout does not affect other unit operations.

The outdoor air temperature must rise 9°F (5°C) above the low ambient damper lockout setpoint before economizing and ventilation become possible again.

Exhaust fan operation

This sequence applies to both space temperature control and discharge air temperature control.

The exhaust fan/damper is coordinated with the unit supply fan and outdoor damper operation. The exhaust output is energized only when the unit supply fan is operating and the outdoor damper position is greater than or equal to the configurable exhaust fan start setpoint. The exhaust fan output is disabled when the outdoor air damper position drops 10% (configurable) below the exhaust fan start setpoint. If the enable point is less than 10% (configurable), the unit turns On at the start setpoint and Off at zero.

The controller logic commands the exhaust fan to be energized/de-energized based on the target position of the economizing damper. Because of device stroke time, the state of the exhaust fan may change before the economizing damper reaches its target position.

If the exhaust fan start setpoint is set at or lower than the outdoor air damper minimum position, the exhaust fan will be On continuously when the outdoor air damper is at minimum position.

If the exhaust fan start setpoint is set higher than the outdoor air damper minimum position (minimum ventilation) the exhaust fan will be Off during periods of minimum ventilation. During economizer cooling operation the exhaust fan start setpoint can be selected to compensate for the increased outdoor ventilation.

The exhaust fan status binary input is present to detect operation of a belt-driven exhaust fan. An Exhaust Fan Air Flow diagnostic is detected when the control starts the exhaust fan and the exhaust fan status binary input does not indicate operation after two minutes. This is an exhaust fan latching diagnostic and discontinues exhaust operation until the diagnostic is reset. All other control functions continue to operate normally.

Electric heat operation

This sequence applies to both space temperature control and discharge air temperature control, with differences as noted.

The Tracer AH540/541 supports two methods of controlling staged electric heat:

1. Staged electric heat using binary outputs.
2. Staged electric heat using a sequencer

For details, see “Staged electric heat”.

Electric heat operation can produce high discharge air temperatures if the unit air flow rate is low or the entering air temperature is high. The controller provides an electric heat discharge high limit control in addition to functional and safety limits of the product. In draw-through unit configurations in which the electric heat source is positioned before the supply fan in the air stream, the discharge air temperature is limited to 115°F (default). Blow-through electric heat unit configurations allow a discharge-air-control high limit of 135°F.

The Tracer AH540/541 controller supports only unit configurations with one source of heating capacity, with the exception of a two-pipe changeover unit with electric heat, if the controller is configured for space temperature control (see "Two-pipe changeover"). When hydronic-heating capacity is available, electric heat operation is disabled. If hydronic-heating capacity is not available, electric heat is enabled.

Electric heat is normally disabled during:
- Hydronic heating (two-pipe changeover unit)
- Building automation system mechanical heating lockout is active
- Cooling modes of operation (except dehumidification)
- Anytime the supply fan is Off

Electric heat operation is restricted to heating modes of operation. When staged electric heat is mounted in preheat position (before cooling capacity), the controller will not allow the use of electric heat for mixed-air preheat control. If mixed-air temperature control is desired because of installed hydronic capacity, mixed-air temperature control should be used rather than mixed-air preheat control.

Space temperature control: Electric heat

For space temperature control applications, the Tracer AH540/541 performs cascade space temperature control and stages electric heat capacity up and down based on the discharge air temperature and discharge air temperature setpoint.

Staged electric heat

The controller stages the heaters On sequentially, adding 1 stage every 2 minutes. In the unoccupied heating mode, the supply fan will delay turning Off for 120 seconds after electric heat capacity stages Off to remove residual heat.
The controller supports two methods of controlling staged electric heat:
- Staged electric heat using binary outputs

Staged electric heat using binary outputs

One to four electric heat stages can be directly controlled from binary outputs. Because the controller binary outputs can also be configured for stages of DX cooling the binary outputs are assigned as follows where the number of electric heat stages plus the number of DX cooling stages cannot exceed four outputs.
1. BO3: DX cooling stage 1 or Electric heat stage 4
2. BO4: DX cooling stage 2 or Electric heat stage 3
3. BO5: DX cooling stage 3 or Electric heat stage 2
4. BO6: DX cooling stage 4 or Electric heat stage 1

DX cooling operation

This sequence applies to both space temperature control and discharge air temperature control.

The Tracer AH540/541 controller provides four DX cooling binary outputs to control up to four stages of cooling. A cascade control algorithm is used for space temperature control. Valid discharge air temperature sensor and space temperature sensor inputs are required for operation. As space temperature rises above the cooling setpoint, it creates a demand for more discharge-air cooling capacity. Discharge air temperature control directly controls DX cooling to provide discharge air temperature at the desired discharge-air cooling setpoint.

Anytime the discharge air temperature drops below the discharge-air low-limit setpoint (45°F, configurable) DX cooling capacity is reduced to prevent low discharge air temperatures.

DX cooling operation will be suspended if the outdoor air temperature falls below the compressor lockout temperature setpoint (50°F default, configurable). DX cooling will automatically resume when the outdoor air temperature is greater than the compressor lockout temperature plus 5°F. DX cooling can also be suspended by communicated mechanical cooling lockout command from a building automation system. DX cooling will remain disabled until the mechanical cooling lockout is released.

DX cooling can be coordinated with economizer operation by adjusting the Economizer Enable Temperature (60°F, default). Given the default setpoints for DX cooling and economizer operation based on outdoor air temperature, DX and economizer operation will be initiated when outdoor air temperature falls below 60°F. DX cooling will be disabled below 50°F outdoor air temperature and economizing will be disabled above 65°F outdoor air temperature.

When outdoor air temperature is less than 50°F DX cooling operation will be disabled. When outdoor air temperature rises above 65°F, economizer operation is disabled.

DX cooling is normally disabled if:
- System mechanical cooling lockout is active
- Outside air temperature is less than compressor cooling lockout setpoint
- Defrost condition exists
- Supply fan is Off

Staged DX cooling
One to four DX cooling stages can be directly controlled from binary outputs. Since the controller binary outputs can also be configured for stages of electric heat the binary outputs are assigned as follows where the number of DX cooling stages plus the number of electric heat stages cannot exceed four outputs.
- BO3: DX cooling stage 1 or Electric heat stage 4
- BO4: DX cooling stage 2 or Electric heat stage 3
- BO5: DX cooling stage 3 or Electric heat stage 2
- BO6: DX cooling stage 4 or Electric heat stage 1

The controller will enforce a minimum On time and minimum Off time for each compressor stage. A compressor will not be allowed to stage On until the compressor minimum Off time has expired and a compressor will not be allowed to stage Of until the compressor minimum On time has expired.

Inter-stage delays are also enforced. A minimum of 3 minutes will be enforced between additional cooling stages. A minimum of 2 minutes will be enforced between subtracting cooling stages.

Defrost operation
Low evaporator refrigerant temperatures can cause the coil to frost. The Tracer AH540/541 controller provides two methods of detecting low evaporator refrigerant temperatures:
1. One uses the evaporator refrigerant temperature (analog input IN13) to measure suction temperature
2. The other uses a binary thermostat device (binary input IN7 or IN12) applied to the evaporator suction line

Two-circuit split-system DX cooling applications should provide an evaporator refrigerant sensor or binary thermostat device on the first circuit or the circuit with the first cooling stage. As an option, both an evaporator refrigerant sensor and binary thermostat can be used on a unit with one device installed on each circuit. The controller will respond according to either frost input.

Two binary thermostat devices can also be used with one device installed on each circuit. The devices are separately hardwired to coil defrost inputs IN7 and IN12, or the thermostat devices are wired in series to coil defrost input IN7 or IN12.

Evaporator refrigerant temperature
A 10kΩ thermistor can be hard-wired to the universal analog input IN13. The controller has the ability to directly measure the evaporator refrigerant temperature. If evaporator refrigerant temperature drops below the defrost setpoint (30°F, default) the controller will unload one compressor stage every 120 seconds. If the refrigerant temperature rises above the defrost setpoint, DX cooling will stop unloading and each stage that frosted will be enabled after a minimum of 10 minutes. If the refrigerant temperature increases above the defrost setpoint + 10°F, an integrating function is initiated. When the evaporator refrigerant time-temperature satisfied, defrost operation is terminated. When defrost is terminated, DX cooling capacity is allowed to once again stage On (see Table O-SO-12).

Coil defrost binary input
The controller provides two binary inputs that can optionally be configured for coil defrost, IN7 and IN12. These inputs should be used if the universal analog input is not available or cannot be configured for evaporator refrigerant temperature.

When the coil defrost binary input is active, the controller de-energizes the last active DX cooling stage. All subsequent binary outputs will deenergize; one stage every 120 seconds or until the coil defrost binary input resets to a normal state.

Table O-SO-12. Evaporator refrigerant temperature effect onDX cooling

Evaporator refrigerant temperature	DX cooling operation
Less than defrost setpoint.	DX cooling outputs will turn Off in sequence according to a time-temperature function until the refrigerant temperature rises above the defrost setpoint.
Between defrost setpoint and defrost setpoint +10˚F.	DX cooling outputs stop unloading. Frosted DX cooling outputs will be re-enabled following a minimum 10 minute defrost time interval.
Greater than defrost setpoint +10˚F.	A time-temperature function will enable all compressor stages.

