Rheia System Overview

Rheia is leading the homebuilding industry to expect and deliver higher quality HVAC systems. Rheia is a home run air distribution system that works with any size of standard residential air handling unit (AHU) from any manufacturer and easily accommodates upflow, downflow, and horizontal units. It is the first fully engineered air distribution system for the homebuilding industry, from design intent through installed performance. By using custom design software, engineered components, simplified installation, and technology-based commissioning, Rheia offers balanced, controlled comfort for a better home.

This manual provides an overview of the Rheia system, fundamentals for Rheia design, and the process for using the Rheia Design plugin for Right-Suite® Universal (RSU)software. It is intended for experienced HVAC designers who are familiar with the RSU environment, Manual J, and Manual S. While Manual D and Manual T contain valuable information, they do not specifically apply when designing a Rheia system because Rheia uses custom component sizing. This manual supersedes Manuals D and T.

The key principle in designing with Rhea is that all equipment—air handling unit, ducts, returns—is located entirely within the building thermal envelope. This allows Rheia systems to use uninsulated ducts without increasing the home's heating and cooling loads while meeting code requirements.

Supply system

All ducts are small-size, only 3" or 4" in diameter. You can easily route them between floors, in conditioned basements, vertically in interior walls, through dropped ceilings, and through insulated soffits. Ducts are joined using engineered thermoplastic components for nearly leak-free connections. Rheia uses a high number of diffusers per room for better airflow and air mixing.

The basic supply system layout is:

- An engineered manifold connects to the AHU.
- All duct runs take off from the manifold and route directly to multiple boot/diffuser assemblies in rooms throughout home.
- Rheia component parts (take offs, ferrules, elbows, couplers, boots, and diffusers) are engineered thermoplastic and snap-fit or twist-fit together for nearly airtight connections without tape or mastic.
- Every boot has a built-in, manually adjustable damper. During the design process the Rheia Design plugin calculates the position needed on each damper to deliver the correct amount of air. During commissioning, Rheia Verify mobile app validates damper positions based on installed system performance and dampers are adjusted as needed for balanced air delivery.

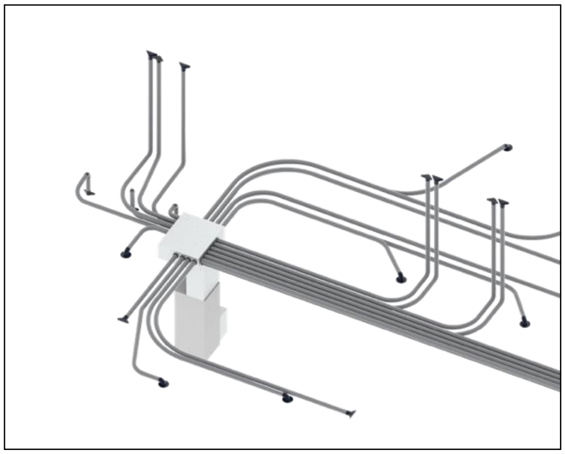


Figure 1. Rheia is a fully engineered, home run air distribution system.

Return system

For the best performance results, Rheia recommends specifying a compact, central return. Rheia's high number of diffusers per room and better throw performance provide adequate air mixing without a return duct in each room. The Rheia supply system can have a slightly higher static pressure drop (0.3-0.4 IWC) compared to a conventional supply system, therefore, Rheia recommends oversizing the return components to keep the return static pressure as low as possible. Use jump ducts and transfer grilles to relieve pressure from individual rooms. Currently, Rheia does not offer any return components, so conventional materials will be used for the return.

Component parts

Rheia components parts are engineered to deliver quiet, consistent airflow with low static pressure drops. Our injection-molded thermoplastic parts are precise and durable. They connect tightly to the manifold and ducts for a nearly leak-free supply system.

A complete Rheia system uses only 16 SKUs. This small number of unique parts saves time and expense by simplifying design, ordering, inventory, warehousing, and installation.

Table 1. Rheia component parts

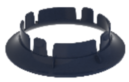
Image	Part name	Description
	Manifold Take Off Inside	A two-part assembly. The two halves clamp 1" duct board through a 3.5" hole forming a tight seal. The inside take off is designed to guide air into the duct.
	Manifold Take Off Outside	A two-part assembly. The two halves clamp 1" duct board through a 3.5" hole forming a tight seal. The outside take off connects to a ferrule or elbow.
	3" Ferrule	The 3" ferrule twists into the end of a 3" diameter duct, using a patent-pending threaded system. This technology ensures a near air-tight seal to the duct. UL 181C and UL2043 certified.

