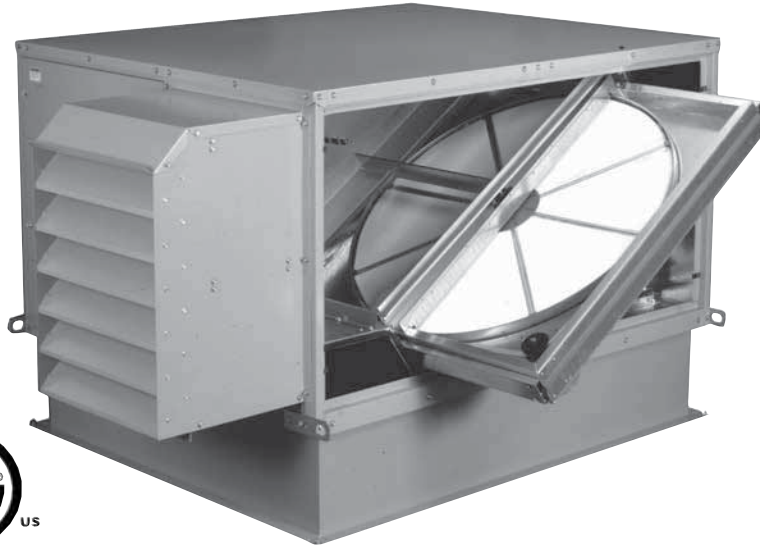


## Installation, Operation and Maintenance Manual

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

**Models:** ERV-251  
ERV-361  
ERV-521  
ERV-581  
ERV-522  
ERV-582



### General Safety Information

Only qualified personnel should install this system. Personnel should have a clear understanding of these instructions and should be aware of general safety precautions. Improper installation can result in electric shock, possible injury due to coming in contact with moving parts, as well as other potential hazards. Other considerations may be required if high winds or seismic activity are present. If more information is needed, contact a licensed professional engineer before moving forward.

#### **DANGER**

Always disconnect power before working on or near this equipment. Lock and tag the disconnect switch or breaker to prevent accidental power up.

#### **CAUTION**

When servicing the unit, the internal components may be hot enough to cause pain or injury. Allow time for cooling before servicing.

#### **CAUTION**

Precaution should be taken in explosive atmospheres.

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC), the National Fire Protection Agency (NFPA), where applicable. Follow the Canadian Electrical Code (CEC) in Canada.
2. All moving parts must be free to rotate without striking or rubbing any stationary objects.
3. Unit must be securely and adequately grounded.
4. Do not spin fan wheel faster than maximum cataloged fan RPM. Adjustments to fan speed significantly effects motor load. If the fan RPM is changed, the motor current should be checked to make sure it is not exceeding the motor nameplate amps.
5. Do not allow the power cable to kink or come in contact with oil, grease, hot surfaces or chemicals. Replace cord immediately if damaged.
6. Verify that the power source is compatible with the equipment.
7. Never open access doors to the unit while it is running.

## Receiving

Upon receiving the product, check to make sure all items are accounted for by referencing the bill of lading to ensure all items were received. Inspect each crate for shipping damage before accepting delivery. Notify the carrier if any damage is noticed. The carrier will make notification on the delivery receipt acknowledging any damage to the product. All damage should be noted on all the copies of the bill of lading which is countersigned by the delivering carrier. A Carrier Inspection Report should be filled out by the carrier upon arrival and the Traffic Department. If damaged upon arrival, file claim with carrier. Any physical damage to the unit after acceptance is not the responsibility of Greenheck Fan Corporation.

## Unpacking

Verify that all required parts and the correct quantity of each item have been received. If any items are missing report shortages to your local representative to arrange for obtaining missing parts. Sometimes it is not possible that all items for the unit be shipped together due to availability of transportation and truck space. Confirmation of shipment(s) must be limited to only items on the bill of lading.

## Handling

Units are to be rigged and moved by the lifting brackets provided or by the skid when a forklift is used. Location of brackets varies by model and size. Handle each piece in such a manner as to keep from scratching or chipping the coating. Damaged finish may reduce ability of the unit to resist corrosion.

## Storage

Units are protected against damage during shipment. If the unit cannot be installed and operated immediately, precautions need to be taken to prevent deterioration of the unit during storage. The user assumes responsibility of the unit and accessories while in storage. The manufacturer will not be responsible for damage during storage. These suggestions are provided solely as a convenience to the user.

## Inspection and Maintenance during Storage

While in storage, inspect units once per month. Keep a record of inspection and maintenance performed

If moisture or dirt accumulations are found on parts, the source should be located and eliminated. At each inspection, rotate all moving components by hand ten to fifteen revolutions to distribute lubricant on motor and bearings. If paint deterioration begins, consideration should be given to touch-up or repainting. Units with special coatings may require special techniques for touch-up or repair.

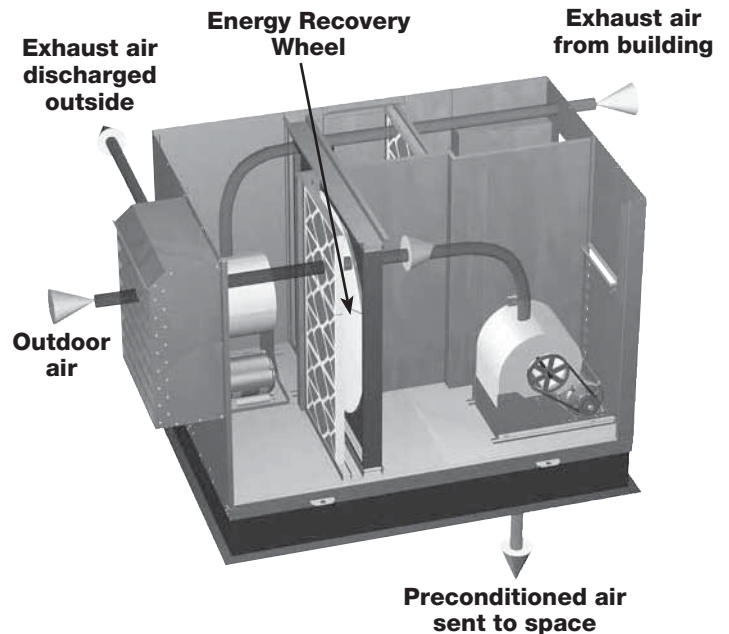
Machined parts coated with rust preventive should be restored to good condition promptly if signs of rust occur. Immediately remove the original rust preventive coating with petroleum solvent and clean with lint-free cloths. Polish any remaining rust from surface with crocus cloth or fine emery paper and oil. Do not destroy the continuity of the surfaces. Wipe clean thoroughly with Tectyl® 506 (Ashland Inc.) or the equivalent. For hard to reach internal surfaces or for occasional use, consider using Tectyl® 511M Rust Preventive or WD-40® or the equivalent.

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## Basic Operation

The ERV brings in fresh, outdoor air and removes stale, exhaust air. Prior to discharging the exhaust air, the energy recovery wheel transfers energy from the exhaust air to the outdoor air at an efficiency of 70-80%. Simply put, this unit preconditions the outdoor air to save money on heating and cooling costs.



## Supplemental Installation, Operation and Maintenance Manuals

Refer to the following Installation, Operation and Maintenance Manuals for additional details:

- Part #460988 – ERV-522 and ERV-582 Curbs
- Part #462844 – ERV Exhaust Weatherhood

## Installation

The system design and installation should follow accepted industry practice, such as described in the ASHRAE Handbook.

Adequate space should be left around the unit for filter replacement and maintenance. Sufficient space should be provided on the side of the unit for routine service and component removal should that become necessary.

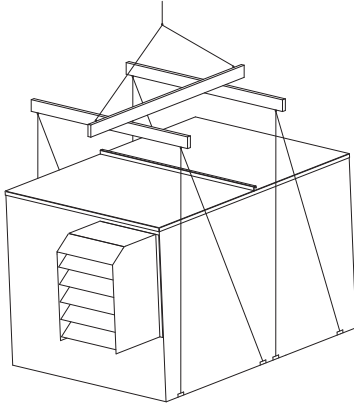
See Service Clearances and Access Panel Description sections for more details.

### WARNING

All factory provided lifting lugs must be used when lifting the unit. Failure to comply with this safety precaution could result in property damage, serious injury or death.

## Lifting

1. Before lifting, be sure that all shipping material has been removed from unit.
2. To assist in determining rigging requirements, weights are shown below.
3. Unit must be lifted by all lifting lugs provided on base structure.
4. Rigger to use suitable mating hardware to attach to unit lifting lugs.
5. Spreader bar(s) must span the unit to prevent damage to the cabinet by the lift cables.

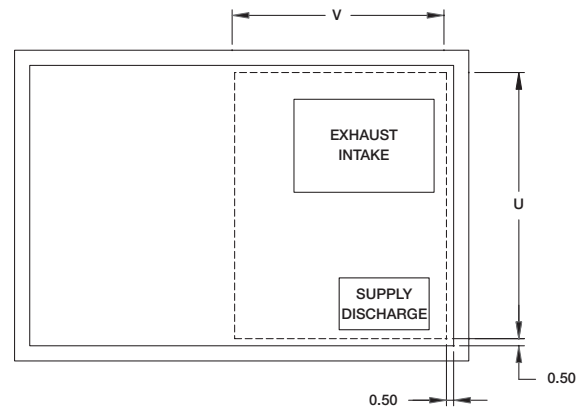


6. Always test-lift the unit to check for proper balance and rigging before hoisting to desired location.
7. Never lift units by weatherhoods.
8. Never lift units in windy conditions.
9. Preparation of curb and roof openings should be completed prior to lifting unit to the roof.
10. Check to be sure that gasketing (supplied by others) has been applied to the curb prior to lifting the unit and setting on curb.
11. Do not use fork lifts for handling unit.

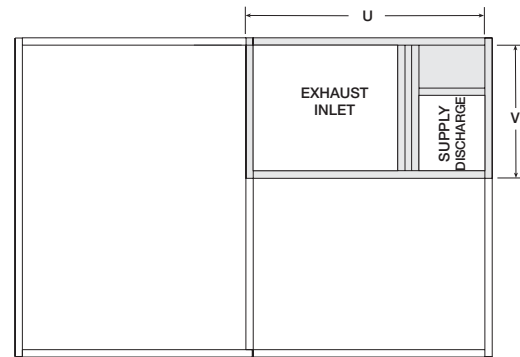
Unit Weights	
Unit Size	Approx. Weight (lbs)*
ERV-251	340
ERV-361	860
ERV-521	1290
ERV-581	1470
ERV-522	3230
ERV-582	3700

\*Weight assumes outdoor unit with filters, weatherhoods and outdoor air intake damper.

## Recommended Roof Opening



**ERV-251, 361, 521 and 581**



**ERV-522 and 582**

Position the unit roof opening such that the supply discharge and exhaust inlet of the unit will line up with the corresponding ductwork. Be sure to allow for the recommended service clearances when positioning opening

Unit Size	U	V
ERV-251	26.5	20
ERV-361	43	26
ERV-521	58	35
ERV-581	60	30
ERV-522	62	36
ERV-582	77	38

All dimensions are in inches.

(see Service Clearances). Do not face the outdoor air intake of the unit into prevailing wind and keep the intake away from any other exhaust fans. Likewise, position the exhaust discharge opening away from outdoor air intakes of any other equipment.

When cutting only duct openings, cut opening 1 inch (25mm) larger than duct size to allow clearance for installation. Area enclosed by roof curb must comply with clearance to combustible materials. If the roof is constructed of combustible materials, area within the roof curb must be ventilated, left open, or covered with non-combustible material which has an "R" value of at least 5. If area within curb is open, higher radiated sound levels may result.

Where the supply or warm air duct passes thru a combustible roof, a clearance of one inch must be maintained between the outside edges of the duct and combustible material in accordance with NFPA Standard 90A.

## Roof Curb Mounting

Roof curb details including duct location dimensions, are available on ERV-522 & 582 Roof Curb Assembly Instructions, Part #460988.

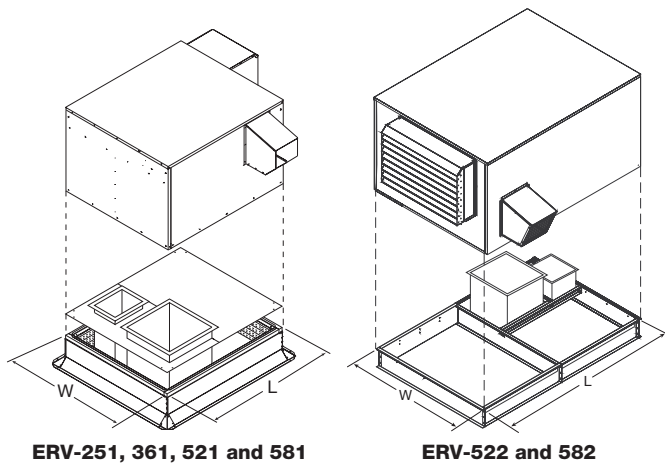
Rooftop units require curbs to be mounted first. The duct connections must be located so they will be clear of structural members of the building.

- 1. Factory Supplied Roof Curbs:** Roof curbs are Model GPI or GPNS for the ERV-251, 361, 521, 581. The GPI or GPNS ships assembled and includes a duct adapter.

Roof curbs are Model GKD for the ERV-522 and 582. The GKD ships in a knockdown kit (includes duct adapter) and requires field assembly (by others). Assembly instructions are included with the GKD curbs.

- 2. Install Curb:** Locate curb over roof opening and fasten in place. (Refer to Recommended Roof Openings). Check that the diagonal dimensions are within  $\pm 1/8$  inch of each other and adjust as necessary. For proper unit operation, it is important that the installation be level. Shim as required to level.
- 3. Install Ductwork:** Installation of all ducts should be done in accordance with SMACNA and AMCA guidelines. Duct adapter provided to support ducts prior to setting the unit.
- 4. Set the Unit:** Lift unit to a point directly above the curb and duct openings. Guide unit while lowering to align with duct openings. Roof curbs fit inside the unit base. Make sure the unit is properly seated on the curb and is level.

## Curb Outside Dimensions and Weights



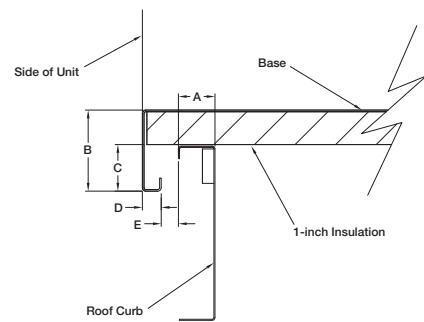
ERV-251, 361, 521 and 581

ERV-522 and 582

Unit Size	L	W	Curb Weight (lbs.)
ERV-251	42.5	30.5	60
ERV-361	58.5	47.5	115
ERV-521	63.5	63.5	160
ERV-581	71.8	66	185
ERV-522	120.5	80.5	520
ERV-582	142.25	93	700

All dimensions are in inches. Weights are for 12-inch high GPI type curbs.