DX split-system cooling

The Tracer AH540/541 controller provides air-handling-unit, direct expansion-cooling sequence of operation for split-system air-handling units. For the control system to operate, the controller must be properly wired and configured to the condensing unit.

The controller does not provide any lead-lag, condensing unit protection, condenser fan control, or periodic pump-out control. Pump-out and condenser fan control must be coordinated with condensing unit operation using electromechanical devices.

Compressor stages and circuits
The Tracer AH540/541 controller provides four 24 Vac binary outputs (BO3 to BO6) for staged DX cooling. Each output is energized sequentially BO3, BO4, BO5, BO6 as cooling capacity demand increases in a last-On, first-Off method. To optimize the controller ability to manage coil frost conditions, adhere to the following staging and circuit information when making wiring connection between the controller and the condensing unit.

For four-stage, two-circuit condensing units connect BO3 to the first stage of circuit 1, BO4 to the first stage of circuit 2, BO5 to the second stage of circuit 1, and, finally, BO6 to the second stage of circuit 2 (see Table O-SO-13).

Table O-SO-13. DX cooling compressor circuit wiring

Tracer AH540/541 controller		Condensing unit	
DX cooling stages	Binary output	Single circuit	Two circuit
1	BO3	1st stage	N/A
2	BO3	1st stage	1st stage of circuit 1
	BO4	2nd stage	1st stage of circuit 2
4	BO3	1st stage	1st stage of circuit 1
	BO4	2nd stage	1st stage of circuit 2
	BO5	3rd stage	2nd stage of circuit 1
	BO6	4th stage	2nd stage of circuit 2

Frost protection
The controller provides three options for coil frost protection. Use the Rover service tool to properly configure the controller for the following options.

- Analog thermistor input (evaporator refrigerant temperature sensor) wired to the universal analog input (IN13).
- Binary thermostat device wired to binary input IN7, coil defrost input.
- Binary thermostat device wired to binary input IN12, coil defrost input.

Two-circuit split-system DX cooling applications should apply an evaporator refrigerant sensor or binary thermostat device on the first circuit or the circuit of the first cooling stage.

For protection on each circuit both an evaporator refrigerant sensor and binary thermostat sensor or two binary thermostat sensors can be used at the same time. Apply a sensor to each circuit. The controller will respond according to the active input.

Also two binary thermostat devices can be applied to each circuit and wired in series to binary input IN7 or IN12. If either device detects a low refrigerant temperature condition, the controller will enter a defrost mode of operation.

Minimum On and Off timers
Remove (if installed), or disable, all electromechanical compressor minimum On and Off timers from the condensing unit. The controller will enforce a minimum On time and minimum Off time for each compressor stage. A compressor will not be allowed to stage On until the compressor minimum Off time has expired, and a compressor will not be allowed to stage Off until the compressor minimum On time has expired.

Neglecting to remove or disable the electromechanical timers will cause the compressor operation to lose coordination with the controller compressor staging control, and will result in poor control performance.

Dehumidification

This sequence applies only to space temperature control.

The Tracer AH540/541 controller provides both occupied and unoccupied dehumidification control when cooling and reheat capacity is available. The dehumidification control sequence is allowed on unit configurations with hydronic or DX cooling and hydronic or electric reheat.

Both occupied and unoccupied space humidity setpoints are provided as well as setpoint offset values (10% default) to terminate dehumidification mode. To disable occupied space dehumidification, set the Occupied Space RH setpoint to 0%. Likewise, to disable unoccupied space dehumidification, set the Unoccupied Space RH setpoint to 0%. Use the Rover service tool to edit these setpoints.

Space dehumidification requires a space relative humidity sensor input hard-wired to the universal analog input IN13 or a communicated RH value. If both a hard-wired relative humidity sensor and a communicated RH value is present, the communicated value will be used for dehumidification control.

Occupied and unoccupied mode dehumidification
When the space relative humidity is greater than the Occupied Space RH Setpoint, dehumidification control is initiated. The dehumidification control mode will remain active until space relative humidity is less than the Occupied Space RH Setpoint minus Occupied Space RH Offset value. The controller will automatically revert back to occupied or occupied standby space temperature control.

When in unoccupied mode and the space relative humidity is greater than the Unoccupied Space RH Setpoint, dehumidification is initiated until space relative humidity is less then the Unoccupied Space RH Setpoint minus Unoccupied Space RH Offset value. The controller will automatically revert back to unoccupied space temperature control.

Space temperature and relative humidity are both controlled when dehumidification is active. Cooling capacity is modulated or staged to reduce space humidity, while heating capacity is modulated or staged to control space temperature. Hydronic cooling capacity is modulated (increased and decreased) to offset the relative humidity load in the space. DX cooling capacity operates as a limit control and is only allowed to stage up (increase) to maintain or decrease the relative humidity in the space.

Occupied and unoccupied mode dehumidificiation: Cooling only
In occupied or unoccupied mode, when dehumidification mode is active and space temperature is greater than the space occupied cooling setpoint minus 1.5°F (0.83°C), dehumidification is controlled with only cooling capacity. Cooling capacity is increased to further dry the supply air to the space (see A in Figure O-SO-4).

Occupied and unoccupied mode dehumidificiation: Cooling and reheat
If the space temperature drops 1.5°F (0.83°C) below the occupied cooling setpoint, reheat capacity is invoked and modulated to maintain space temperature control. Cooling capacity continues to modulate or stage to reduce space humidity (see B in Figure O-SO-4).

Occupied and unoccupied mode dehumidificiation: Reheat only
Anytime the space temperature drops below the occupied heating setpoint (occupied, occupied standby, or unoccupied), cooling capacity is disabled and reheat only is provided until the space temperature raises to 3°F (1.67°C) below the occupied cooling setpoint.

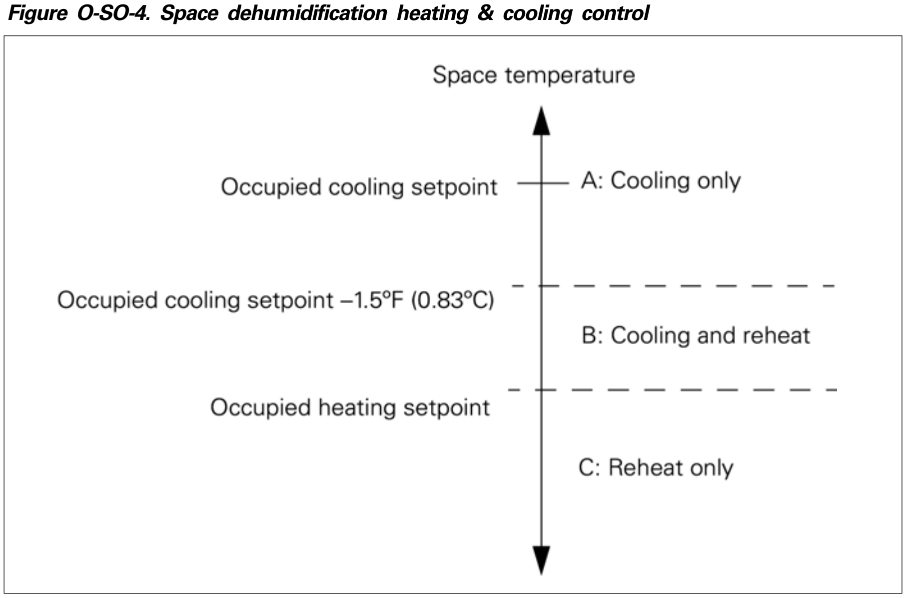
At the time dehumidification is initiated, if space temperature is greater than 3°F (1.67°C) below the occupied cooling setpoint, reheat only is provided until space temperature rises to within 3°F (1.67°C) of the occupied cooling setpoint (see C in Figure O-SO-4.)

Unit protection strategies

The following strategies are initiated, for both space temperature control and discharge air temperature control, when specific conditions exists to protect the unit or building from damage:

- Run/stop binary input (see "IN8: Run/stop" on page 25)
- Supply fan status ("IN10: Supply fan status")
- Condensing unit protection
  1. Coil defrost (see "Defrost operation")
  2. Compressor minimum On/Off timers (see "DX cooling operation")

Figure O-SO-4. Space dehumidification heating & cooling control



- Duct static pressure high limit (see "Variable-air-volume supply fan operation: Duct static pressure")
- Coil freeze protection
  1. Face-and-bypass heating ("Face-and-bypass damper operation")
  2. Freeze avoidance (see "Freeze-avoidance valve cycling")
  3. Mixed-air temperature control (see "Mixed-air temperature control")
  4. Low-temperature detection (see "IN7: Low-temperature detection or coil defrost")
- Supply fan motor thermal protection (see "Electric heat operation")
- Filter status (see "Filter status")
- Freeze avoidance (see "Freeze avoidance")

Filter status
The controller filter status is based on the supply fan cumulative run hours. The controller compares the fan run time against an adjustable fan run hours limit (maintenance required setpoint time, stored in the controller) and recommends unit maintenance as required. The Maintenance Required diagnostic is informational only. Its state does not affect unit operation.