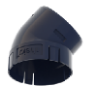
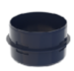
Image	Part name	Description
	4” Ferrule	The 4” ferrule twists into the end of a 4” diameter duct, using a patent-pending threaded system. This technology ensures a near air-tight seal to the duct. UL 181C and UL2043 certified.
	45 Deg. Elbow	A 45-degree component that can be doubled up to form a 90-degree turn. The male end connects to a ferrule and the female end can connect to a manifold takeoff, boot, or coupler. UL 181C and UL2043 certified.
	3”and 4” Duct Uninsulated	The Rheia 3” and 4” diameter uninsulated ducts are highly durable, flexible, and available in 50’ lengths. UL 181 Class 1 flexible duct certification.
	Coupler	The coupler is used to connect two ducts together. It features two male ends that can connect to a ferrule or an elbow. UL 181C and UL2043 certified.
	High Sidewall Boot Assembly	The high sidewall boot delivers air high on an interior wall. The boot design enables installation in 2x4 walls. It mounts to vertical framing using a Rheia Hanger Bar Assembly or by screwing to horizontal blocking. Includes a five-position adjustable damper blade.
	Pass-Through Boot Assembly	The pass-through boot assembly is for ducts terminating in high sidewalls from a dropped ceiling or bulkhead. It mounts to vertical framing using a Rheia Hanger Bar Assembly or by screwing to horizontal blocking. Includes a five-position adjustable damper blade.
	Ceiling Boot Assembly	The ceiling boot is installed using two Rheia Hanger Bar Assemblies or by screwing to horizontal blocking. A 45-degree or 90-degree elbow is used to connect to ducts running horizontally in floor structures or dropped ceilings. Includes a five-position adjustable damper blade.
	Floor Boot 4x10 Assembly	The floor boot assembly is used for ducts terminating at floor level. It attaches directly to the floor surface. Includes a five-position adjustable damper blade.

Image	Part name	Description
	Hanger Bar Assembly	The Rheia-specific bracket assembly is used for all boot installations. Tabs register the boot to the face of the framing. The brackets allow installation within wall cavities and bulkheads between 12" and 24".
	Slotted Diffuser	The slotted diffuser throws air across a room with minimal pressure loss. Installation is by pushing into the high sidewall or pass-through boot assembly. This diffuser will draw up to the drywall surface for a flush fit.
	Ceiling Diffuser Assembly	The ceiling diffuser distributes air in all directions across a ceiling with minimal pressure loss. Installation is by twisting into the ceiling boot. The integrated latch will draw the diffuser up to the drywall surface for a flush fit.
	Metal Floor Diffuser 4x10	The metal floor diffuser is a one-piece assembly. Installation is by dropping into the floor boot. This component distributes air in a two-way throw pattern.

Engineering calculation method

At each step of the design process, you will use the Rheia Design plugin to perform the underlying engineering calculations needed to specify a balanced system. The calculating engine is based on fundamental fluid mechanics and modern computational solvers. For each duct run, it calculates the airflow vs. pressure curve based on part-specific engineering data for the parts in that run. The manifold equally distributes static pressure to each take off. Given the system design airflow, the airflow through each duct run and the supply static pressure can be determined.

Rheia fundamentals

To take full advantage of the cost savings and performance benefits Rheia has to offer, it is important for you to understand these Rheia design fundamentals and advocate for them in your design discussions with the builder, architect, structural engineer, and contractor.

Tip: Reviewing the floorplans upfront and making recommendations to the group is an important role of the designer. Help build consensus with the builder, architect, and structural engineer for a duct routing strategy before beginning a design.

AHU location and duct routing

As with any duct supply system, architectural accommodations will be needed. The extent will vary by market and floorplan, and they will be influenced by the practices of the specific builder and architect.

- Locate the AHU, supply system, and return system within the building thermal envelope.
- Route supply ducts in the most direct paths from the diffusers back to the manifold. A floor system between two conditioned living areas is typically the most direct path.
- Strive for compact duct design by locating high sidewall diffusers on central, interior walls and by locating ceiling diffusers centrally in rooms. Locate floor boots near exterior walls where they will not be covered by furniture.
- Note where I-joists are located. Group duct runs together, where possible, to minimize the number and sizes of holes that must be drilled through I-joists.
- Note where beams are located. Ducts cannot run through a beam, therefore specify an alternate route around the beam or discuss adding a bulkhead.
- When dropped ceilings must be added to accommodate duct routing, plan to have them located in low-visibility areas (hallways, closets, bathrooms) to minimize poor aesthetics.
- 4" ducts cannot fit within 2x4 walls. Only use 3" ducts when running up a 2x4 wall or utilize 2x6 walls for vertical 4" runs.

Diffusers

In a Rheia design, the designer specifies the number of 3" or 4" ducts and diffusers required to meet airflow needs in each room. This contrasts with conventional systems, in which the number of ducts and registers per room is one or two, and the designer specifies a wider range of duct sizes to meet the needs.