## Curb Outside Dimensions - continued



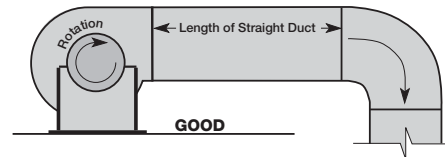
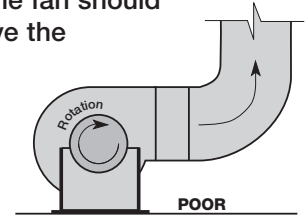
### Curb Cap Details for Factory Supplied Roof Curbs

Unit Size	A	B	C	D	E
ERV-251	1.75	2.00	1.00	1.125	0.750
ERV-361	1.75	2.00	1.00	1.200	0.875
ERV-521	1.75	2.00	1.00	0.813	0.875
ERV-581	1.75	2.00	1.00	0.813	0.750
ERV-522	1.813	4.00	1.75	1.000	0.750
ERV-582	1.938	4.125	1.938	1.125	0.625

All dimensions are in inches.

## Ductwork Connections

Examples of poor and good fan-to-duct connections are shown. Airflow out of the fan should be directed straight or curve the same direction as the fan wheel rotates. Poor duct installation will result in low airflow and other system effects.



Recommended Discharge Duct Size and Length			
Model	Blower Size	Duct Size	Straight Duct Length
ERV-251	10	9 x 9	36
ERV-361	10	14 x 14	36
ERV-521	12	20 x 20	36
ERV-581	15	28 x 28	60
ERV-522S	15	28 x 28	60
ERV-522H	18	32 x 32	60
ERV-582	20	34 x 34	72

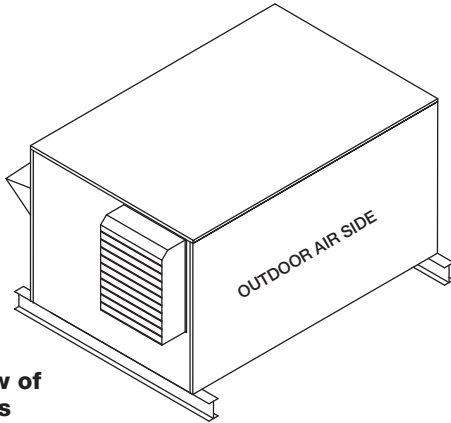
All dimensions shown in inches.

- Recommended duct sizes are based on velocities across the cfm range of each model at approximately 800 feet per minute (FPM) at minimum airflow and up to 1600 fpm at maximum airflow. Recommended duct sizes are only intended to be a guide and may not satisfy the requirements of the project. Refer to plans for appropriate job specific duct size and/or velocity limitations.
- Straight duct lengths were calculated based on 100% effective duct length requirements as prescribed in AMCA Publication 201. Calculated values have been rounded up to nearest foot.

## Rail Mounting / Layout

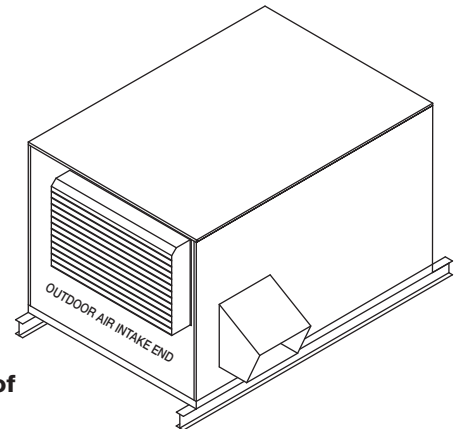
- Rails designed to handle the weight of the ERV should be positioned as shown on the diagram (rails by others).
- Make sure that rail positioning does not interfere with the supply air discharge opening or the exhaust air intake opening on the ERV unit. Avoid area dimensioned “B” below.
- Rails should extend beyond the unit a minimum of 12 inches on each side.
- Set unit on rails.

ERV-251  
ERV-361  
ERV-521  
ERV-581

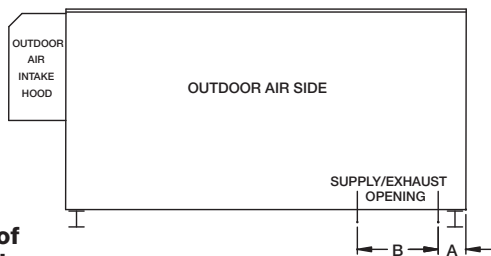


Isometric view of ERV on rails

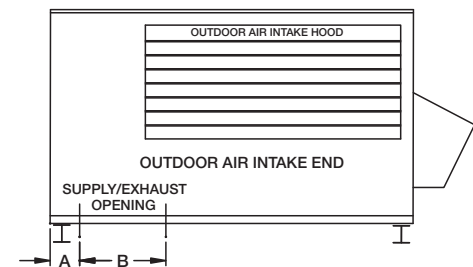
ERV-522  
ERV-582



Isometric view of ERV on rails



Side view of ERV on rails



Side view of ERV on rails

Unit Size	A	B
ERV-251	4.50	16
ERV-361	4.75	18
ERV-521	5.75	24
ERV-581	4.875	22

All dimensions are in inches.

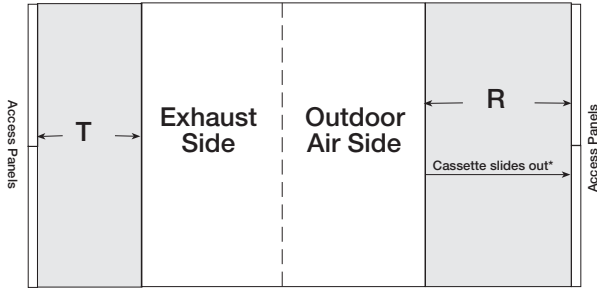
Unit Size	A	B
ERV-522	4.625	32
ERV-582	4.875	33.25

All dimensions are in inches.

# Service Clearances

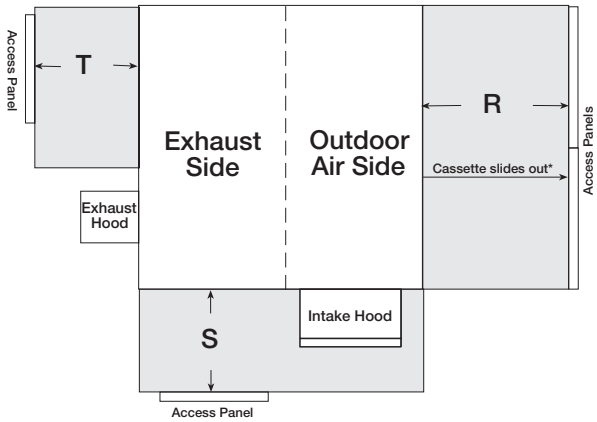
ERV-251, 361, 521 and 581 units require minimum clearances to perform routine maintenance, such as filter replacement, energy wheel cassette inspection, and fan belt adjustment. Blower and motor assemblies, energy recovery wheel cassette and filter sections are always provided with a service door or panel for proper component access. *Clearances for component removal may be greater than the service clearances, refer to drawings below for these dimensions.*

## ERV-251, ERV-361, ERV-521, ERV-581



\*ERV-251, 361, and 521 only.

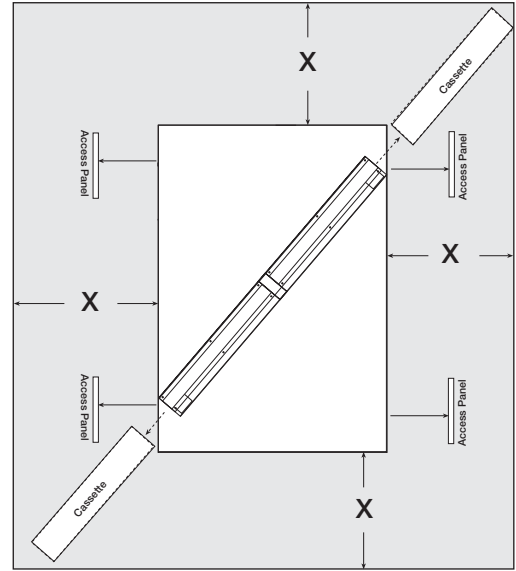
**Arrangement A**



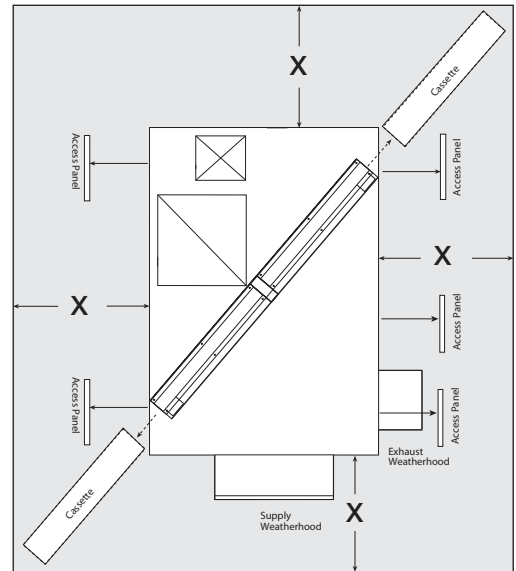
\*ERV-251, 361, and 521 only.

**Arrangement B, C or D**

## ERV-522, ERV-582



**Arrangement A**



**Arrangement B, C or D**

Recommended Service Clearances				
Unit Size	R	S	T	X
ERV-251	32	30	30	
ERV-361	44 (30 for maintenance)	30	30	
ERV-521	60 (39 for maintenance)	40	40	
ERV-581	65 (32 for maintenance)	40	40	
ERV-522				38
ERV-582				42

All dimensions are in inches.

## Electrical Information

The unit must be electrically grounded in accordance with the current National Electrical Code, ANSI/NFPA 70. In Canada, use current CSA Standard C22.1, Canadian Electrical Code, Part 1. In addition, the installer should be aware of any local ordinances or electrical company requirements that might apply. System power wiring must be properly fused and conform to the local and national electrical codes. System power wiring is to the unit main disconnect (door interlocking disconnect switch standard on most units) or distribution block and must be compatible with the ratings on the nameplate: supply power voltage, phase, and amperage (Minimum Circuit Amps - MCA, Maximum Overcurrent Protection - MOP). All wiring beyond this point has been done by the manufacturer and cannot be modified without affecting the unit's agency / safety certification.

If field installing an additional disconnect switch, it is recommended that there is at least four feet of service room between the switch and system access panels. When providing or replacing fuses in a fusible disconnect, use dual element time delay fuses and size according to the rating plate.

If power supply is desired through bottom of unit, run the wiring through the curb, cut a hole in the cabinet bottom, and wire to the disconnect switch. Seal penetration in cabinet bottom to prevent leakage.

The electric supply to the unit must meet stringent requirements for the system to operate properly. Voltage supply and voltage imbalance between phases should be within the following tolerances. If the power is not within these voltage tolerances, contact the power company prior to operating the system.

**Voltage Supply:** See voltage use range on the rating plate. Measure and record each supply leg voltage at all line disconnect switches. Readings must fall within the allowable range on the rating plate.

**Voltage Imbalance:** In a 3-phase system, excessive voltage imbalance between phases will cause motors to overheat and eventually fail. Maximum allowable imbalance is 2%. To determine voltage imbalance, use recorded voltage measurements in this formula.

**Key:** V1, V2, V3 = line voltages as measured  
 $VA$  (average) =  $(V1 + V2 + V3) / 3$   
VD = Line voltage (V1, V2 or V3) that deviates farthest from average (VA)

**Formula:** % Voltage Imbalance =  $[100 \times (VA - VD)] / VA$

## WARNING

To prevent injury or death due to electrocution or contact with moving parts, lock disconnect switch open.

Most factory supplied electrical components are prewired. To determine what electrical accessories require additional field wiring, refer to the unit specific wiring diagram located on the inside of the unit control center access door. The low voltage control circuit is 24 VAC and control wiring should not exceed 0.75 ohms.

Refer to Field Control Wiring Length/Gauge table for wire length maximums for a given wire gauge.

Field Control Wiring Length/Gauge	
Total Wire Length	Minimum Wire Gauge
125 ft.	18
200 ft.	16
300 ft.	14
450 ft.	12

Control wires should not be run inside the same conduit as that carrying the supply power. Make sure that field supplied conduit does not interfere with access panel operation.

If wire resistance exceeds 0.75 ohms, an industrial-style, plug-in relay should be added to the unit control center and wired in place of the remote switch (typically between terminal blocks R and G on the terminal strip (refer to Typical Control Center Components). The relay must be rated for at least 5 amps and have a 24 VAC coil. Failure to comply with these guidelines may cause motor starters to "chatter" or not pull in which can cause contactor failures and/or motor failures.

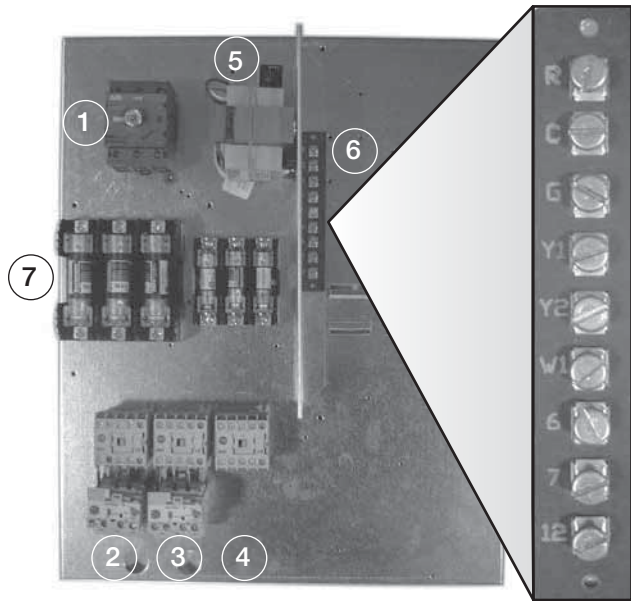
## CAUTION

If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring material having a temperature rating of at least 105°C.



## Typical Control Center Components

1. Main Disconnect (non-fusible, lockable)
2. Motor Starter – Exhaust Air Fan
3. Motor Starter – Outdoor Air Fan
4. Motor Contactor – Energy Wheel
5. 24 VAC Control Transformer
6. 24 VAC Terminal strip
7. Fuses for blower motors



**Exploded Detail  
of Terminal Strip**

## Electric Heater Application/Operation

Factory installed electric heaters can be provided for preheat frost control. An electric preheater warms the outdoor air prior to the energy recovery wheel to prevent frosting on the wheel. Electric heaters are available in 208, 230, or 460 VAC (refer to heater nameplate for voltage).

**Preheaters:** Preheaters are standard as single-stage on/off control. Preheaters are single point wired at the factory. A thermodisc temperature sensor (with a 5°F set point) is mounted in the outdoor airstream after the preheater to turn the preheater on. See Frost Control Application/Operation for typical set points. If the temperature falls below the set point and the wheel pressure drop sensor is triggered, the preheater will turn on.

Access to the preheater control panel is through the outdoor air filter door.