Use the Rover service tool to edit the Maintenance Required setpoint time. When the setpoint limit is exceeded, the controller generates a Maintenance Required diagnostic. To disable the diagnostic feature, set the maintenance required setpoint time to zero.

You can use Rover service tool or Tracer Summit to clear the Maintenance Required diagnostic. When the diagnostic is cleared, the controller resets the fan run time to zero and resumes accumulating fan run hours.

Freeze avoidance
Freeze avoidance is used as low ambient temperature protection and is only initiated anytime the supply fan is Off. The controller enters the freeze avoidance mode when the outdoor air temperature is below the freeze avoidance setpoint (configurable). The controller disables freeze avoidance when the outdoor air temperature rises 3°F (1.67°C) above the freeze avoidance setpoint. When the controller is in freeze avoidance mode:

- All water valves are driven open to allow water to flow through the coil
- Steam and hydronic heat valves are cycled open and closed to prevent excessive cabinet temperatures
- Supply fan is Off
- Face-and-bypass damper (when present) is at full bypass

Freeze avoidance protects the air handling unit hydronic heating and cooling coils from freezing when cold outdoor air temperatures are present and the supply fan is Off. For example, the Tracer AH540/541 is not able to run the air-handling unit because the run/stop input is set to stop (supply fan is Off). If the outdoor air temperature is below the freeze avoidance setpoint, the Tracer AH540/541 opens all water valves.

Overrides

The controller has the capability, whether using space temperature control or discharge air temperature control, to override both analog and binary output (typically for testing and commissioning) through the Tracer Summit building automation system or from the Rover service tool. For more information about the output overrides, refer to literature for those products. In addition, AH540/541 override capability include:

- Manual output test
- Emergency override
- Water valve override

Manual output test

The controller includes a manual output test function, which allows the user to manually exercise the outputs in a predefined sequence using the Test push button (see "Performing a manual output test"). You can also perform the manual output test remotely using the Rover service tool. The Rover service tool communications through the Comm5 link to place the controller in service override mode. From the Rover computer screen you can step the controller through the manual output test.

Emergency override
The Tracer AH540/541 controller can be placed into emergency override by using the communication variable (nviEmergOverride). Emergency override allows a building automation system such as Trane Tracer Summit to pressurize, depressurize, or purge the air from a building space. It can also be used to shut down the controller operation of the unit.

The emergency override command influences the controller's supply fan, outdoor air damper, and exhaust fan to create the desired condition, as shown in Table O-SO-14.

Duct static pressure (when present) is always controlled when the supply fan is running. Freeze avoidance in emergency override can force the heating and cooling valves open.

Water valve override
To support water balancing, the controller includes a communication variable (nviValveOverride) that allows a user to specify the desired state of all water valves. The states supported are:

- Open all valves
- Close all valves

Unless the communicated variable is refreshed within 10 hours, the override ends and the valve operation reverts to normal heating/cooling operation.

Use the Rover service tool to access this feature.

Table O-SO-14. Emergency override commands

Command	Supply fan	Outdoor air damper	Exhaust fan
Pressurize	On	Open	Off
Depressurize	Off	Close	On
Purge	On	Open	On
Shutdown	Off	Close	Off

Verifying operation and communication

This section describes:
- Test button
- How to perform a manual output test
- Service Pin button
- Light-emitting diodes (LEDs)
- Diagnostic conditions

Test button
The Test button is located on the main controller board, as identified in Figure O-SO-5. You can use it to perform the manual output test, which verifies that the controller is operating properly. The manual output test is described in the next section.

Performing a manual output test
The manual output test sequentially controls all outputs to verify their wiring and operation. Normal operation of the controller is suspended while the manual output test is being performed.

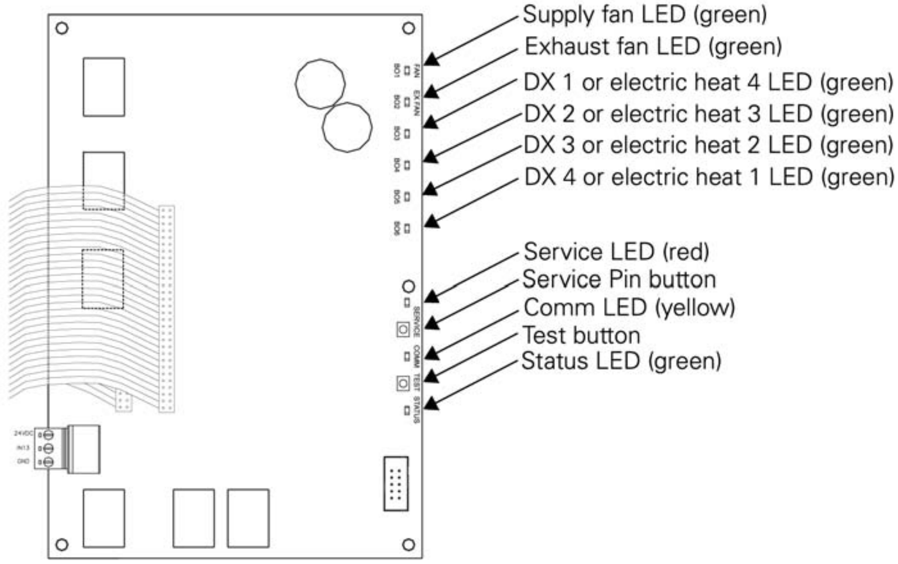
You can use the manual output test to clear the controller of diagnostics. If any diagnostics are present when a manual test is initiated, the Status LED blinks twice. During the second step of the test, the controller attempts to clear the diagnostics. If the controller cannot clear a diagnostic, the controller exits the manual output test.

You can also use the manual output test for air and water balancing. Step four of the test provides cooling capacity. Step five provides heating capacity. Step four also opens the outdoor air damper to the minimum occupied position and controls the duct static-pressure to the duct static-pressure setpoint.

You can perform the manual output test in three ways:
- Press the Test button to proceed through the test sequence
- Use the Rover service tool
- Use the operator display

To perform a manual output test using the Test button:
1. Press and hold the Test button for 3 to 4 seconds, then release the button to start the test mode. The green Status LED light turns Off when the Test button is pressed, and then it blinks (as described in Table O-SO-18) when the button is released to indicate the controller is in manual test mode.
2. Press the Test button (no more than once per second) to advance through the test sequence.
3. Finish the test by advancing through the complete test sequence. The test will end automatically if the unit remains in a single step for ten hours.

Figure O-SO-5. Location of Test buttons, Service Pin button, and LEDs



Service Pin button
The Service Pin button is located on the main circuit board as shown in Figure O-SO-5. You can use the Service Pin button to:
- Identify a device
- Add a device to the active group in Rover
- Verify communication with Rover
- Make the green Status LED "wink" to verify the controller is communicating on the link

Note: As an alternative to pressing the Service Pin button, you can hold down the zone sensor ON button for 10 seconds to verify communication with Rover by sending a Service Pin message request (see "Service Pin message request").

Refer to the *Rover Operation and Programming* guide, EMTX-SVX01E-EN, for information on how to use the Service Pin button.

Interpreting LEDs

The information in this section will help you interpret LED activity. The location of each LED is shown in Figure O-SO-5.

Binary output LEDs (green)
The FAN (BO1) LED indicates the status of the first binary output, which controls the supply fan. The EX FAN (BO2) LED indicates the status of the second binary output, which controls the exhaust fan. Binary outputs BO3, BO4, BO5, and BO6 indicate the status of stages of DX cooling and electric heat. Table O-SO-16 describes the LED activity for these binary outputs.

Note: Each binary output LED reflects the status of the output relay on the circuit board. It may or may not reflect the status of the equipment the binary output is controlling. Field wiring determines whether or not the state of the binary output LED also applies to status of the end device. Table O-SO-16 describes the LED states.

Table O-SO-15. Manual output test sequence

Step[1] (number of times Test button is pressed in sequence)	Supply fan	Cool output(s)	Heat output(s)	Face and bypass damper	Outdoor air damper	Exhaust fan
Step 1[2]	Off, 0%	Closed	Closed	Bypass	Closed	Off
Step 2[3]	On, 0%	Closed	Closed	Face	Closed	Off
Step 3	On, DSP[4]	Closed	Closed	Face	Closed	Off
Step 4	On, DSP	Open or On[5, 6]	Closed	Face	Occupied minimum position	Off
Step 5	On, DSP	Closed	Open or On[7]	Face	Occupied minimum position	Off
Step 6	On, DSP	Closed	Closed	Bypass	Open	On[8]
Step 7	Return to normal operation[9]					

1 The following diagnostics cause the Tracer AH540/541 to exit the manual output test:
Duct Static-pressure High Limit
Low Supply Fan Air Flow
Low Temp Detect
Unit Shutdown
2 When the manual output test starts, all outputs are turned Off or closed. The status LED blinks once if there are no diagnostics and blinks twice if any diagnostics are present.
3 At the beginning of step 2, the controller attempts to clear any existing diagnostics. If the controller is unsuccessful clearing a diagnostic, the controller exits the manual output test.
4 If the controller is configured for variable-air-volume (VAV) control, the controller tests duct static-pressure (DSP) control during steps 3 through 6.
5 If the Tracer AH540/541 cooling type is hydronic or two-pipe changeover, the valve will open 100% in step 4. If the cooling type is DX the first stage of cooling will be energized in step 4, and each additional DX output will energize sequentially with each Test button press (maximum of 4-stages).
6 DX cooling stages will not energize if defrost operation is active. See "Defrost operation" for more information.
7 If the Tracer AH540/541 heating type is hydronic or steam, the valve will open 100% in step 5. If the heat type is staged electric or analog electric the first stage of heating will be energized in step 5, and each additional electric heat output will energize sequentially with each Test button press. Staged electric can have a maximum of 4-stages. Analog electric can have a maximum of 6 stages.
8 If an exhaust-fan status diagnostic occurs, the controller turns Off the exhaust fan during step 6.
9 The controller exits the test by initiating a reset and returning the controller to normal operation.