Table 2. Example comparison of ducts and diffusers

	Rheia: all ducts are 3" or 4" diameter	Conventional: miscellaneous duct sizes
Great room	3-6 ducts and diffusers	1-2 ducts and registers
Kitchen	2-3 ducts and diffusers	1 duct and register
Owner's suite	2-4 ducts and diffusers	1-2 ducts and registers
Bedroom 2	2-3 ducts and diffusers	1 duct and register

Locating all diffusers in functional and aesthetically pleasing ways around lighting and architectural features is an important role for the designer. Use the duct routing strategy agreed upon with the builder and architect to space out the diffusers in each room, on both ceilings and walls.

Orientation-specific designs

Rheia strongly advocates for an individual design for each orientation of a floorplan (N-NE-E-SE-S-SW-W-NW) for several reasons:

- When sizing cooling equipment, the orientation of the home can impact load so much that the tonnage needed will increase (or can be decreased for builder savings).
- Data from each Rheia design will be used to commission each home, therefore, the more specific the design, the better the installed performance.
- Materials cost will be reduced by not adding additional ducts to meet worst-case orientation design needs.
- Right-sized systems are more energy efficient and proactively meet increasingly strict energy codes.

While some builders may prefer to have a single design for a given floorplan, everyone should be aware of the tradeoff costs with this approach, such as: worst-case scenario designs that specify oversized equipment and higher duct counts are more costly for the builder; a poor-performing system limits homeowner comfort; both builders and contractors incur costs from increased comfort callbacks.

Builder approach to orientation-specific designs will differ among builders and across markets. While the builder may previously have decided their preference at a corporate or divisional level, it is still important for the designer to revisit this idea before beginning a Rheia design.

Tip: From the designer's standpoint, it's also useful to know that with the Rheia Design plugin you can easily generate eight orientation-specific designs at the end of the design process.

Purchasing, installation, and commissioning

At the end of the design process, you will draw the final design(s)in a CAD program of your choice or from the drawing built into RSU. The contractor and commissioning technician both use this design to complete their work. Before beginning this drawing, discuss any specific needs with the contractor and commissioning tech and strive to complete the drawing so it's most useful to them. Draw the final design so it's easy to see all supply and return components in conjunction with all architectural and lighting elements.

Tip: The accuracy and detail of the CAD drawing is critical during installation and commissioning. The more specific information you can provide, the more likely the installed system will match your design intent.

In addition, you'll export your final design from the Rheia Design plugin as a JSON file that will be used in commissioning. Specifically, the data from your design will be:

- Uploaded to the Rheia Manage database, where it will be assigned to given lots within communities.
- Accessed by Rheia Verify mobile app during the commissioning process. The app measures the performance of the installed system and compares the data to the design intent data. Built-in dampers can be adjusted manually as needed to fine-tune airflow.

Practical application examples

Let's take some common floorplan scenarios and discuss how to implement an effective Rheia design with minimal changes to the home's architecture and structure.

- Basement foundation with AHU in basement
- Slab-on-grade foundation, two story
- Slab-on-grade foundation, single story
- Duct runs through open-web truss floor system
- Duct runs through I-joist floor system
- Rooms above a garage

Basement foundation, AHU in basement

In a home where the AHU is in the basement, very few architectural changes are required. For a single-story home, route the ducts from the basement through the first level floor system. Continue vertically through any interior wall to Rheia High Sidewall Boot Assemblies and Slotted Diffusers to serve the first level. This keeps all ducts within the conditioned space without requiring any dropped ceilings. Ducts cannot run up exterior walls for lack of space; the ducts cannot fit between the insulation and drywall.

For a two-story home, use a chase from the basement to the first-floor ceiling. Supply the first floor using High Sidewall Boots or Ceiling Boots. To supply the second floor, run ducts vertically through the chase to the first-floor ceiling, then vertically through any interior wall to High Sidewall Boot Assemblies and Slotted Diffusers.

Tip: Floor Boots can be used to serve any level where ducts are running through the floor system below, however, Rheia recommends using High Sidewall Boots over Floor Boots. High Sidewall Boots provide superior air delivery into the room by mixing the air better and eliminating drafting. Floor Boots risk being covered by homeowner furniture, thus blocking airflow. Consider using Floor Boots only if there is no interior wall to locate a High Sidewall Boot or if the builder prefers it.