## Unit Accessories

### Outdoor Air Weatherhood

Outdoor air weatherhood will be factory mounted.

### Exhaust Weatherhood

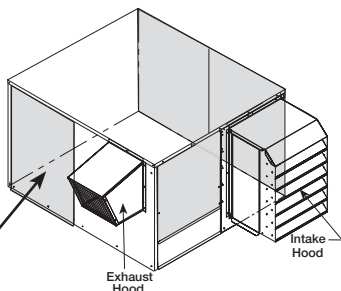
The exhaust weatherhood is shipped separately as a kit with its own instructions.

### Dampers

Backdraft dampers are always included as an integral part of the exhaust hood assemblies. Motorized outdoor air and exhaust air dampers are optional and are factory mounted (and wired) at the intake.

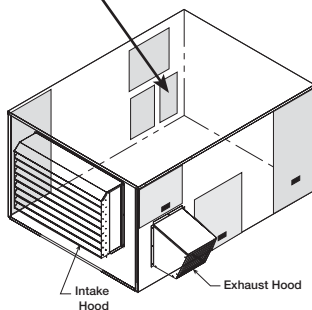


**ERV-251, 361, 521, 581**

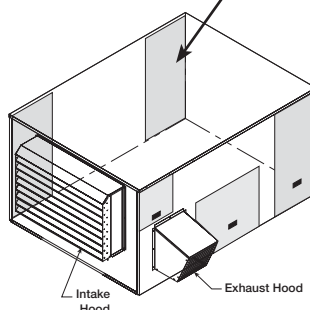


**Access to Control Center Components  
is gained through the access panel indicated.**

**ERV-522**



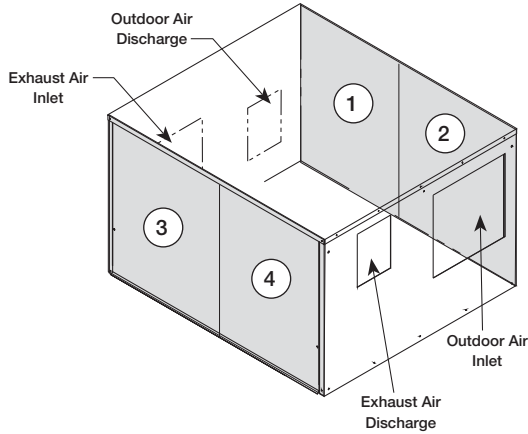
**ERV-582**



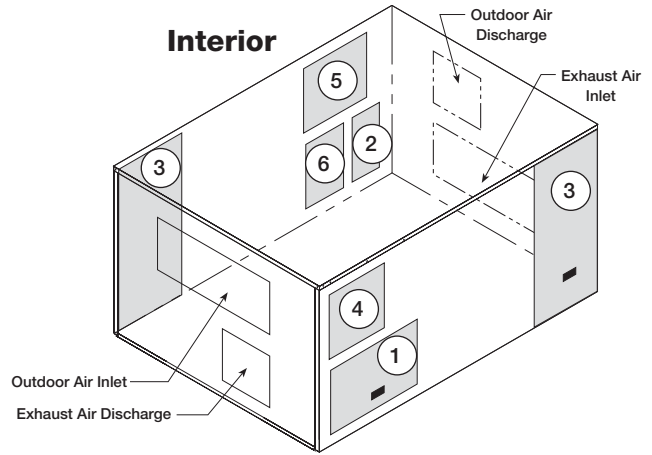
# Access Panel Description and Location

ERV-251, ERV-361, ERV-521, ERV-581

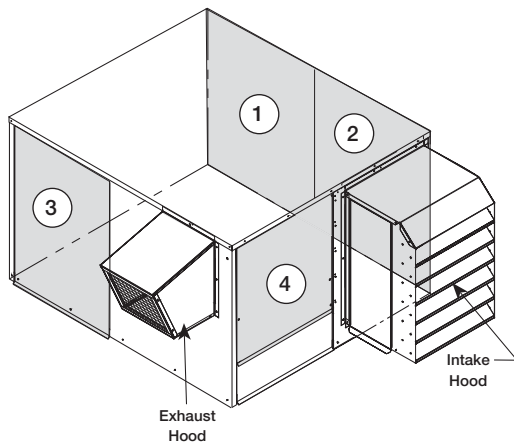
ERV-522



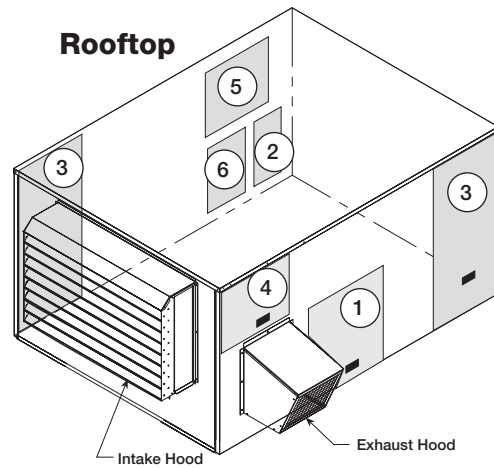
**Arrangement A**



**Arrangement A**



**Arrangement B, C or D**

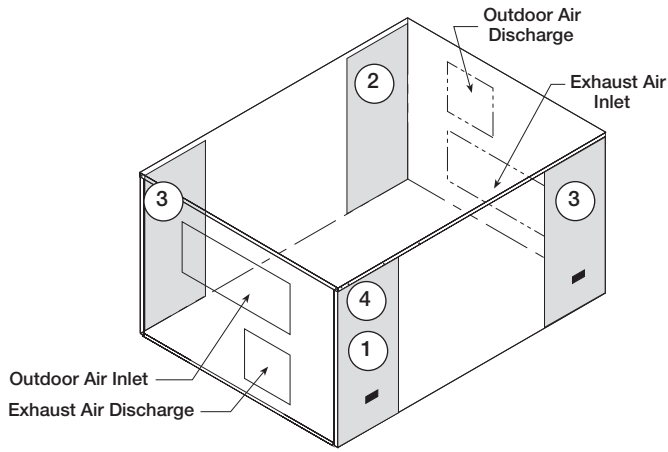


**Arrangement B, C or D**

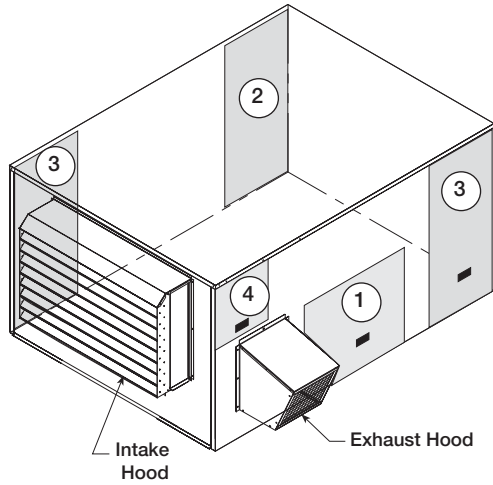
①	Outdoor air blower and motor Energy wheel cassette
②	Energy wheel cassette Internal filters Outdoor air intake damper Frost control Outdoor air sensors
③	Main disconnect Electrical control center Internal filters
④	Exhaust air blower and motor

①	Exhaust blower and motor
②	Electric control center Main Disconnect
③	Energy wheel cassette Internal filters Frost control Outdoor air sensors
④	Preheater controls Outdoor air intake damper
⑤	Supply blower and motor
⑥	Exhaust air intake damper

**ERV-582**



**Arrangement A**



**Arrangement B, C or D**

①	Exhaust blower and motor
②	Electric control center Main disconnect Supply blower and motor Exhaust air intake damper
③	Energy wheel cassette Internal filters Frost control Outdoor air sensor
④	Preheater controls Outdoor air intake damper

# Dimensional Data

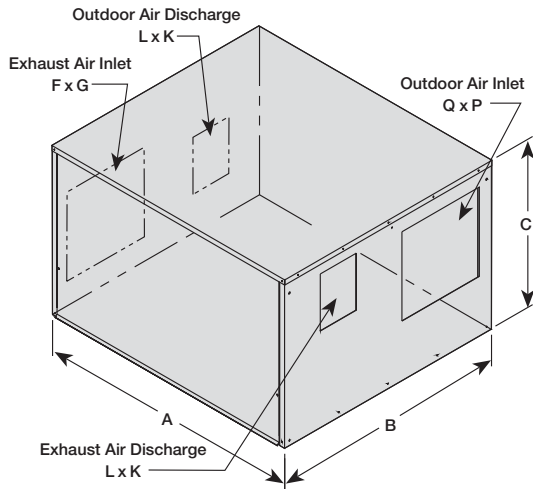
## ERV-251, 361, 521 and 581

Unit Size	Exterior Dimensions				
	A	B	C	D	E
ERV-251	46	34	27	12	8
ERV-361	62	51	34	18	15
ERV-521	67	67	44	16	15
ERV-581	75	70	67	16	22

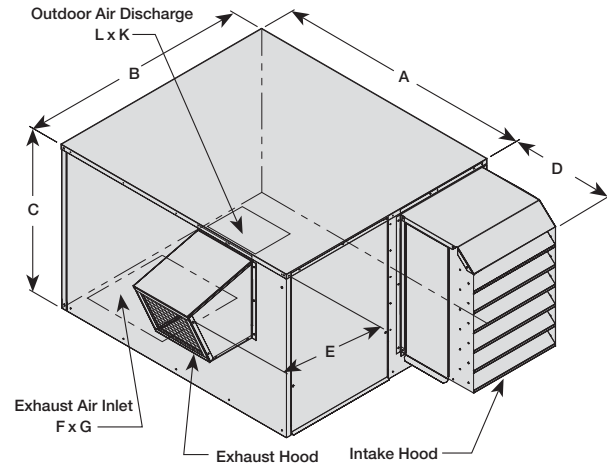
All dimensions are in inches.

Unit Size	Unit Opening Dimensions					
	F	G	K	L	Q	P
ERV-251	10	16	6 $\frac{3}{4}$	7	10	16
ERV-361	18	18	8 $\frac{5}{8}$	11 $\frac{1}{2}$	19	18
ERV-521	24	24	10 $\frac{3}{4}$	13 $\frac{1}{2}$	26	26
ERV-581	22	27	16	18 $\frac{3}{4}$	28	48

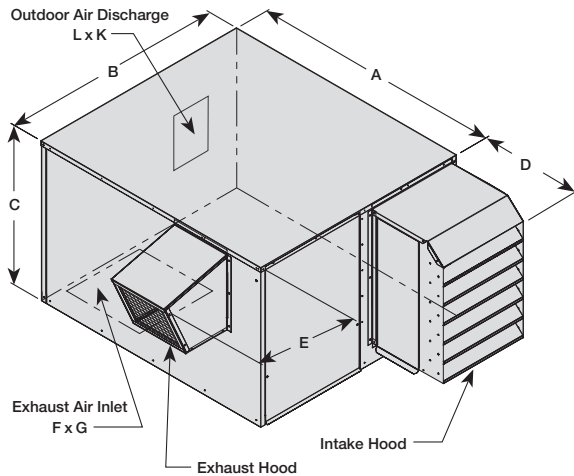
All dimensions are in inches.



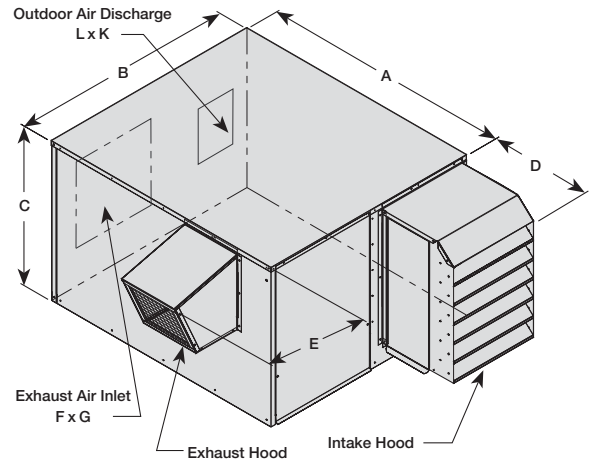
**Arrangement A**



**Arrangement B**



**Arrangement C**



**Arrangement D**

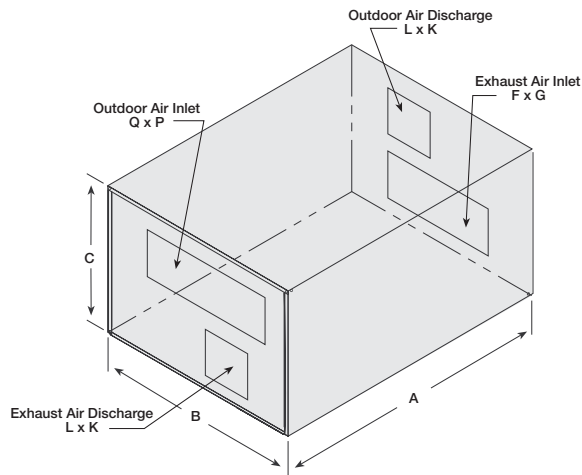
**ERV-522 and 582**

Unit Size	Exterior Dimensions				
	A	B	C	D	E
ERV-522S	124	84	64	16	19
ERV-522H	124	84	64	16	19
ERV-582H	146	97	77	17½	26¾

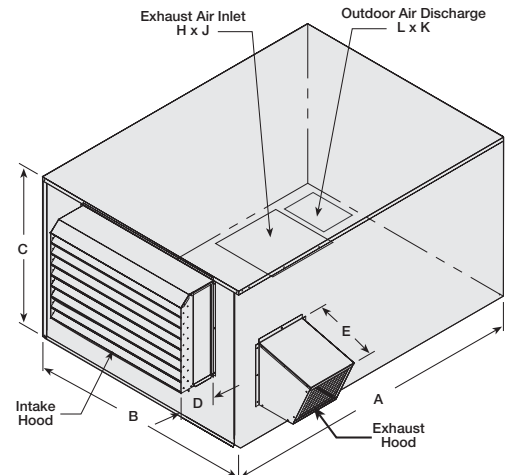
All dimensions are in inches.

Unit Size	Unit Opening Dimensions					
	F	G	K	L	Q	P
ERV-522S	48	25	16	18¾	60	25
ERV-522H	48	25	19	22	60	25
ERV-582H	60	28	23	25	70	30

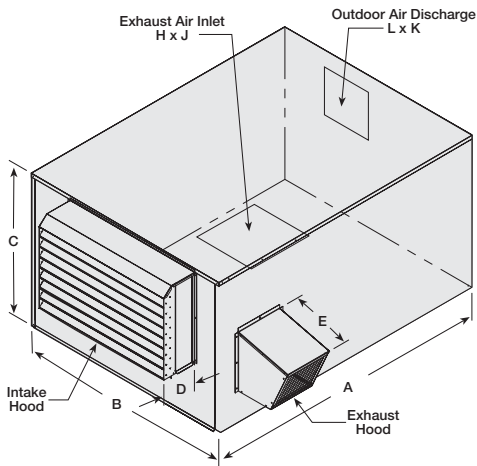
All dimensions are in inches.