Table O-SO-16. Binary output LEDs (green)

LED activity	Explanation
LED is On continuously	The relay output is energized.
LED is Off continuously	The relay output is de-energized or there is no power to the board.

Service LED (red)
The Service LED indicates whether the controller is operating normally. Table O-SO-17 describes Service LED activity.

Status LED (green)
The green Status LED indicates whether the controller is receiving power and if the controller is in manual test mode. Table O-SO-18 describes Status LED activity.

Comm LED (yellow)
The yellow Comm LED indicates the communication status of the controller. Table O-SO-19 describes Comm LED activity.

Required inputs for unit operation
The following locally wired sensor or communicated inputs are required for each control function listed in Table O-SO-20. If any one of the sensors does not exist, the controller operates the control function.

Table O-SO-17. Service LED (red)

LED activity	Explanation
LED is Off continuously when power is applied to the controller	The controller is operating normally.
LED is On continuously when power is applied to the controller	The controller is not working properly, or someone is pressing the Service Pin button.
LED blinks once every second	The controller is not executing the application software because the network connections and addressing have been removed.[1]

1 Restore the controller to normal operation using the Rover service tool.

Table O-SO-18. Status LED (green)

LED activity	Explanation
LED is On continuously	Power is on (normal operation).
LED blinks once	The controller is in manual output test mode. No diagnostics are present.
LED blinks twice	The controller is in manual output test mode. One or more diagnostic is present.
LED blinks (¼ second On, ¼ second Off for 10 seconds)	The auto-wink option is activated, and the controller is communicating.[1]
LED blinks rapidly	Flash download is being received.
LED is Off continuously	Either the power is Off or the controller has malfunctioned.

1 By sending a request from the Rover service tool, you can request the controller's green LED to blink ("wink"), a notification that the controller received the signal and is communicating.

Table O-SO-19. Comm LED (yellow)

LED activity	Explanation
LED is Off continuously	The controller is not detecting any communication (normal for stand-alone applications).
LED blinks	The controller detects communication (normal for communicating applications, including data sharing).
LED is On continuously	An abnormal condition that may occur during discovery. The LED may flash fast enough to look as if it is on continuously. If this LED activity occurs at any other time, the site may have excessive radio frequency interference (RFI).

Table O-SO-20. Required inputs

Control function	Input required to be present (locally wired sensor or communicated value)	Controller operation if input is not present
Variable-air-volume control	Duct static pressure	Diagnostic shutdown
Discharge air temperature control	Discharge air temperature	Diagnostic shutdown
Space temperature control	Space temperature Discharge air temperature	Diagnostic shutdown Diagnostic shutdown
Economizer operation	Outdoor air temperature Mixed-air temperature	Economizer disabled
Space dehumidification	Space relative humidity	Dehumidification disabled
Two-pipe changeover	Entering water temperature	Hydronic capacity assumed to be appropriate for cooling

Diagnostics

Table M-D-2 describes the diagnostics that can be generated by the Tracer AH540/541 controller. There are three types of diagnostics:

1. Critical: The controller shuts down the unit to prevent possible damage. The controller cannot operate until the diagnostic condition is corrected.
2. Service required: The controller disables certain sequences of operation while attempting to maintain unit operation. For example, if the mixed-air temperature sensor fails or is not wired, the controller disables economizer operation.
3. Informational: The controller operates normally.

Resetting diagnostics
Diagnostics that cause the unit to shutdown or disable certain operations are either latching or non-latching. Latching diagnostics require manual resetting. Non-latching diagnostics automatically clear when the condition that caused the diagnostic is solved.

Resetting is similar to cycling power to the unit. Resetting clears any latching diagnostics and allows the controller to restart the air-handling unit, if it is running normally. If the condition that caused the latching diagnostic is still present, however, the controller immediately shuts down the unit.

You can reset diagnostics in a variety of ways:

- Manual output test
- Cycling power to the controller
- Building automation system
- Rover service tool
- Any communicating device able to access the diagnostic reset input of the controller
- Zone sensor fan mode switch
- Operator display

Manual output test
Use the Test button on the controller during installation to verify proper end-device operation or during troubleshooting. When you press the Test button, the controller exercises all outputs in a predefined sequence. The first and last outputs of the sequence reset the controller diagnostics. See "Performing a manual output test".

Cycling power
When the 24 Vac power to the controller is turned Off and then On, the unit cycles through a power-up sequence (see "Power-up sequence"). By default, the controller attempts to reset all diagnostics during this sequence.

Building automation system
Some building automation systems can reset controller diagnostics. For more complete information, refer to the product literature for the building automation system.

Rover service tool
You can reset controller diagnostics with the Rover service tool (see the Rover Operation and Programming guide, EMTX-SVX01E-EN).

Diagnostic reset input
Any device that can communicate the network variable nviRequest (enumeration "clear_alarm") can reset controller diagnostics.

Zone sensor fan mode switch
When the zone sensor fan mode switch is changed from Off to Auto, the controller attempts to reset all diagnostics. If the zone sensor fan mode switch has been disabled by configuration, then the switch is ignored and cannot be used to reset diagnostics.

Operator display
You can view and reset active diagnostics from the operator display. Active diagnostics are indicated by a flashing status light on the display.

Interpreting multiple diagnostics
Two or more diagnostics can be present at the same time. Diagnostics are reported in the order in which they occur, but each diagnostic has a different priority. For example, if a freezestat condition occurs, the controller communicates a Low Temp Detect diagnostic message at priority one, shuts down the air-handler, and opens all valves. If a stop input condition then occurs, the controller communicates a Unit Shutdown diagnostic message at priority two. However, because the Low Temp Detect diagnostic has a higher priority, the controller does not close the valves.

Table M-D-1 lists the Tracer AH540/541 diagnostics in order of priority, with 1 being the highest and 22 being the lowest.

Table M-D-2 interprets each diagnostic according to what effect it has on the controller outputs.

Table M-D-1. Diagnostics in order of priority

1	Emergency Override
2	Manual Output Test
3	Low Temp Detect
4	Unit Shutdown
5	Low Supply Fan Air Flow
6	Low Exhaust Fan Air Flow
7	Space Temperature Failure
8	Duct Static Press Failure
9	Duct Static Press High Limit
10	Discharge Air Temp Failure
11	Local Space Setpoint Failure
12	Local Fan Switch Failure
13	Outdoor Air Temp Failure
14	Mixed Air Temp Failure
15	Humidity Input Failure
16	Entering Water Temp Failure
17	CO_2 Sensor Failure
18	Evap Refrigerant Temp Failure
19	Generic Temperature Failure
20	Dirty Filter
21	Maintenance Required
22	Invalid Unit Configuration

Table M-D-2. Tracer AH540/541 diagnostics

<table>
<tr><th>Diagnostic</th><th>Configuration</th><th>Outputs</th></tr>
<tr><td>Emergency Override
(informational; nonlatching)</td><td>Space temperature control
Discharge air temperature control</td><td>See “Emergency override”</td></tr>
<tr><td>Manual Output Test
(informational; nonlatching)</td><td>Space temperature control
Discharge air temperature control</td><td>See “Performing a manual output test”</td></tr>
<tr><td>Low Temp Detect[1,2]
(critical or service required; latching)</td><td>Space temperature control
Discharge air temperature control</td><td>Supply fan: Off
Valves (cooling): Open
Valves (heating): Open/closed
DX cooling/Electric heat: Disabled
Outdoor air damper: Closed
Face and bypass damper: Face
Exhaust fan: Off</td></tr>
<tr><td>Duct Static Press High Limit[2]
(critical or service required; latching)</td><td rowspan="2">Discharge air temperature control</td><td rowspan="7">Supply fan: Off
Valves: Closed
DX cooling /Electric heat: Disabled
Outdoor air damper: Closed
Face and bypass damper: Bypass
Exhaust fan: Off</td></tr>
<tr><td>Duct Static Press Failure
(critical; nonlatching)</td></tr>
<tr><td>Unit Shutdown[2]
(critical or service required; latching)</td><td rowspan="4">Space temperature control
Discharge air temperature control</td></tr>
<tr><td>Low Supply Fan Air Flow[2]
(critical or service required; latching)</td></tr>
<tr><td>Discharge Air Temp Failure[2,3]
(critical or service required; nonlatching)</td></tr>
<tr><td>Invalid Unit Configuration[2]
(service required; latching)</td></tr>
<tr><td>Space Temperature Failure[2,3]
(critical or service required; nonlatching)</td><td>Space temperature control</td></tr>
<tr><td>Low Exhaust Fan Air Flow
(service required; latching)</td><td>Space temperature control
Discharge air temperature control</td><td>Supply fan: Normal operation
Valves: Normal operation
DX cooling /Electric heat: Normal operation
Outdoor air damper: Normal operation
Face and bypass damper: Normal operation
Exhaust fan: Off</td></tr>
<tr><td>Outdoor Air Temp Failure[3]
(service required; nonlatching)</td><td rowspan="2">Space temperature control
Discharge air temperature control</td><td rowspan="2">Supply fan: Normal operation
Valves: Normal operation
DX cooling /Electric heat: Normal operation
Outdoor air damper: Minimum position[5]
Face and bypass damper: Normal operation
Exhaust fan: Normal operation</td></tr>
<tr><td>Mixed Air Temp Failure
(service required; nonlatching)</td></tr>
</table>