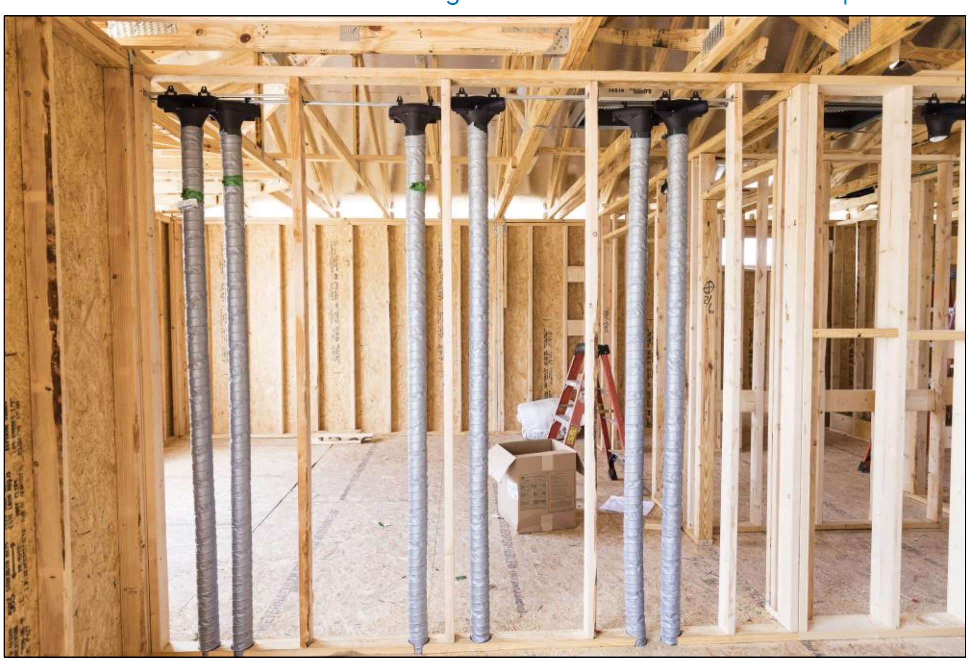


Figure 2. Run ducts vertically through interior walls to High Sidewall Boot Assemblies and Slotted Diffusers.

Slab-on-grade foundation, two story

In any two-story plan, the floor system is the easiest location for routing supply ducts within the building thermal envelope. If the mechanical closet is on the first level, Rheia recommends using an upflow AHU to feed the ducts directly into the floor system. If the mechanical closet is on the second level, Rheia recommends using a downflow AHU to feed the ducts directly into the floor system. In all cases, route the ducts horizontally throughout the floor system. To supply the second level, rise vertically through any interior wall to High Sidewall Boot Assemblies and Slotted Diffusers. Floor boots can also be used to supply the second level. To supply the first level, route ducts to Ceiling Boot Assemblies and Ceiling Diffusers.

Tip: First floor ceilings can become cluttered with lights, fans, etc. To minimize the number of objects on a ceiling, consider using High Sidewall Boots (rather than Ceiling Boots) where interior walls are available. High Sidewall Boots can be flipped upside-down and be located on an interior wall a few inches down from the ceiling.

Slab-on-grade foundation, single story

Single-story homes on a slab are the most challenging home type for routing ducts within the conditioned space. A floor system provides the best pathways, but because this home type does not have a floor system, Rheia has developed three alternate solutions for designers to consider (dropped ceiling, inverted soffits, or thickened walls). All three methods require additional coordination to ensure the Rheia system will fit and function correctly. Visit https://www.rheiacomfort.com/resources/designers for details and conceptual drawings on how to design and execute these solutions. Then, share these concepts with the builder and architect for their input on the preferred method. Inverted soffits will not impact the visible architecture of the home, but they are the most difficult to coordinate and execute. Cost of each solution will vary depending on the market prices of materials and layout of the home.

Dropped ceiling

Rheia's small-diameter, 3" and 4" supply ducts allow the dropped ceiling to be shallow—only 7" is required to house a single row of Rheia ducts, including framing and drywall thickness. (10" is required for two rows, etc.) This is another Rheia advantage over conventional ductwork, and it means that builders may be more open to adding a dropped ceiling.

Work with builders and architects to locate dropped ceilings in low-visibility areas (hallways, closets, laundry room, bathrooms) to minimize poor aesthetics.