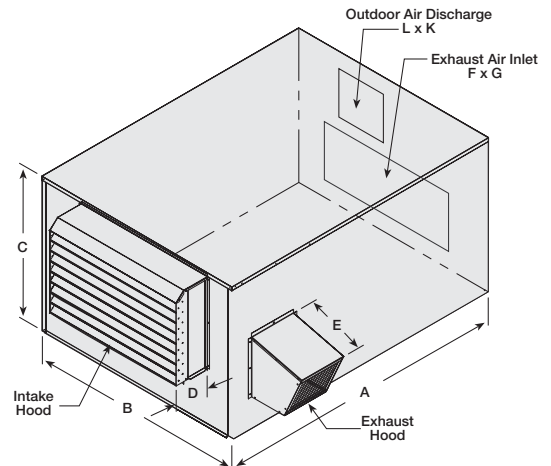
**Arrangement A**



**Arrangement B**



**Arrangement C**



**Arrangement D**

## Optional Accessories

### Frost Control Application/Operation

Extremely cold outdoor air temperatures can cause moisture condensation and frosting on the energy recovery wheel. Frost control is an optional feature that will prevent/control wheel frosting. Three options are available:

1. Timed Exhaust frost control
2. Electric preheat frost control
3. Modulating wheel frost control

All of these options are provided with a thermostat (with probe) mounted in the outdoor air intake compartment and a pressure sensor to monitor pressure drop across the wheel.

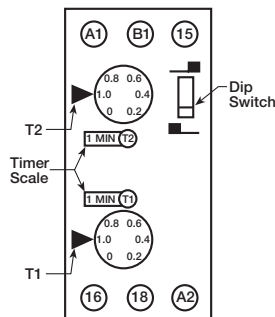
Frost Threshold Temperatures	
Indoor RH @ 70°F	Frost Threshold Temp
20%	-10° F
30%	-5° F
40%	0° F

The typical temperature setting corresponds to the indoor air relative humidity as shown in the Frost Threshold Temperatures Table and represents when frost can occur. An increase in pressure drop would indicate that frost is occurring. Both the pressure sensor **AND** the outdoor air temperature sensor must trigger in order to initiate frost control. The two sensors together ensure that frost control is only initiated during a real frost condition. Field wiring of a light (or other alarm) between 6 & C in the control center will notify personnel when unit is in frost control mode (refer to Remote Panel Wiring schematics section for wiring details). The following explains the three options in more detail.

**Timed exhaust frost control** includes a timer in addition to the thermostat and wheel pressure sensor. When timed exhaust frost control is initiated, the timer will turn the supply blower on and off to allow the warm exhaust air to defrost the energy recovery wheel. Default factory settings are 5 minutes off and 30 minutes on. Use the following test procedure for troubleshooting.

**Testing** (refer to Timer Faceplate drawing below)

- Jumper the wheel pressure switch in the unit control center. Set the Timer Scale for T1 and T2 to 1 minute. Set the Timer Settings for T1 and T2 to 1.0. Set the dip switch to the down position. (normal position)
- Turn the temperature sensor up as high as possible. The supply blower should cycle on for one minute, then turn off for one minute.



- After testing, set the Timer Scale as follows:  
T1 = 10 minutes, T2 = 1 hour
- Set the Timer Settings as follows:  
T1 = 0.5, T2 = 0.5  
The timer is now set for 5 minutes off and 30 minutes on. Remember to remove the jumper.

**Electric preheat frost control** includes an electric heater (at outdoor air intake), an airflow pressure switch and thermodisc temperature sensor (located at the preheater) in addition to a pressure sensor across the energy wheel. (Refer to Electric Heater Application/Operation for electric preheater location). When electric preheat frost control is initiated, the electric preheater will turn on and warm the air entering the energy wheel to avoid frosting. The thermodisc temperature sensor installed has a 5°F nonadjustable set point. For custom temperature set point thermodiscs, please contact the factory. Use the following test procedure for troubleshooting.

#### Testing:

- Jumper out the thermodisc temperature sensor and the wheel pressure sensor. The heater should turn on.
- If it doesn't, either put the outdoor air side doors on or temporarily jumper the airflow pressure switch in the preheater control center to avoid nuisance tripping of the pressure switch. Also check the airflow switch pressure tap located at the supply discharge blower to ensure the tubing is connected and the tap is not blocked. *Remember to remove the jumpers.*

**Modulating wheel frost control** includes a variable frequency drive in addition to the thermostat and pressure sensor. When modulating wheel frost control is initiated, the variable frequency drive will reduce the speed of the wheel. Reducing the speed of the energy wheel reduces its effectiveness, which keeps the exhaust air condition from reaching saturation, thus, eliminating condensation and frosting. If the outdoor air temperature is greater than the frost threshold temperature OR the pressure differential is less than the set point, the wheel will run at full speed. If the outdoor air temperature is less than the frost threshold temperature AND the pressure differential is greater than the set point, the wheel will run at reduced speed until the pressure differential falls below the set point. The temperature and pressure differential set points are set at the factory, but are field-adjustable (refer to VFD section for more information). The variable frequency drive will be fully programmed at the factory.

## Economizer Application/Operation

The energy recovery wheel operation can be altered to take advantage of economizer operation (free cooling). Two modes are available:

1. De-energizing the wheel
2. Modulating the wheel

A field supplied call for cool (Y1) is required.

De-energizing the wheel is accomplished with a signal from a Temperature or Enthalpy sensor mounted in the air intake compartment. This primary sensor will de-energize the energy wheel when the outdoor air temperature (factory default is 65°F) or enthalpy (factory default is the 'D' setting) is below the field adjustable set point. An Override temperature sensor is also furnished in the outdoor air intake compartment to deactivate economizer mode. The Override (with field adjustable set point) is set at some temperature lower than the primary sensor (factory default is 50°F). Effectively, the two sensors create a deadband where the energy recovery wheel will not operate and free cooling from outside can be brought into the building unconditioned.

### Testing

#### Temperature Sensor with Override

- Turn both Temperature and Override thermostats down as low as they go. The wheel should be rotating.
- Turn the Temperature sensor up as high as it goes, and keep the Override sensor as low as it will go. The wheel should stop rotating.
- Turn both sensors as high as they will go. The wheel should start rotating.
- Set the Temperature sensor at desired point for economizer operation to begin. Set the Override sensor at desired point for economizer operation to end (factory default is 65°F and 50°F, respectively).



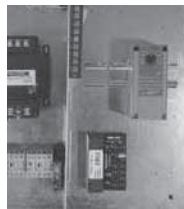
**Temperature Sensor with Override**

#### Enthalpy Sensor with Override

- Turn unit power off. Disconnect C7400 Solid State Enthalpy Sensor from terminal So on the enthalpy controller. Also, disconnect the 620 ohm resistor from terminal Sr on the enthalpy controller. Turn unit power on. The LED on the enthalpy controller should light and the energy recovery wheel should not rotate.
- Turn unit power off. Reconnect 620 ohm resistor to terminal Sr on the enthalpy controller. Turn unit power on.



**Enthalpy Controller**



**Enthalpy Sensor with Override**

The LED on the enthalpy controller should not light and the energy recovery wheel should energize and rotate.

If these steps provide the results described, the enthalpy economizer is working properly.

- Turn unit power off. Reconnect C7400 Solid State Enthalpy Sensor to terminal So.

### Modulating the Wheel

In applications in which an internal heat gain is present in the space, the rotational speed of the energy wheel may be modulated (via variable frequency drive) to avoid overheating the space during the winter. The speed of the energy wheel will be controlled in response to the discharge temperature set point.

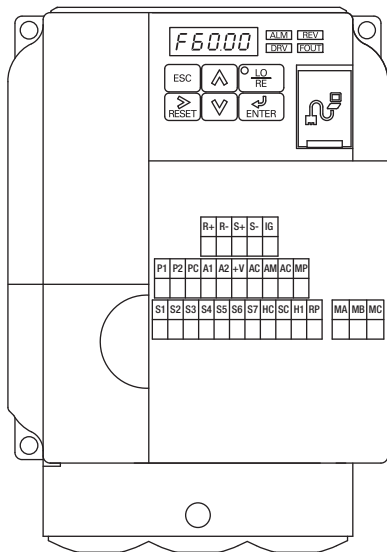
**Sequence of Operation:** The variable frequency drive is fully programmed at the factory (refer to VFD section for more information). A “call for cool” must be field wired to the unit (terminals provided in unit - refer to wiring diagram in unit control center) to allow for initiation of economizer mode. When the space calls for cooling, factory supplied controls will drive the following wheel operations:

$T_{OA} > T_{RA}$	Wheel runs at full speed. (maximum energy recovery)
$T_{OA} < T_{RA}$ and $T_{OA} > T_{SA}$	Wheel is at minimum speed. (no energy recovery)
$T_{OA} < T_{RA}$ and $T_{OA} < T_{SA}$	Wheel will modulate to maintain discharge temperature.

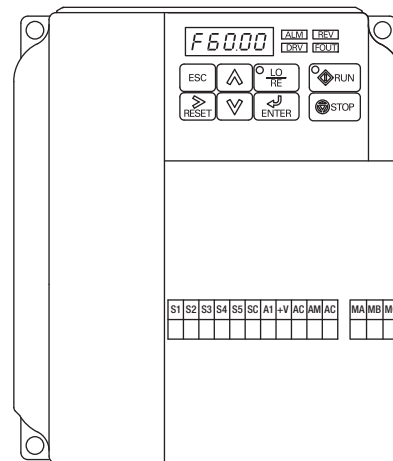
Where ( $T_{OA}$ ) is the outdoor air temperature set point, ( $T_{RA}$ ) is the return air temperature set point, and ( $T_{SA}$ ) is the supply air discharge thermostat set point.

## Variable Frequency Drives for Energy Recovery Blowers

Optional factory installed, wired, and programmed variable frequency drives (VFDs) may have been provided for modulating or multi-speed control of the blowers. One VFD is provided for each blower (supply air and exhaust). The VFD's provided are either Yaskawa model V1000 or J1000. Refer to the tables in this section for factory settings and field wiring requirements. Refer to the unit control center for unit specific wiring diagram (an example wiring diagram has been provided in this manual for reference). When making adjustments outside of the factory set points, refer to Yaskawa VFD instruction manual, which can be found online at [www.drives.com](http://www.drives.com). For technical support, contact Yaskawa direct at 1-800-927-5292.



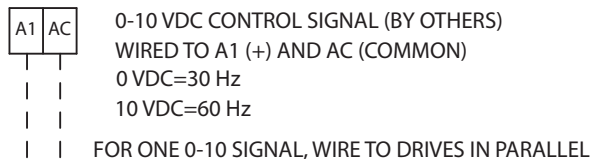
V1000



J1000

OPTION 1 - 0-10 VDC CONTROL

USER TO PROVIDE ISOLATION AS REQUIRED

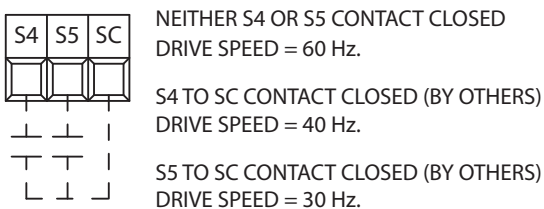


SEE VFD INSTALLATION MANUAL FOR MORE DETAIL

FOR CONTINUOUS 60Hz OPERATION JUMPER TERMINALS A1 AND +V.

OPTION 2 - MULTI SPEED CONTROL

USER TO PROVIDE CONTACTS AND ISOLATION AS REQUIRED



SEE VFD INSTALLATION MANUAL FOR MORE DETAIL

TO CHANGE THE FACTORY SET Hz CHANGE THE FOLLOWING PARAMETERS.

PARAMETER n01 CHANGE TO 1  
 PARAMETER n21 FOR NEW 60Hz SETTING  
 PARAMETER n22 FOR NEW 40Hz SETTING  
 PARAMETER n23 FOR NEW 30Hz SETTING  
 PARAMETER n01 CHANGE TO 0

## Factory Set Points

Variable Frequency Drives (VFDs) for the blowers are factory setup to operate in one of the three following modes:

**Modulating:** 0-10 VDC signal wired in the field by others varies the speed of the blower between 30 and 60Hz

**Multi-speed:** Digital contact closures by others command the VFD to run at multiple speed settings:

- SC to S4 - Drive runs at 40Hz
- SC to S5 - Drive runs at 30Hz

**CO<sub>2</sub> Sensor:** A digital contact closure from an optional factory provided CO<sub>2</sub> sensor sends the VFD to high or low speed depending on CO<sub>2</sub> ppm levels at the sensor.

The terminal locations for Modulating (option 1) and Multi-speed (option 2) are shown on the left. Most of the set points in the VFDs are Yaskawa factory defaults. However, a few set points are changed at Greenheck and are shown in the tables on the next page. These settings are based on the VFD mode selected.

To gain access to change set points on the V1000 and J1000 drives, parameter A1-01 needs to be set at "2". To prevent access or tampering with drive settings on either drive, change parameter A1-01 to "0".

## Drive Operation

SC to S1 contact for On/Off

A1 (0-10 VDC) referenced to AC. *Can use +15 VDC from +V*



## Factory Set Points - *continued*

### Resetting the drive to factory defaults

To reset the drive back to Greenheck factory defaults go to parameter A1-01 and set it to “2”. Then go to A1-03 and change it to “1110” and press enter. The drive is now reset back to the settings programmed at Greenheck.