Table M-D-2 continued – Tracer AH540/541 diagnostics

Diagnostic	Configuration	Outputs
Space Temperature Failure (service required; nonlatching)	Discharge air temperature control	Supply fan: Normal operation Valves: Normal operation DX cooling/Electric heat: Normal operation Outdoor air damper: Normal operation Face and bypass damper: Normal operation Exhaust fan: Normal operation
Humidity Input Failure (service required; nonlatching)		
Duct Static Press Failure (informational; nonlatching)	Discharge air temperature control	
Humidity Input Failure[2] (critical or service required; nonlatching)	Space temperature control	
Entering Water Temp Failure[2, 6] (critical or service required; nonlatching)		
Local Space Setpoint Failure (service required; nonlatching)	Space temperature control Discharge air temperature control	
Dirty Filter (informational; nonlatching)		
Maintenance Required (informational; latching)		
Local Fan Switch Failure (informational; latching)		
CO_2 Sensor Failure (informational; nonlatching)		
Generic Temperature Failure (informational; nonlatching)		
Evaporator Refrigerant Temp Failure (informational; nonlatching)		
Normal (informational)		

1 If the freezestat device sending the Low Temp Detect diagnostic requires a manual reset, first reset the freezestat device and then reset the controller.
2 This diagnostic can be configured as a service required alarm or a critical alarm.
3 When a local temperature, setpoint, or pressure sensor has failed after being valid, the controller generates a diagnostic to indicate the sensor loss condition. Because this is a latching diagnostic, the controller automatically clears the diagnostic once a valid sensor value is present.
4 A Space Temperature Failure diagnostic disables morning and daytime warm-up sequence of operation when the controller is configured for constant volume discharge air control or variable-air-volume control.
5 If the outdoor air temperature sensor or the mixed-air sensor fails or is not present, economizer operation is disabled and the outdoor air damper is opened to its minimum position.
6 If the entering water temperature sensor fails, Tracer AH540/541 operation will default to heating mode.

Troubleshooting

Use Tables M-T-1 through M-T-7 to assist diagnosis of the following operational problems you might have with the Tracer AH540/541 controller:

- Fans do not energize
- Valves stay closed
- Outdoor air damper stays open
- Outdoor air damper stays closed
- DX cooling binary outputs do not energize
- Electric heat binary outputs do not energize

Table M-T-1. Fan outputs do not energize

Probable cause	Explanation
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off until one of two conditions occurs: The controller exits power-up control wait when it receives communicated information. The controller exits power-up control wait when the power-up control wait time expires.
Unoccupied operation	When the controller is in the unoccupied mode, the fan is cycled between high speed and Off with capacity to maintain zone temperature control.
Fan mode Off	When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the Off position controls the unit Off.
Requested mode Off	You can communicate a desired operating mode (such as Off, Heat, and Cool) to the controller. When Off is communicated to the controller, the unit controls the fan Off. There is no heating or cooling.
Diagnostic present	Specific diagnostics affect fan operation. For more information, see Table 63
No power to the controller	If the controller does not have power, the unit fan does not operate. For the controller to operate normally, it must have an input voltage of 24 Vac. When the green LED is Off continuously, the controller does not have sufficient power or has failed.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the fan may not work correctly.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the unit fan may not be on. Refer to “Performing a manual output test”
Unit wiring	The wiring between the controller outputs and the fan relays and contacts must be present and correct for normal fan operation.

Table M-T-2. Valves stay open

Probable cause	Explanation
Normal operation	The controller opens and closes the valves to meet the unit capacity requirements.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the valve(s) may be open. Refer to “Performing a manual output test”.
Freeze avoidance	When the controller is in the unoccupied mode with no demand for capacity (0%) and the outdoor air temperature is below the freeze avoidance setpoint, the controller opens the water valves (100%) and the face and bypass damper to prevent coil freezing.
Diagnostic present	Specific diagnostics affect valve operation. For more information, see Table 63.
No power to the controller	If the controller does not have power, a normally open valve remains open. For the controller or valve to operate normally, it must have an input voltage of 24 Vac. When the green LED is Off continuously, the controller does not have sufficient power or has failed.
No power to the valves	If the valve does not have power, a normally open valve remains open. The valves are powered separately from the controller’s output signal. If the valves do not have 24 Vac, the controller cannot operate the valves.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the valves may not work correctly.
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation.

Table M-T-3. Valves stay closed

Probable cause	Explanation
Requested mode Off	You can communicate a desired operating mode (such as Off, Heat, and Cool) to the controller. When Off is communicated to the controller, the unit controls the fan Off. There is no heating or cooling (valves are closed).
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off until one of two conditions occurs: The controller exits power-up control wait when it receives communicated information. The controller exits power-up control wait when the power-up control wait time expires.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the valve(s) may not be open. Refer to "Performing a manual output test".
Fan mode Off	When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the Off position controls the unit Off and closes the valves.
Diagnostic present	Specific diagnostics affect valve operation. For more information, see Table 63.
No power to the controller	If the controller does not have power, a normally open valve remains closed. For the controller or valve to operate normally, it must have an input voltage of 24 Vac. When the green LED is Off continuously, the controller does not have sufficient power or has failed.
No power to the valves	If the valve does not have power, a normally open valve remains closed. The valves are powered separately from the controller's output signal. If the valves do not have 24 Vac, the controller cannot operate the valves.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the valves may not work correctly.
Unit wiring	The wiring between the controller outputs and the valve(s) must be present and correct for normal valve operation.

Table M-T-4. Outdoor air damper stays open

Probable Cause	Explanation
Normal operation	The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan operation. Normally, the outdoor air damper is open during occupied, occupied standby, and occupied bypass mode when the fan is running and closed during unoccupied mode unless the controller is economizing. Refer to "Outdoor air damper operation".
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the outdoor air damper may be open. Refer to "Performing a manual output test".
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the outdoor air damper may not work correctly.
Unit wiring	The wiring between the controller outputs and the outdoor air damper must be present and correct for normal outdoor air damper operation.

Table M-T-5. Outdoor air damper stays closed

Probable cause	Explanation
Normal operation	The controller opens and closes the outdoor air damper based on the controller's occupancy mode and fan operation. Normally, the outdoor air damper is open during occupied, occupied standby, and occupied bypass mode when the fan is running and closed during unoccupied mode unless the controller is economizing. Refer to "Outdoor air damper operation".
Warm-up and cool down	The controller includes both a morning warm-up and cool down sequence to keep the outdoor air damper closed during the transition from unoccupied to occupied. This sequence is an attempt to bring the space under control as quickly as possible.
Unoccupied mode	When the controller is in the unoccupied mode, the outdoor air damper remains closed unless economizing is enabled.
Low ambient damper lock out	When the outdoor air temperature is less than the low ambient damper lockout setpoint (which can be changed with the Rover service tool), the outdoor air damper is closed.
Requested mode Off	You can communicate a desired operating mode (such as Off, Heat, and Cool) to the controller. When Off is communicated to the controller, the unit controls the fan Off. There is no heating or cooling (valves are closed). The outdoor air damper is closed.
Power-up control wait	When power-up control wait is enabled (non-zero time), the controller remains Off until one of two conditions occurs: The controller exits power-up control wait when it receives communicated information. The controller exits power-up control wait when the power-up control wait time expires.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the outdoor air damper may not be open. Refer to "Performing a manual output test".
Fan mode Off	When a zone sensor fan mode switch determines the fan operation, the Off position controls the unit Off and closes the outdoor air damper.
No power to the controller	If the controller does not have power, the unit fan does not operate. For the controller to operate normally, it must have an input voltage of 24 Vac. When the green status LED is Off continuously, the controller does not have sufficient power or has failed.
Diagnostic present	Specific diagnostics affect outdoor air operation. For more information, see Table 64.
No power to the damper actuator	If the outdoor air damper actuator does not have power, a normally open damper remains closed. The damper actuator is powered separately from the controller's output signal. If the damper actuator does not have 24 Vac, the controller cannot operate the outdoor air damper.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, the outdoor air damper may not work correctly.
Unit wiring	The wiring between the controller outputs and the outdoor air damper must be present and correct for normal damper operation.