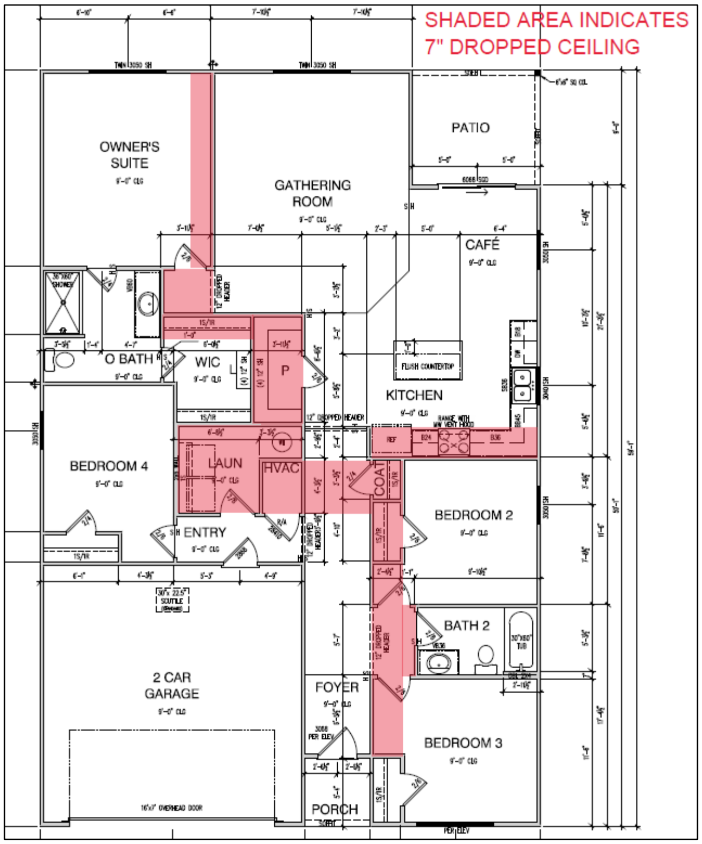


Figure 3. Example showing dropped ceiling in low-visibility areas to limit impact on interior space and to minimize poor aesthetics.

Route ducts directly from the manifold through the dropped ceiling and to Pass-Through Boot Assemblies into various rooms, where they will terminate in Slotted Diffusers.

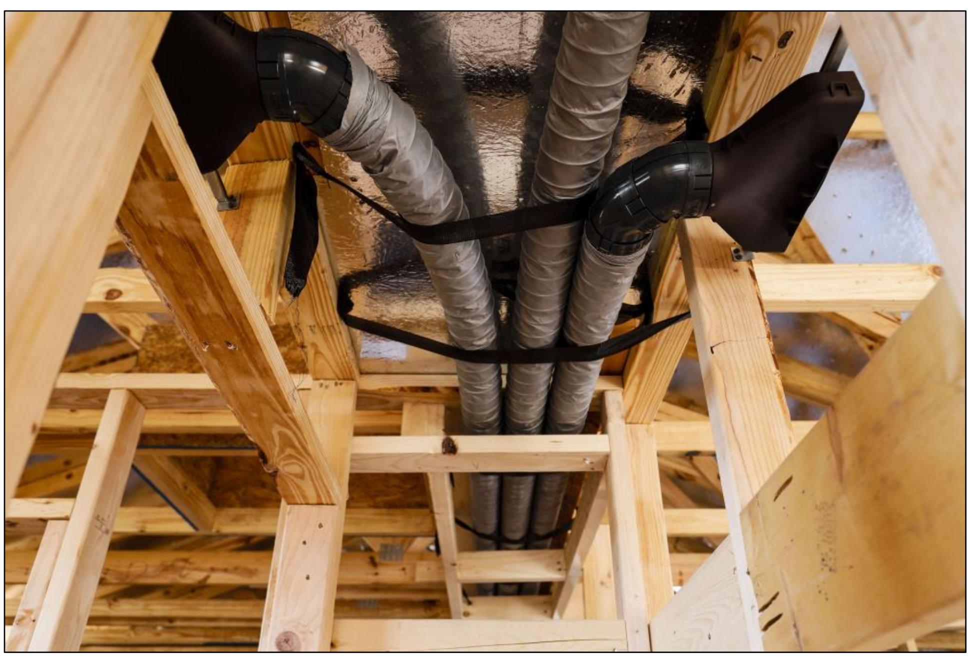


Figure 4. The ducts run through this hallway dropped ceiling and into Pass-Through Boot Assemblies for different rooms.

Air sealing the dropped ceiling from the attic is critical to meet code requirements and prevent condensation on the ducts. Visit https://www.rheiacomfort.com/resources/designers for details on how to construct the dropped ceilings.

Inverted soffits

Inverted soffits provide a cavity above the top plate for routing ducts. These must be accounted for in the structural design. Work with the builder and structural engineer to locate inverted soffits down a roof truss bay and/or across the bottom chords of the trusses. When the inverted soffit goes the opposite direction of the roof trusses, a modified truss will be required. See the detail in Figure 6. Careful coordination with the builder and structural engineer is critical for success.

No additional framing is needed on the inside of the inverted soffit. Therefore, specify the soffit height just to accommodate the ducts. Provide an additional 2" to allow the duct to turn downward into walls or ceiling boots (i.e., 6" tall soffit to house one row of 4" diameter ducts, 10" tall soffit to house two rows of 4" diameter ducts, etc.).