<b>MODULATING CONTROL FOR FAN SPEED (0-10 VDC)</b>			
Parameter		Setting	
		V1000	J1000
A1-01	Access Level	2	2
b1-17	VFD Start-Up Setting	1	1
C1-01	Acceleration Time	30 sec.	30 sec.
C1-02	Deceleration Time	30 sec.	30 sec.
C6-02	Carrier Frequency	1	1
d2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	Motor FLA	Motor FLA
H3-04	Terminal A1 Bias	50%	50%
A1-01	Access Level	0	0

<b>MULTI-SPEED CONTROL FOR FAN SPEED (1/3 OR 1/2 SPEED REDUCTION)</b>			
Parameter		Setting	
		V1000	J1000
A1-01	Access Level	2	2
b1-01	Reference Source (Frequency)	0	0
b1-17	VFD Start-Up Setting	1	1
C1-01	Acceleration Time	30 sec.	30 sec.
C1-02	Deceleration Time	30 sec.	30 sec.
C6-02	Carrier Frequency	1	1
d1-01	Frequency Reference 1	60 Hz	60 Hz
d1-02	Frequency Reference 2	40 Hz	40 Hz
d1-03	Frequency Reference 3	30 Hz	30 Hz
d1-04	Frequency Reference 4	60 Hz	60 Hz
d2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	Motor FLA	Motor FLA
H1-04	Multi-Function Input Sel 4 (Terminal S4)	3	3
H1-05	Multi-Function Input Sel 5 (Terminal S5)	4	4
H1-06	Multi-Function Input Sel 6 (Terminal S6)	5	NA
H3-10	A2 Not Used	F	NA
A1-01	Access Level	0	0

<b>CO<sub>2</sub> SENSOR CONTROL FOR FAN SPEED (1/2 SPEED WHEN CO<sub>2</sub> DROPS BELOW 700 PPM)</b>			
Parameter		Setting	
		V1000	J1000
A1-01	Access Level	2	2
b1-01	Reference Source (Frequency)	0	0
b1-17	VFD Start-Up Setting	1	1
C1-01	Acceleration Time	30 sec.	30 sec.
C1-02	Deceleration Time	30 sec.	30 sec.
C6-02	Carrier Frequency	1	1
d1-01	Frequency Reference 1	60 Hz	30 Hz
d1-02	Frequency Reference 2	30 Hz	60 Hz
d2-02	Ref Lower Limit	50%	50%
E2-01	Motor Rated FLA	Motor FLA	Motor FLA
H3-10	A2 Not Used	F	NA
A1-01	Access Level	0	0

## Variable Frequency Drives for Energy Recovery Wheel

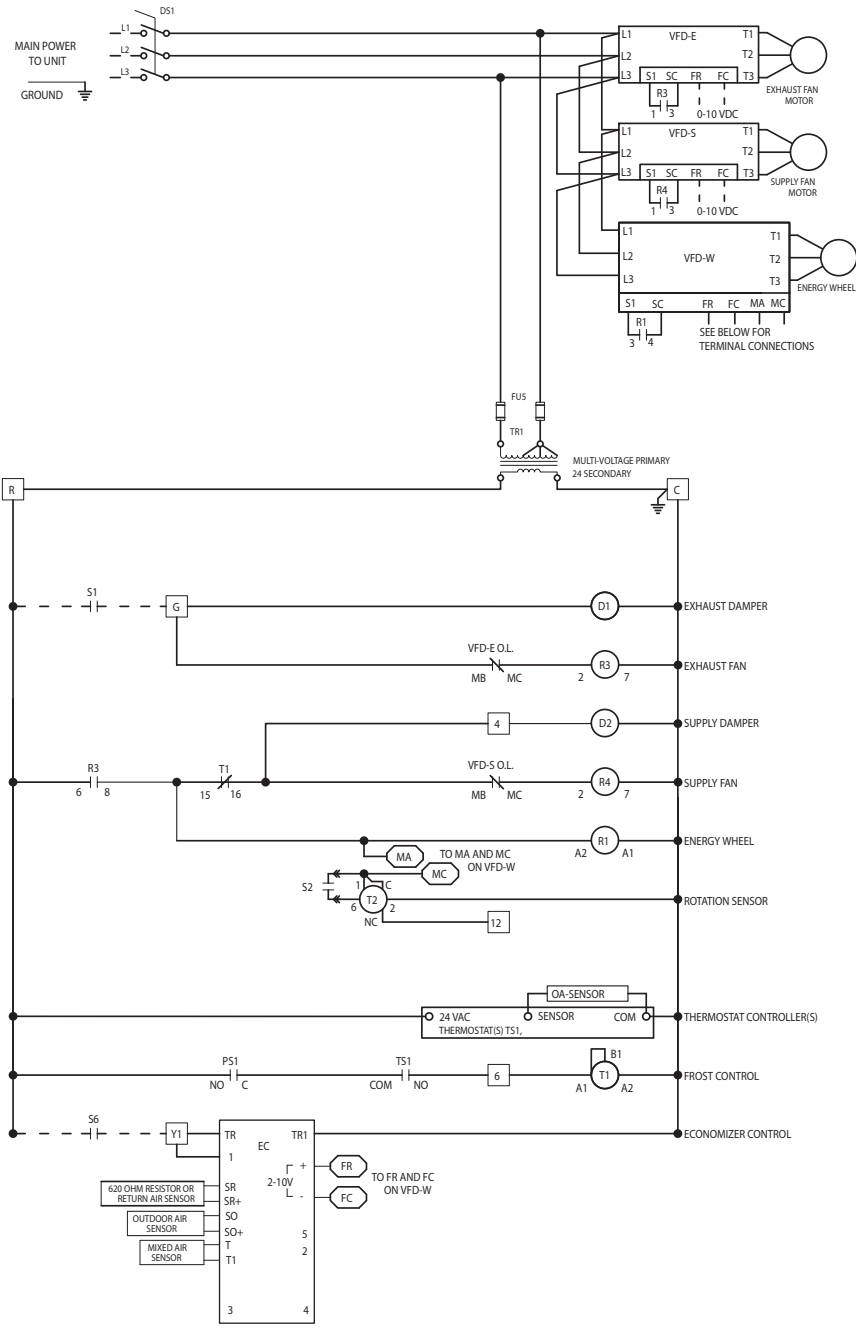
Optional factory installed VFD for the energy recovery wheel is programmed at the factory per the settings shown below for economizer and frost control modes. The VFD provided is a Yaskawa model J1000. Refer to the VFD instruction manual that ships with the unit when making adjustments.

Parameter		Setting – J1000	
A1-01	Access Level	2	
b1-17	VFD Auto Start	1	
C6-02	Carrier Frequency	2	
d2-01	Ref Upper Limit	100% or 66%*	
d2-02	Ref Lower Limit	5%	
E2-01	Motor Rated FLA	Motor FLA	
E2-03	Motor No-Load Current	Must be less than FLA	
H1-02	Multi-Function Input (Terminal S2)	6	
H2-01	Multi-Function Output (MA, MB, MC)	5	
<b>Economizer Signal Source (0-10 VDC)</b>		Setting	
		Honeywell Module	Carel Controller
H3-03	Analog Frequency Reference (Gain)	0	100
H3-04	Analog Frequency Reference (Bias)	99	0
L1-01	Elect Thermal Overload	2	
L4-01	Frequency Detection Level	20	
A1-01	Access Level	0	

\*36 inch wheel is 66% (40 Hz). All other wheels are 100% (60 Hz).

# Typical Wiring Diagram

Following is an example of a typical wiring diagram located in the unit control center. This wiring diagram includes a legend highlighting which accessories were provided with the unit. Factory wiring and field wiring are also indicated. This particular example includes 1) variable frequency drives on the blowers requiring a modulating input, 2) modulating energy recovery wheel with factory controls for economizer, 3) energy recovery wheel rotation sensor, 4) outdoor air and exhaust air dirty filter switches, 5) motorized outdoor air and exhaust air intake dampers, and 6) timed exhaust frost control. Many other factory installed and wired accessories are available.



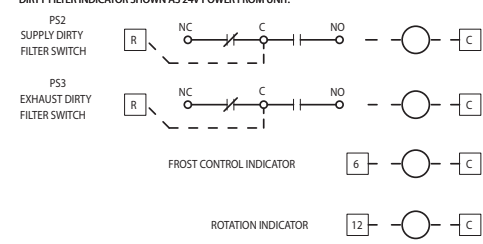
### LEGEND

- CC COMPRESSOR CONTACTOR
- CF CONDENSING FAN CONTACTOR
- CH COMPRESSOR SUMP HEATER
- \*D DAMPER
- DB POWER DISTRIBUTION BLOCK
- DL DAMPER LIMIT SWITCH
- \*DS DISCONNECT SWITCH
- \*EC ECONOMIZER CONTROLLER
- FCS CONDENSER FAN CYCLE SWITCH
- FU FUSES
- \*FUS CONTROL TRANSFORMER FUSES (NOT ON CLASS II)
- FZ1 FREEZE PROTECTION
- HPS HIGH PRESSURE SWITCH (MANUAL RESET)
- LPS LOW PRESSURE SWITCH
- \*PS1 WHEEL FROST PRESSURE SWITCH
- \*PS2 SUPPLY DIRTY FILTER PRESSURE SWITCH
- \*PS3 EXHAUST DIRTY FILTER PRESSURE SWITCH
- \*R1 ENERGY WHEEL RELAY CONTACTOR
- R2 OCCUPIED/UNOCCUPIED RELAY
- \*R3 EXHAUST BLOWER VFD RELAY
- \*R4 SUPPLY BLOWER VFD RELAY
- R5 MODULATING WHEEL FROST CONTROL RELAY
- R6 ECONOMIZER RELAY
- R7 COMPRESSOR INTERLOCK RELAY
- R8 EVAP RELAY (INDIRECT)
- R9 EVAP RELAY (DIRECT)
- R10 UNIT RELAY
- \*S1 FAN SWITCH
- \*S2 ROTATION SENSOR REED SWITCH
- S3 ROTATION SENSOR REED SWITCH
- S4 CALL FOR HEAT SWITCH
- S5 BYPASS SWITCH
- \*S6 CALL FOR COOL SWITCH (FIRST STAGE)
- S7 CALL FOR COOL SWITCH (SECOND STAGE)
- \*ST MOTOR STARTER
- \*T1 FROST CONTROL THERMOSTAT  
TYPICAL SETTINGS t1(OFF) = 5 MIN., t2(ON) = 30 MIN.
- \*T2 ROTATION SENSOR TIMER
- T3 ROTATION SENSOR TIMER
- T4 ECONOMIZER WHEEL JOG TIMER  
TYPICAL SETTINGS t1(OFF) = 3 HRS., t2(ON) = 10 SEC.
- T5 EVAP DELAY OFF TIMER
- T6 COMPRESSOR MINIMUM OFF TIMER (TYP. 3 MIN.)
- T7 COMPRESSOR MINIMUM OFF TIMER (TYP. 3 MIN.)
- \*TR TRANSFORMER
- \*TS1 FROST CONTROL THERMOSTAT (JUMPER - HEAT)  
CLOSES ON TEMP. DECREASE TYPICAL SETTING 5° F.
- TS2 ECONOMIZER LOW LIMIT THERMOSTAT (JUMPER - HEAT)  
OPENS ON TEMP. DECREASE TYP. SETTING 20° OFFSET OR 50° F.
- TS3 ECONOMIZER UPPER LIMIT THERMOSTAT (JUMPER - HEAT)  
CLOSES ON TEMP. DECREASE TYP. SETTING 65° F./2° DIFF.
- TS4 ROOM OVERRIDE SENSOR
- TS5 INLET AIR POST HEATER LOCKOUT THERMOSTAT (AFTER WHEEL)  
CLOSES ON TEMP. DECREASE TYPICAL SETTING 65° F.
- TS6 INLET AIR COMPRESSOR LOCKOUT THERMOSTAT (JUMPER-HEAT)  
OPENS ON TEMP. DECREASE TYPICAL SETTING 60° F./2° DIFF.

\* FACTORY SUPPLIED AND WIRED  
o FIELD WIRED  
FIELD CONTROL WIRING RESISTANCE SHOULD NOT EXCEED 0.75 OHM. IF RESISTANCE EXCEEDS 0.75 OHM THEN CONSULT FACTORY. USE 14 GAUGE MINIMUM WIRE THICKNESS FOR CONTROL WIRING.  
REPLACEMENT FUSES: MUST HAVE A MINIMUM I.R. RATING OF 5 KA  
**CAUTION:**  
UNIT SHALL BE GROUND IN ACCORDANCE WITH N.E.C.  
POWER MUST BE OFF WHILE SERVICING.

### USER INTERFACE CONNECTIONS:

USER TO VERIFY THAT TR1 CAN HANDLE THE VA LOAD OF INDICATOR DEVICES.  
DIRTY FILTER INDICATOR SHOWN AS 24V POWER FROM UNIT.



## Rotation Sensor

The rotation sensor monitors energy recovery wheel rotation. If the wheel should stop rotating, the sensor will close a set of contacts in the unit control center. Field wiring of a light (or other alarm) between terminals R & 12 in the unit control center will notify maintenance personnel when a failure has occurred (refer to Remote Panel Wiring Schematics section for wiring details).

## Dirty Filter Sensor

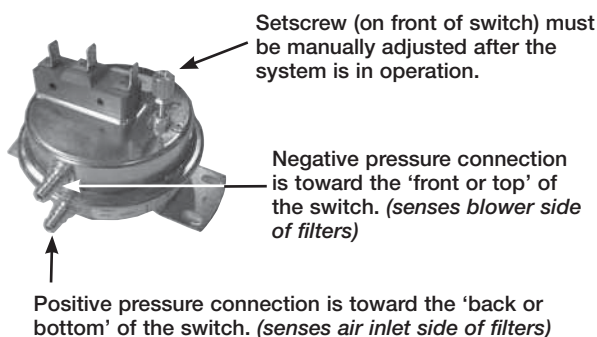
Dirty filter sensors monitor pressure drop across the outdoor air filters, exhaust air filters or both. If the pressure drop across the filters exceeds the set point, the sensor will close a set of contacts in the unit control center. Field wiring of a light (or other alarm) to these contacts will notify maintenance personnel when filters need to be replaced.

The switch has not been set at the factory due to external system losses that will affect the switch. This switch will need minor field adjustments after the unit has been installed with all ductwork complete. The dirty filter switch is mounted in the exhaust inlet compartment next to the unit control center or in unit control center.

To adjust the switch, the unit must be running with all of the access doors in place, except for the compartment where the switch is located (exhaust intake compartment). Model ERV units require the opening around the control center to be covered (with cardboard, plywood, etc.) to set up the dirty filter switch.

The adjusting screw is located on the top of the switch. Open the filter compartment and place a sheet of plastic or cardboard over 50% of the filter media. Replace the filter compartment door. Check to see if there is power at the alert signal leads (refer to electrical diagram).

Whether there is power or not, turn the adjustment screw on the dirty filter gauge (clockwise if you did not have power, counterclockwise if you did have power) until the power comes on or just before the power goes off. Open the filter compartment and remove the obstructing material. Replace the door and check to make sure that you do not have power at the alert signal leads. The unit is now ready for operation.



## CO<sub>2</sub> Sensor

This accessory is often used to provide a modulating control signal to a variable frequency drive to raise and lower airflow in relationship to the CO<sub>2</sub> levels in the space. This strategy is often referred to as Demand Control Ventilation and provides further energy savings to the system. Follow instructions supplied with sensor for installation and wiring details.

## Service Outlet

120 VAC GFCI service outlet ships loose for field installation. Requires separate power source so power is available when unit main disconnect is turned off for servicing.



## Vapor Tight Lights

Vapor tight lights provide light to each of the compartments in the energy recovery unit. The lights are wired to a junction box mounted on the outside of the unit. The switch to turn the lights on is located in the unit control center. The switch requires a separate power source to allow for power to the lights when the unit main disconnect is off for servicing.