Table M-T-6. DX cooling binary outputs do not energize

Probable cause	Explanation
Normal operation	The controller energizes the DX cooling binary output during cooling modes of operation. If low evaporator refrigerant temperature or coil defrost status binary input can disable DX compressor operation until the condition is removed. DX cooling is also suspended if the outdoor air temperature is less than the compressor lockout setpoint. Mechanical cooling lockout can also be enforced through the building automation system.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the DX cooling outputs could be Off. See the “Performing a manual output test”.
Fan mode Off	When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the Off position controls the unit Off and turns Off all outputs.
Diagnostic present	Specific diagnostics affect DX cooling operation. For more information, see Table
No power to the controller	If the controller does not have power, a binary output remains de-energized. For the controller or outputs to operate normally, it must have an input voltage of 24 Vac. When the green Status LED is Off continuously, the controller does not have sufficient power or has failed.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, DX cooling outputs may not work correctly. See Table 34 on page 75 and Table 39.
Unit wiring	The wiring between the controller outputs and the compressor contactors must be present and correct for normal DX cooling operation.

Table M-T-7. Electric heat binary outputs do not energize

Probable cause	Explanation
Normal operation	The controller energizes the electric heat binary outputs during heating and dehumidification modes of operation. Two pipe changeover unit configurations with hydronic heating available will disable electric heat operation. Mechanical heating lockout can also be enforced through the building automation system.
Manual output test	The controller includes a manual output test sequence you can use to verify output operation and associated output wiring. However, based on the current step in the test sequence, the electric heat outputs could be Off. See the "Performing a manual output test".
Fan mode Off	When a local fan mode switch (provided on the Trane zone sensor) determines the fan operation, the Off position controls the unit Off and turns Off all outputs.
Diagnostic present	Specific diagnostics affect electric heat operation. For more information, see Table 6
No power to the controller	If the controller does not have power, a binary output remains de-energized. For the controller or outputs to operate normally, it must have an input voltage of 24 Vac. When the green Status LED is Off continuously, the controller does not have sufficient power or has failed.
Unit configuration	The controller must be properly configured based on the actual installed end devices and application. When the unit configuration does not match the actual end devices, electric heat outputs may not work correctly. See Table 34.
Unit wiring	The wiring between the controller outputs and the compressor contactors must be present and correct for normal electric heat operation.

Maintenance Procedures

Perform the following maintenance procedures to ensure proper unit operation.

⚠ *WARNING*

Live Electrical Components!

During installation, testing, servicing, and troubleshooting this equipment, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who is properly trained in handling live electrical components perform these tasks. Failure to follow all electrical components could result in death or serious injury.

⚠ WARNING

Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided by Trane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

Air Filters

Reference unit air filter sizes in Table I-GI-1. Always install filters with directional arrows pointing toward the fan.

Fan Motors

Inspect fan motors periodically for excessive vibration or temperature. Operating conditions will vary the frequency of inspection and lubrication. Motor lubrication instructions are on the motor tag or nameplate. If for some reason these instructions are not available, contact the motor manufacturer. Some motor manufacturers may not provide oil tubes on motors with permanently sealed bearings.

Lubricating the Motor

Before lubricating the motor:

1. Turn the motor off and disconnect power to the unit to ensure the motor doesn't accidentally start.
2. Use a No. 10 SAE, non-detergent automotive type oil. Do not over-oil.

Fan Bearings

Fan bearings are permanently lubricated and do not require additional lubrication.

Sheave Alignment

To prevent interference of the fan frame with the belt, make sure that the belt edge closes to the motor has the proper clearance from the fan frame as shown in Figure M-MP-1.

Align the fan and motor sheaves by using a straight-edge or taut string, as shown in Figure M-MP-1. The straight-edge must be long enough to span the distance between the sheave outside edges. When the sheaves are aligned, the straigt-edge will touch both sheaves at points A through D, as shown in Figure M-MP-1. For uneven width sheaves, place a string in the center groove of both sheaves and pull tight. Adjust sheaves and tighten the sheave set screws to the correct torques recommended in Table M-MP-1.

Fan Assembly Set Screws

Check and adjust fan wheel, bearing, and sheave set screws whenever a component is removed or an adjustment is made. Refer to Table M-MP-1 for recommendations.

Fan Belt Tension

Proper belt tension is necessary to endure maximum bearing and drive component life and is based on fan brake horsepower requirements. Replace belt when frayed or worn.

Fan belt tension should only be tight enough so the belt does not slip and maintains adequate airflow.

Note: Check fan belt tension at least twice during the first days of new belt operation since there is a rapid decrease in tension until belts are run-in.

Be careful not to over-tension fan belt. Excessive tension will reduce fan and motor bearing life, accelerate belt wear, and possibly cause shaft failure. Clean the sheaves and belt with a dry cloth. Keep oil and grease away from the belt because they may cause belt deterioration and slippage. Trane does not recommend belt dressing.

CAUTION

Belt Tension!

Do not over-tension belts. Excessive belt tension will reduce fan and motor bearing life, accelerate belt wear and possibly cause shaft failure.

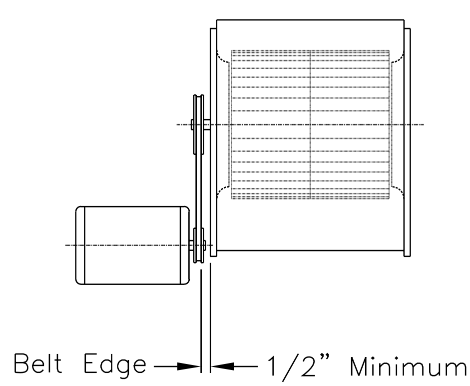


Figure M-MP-1. Proper sheave clearance and alignment.

Coil Maintenance

Keep coils clean to maintain maximum performance. For operation at its highest efficiency, clean the coil often during periods of high demand or when dirty conditions prevail. Clean the coil a minimum of once a year to prevent dirt buildup in the coil fins, where it may not be visible.

Remove large debris from the coils and straighten fins before cleaning. Remove filters before cleaning.

Clean the coil fins using steam with detergent, hot water spray and detergent, or a commercially available chemical coil cleaner. Be sure to rinse coils thoroughly after cleaning.

WARNING

Hazardous Chemicals!

Coil cleaning agents can be either acidic or highly alkaline. Handle chemical carefully. Proper handling should include goggles or face shield, chemical resistant gloves, boots, apron or suit as required. For personal safety refer to the cleaning agent manufacturer's Materials Safety Data Sheet and follow all recommended safe handling practices. Failure to follow all safety instructions could result in death or serious injury.

Inspecting and Cleaning Coils

Coils become externally fouled as a result of normal operation. Dirt on the coil surface reduces it's ability to transfer heat that can result in comfort problems, increased airflow resistance and thus increased operating energy costs. If the coil surface dirt becomes wet, which commonly occurs with cooling coils, microbial growth (mold) may result, causing unpleasant odors and serious health-related indoor air quality problems.

Inspect coils at least every six months or more frequently as dictated by operating experience. Cleaning frequently is dependent upon system operating hours, filter maintenance, and efficiency and dirt load. Follow the suggested methods in the following paragraphs.

Steam and Hydronic Coil Cleaning Procedure

1. Disconnect all electrical power to the unit.
2. Don the appropriate personal protective equipment (PPE).
3. Gain access to both sides of the coil.
4. Use a soft brush to remove loose debris from both sides of the coil.
5. Use a steam cleaning machine, starting from the top of the coil and working downward. Clean the leaving air side of the coil first, then the entering air side. Use a block-off to prevent steam from blowing through the coil and into a dry section of the unit.
6. Repeat step 5 as necessary. Confirm that the drain line is open following completion of the cleaning process.
7. Allow the unit to dry thoroughly before putting the system back into service.
8. Straighten any coil fins that may be damaged with a fin rake.
9. Replace all panels and parts and restore electrical power to the unit.
10. Ensure that contaminated material does not contact other areas of the unit or building. Properly dispose of all contaminated materials and cleaning solutions.

Winterizing the Coil

Make provisions to drain coils that are not in use, especially when subjected to freezing temperatures.

To drain the coil, first blow out the coil with compressed air. Next, fill and drain the tubes with full-strength ethylene glycol several times. Then drain the coil as completely as possible.

CAUTION

Coil Freeze-up Damage!

Failure to properly drain and vent coils when not in use during freezing temperatures may result in coil freeze-up damage.

Refrigerant Coil Cleaning Procedure

1. Disconnect all electrical power to the unit.
2. Wearing the appropriate personal protective equipment, use a soft brush to remove loose debris from both sides of the coil.
3. Install a block-off to prevent spray from going through the coil and into a dry section of the unit and/or system ductwork.

WARNING

Hazardous Pressures!

Coils contain refrigerant under pressure. When cleaning coils, maintain coil cleaning solution temperature under 150°F to avoid excessive pressure in the coil. Failure to follow these safety precautions could result in coil bursting, which could result in death or serious injury.

4. Mix a high-quality coil cleaning detergent with water according to the manufacturer's instructions.

Note: If the detergent is strongly alkaline after mixing (pH of 8.5 or higher), it must contain an inhibitor. Follow the cleaning solution manufactuer's instructions regarding the use of the product.