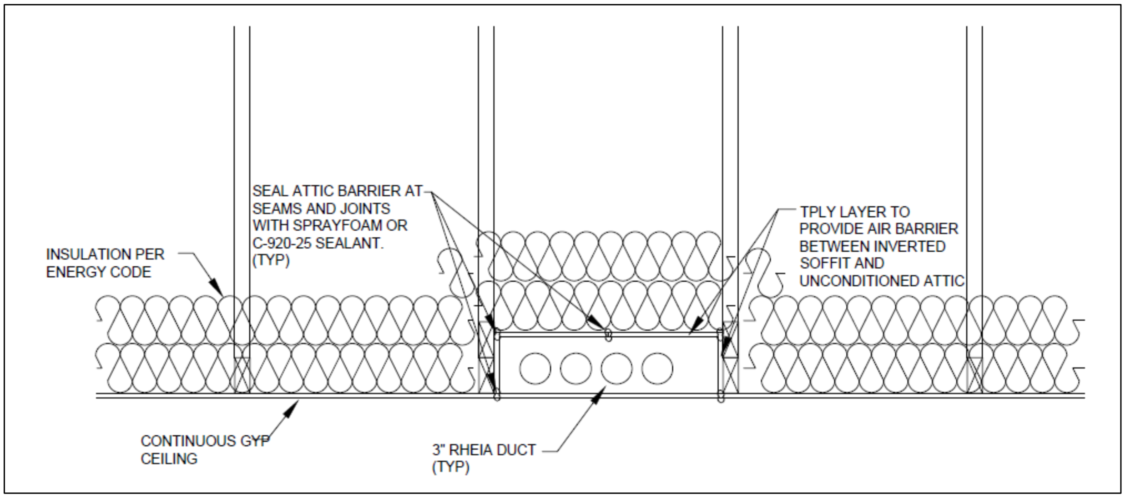


Figure 5. Detail for an inverted soffit running down a roof truss bay.

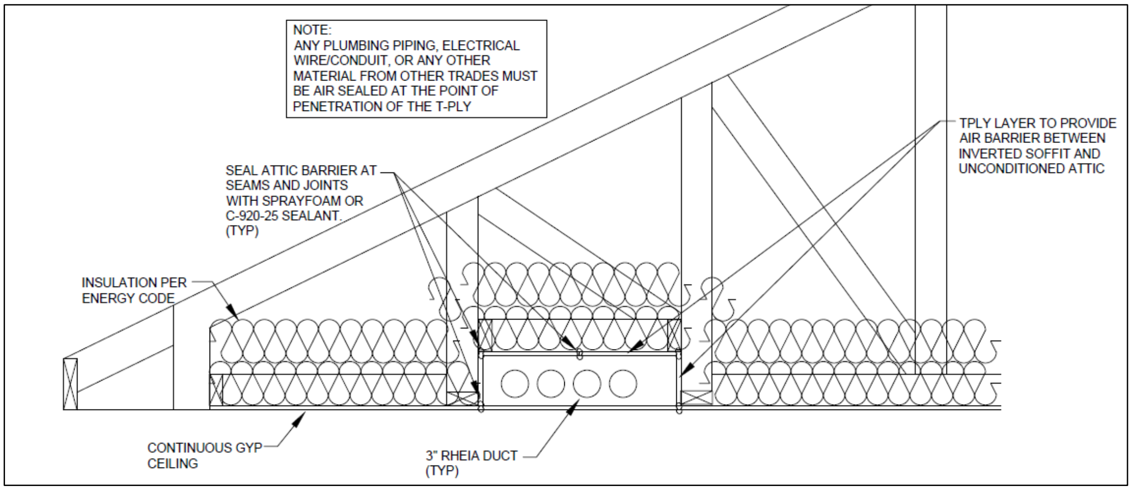


Figure 6: Detail for an inverted soffit running across bottom chords of the trusses.

Air sealing the inverted soffits from the attic is critical to meet code requirements and prevent condensation on the ducts. Visit https://www.rheiacomfort.com/resources/designers for details on how to construct the inverted soffits.

Thickened walls

Walls constructed with 2x8 top and bottom plates and studs turned on their flats will provide a cavity to route Rheia 3” and 4” diameter ducts horizontally. The number of ducts that can stack within the cavity will be constrained by other framing requirements, especially when the wall has a door.