## Remote Control Panel and Wiring Schematics

The remote panel is available with a number of different alarm lights and switches to control the unit. The remote panel ships loose and requires mounting and wiring in the field

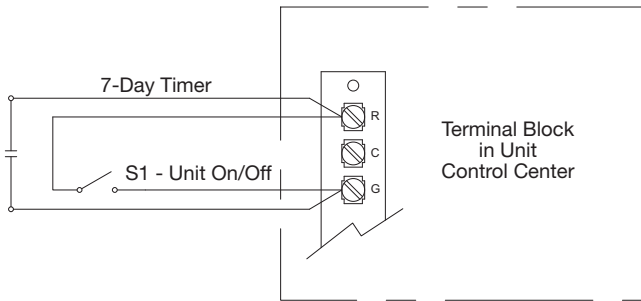
The remote panel is available with the following options:

- Unit on/off switch
- Unit on/off light
- 7-day time clock
- Hand/off/auto switch
- Time delay override
- Economizer light
- Frost control light
- Exhaust air dirty filter light
- Outdoor air dirty filter light
- Wheel rotation sensor light



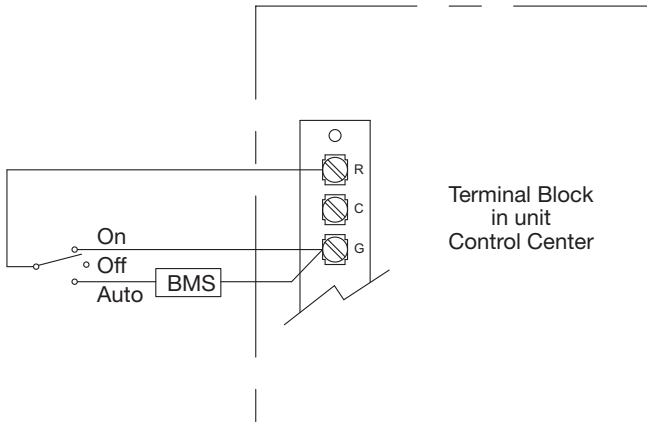
Refer to *Electrical Connections* section for *Field Control Wiring* recommendations.

### 7-Day Timer or On/Off Switch



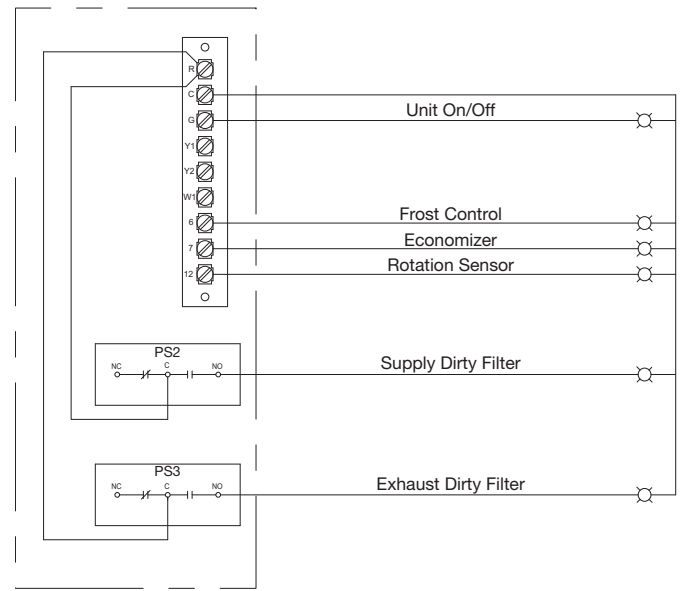
For 7-Day Timer, use blue and black wires. Red wires should be capped off.

### Hand/Off/Auto Switch

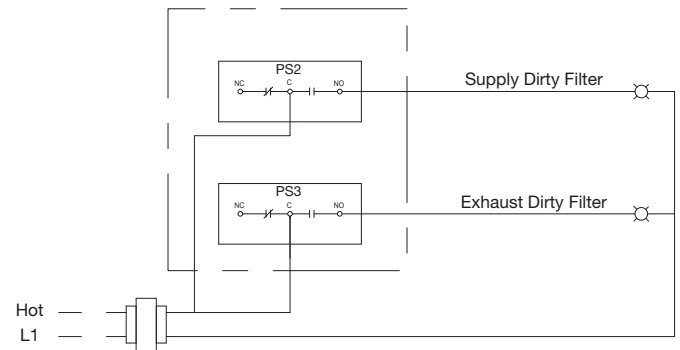


Hand/Off/Auto Switch allows the unit to  
 "Off" - off  
 "On" - Manual Operation  
 "Auto" - Unit is controlled by BMS, RTU, etc.  
 NOTE: RTU controllers are by others.

## Indicator Lights powered by the ER Unit



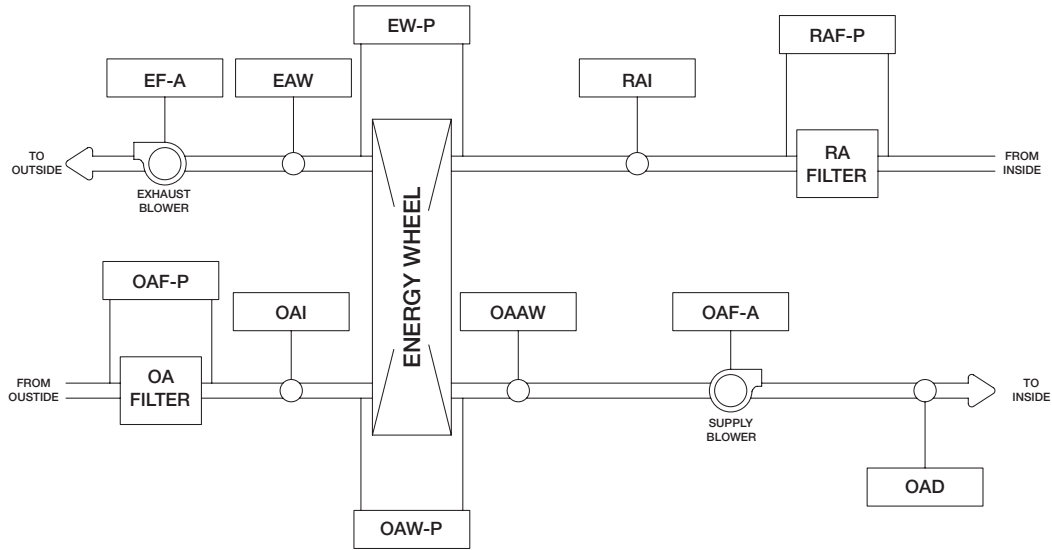
### Dirty Filter Indicator (power by others)



Refer to *Pressure Switch* for voltage and load ratings.

## Sensors Mounted by Factory

Factory mounted temperature, pressure, and current sensors are available in the locations indicated on the unit diagram below. A list of available sensors is shown below. The specific sensors provided on a given unit are labeled in the unit control center on the terminal strip. Sensors are wired to the terminal strip to make it easy for the controls contractor to connect the Building Management System for monitoring purposes.



Temperature Sensors - 1K Ohm RTD	
Drawing Labels	Terminal Strip Labels
OAI	OA/Supply Inlet Temp
OAAW	OA After Wheel
RAI	RA/Exhaust Inlet Temp
OAD	Supply Discharge Temp
EAW	Exhaust After Wheel Temp
Pressure Sensors (analog or digital)	
Drawing Labels	Terminal Strip Labels
OAF-P	OA/Supply Filter Pressure
OAW-P	Outdoor Air Wheel Pressure
RAF-P	RA/Exhaust Filter Pressure
EW-P	Exhaust Wheel Pressure
Amp - Current Sensors (analog or digital)	
Drawing Labels	Terminal Strip Labels
OAF-A	Supply Fan Amps
EF-A	Exhaust Fan Amps

# Start-Up

## DANGER

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit to OFF at disconnect switch(es). Unit may have multiple power supplies.

## WARNING

Use caution when removing access panels or other unit components, especially while standing on a ladder or other potentially unsteady base. Access panels and unit components can be heavy and serious injury may occur.

Do not operate energy recovery ventilator without the filters and birdscreens installed. They prevent the entry of foreign objects such as leaves, birds, etc.

## CAUTION

Do not run unit during construction phase. Damage to internal components may result and void warranty.

### General Start-Up Information

Every installation requires a comprehensive start-up to ensure proper operation of the unit. As part of that process, the following checklist must be completed and information recorded. Starting up the unit in accordance with this checklist will not only ensure proper operation, but will also provide valuable information to personnel performing future maintenance. Should an issue arise which requires factory assistance, this completed document will allow unit experts to provide quicker resolve. Qualified personnel should perform start-up to ensure safe and proper practices are followed.

Unit Model Number \_\_\_\_\_  
(e.g. ERV-361)

Unit Serial Number \_\_\_\_\_  
(e.g. 04C99999 or 10111000)

Energy Wheel Date Code \_\_\_\_\_  
(e.g. 0450)

Start-Up Date \_\_\_\_\_

Start-Up Personnel Name \_\_\_\_\_

Start-Up Company \_\_\_\_\_

Phone Number \_\_\_\_\_

### Pre Start-Up Checklist – check as items are completed.

- Disconnect and lock-out all power switches
- Remove any foreign objects that are located in the energy recovery unit.
- Check all fasteners, set-screws, and locking collars on the fans, bearings, drives, motor bases and accessories for tightness.

- Rotate the fan wheels and energy recovery wheels by hand and ensure no parts are rubbing. If rubbing occurs, refer to Start-Up section for more information.
- Check the fan belt drives for proper alignment and tension (refer to Start-Up section for more information).
- Filters can load up with dirt during building construction. Replace any dirty pleated filters and clean the aluminum mesh filters in the intake hood (refer to Routine Maintenance section).
- Verify that non-motorized dampers open and close properly.
- Check the tightness of all factory wiring connections.
- Verify control wire gauge (refer to the Electrical Connections section).
- Verify diameter seal settings on the energy recovery wheel (refer to Start-Up section for more information).

### SPECIAL TOOLS REQUIRED

- Voltage Meter (with wire probes)
- Amperage Meter
- Thermometer
- Tachometer
- Incline manometer or equivalent

### Start-Up Checklist

The unit will be in operational mode during start-up. Use necessary precautions to avoid injury. All data must be collected while the unit is running. In order to measure volts & amps, the control center door must be open, and the unit energized using a crescent wrench to turn the disconnect handle.

Check line voltage at unit disconnect

\_\_\_\_\_ L1-L2 volts  
 \_\_\_\_\_ L2-L3 volts  
 \_\_\_\_\_ L1-L3 volts

#### Motor Amp Draw

• Supply Fan	_____ L1 amps	• Exhaust Fan	_____ L1 amps
	_____ L2 amps		_____ L2 amps
	_____ L3 amps		_____ L3 amps
• Energy Wheel	_____ L1 amps		
	_____ L2 amps		
	_____ L3 amps		

#### Fan RPM

\_\_\_\_\_ Supply Fan      \_\_\_\_\_ Exhaust Fan

#### Correct fan rotation direction

Supply Fan	Yes / No
Exhaust Fan	Yes / No



## Optional Accessories Checklist

Refer to the respective sections in this Installation, Operation and Maintenance Manual for detailed information.

Refer to wiring diagram in unit control center to determine what electrical accessories were provided.

### Provided with Unit?

Frost Control Application / Operation section:			Setting	Factory Default
Yes	No	Frost Control set point		5°F
		Differential		2°F
		Timer		Refer to IOM
Yes	No	Frost Control Modulating		Refer to IOM

### Economizer Application / Operation section:

Yes	No	Economizer (temperature)		
		Set point		65°F
		Offset		20°F
		Differential		2°F
Yes	No	Economizer (enthalpy)		
		Set point		D
Yes	No	Economizer (modulating)		Refer to IOM

### Optional Accessories section:

#### Operational

Yes	No	Wheel Rotation Sensor	Yes	No	N/A
Yes	No	OA Dirty Filter Sensor	Yes	No	N/A
Yes	No	EA Dirty Filter Sensor	Yes	No	N/A
Yes	No	CO <sub>2</sub> Sensor	Yes	No	N/A
Yes	No	Service Outlet	Yes	No	N/A
Yes	No	Vapor Tight Lights	Yes	No	N/A
Yes	No	Remote Control Panel	Yes	No	N/A

### Variable Frequency Drives section:

#### Operational

Yes	No	Blower VFDs	Yes	No	N/A
Yes	No	Wheel VFD	Yes	No	N/A

### Damper section:

#### Operational

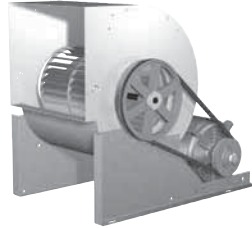
Yes	No	Outdoor Air Damper	Yes	No	N/A
Yes	No	Exhaust Air Damper	Yes	No	N/A

## Unit Start-Up

Refer to Parts List section for component locations.

### Fans

The ERV models contain two forward curved (supply & exhaust) fans. These forward curved fans should be checked for free rotation. If any binding occurs, check for concealed damage and foreign objects in the fan housing. Be sure to check the belt drives per the start-up recommendations in the following section.



**Forward Curved Exhaust Fan**

### CAUTION

When operating conditions of the fan are to be changed (speed, pressure, temperature, etc.), consult Greenheck to determine if the unit can operate safely at the new conditions.

### Fan Performance Modifications

Due to job specification revisions, it may be necessary to adjust or change the sheave or pulley to obtain the desired airflow at the time of installation. Start-up technician must check blower amperage to ensure that the amperage listed on the motor nameplate is not exceeded. Amperage to be tested with access doors closed and ductwork installed.

### Fan Belt Drives

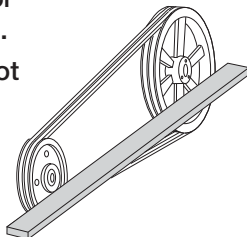
The fan belt drive components, when supplied by Greenheck, have been carefully selected for the unit's specific operating condition. Utilizing different components than those supplied could result in unsafe operating conditions which may cause personal injury or failure of the following components:

- Fan Shaft
- Bearings
- Motor
- Fan Wheel
- Belt

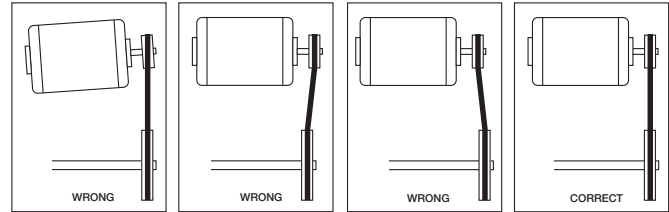
Tighten all fasteners and set screws securely and realign drive pulleys after adjustment. Check pulleys and belts for proper alignment to avoid unnecessary belt wear, noise, vibration and power loss. Motor and drive shafts must be parallel and pulleys in line (see diagrams in this section).

### Belt Drive Installation

1. Remove the protective coating from the end of the fan shaft and assure that it is free of nicks and burrs.
2. Check fan and motor shafts for parallel and angular alignment.
3. Slide sheaves on shafts. Do not drive sheaves on as this may result in bearing damage.
4. Align fan and motor sheaves with a straight-edge or string and tighten.