5. Place the mixed solution in a garden pump-up sprayer or high-pressure sprayer. If using a high-pressure sprayer, follow these guidelines:
   - maintain minimum nozzle spray angle of 15 degrees
   - spray perpendicular to the coil face
   - keep the nozzle at least six inches from the coil
   - do not exceed 600 psi
6. Spray the leaving air side of the coil first, then the entering air side.
7. Thoroughly rinse both sides of the coil and drain pan with cool, clean water.
8. Repeat steps 6 and 7 as necessary.
9. Straighten any coil fins damaged during the cleaning process.
10. Confirm the drain line is open following the cleaning process.
11. Allow the unit to dry thoroughly before putting it back into service.
12. Replace al panels and parts and restore electrical power to the unit.
13. Do not allow contaminated material to contact other areas of the unit or building. Properly dispose of all contaminated materials and cleaning solution.

Periodic Maintenance Checklists

Monthly Checklist

The following check list provides the recommended maintenance schedule to keep the unit running efficiently.

⚠ *WARNING*

Live Electrical Components!

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⚠ WARNING

Hazardous Voltage w/Capacitors!

Disconnect all electric power, including remote disconnects and discharge all motor start/run capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power cannot be inadvertently energized. For variable frequency drives or other energy storing components provided byTrane or others, refer to the appropriate manufacturer's literature for allowable waiting periods for discharge of capacitors. Verify with an appropriate voltmeter that all capacitors have discharged. Failure to disconnect power and discharge capacitors before servicing could result in death or serious injury.

1. Inspect unit air filters. Clean or replace if airflow is blocked or if filters are dirty.
2. Check the condition and tension of fan belts. Adjust tension if belts are floppy or squeal continually. Replace worn or fraying belts in matched sets.

Note: Check and adjust belt tension at least twice daily the first days of new belt operation. Belt tension will rapidly decrease until the belts are run in.

3. Re-lubricate motor bearings, if motor is fitted with oil tubes and operating conditions include moist or dirty air, continuous duty and/or high temperatures.

Semi-Annual Maintenance

1. Verify the fan motor is properly lubricated. Follow lubrication recommendations on the motor tag or nameplate. Contact the motor manufacturer for more information.
2. Check bearing locking collar and sheave set screws for proper tightness.
3. With power disconnected, manually rotate the fan wheel to check for obstructions in the housing or interference with fan blades. Remove any obstructions and debris.
4. Check the fan assembly sheave alignment.Tighten set screws to their proper torques.
5 Check fan belt tension. Adjust the belt if it is slipping. Replace if belt is worn or frayed.
6. Inspect the coils for dirt build-up. Clean fins if airflow is clogged.

Annual Maintenance

Check and tighten all set screws, bolts, locking collars and sheaves.

1. Inspect, clean, and tighten all electrical connections and wiring.
2. Visually inspect the entire unit casing for chips or corrosion. Remove rust or corrosion and repaint surfaces.
3. Clean fan wheels and fan shaft. Remove any rust from the fan shaft with an emergy cloth and recoat with L.P.S. 3 or equivalent.
4. Inspect the drainpan for sludge or other foreign material. Clear the drain openings and drain line to ensure adequate flow.
5. Rotate the fan wheel and check for obstructions in the fan housing.The wheel should not rub on the fan housing or cutoff. Adjust to center if necessary and tighten the wheel set screws per torque recommendations in Table M-A-1.
6. Examine flex connector for cracks or leaks.
7. Repair or replace any damaged duct material.

Note: Reference the Appendix for recommended torques for tightening sheaves, bearing thrust collar, belt, bearing mounting bolts, sheave set screw, sheave bushing cap and damper linkage components.

Instructions for Changing Out Spring Isolators on LPC

Unit Sizes 3 through 10:
Units ranging in size from 3 to 10 use a 1″ defelection isolator assembly like the one shown in the figure below. Lateral movement is limited by the snubber bolt. The spring is supported at the bottom by the isolator bracket, but the two are not mechanically attached to one another.
To change out the spring in this type of assembly perform the following steps:

1. Disconnect power to the unit.
2. Loosen the lock nuts on the snubber bolts for all four corners. Remove the lock nut the spring that needs to be removed.
3. Elevate the isolation base so that the weight of the fan and mtor is removed from the spring. The picture shown below is of an unloaded spring with the isolation base held up by blocks.
4. Loosen the flange nut at the base of the snubber bolt from rotating while loosening the flange nut.
5. Remove the nuts that were cinched together in the step above. As the flange nit is being loosened, the snubber bolt should drop down inside the isolator bracket.
6. Push the snubber bolt down though the isolation base into the isolation bracket as far as it will go. This should allow some space between the end of the snubber bolt and the isolation base.
7. Remove old spring and replace with new one.
8. Tighten flange nut until snubber bolt is back to its original position. The nuts that were cinched together in step 3 may be needed again to prevent the bolt from rotating while the flange nut is being tightened.
9. Replace washers and lock nut.
10. Remove blacoks holding up the isolation base and tighten all lock nuts to their original postion so that isolation assembly is level.

Unit Sizes 12 through 30:

Units ranging in size from 12 to 30 use a 2″ deflection isolator assembly like the one shown in the picture below. Lateral movement is limited by snubber brackets (not shown). The spring is supported at the bottom by the isolator bracket, but the two are not mechanically attached toone another. Another identical isolator bracket is inverted and is located above the spring. An adjustment bolt runs thro9ugh theh top bracket and pushed against athe sping cap resting on the top of the spring. To change out the spring in this tupe of assembly perform the following steps:

1. Disconnect power from the unit
2. Loosen and remove the adjustment bolt
3. Remove the sping cap and spring
4. In some cases there is not enough clearance between the top isolator bracket andthe cabinet to allow the spring mounting screws. Be sure the isolation base is secured or elevated with blocks before removing the top bracket
5. Replace old spring with a new one and also replace the spring cap
6. Reattch top isolator bracket if removed in step 3
7. Return adjustment bolt to its original position so that the isolation base assembly is level

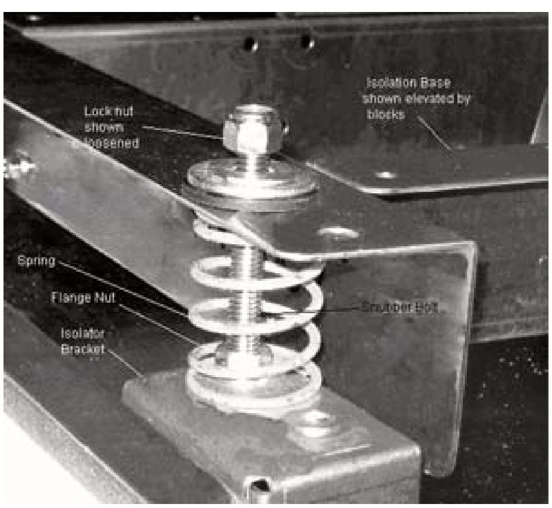


Figure M-MP-2. One-inch Deflection Isolator Assembly

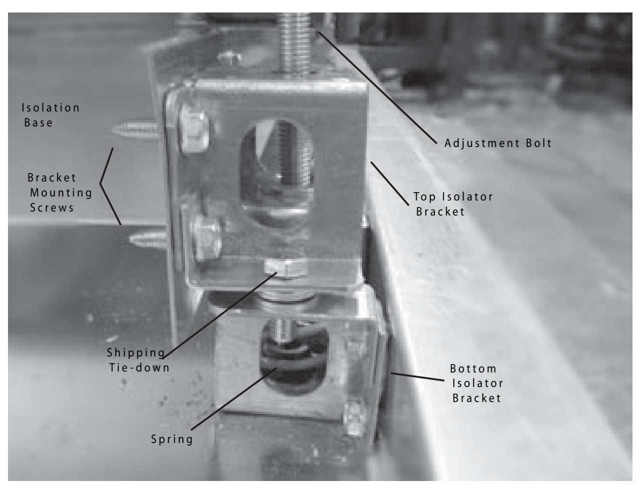
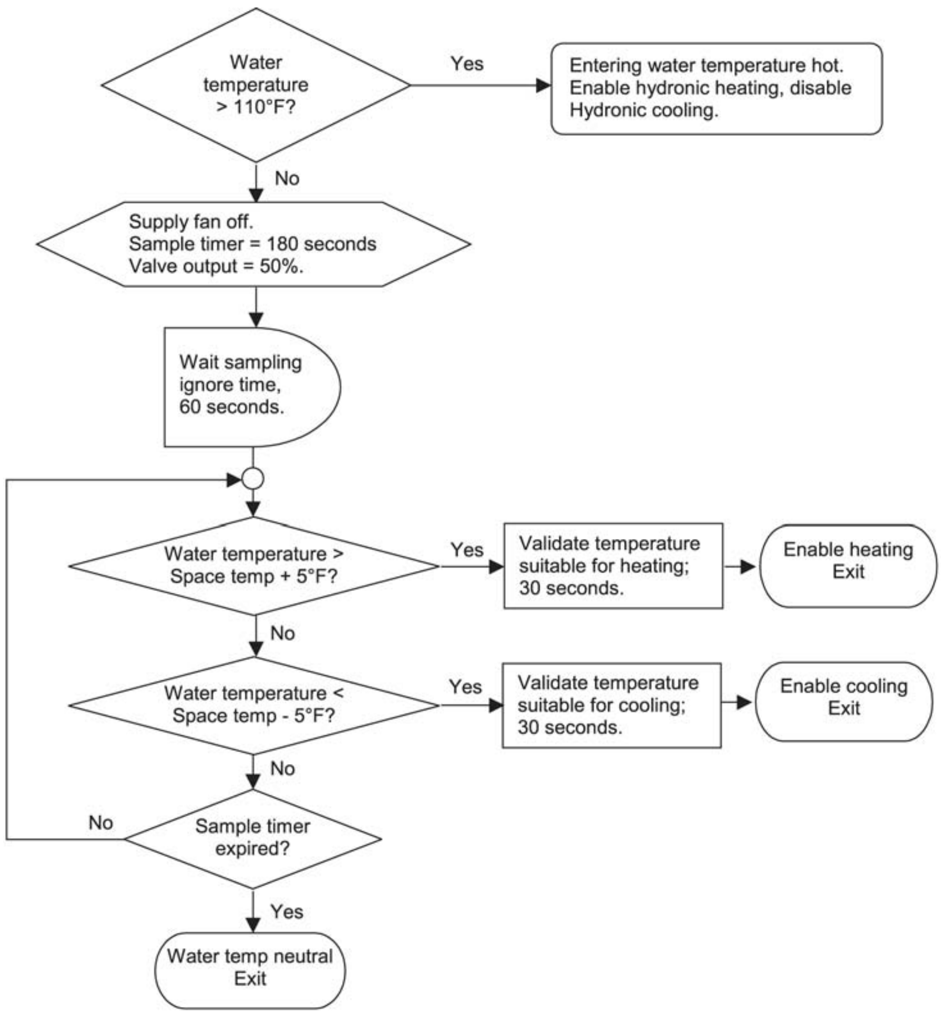