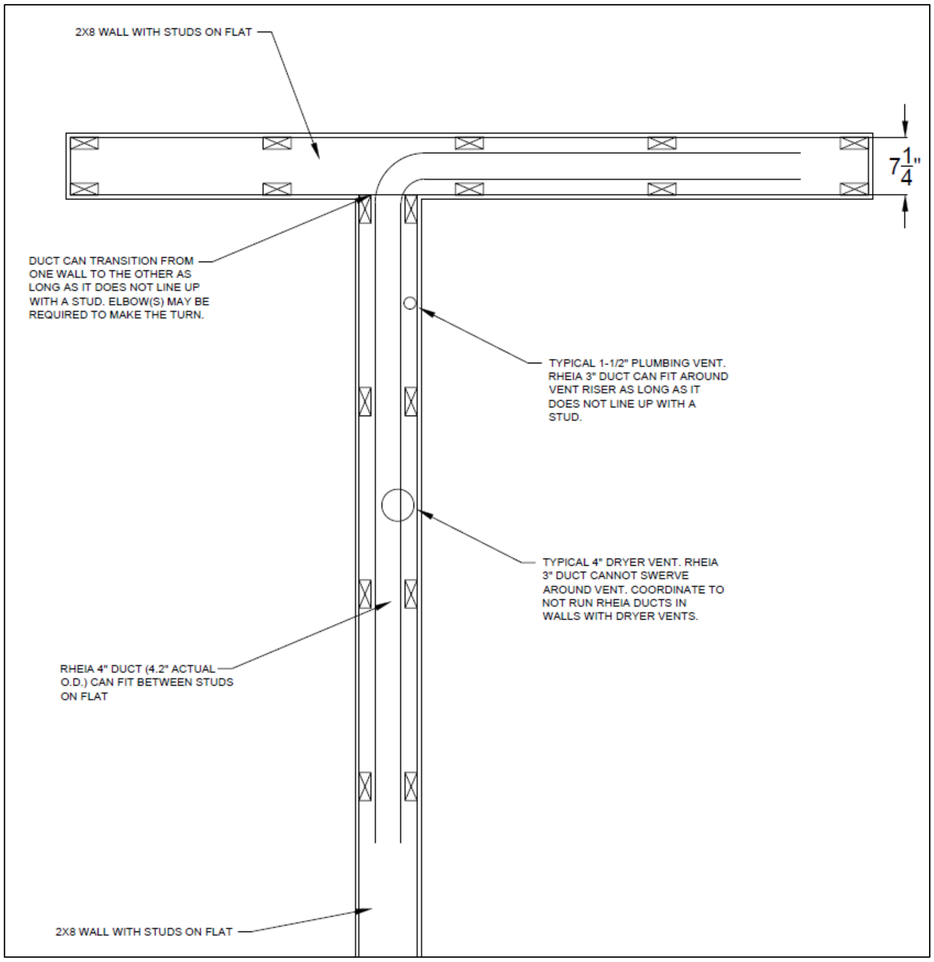


Figure 7: Detail for ducts running through a thickened wall.

Duct runs through open-web truss floor system

The small-diameter, 3” and 4” diameter ducts can easily be routed throughout an open-web truss floor system without any architectural or structural accommodations. Strive to route the ducts in smooth, sweeping runs between the framing; avoid any hard turns that might kink the ducts and limit airflow.

Figure 8. These ducts run from the basement AHU via a chase and fan out easily through the open-web truss floor system. Ducts supply the first floor and terminate at Ceiling Boots, while ducts supply the second floor by routing from the trusses up through interior walls and terminating at High Sidewall Boots.

Duct runs through I-joist floor system

Routing ducts through I-joist floor systems requires coordination between the designer and the structural engineer. Run the ducts through I-joist bays or through drilled holes in the I-joists and continue the run perpendicular to the I-joists. The goal with these duct runs is to minimize the number and size of holes that need to be cut through the I-joists by grouping the ducts as much as possible.

Figure 9. These ducts run through floor joist bays, then turn 90° through pre-cut holes in the joists. Ducts supply the first floor and terminate at Ceiling Boots, while ducts supply the second floor by routing from the trusses up through interior walls and terminating at High Sidewall Boots.

During the design process, it's important to work with the structural engineer and determine the allowable locations and maximum sizes for any drilled holes. Refer to the charts provided in the

Number of Rheia Ducts in Holes Through Joists document found at https://www.rheiacomfort.com/resources/designers for guidance on how many ducts can fit within varying sizes of holes.

Tip: Ultimately, builders can streamline installation by coordinating with the structural engineer and the I-joist provider to precut the floor joist package to match the duct routing plan.

Rooms above a garage

Rooms located above a garage pose a unique challenge because the areas directly above and below the living space are not within the building thermal envelope, and therefore cannot be used for routing supply ducts. To service rooms above a garage, you have many options. You can use any of the three solutions suitable for slab-on-grade foundation, single story, including dropped ceilings, inverted soffits, or thickened walls. In addition, you can create an air sealed cavity above the garage, as shown in the following figure. Figure 10 shows an example of a construction detail that creates an air sealed cavity to route ducts, though other details can be developed and used depending on the floor system. Work with the builder and architect to determine the best approach.