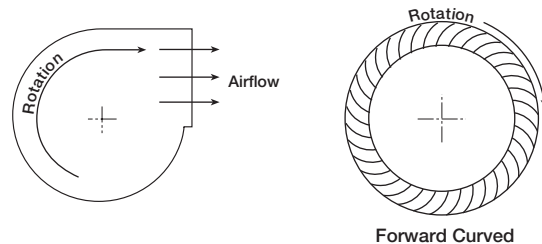


5. Place belts over sheaves. Do not pry or force belts, as this could result in damage to the cords in the belts.
6. With the fan off, adjust the belt tension by moving the motor base. (See belt tensioning procedures in the Routine Maintenance section of this manual). When in operation, the tight side of the belts should be in a straight line from sheave to sheave with a slight bow on the slack side.



### Direction of Fan Wheel Rotation

Blower access is labeled on unit. Check for proper wheel rotation by momentarily energizing the fan. Rotation is determined by viewing the wheel from the drive side and should match the rotation decal affixed to the fan housing (see Rotation Direction figures). If the wheel is rotating the wrong way, direction can be reversed by interchanging any two of the three electrical leads. Check for unusual noise, vibration, or overheating of bearings. Refer to the Troubleshooting section of this manual if a problem develops.



Forward Curved

### Fan RPM

Supply fan and exhaust fan will have an adjustable motor pulley (on 15 HP and below) preset at the factory to the customer specified RPM. Fan speed can be increased or decreased by adjusting the pitch diameter of the motor pulley. Multi-groove variable pitch pulleys must be adjusted an equal number of turns open or closed. Any increase in fan speed represents a substantial increase in load on the motor. Always check the motor amperage reading and compare it to the amperage rating shown on the motor nameplate when changing fan RPM. All access doors must be installed except the control center door. *Do not operate units with access doors open or without proper ductwork in place as the fan motors will overload.*



## Vibration

Excessive vibration may be experienced during initial start-up. Left unchecked, excessive vibration can cause a multitude of problems, including structural and/or component failure. The most common sources of vibration are listed.

Many of these conditions can be discovered by careful observation. Refer to the Troubleshooting section of this manual for corrective actions. If observation cannot locate the source of vibration, a qualified technician using vibration analysis

Wheel Unbalance  
Drive Pulley Misalignment  
Incorrect Belt Tension  
Bearing Misalignment  
Mechanical Looseness  
Faulty Belts  
Drive Component Unbalance  
Poor Inlet/Outlet Conditions  
Foundation Stiffness

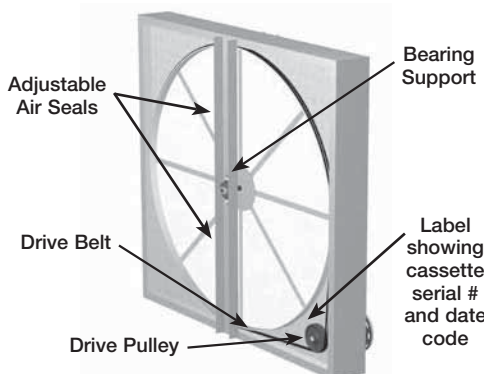
equipment should be consulted. If the problem is wheel unbalance, in-place balancing can be done.

Generally, fan vibration and noise is transmitted to other parts of the building by the ductwork. To eliminate this undesirable effect, the use of heavy canvas connectors is recommended.

## Energy Recovery Wheel

The ERV models contain a total energy recovery wheel. The wheels are inspected for proper mechanical operation at the factory. However, during shipping and handling, shifting can occur that may affect wheel operation. The wheel is accessible through the access door marked "Energy Wheel Cassette Access". For the ERV-251, 361, 521, and 522, the wheel cassette(s) slide out. Due to the size and weight of the ERV-581 and 582 wheels, they remain stationary and all maintenance is performed in place. There is room inside the unit to perform energy recovery wheel servicing.

Turn the energy recovery wheels by hand to verify free operation. The wheel should rotate smoothly and should not wobble.



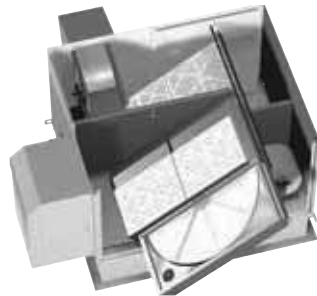
## Drive Belt

Inspect the drive belt. Make sure the belt rides smoothly through the pulley and over the wheel rim.

## Air Seals

Check that the air seals located around the outside of the wheel and across the center (both sides of wheel) are secure and in good condition. Air seal clearance is determined by placing a sheet of paper, to act as a feeler gauge, against the wheel face. To access seals, enter the unit for the ERV-581 and 582, or pull out the cassette for the ERV-251, 361, 521, and 522, following the instructions in the Energy Recovery Wheel Maintenance section. To adjust the air seals, loosen all eight seal retaining screws. These screws are located on the bearing support that spans the length of the cassette through the wheel center. Tighten the screws so the air seals tug slightly on the sheet of paper.

Replace cassette into unit, plug in wheel drive, replace access door and apply power. Observe by opening door slightly (remove filters if necessary to view wheel) the wheel should rotate freely at about 50-60 RPM.



Inside layout of ERV-361



Inside layout of ERV-522

## Routine Maintenance

### DANGER

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit to OFF at disconnect switch(es). Unit may have multiple power supplies.

### CAUTION

Use caution when removing access panels or other unit components, especially while standing on a ladder or other potentially unsteady base. Access panels and unit components can be heavy and serious injury may occur.

Once the unit has been put into operation, a routine maintenance program should be set up to preserve reliability and performance. Items to be included in this program are:

#### Lubrication

Apply lubrication where required

#### Dampers

Check for unobstructed operation

#### Fan Belts

Check for wear, tension, alignment

#### Motors

Check for cleanliness

#### Blower Wheel & Fasteners

Check for cleanliness

Check all fasteners for tightness

Check for fatigue, corrosion, wear

#### Bearings

Check for cleanliness

Check set screws for tightness

Lubricate as required

#### External Filter

Check for cleanliness - clean if required

#### Internal Filter

Check for cleanliness - replace if required

#### Door Seal

Check if intact and pliable

#### Energy Recovery Wheel

Check for cleanliness - clean if required

Check belt for wear

Check pulley, bearings, and motor

## Maintenance Procedures:

### Lubrication

Check all moving components for proper lubrication. Apply lubrication where required. Any components showing excessive wear should be replaced to maintain the integrity of the unit and ensure proper operation.

## Dampers

Check all dampers to ensure they open and close properly and without binding. Backdraft dampers can be checked by hand to determine if blades open and close freely. Apply power to motorized dampers to ensure the actuator opens and closes the damper as designed.

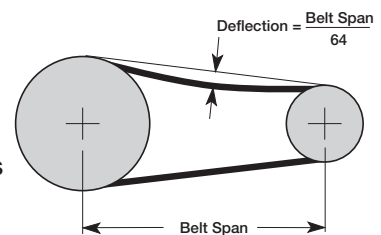
## Fan Belts

Belts must be checked on a regular basis for wear, tension, alignment, and dirt accumulation. Premature or frequent belt failures can be caused by improper belt tension (either too loose or too tight) or misaligned sheaves. Abnormally high belt tension or drive misalignment will cause excessive bearing loads and may result in failure of the fan and/or motor bearings. Conversely, loose belts will cause squealing on start-up, excessive belt flutter, slippage, and overheated sheaves. Both loose and tight belts can cause fan vibration.

When replacing belts on multiple groove drives, all belts should be changed to provide uniform drive loading. Do not pry belts on or off the sheave. Loosen belt tension until belts can be removed by simply lifting the belts off the sheaves. After replacing belts, insure that slack in each belt is on the same side of the drive. Belt dressing should never be used.

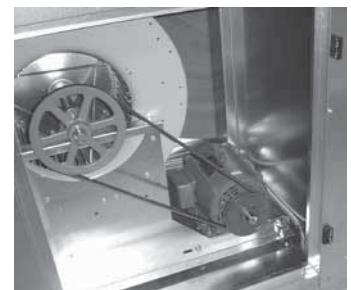
Do not install new belts on worn sheaves. If the sheaves have grooves worn in them, they must be replaced before new belts are installed.

The proper belt setting is the lowest tension at which the belts will not slip under peak load operation. For initial tensioning, set the belt deflection at 1/64-inch for each inch of belt span (measured half-way between sheave centers). For example, if the belt span is 64 inches, the belt deflection should be one inch (using moderate thumb pressure at mid-point of the drive). Check belt tension two times during the first 24 hours of operation and periodically thereafter.



## Fan Motors

Motor maintenance is generally limited to cleaning and lubrication. Cleaning should be limited to exterior surfaces only. Removing dust and grease buildup on the motor housing assists proper motor cooling. Never wash-down motor with high pressure spray. Greasing of motors is only intended when fittings are provided. Many fractional motors are permanently lubricated for life and require no further lubrication.



## Fan Wheel & Fasteners

Wheels require very little attention when moving clean air. Occasionally oil and dust may accumulate on the wheel causing imbalance. When this occurs the wheel and housing should be cleaned to assure smooth and safe operation. Inspect fan impeller and housing for fatigue, corrosion or wear.

Routinely check all fasteners, set screws and locking collars on the fan, bearings, drive, motor base and accessories for tightness. A proper maintenance program will help preserve the performance and reliability designed into the fan.

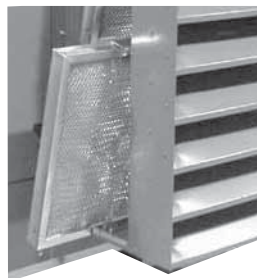
## Bearings

Most bearings are permanently lubricated and require no further lubrication under normal use. Normal use being considered -20°F to 120°F and in a relatively clean environment. Some bearings are re-lubricatable and will need to be regreased depending on fan use. Check your bearings for grease zerk fittings to find out what type of bearing you have. If your fan is not being operated under normal use, bearings should be checked monthly for lubrication.

## External Filter Maintenance

Aluminum mesh, 2-inch deep filters are located in the supply weatherhood (if the weatherhood option was purchased). Filters should be checked and cleaned on a regular basis for best efficiency. The frequency of cleaning depends upon the cleanliness of the incoming air. These filters should be cleaned prior to start-up.

To access these filters, remove bottom bolt in the access door on the side of the weatherhood. Slide the access door up and then pull bottom out to remove door. Then, slide the filters out (see picture at right).



Outdoor air intake hood mesh filter access

Clean filters by rinsing with a mild detergent in warm water.

## Internal Filter Maintenance

The ERV units will typically be provided with 2-inch, pleated filters in the outdoor air and exhaust airstreams. These filters should be checked per a routine maintenance schedule and replaced as necessary to ensure proper airflow through the unit. See table for pleated filter size and quantity for each unit. Replacement filters shall be of same performance and quality as factory installed filters. Filter type must be pleated design with integral metal grid. Two acceptable filter replacements are Aerostar Series 400 or Farr 30/30®.

Filter Size and Quantities			
Unit Size	Internal Filter Size	Quantity Supply	Quantity Exhaust
ERV-251	16 x 25	1	1
ERV-361	16 x 20	2	2
ERV-521	16 x 25	3	3
ERV-581	16 x 20	6	6
ERV-522	16 x 25	7	7
ERV-582	20 x 25	6	6

All dimensions in inches.

**Outdoor Air Filters:** Access to the outdoor air filters is through the door labeled as “Filter Access” on the outdoor air side of the unit.

**Exhaust Air Filters:** Access to the exhaust air filters is through the door labeled as “Filter Access” on the exhaust air side of the unit.

Refer to Access Door Descriptions section for additional information on filter locations.

## Door Seal Maintenance

**ERV-251, 361, 521, and 581:** Closed cell foam tape is installed on the perimeter of the door. Inspect at least annually to ensure that the seal is still intact.

**ERV-522 & 582:** Slip-on type vinyl seal is installed on the perimeter of the door openings. Inspect at least annually to ensure that seal is still pliable and intact.



## Energy Recovery Wheel Maintenance

Annual inspection of the energy recovery wheel is recommended. Units ventilating smoking lounges and other non-clean air spaces should have energy recovery wheel inspections more often based upon need. Inspections for smoke ventilation applications are recommended bimonthly to quarterly until a regular schedule can be established.

### Accessing the Energy Recovery Wheel in Models ERV-251, 361, 521 and 581

Disconnect power to the ERV. Remove access panel(s) labeled “Energy Wheel Cassette Access”.

Unplug the wheel drive motor. The center channel must be removed to access the energy wheel cassette. Use a 5/16 inch open or closed wrench to remove the three (3) fasteners that hold the center channel in place.



Access to wheel through outdoor air filter door

Pull the cassette halfway out as shown. (Except on ERV-581, wheel is stationary).

When service is complete, reattach the center channel before putting access panels back in place.

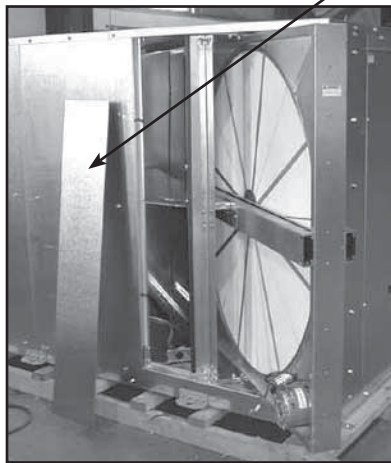
## Accessing the Energy Recovery Wheel in Models ERV-522 and 582

Disconnect power to the ERV. Remove access panel(s) labeled “Energy Wheel Cassette Access”, which reveals the energy wheel cassette. There are additional panels that must be removed in order to slide out the cassettes. (See pictures providing additional visual information).

Unplug the wheel drive motor and pull the cassette halfway out as shown.

**NOTE:** ERV-522 has two energy wheels with access panels for both wheels. Wheels slide out on opposite corners.

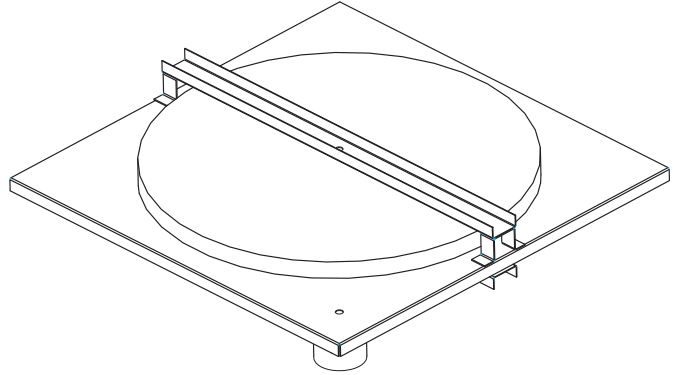
Energy recovery wheels for ERV-582 are hard-wired and not designed to slide out.



This panel must be removed before the energy wheel can slide out. (ERV-522 only)

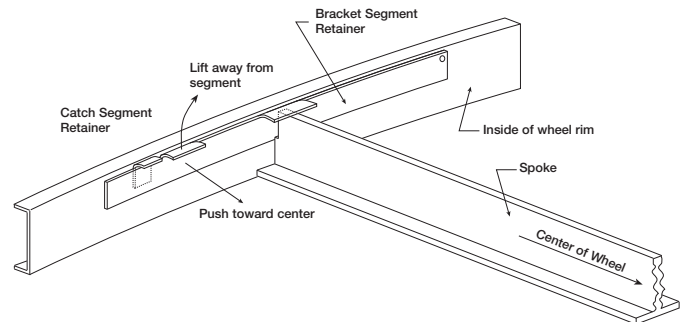
## Removing the Energy Recovery Wheel in ERV-251

First, remove the drive belts and the collars in both bearings. On the pulley side of the cassette, remove the four (4) fasteners that hold the bearing support channel in place. Once the bearing support is removed the wheel can be pulled from the cassette. To replace the wheel, reverse this procedure.