Figure M-MP-3. Two-inch Deflection Isolator Assembly

Entering Water Temperature Sampling Function

Figure M-A-1. Flowchart



Maintenance appendix

Input Sensor Tables

Table M-A-2. Trane zone sensor hard-wired setpoint thumbwheel

Setpoint	Resistance
50°F (10.0°C)	889.4
58°F (14.4°C)	733.6
66°F (18.9°C)	577.9
70°F (21.1°C)	500.0
74°F (23.3°C)	422.1
78°F (25.6°C)	344.2
82°F (27.8°C)	266.4
86°F (30.0°C)	188.5
90°F (32.2°C)	110.6

Table M-A-3. Hard-wired 10 kΩ thermistor values

Temperature	Resistance (k)	Temperature (continued)	Resistance (k) (continued)
0°F (17.8°C)	87.5	77°F (25.0°C)	10.0
5°F (-15.0°C)	74.6	80°F (26.7°C)	9.3
10°F (-12.2°C)	63.8	85°F (29.4°C)	8.2
15°F (9.4°C)	54.6	90°F (32.2°C)	7.3
20°F (6.7°C)	46.9	95°F (35.0°C)	6.5
25°F (3.9°C)	40.4	100°F (37.8°C)	5.8
30°F (-1.1°C)	34.8	105°F (40.6°C)	5.2
35°F (1.7°C)	30.2	110°F (43.3°C)	4.7
40°F (4.4°C)	26.2	115°F (46.1°C)	4.2
45°F (7.2°C)	22.8	120°F (48.9°C)	3.8
50°F (10.0°C)	20.0	125°F (51.7°C)	3.4
55°F (12.8°C)	17.5	130°F (54.4°C)	3.1
60°F (15.6°C)	15.3	135°F (57.2°C)	2.8
65°F (18.3°C)	13.5	140°F (60.0°C)	2.5
70°F (21.1°C)	11.9	145°F (62.8°C)	2.3
75°F (23.9°C)	10.5	150°F (65.6°C)	2.1

Table M-A-4. Hard-wired 1kΩ mixed-air sensor

Temperature	Resistance (k)	Temperature (continued)	Resistance (k) (continued)
0°F (-17.8°C)	930.3	77°F (25.0°C)	1097.3
5°F (-15.0°C)	941.2	80°F (26.7°C)	1103.8
10°F (-12.2°C)	952.1	85°F (29.4°C)	1114.6
15°F (-9.4°C)	963.0	90°F (32.2°C)	1125.3
20°F (-6.7°C)	973.9	95°F (35.0°C)	1136.1
25°F (-3.9°C)	984.8	100°F (37.8°C)	1146.8
30°F (-1.1°C)	995.7	105°F (40.6°C)	1157.5
32°F (0.0°C)	1000.0	110°F (43.3°C)	1168.3
35°F (1.7°C)	1006.5	115°F (46.1°C)	1179.0
40°F (4.4°C)	1017.4	120°F (48.9°C)	1189.7
45°F (7.2°C)	1028.2	125°F (51.7°C)	1200.4
50°F (10.0°C)	1039.0	130°F (54.4°C)	1211.0
55°F (12.8°C)	1049.8	135°F (57.2°C)	1221.7
60°F (15.6°C)	1060.7	140°F (60.0°C)	1232.4
65°F (18.3°C)	1071.5	145°F (62.8°C)	1243.0
70°F (21.1°C)	1082.2	150°F (65.6°C)	1253.7
75°F (23.9°C)	1093.0		

Table M-A-5. Hard-wired relative humidity sensor values

Current (mA)	Relative humidity (%)	Relative humidity (%)	Current (mA)
4	0	0	4
5	6.3	10	5.6
6	12.5	20	7.2
7	18.8	30	8.8
8	25	40	10.4
9	31.3	50	12
10	37.5	60	13.6
11	43.8	70	15.2
12	50	80	16.8
13	56.3	90	18.4
14	62.5	100	20
15	68.8		
16	75		
17	81.3		
18	87.5		
19	93.8		
20	100		

Table M-A-6. Hard-wired CO_2 sensor values

Current (mA)	CO_2 (ppm)
4	0
5	125
6	250
7	375
8	500
9	625
10	750
11	875
12	1000
13	1125
14	1250
15	1375
16	1500
17	1625
18	1750
19	1875
20	2000

Current (mA)	CO_2 (ppm)
4	0
5.6	200
7.2	400
8.8	600
10.4	800
12	1000
13.6	1200
15.2	1400
16.8	1600
18.4	1800
20	2000

Maintenance appendix

Table M-A-7. Recommended Torques for Tightening Bearings Thrust Collar

unit	SKF			Browning			NTN		
size	in-lbs	ft-lbs	N-m	in-lbs	ft-lbs	N-m	in-lbs	ft-lbs	N-m
3	66 - 80	5.5 - 6.7	7.5 - 9.0	66 - 85	5.5 - 7.1	7.5 - 9.6	N/A	N/A	N/A
6	66 - 80	5.5 - 6.7	7.5 - 9.0	66 - 85	5.5 - 7.1	7.5 - 9.6	N/A	N/A	N/A
8	66 - 80	5.5 - 6.7	7.5 - 9.0	66 - 85	5.5 - 7.1	7.5 - 9.6	N/A	N/A	N/A
10	66 - 80	5.5 - 6.7	7.5 - 9.0	66 - 85	5.5 - 7.1	7.5 - 9.6	N/A	N/A	N/A
12	87	7.25	9.83	N/A	N/A	N/A	43	3.58	4.86
14	87	7.25	9.83	N/A	N/A	N/A	43	3.58	4.86
17	165	13.75	18.64	N/A	N/A	N/A	52	4.33	5.88
21	165	13.75	18.64	N/A	N/A	N/A	69	5.75	7.80

Table M-A-8 Minimum Torques for Bearing Mounting Bolts, Belt Tightening Bolts and Motor Mounting Bolts

Size	Inch Lbs.	Foot Lbs.	N-m
1/40-20	72	6	8.13
5/16-18	168	14	18.98
3/8-16	288	24	32.54
7/16-14	504	42	56.94
1/2-13	828	69	93.55

Note: all torque values are +/- 5%.

Table M-A-9. Sheave Set Screw Torque Recommendations

Screw Diameter (in.)	0.313	0.313
Screw Diameter (cm)	0.795	0.795
Screw Length (in.)	</= 0.250	>/= 0.313
Screw Length (cm)	</= 0.635	>/= 0.795
Torque (Inch Lbs)	90	165
Torque (Foot Lbs)	7.5	13.75
Torque (N-m)	10.17	18.64

Note: all torque values are +/- 5%.

Table M-A-10. Sheave Bushing Cap Screw Torque Recommendations

Screw Diameter (in.)	0.25	0.313	0.375
Screw Diameter (cm)	0.635	0.795	0.953
Torque (Inch Lbs)	95	192	348
Torque (Foot Lbs)	7.92	16	29
Torque (N-m)	10.73	21.69	39.32

Note: all torque values are +/- 5%.

Table M-A-11. Minimum Recommended Torques for Damper Linkage Components

Item	Torque		
	Inch Lbs.	Foot Lbs.	N-m
Square head set screw - 1/4 - 20	90	7.50	10.17
Hex head set screw - 1/4 - 20	65	5.42	7.34
Hex head set screw - 5/16 - 24	144	12.00	16.27
Ball joint set screw - 1/4 - 28 thread	40	3.33	4.52
Ball joint set screw - 5/16 - 24	144	12.00	16.27

Note: all torque values are +/- 5%.

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