## Removing the Energy Recovery Wheel Segments ERV-361, 521, 581, 522 and 582 (stainless steel rim)

Steel retainers are located on the inside of the wheel rim. Push the retainer towards the center of the wheel, then lift up and away to release segments.



**Important!** Place retainers back in the original position before rotating the energy recovery wheel, otherwise damage to retainer will occur.



Wheel segment removed

### Cleaning the Energy Recovery Wheel

If the wheel appears excessively dirty, it should be cleaned to ensure maximum operating efficiency. Only excessive buildup of foreign material needs to be removed. Discoloration and staining of energy recovery wheel does not affect its performance.

Thoroughly spray wheel matrix with household cleaner such as Fantastik® or equivalent. Gently rinse with warm water and using a soft brush remove any heavier accumulation. A detergent/water solution can also be used. Avoid aggressive organic solvents, such as acetone. The energy recovery wheel segments can be soaked in the above solution overnight for stubborn dirt or accumulation.

After cleaning is complete, shake the excess water from the wheel or segments. Dry wheel or segments before placing them back into the cassette. Place wheel or segments back into cassette by reversing removal procedures.

#### CAUTION

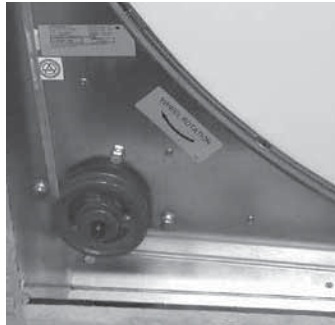
Do not clean energy recovery wheel segments with water in excess of 140°F (60°C).

Do not dry energy recovery wheel segments in air in excess of 140°F (60°C).

The use of a pressure washer to clean segments is **not recommended**. Damage could result.

### Energy Recovery Wheel Belt

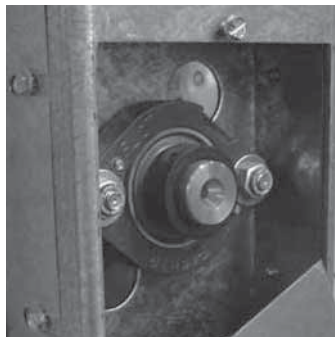
Inspect belts each time filters are replaced. Belts that look chewed up or are leaving belt dust near the motor pulley may indicate a problem with the wheel. Be sure to inspect wheel for smooth and unrestricted rotation. If a belt requires replacement, contact the local Greenheck representative. Instructions for replacement will ship with the new belt.



**Wheel Belt & Pulley**

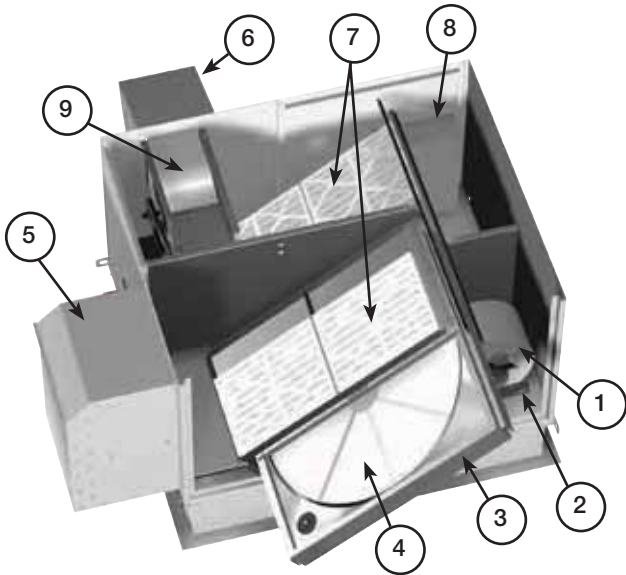
### Energy Recovery Wheel Bearing

In the unlikely event that a wheel bearing fails, the bearing is behind a removable plate on the wheel support beam which is accessible through the outdoor air filter door (and exhaust filter door on the ERV-522 and 582). Contact the local Greenheck representative for detailed instructions on how to replace the bearing.

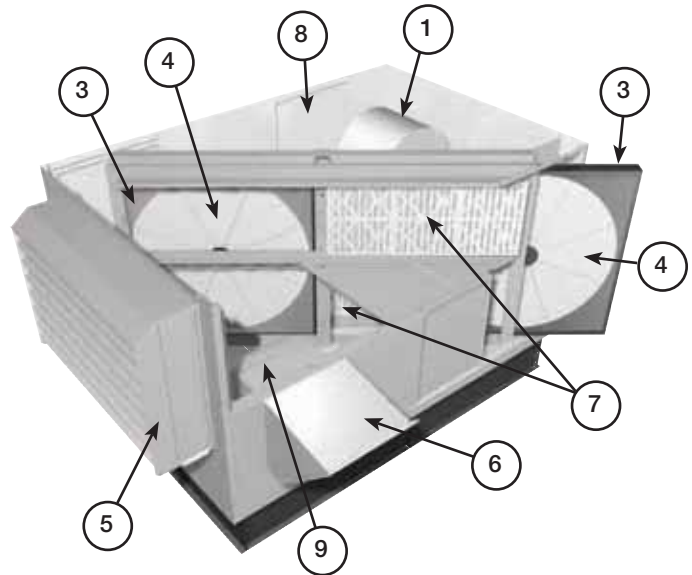


**Wheel Bearing**

## Parts List



**Inside layout of ERV-361**



**Inside layout of ERV-522**

*(shown with intake weatherhood, exhaust weatherhood, outdoor air filters, and exhaust air filters)*

1. Supply blower
  - Forward curved fan
  - Adjustable motor mount for belt tensioning
  - Adjustable sheaves for speed control
2. Vibrations isolators (quantity 4 per blower)
  - Neoprene
3. Energy recovery wheel cassette
  - one wheel on models ERV-251, 361, 521 & 581
  - two wheels on models ERV-522 & 582
4. Removable energy recovery wheel segments
5. Optional supply weatherhood with 2 inch aluminum mesh filter
6. Optional exhaust weatherhood with birdscreen
7. Optional supply and exhaust air filter racks for 2 inch pleated, 30% efficient filters
8. Electrical control box (standard features)
  - Single point power
  - Disconnect interlocked with access door
  - Motor starters for the supply blower, exhaust blower and energy wheel motors
  - 24 VAC control circuit with terminal strip
9. Exhaust blower
  - Forward curved fan
  - Adjustable motor mount for belt tensioning
  - Adjustable sheaves for speed control

## Sequence of Operation

---

### Basic Unit

The ERV units are prewired such that when a call for outside air is made (via field supplied 24 VAC control signal wired to unit control center), the supply fan, exhaust fan and energy wheel are energized and optional motorized dampers open. The ERV is normally slaved (24 volt) to the roof top air handler. When the roof top air handler starts, the auxiliary contactor in the air handler closes to start the ERV.

### Summer Operation

Outdoor air is preconditioned (temperature and moisture levels are decreased) by the transfer of energy from the cooler, drier, exhaust air via the energy recovery wheel. The preconditioned air is typically mixed with return air going back to the air handler for final conditioning.

**Economizer Operation:** Refer to Economizer Application/Operation section.

### Winter Operation

Outdoor air is preconditioned (temperature and moisture levels are increased) by the transfer of energy from the warmer, more humid exhaust air via the energy recovery wheel. The preconditioned air is typically mixed with return air going back to the air handler for final conditioning.

**Frost Control Operation:** Refer to Frost Control Application/Operation section.

### Other Accessories:

**Rotation Sensor:** Refer to Optional Accessories section

**Dirty Filter Sensor:** Refer to Optional Accessories section

**CO<sub>2</sub> Sensor:** Refer to Optional Accessories section

**Variable Frequency Drive (VFD) on Blowers:** VFDs on blowers are often used as part of a demand control ventilation system. This type of system takes advantage of varying occupancy through the use of CO<sub>2</sub> sensors to monitor space CO<sub>2</sub> levels. If CO<sub>2</sub> levels are low in the space, the VFD will operate the blowers at minimum airflow required by code. As the space occupancy increases and CO<sub>2</sub> levels increase, the VFD will increase the amount of fresh outdoor air being brought in to offset the CO<sub>2</sub> levels in the space (exhaust airflow is increased proportionally as outdoor airflow increases). As CO<sub>2</sub> levels come back down, the airflow will decrease back to minimum requirements.

## Troubleshooting – Airflow

### Test and Balance Report

The Test and Balance Report (TAB) is utilized to determine whether the appropriate amount of outdoor air and exhaust air is being supplied and removed from a building, respectively. There are no set rules on what information must be included in a TAB report. As such, if a TAB report indicates that the airflow on a unit is low, prior to contacting the factory, please determine the following information:

	Unit #1	Unit #2	Unit #3	Unit #4
<b>Model Number</b>				
<b>Serial Number</b>				
<b>Nameplate Information</b>				
Voltage				
Hertz				
Phase				
Outdoor Air Fan Amps				
Exhaust Fan Amps				
Outdoor Air Fan Horsepower				
Exhaust Fan Horsepower				
<b>Design Airflow</b>				
Outdoor Air				
Exhaust				
<b>Measured Airflow</b>				
Outdoor Air				
Exhaust				
<b>Measured Data</b>				
Blower Rotation				
Outdoor Air Fan RPM				
Exhaust Fan RPM				
Outdoor Air Fan Amp Draw				
Exhaust Fan Amp Draw				
<b>Pressure Drop Across Energy Recovery Wheel</b>				
Outdoor Air Side				
Exhaust Air Side				

Airflow problems can often be tied back to improper ductwork installation. Be sure to install ductwork in accordance with SMACNA and AMCA guidelines.



## Troubleshooting – Unit

Symptom	Possible Cause	Corrective Action
Blower fails to operate	Blown fuse or open circuit breaker.	Replace fuse or reset circuit breaker and check amps.
	Defective motor or capacitor.	Replace.
	Motor starter overloaded.	Reset starter and check amps.
	Electrical.	Check for On/Off switches. Check for correct supply voltage.
	Drive.	Check for broken or loose belts. Tighten loose pulleys.
Motor starters “chatter” or do not pull in	Control power (24 VAC) wiring run is too long (resistance should not exceed 0.75 ohms).	Shorten wiring run to mechanical room or install a relay which will turn unit on/off. Consult Factory for relay information.
	Incoming supply power is less than anticipated. Voltage supplied to starter coil must be within +10% / -15% of nominal voltage stated on the coil.	Need to increase supply power or use a special control transformer which is sized for the actual supply power.
Motor over amps	CFM too high.	Check cfm and adjust drives if needed.
	Static pressures are higher or lower than design.	If higher, ductwork should be improved. If lower, fan rpm should be lower.
	Blower rotation is incorrect.	Check rotation and reverse if necessary.
	Motor voltage incorrect.	Check motor nameplate versus supplied voltage.
	Motor horsepower too low.	See specifications and catalog for fan curves to determine if horsepower is sufficient.
	Shorted windings in motor.	Replace motor.
Low airflow (cfm)	Unit damper not fully open.	Adjust damper linkage or replace damper motor.
	System static pressure too high.	Improve ductwork to eliminate losses using good duct practices.
	Blower speed too low.	Check for correct drives and rpm with catalog data.
	Fan wheels are operating backwards.	For 3-phase, see Direction of Fan Wheel Rotation under Unit Start-Up section.
	Dirty filter or energy wheel.	Follow cleaning procedures in Routine Maintenance section.
	Leaks in ductwork.	Repair.
	Elbows or other obstructions may be obstructing fan outlet.	Correct or improve ductwork.
	Belt slippage.	Adjust belt tension.
High airflow (cfm)	Blower fan speed too high.	Check for correct fan rpm. Decrease fan speed if necessary.
	Filter(s) not in place.	Install filters.
	Insufficient static pressure (Ps) (airflow resistance).	Induce Ps into system ductwork. Make sure grilles and access doors are installed. Decrease fan speed if necessary.

Always have a completed Pre Start-Up Checklist, unit Start-Up Checklist, and Optional Accessories Checklist prior to requesting parts or service information.

## Troubleshooting – Unit

Symptom	Possible Cause	Corrective Action
One or both blowers turn off intermittently and back on after about 2 minutes	Exhaust Only frost control sensors are tripping.	Adjust frost temperature sensor set point as needed.
Energy wheel does NOT turn	Air seals are too tight.	See Energy Recovery Wheel under Unit Start-Up section.
	“Economizer” sensors are operating.	Adjust temperature or enthalpy set points as needed.
	No power to wheel motor.	Make sure wheel drive is plugged in. Verify power is available.
	Wheel drive belt.	Check for loose or broken belts. Replace belts (consult factory).
	VFD overload. (OL1 on readout)	Refer to VFD section. Compare motor amp rating to setting in VFD. Adjust accordingly.
Energy wheel runs intermittently	Wheel motor overloads are tripping, due to rubbing between wheel and air seals.	Recheck air seals, make sure they are not too tight. See Energy Recovery Wheel under Unit Start-Up Section.
Excessive noise or vibration	Fan wheel rubbing on inlet.	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	Bearings.	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel out of balance.	Replace or rebalance.
	Loose wheel on shaft.	Tighten wheel setscrew.
	Loose motor or blower sheave.	Tighten sheave setscrew.
	Belts too loose.	Adjust belt tension after 24 hours of operation.
	Belts too tight.	Loosen to maintain a 3/8 inch deflection per foot of span between sheaves.
	Worn belt.	Replace.
	Motor base or blower loose.	Tighten mounting bolts.
	Buildup of material on wheel.	Clean wheel and housing.
	Bearing and drive misaligned.	Realign.
	Noise being transmitted by duct.	Make sure ductwork is supported properly. Make sure ductwork metal thickness is sized for proper stiffness. Check duct size at discharge to ensure that air velocities are not too high.

Always have a completed Pre Start-Up Checklist, unit Start-Up Checklist, and Optional Accessories Checklist prior to requesting parts or service information.

# Maintenance Log

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## Our Commitment

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*As a result of our commitment to continuous improvement, Greenheck reserves the right to change specifications without notice.*

Specific Greenheck product warranties are located on [greenheck.com](http://greenheck.com) within the product area tabs and in the Library under Warranties.

Greenheck's Energy Recovery Ventilator catalog provides additional information describing the equipment, fan performance, available accessories, and specification data.

AMCA Publication 410-96, Safety Practices for Users and Installers of Industrial and Commercial Fans, provides additional safety information. This publication can be obtained from AMCA International, Inc. at [www.amca.org](http://www.amca.org).