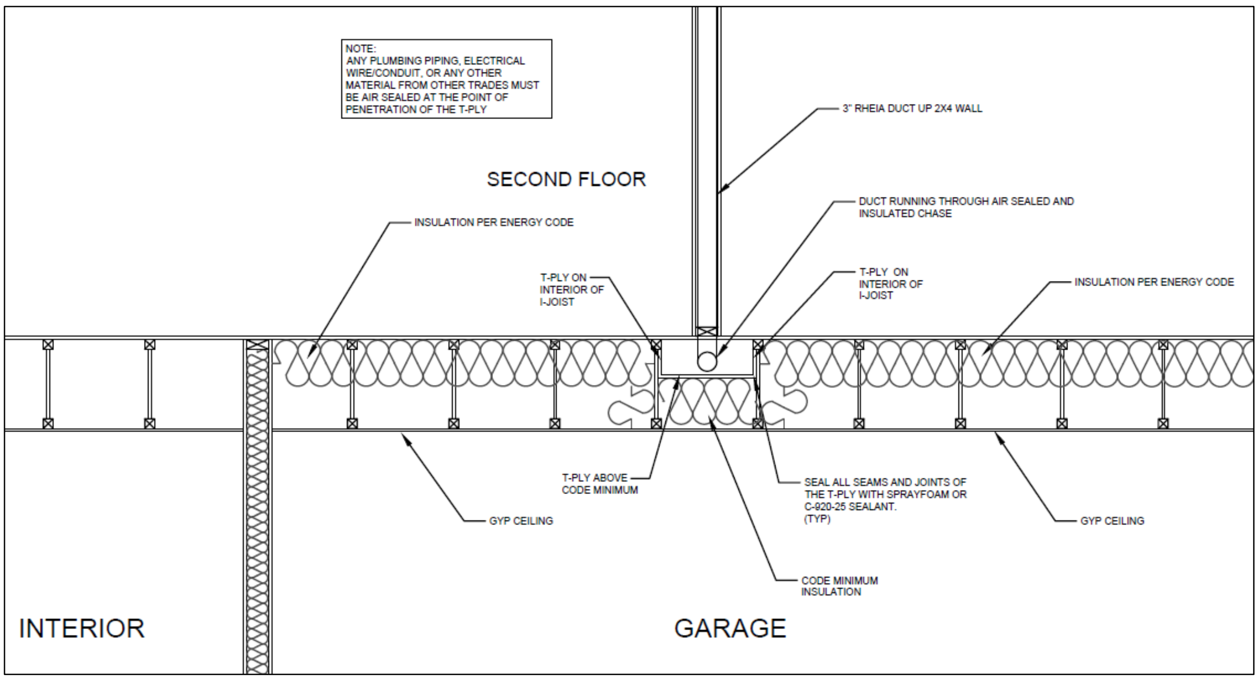


Figure 10. Detail for an air sealed cavity above the garage to route ducts to rooms above a garage.

Additional guidance

If you encounter severe duct routing challenges in a specific floorplan, work with the builder or architect to consider relocating the mechanical closet to better suit the Rheia system. A centrally located AHU generally results in shorter, more efficient duct runs, and it enables more even duct distribution on the manifold faces.

Rheia design process

This process includes pre-design preparation, designing the supply and return systems, specifying the manifold design, generating eight orientation-specific designs per floorplan, drawing final CAD files, and exporting JSON files for Rheia Manage database and Rheia Verify mobile app.

The Rheia Design plugin is available within Right-Suite® Universal. You'll complete all the design work within RSU and Rheia Design plugin, and you'll complete the final CAD drawing in software of your choice or within RSU.

Step 1: Pre-design preparations

Before beginning your design, it's important to:

- Complete Rheia training for designers
- Study the floorplan(s), keeping in mind the Rheia design fundamentals and noting specific points that you'd like to discuss with the builder, architect, and structural engineer.
- Negotiate any architectural or other changes with the builder, architect, or structural engineer regarding framing, structural members, dropped ceilings, and orientation-specific design.

You'll need to access these to complete your design:

- Rheia Performance Data Sheets: https://www.rheiacomfort.com/resources/designers
- Equipment manufacturer's performance data for the AHU and DX Coil
- Rheia Manifold Design Manual: www.rheiacomfort.com/resources/designers
- Rheia Value Engineering Manual: www.rheiacomfort.com/resources/designers
- Rheia Manage Manual: www.rheiacomfort.com/resources/designers

Step 2: Complete Manual J and Manual S using Right-Suite® Universal

Complete Manual J and Manual S using Right-Suite® Universal. With Rheia, all equipment and ducts are located within the conditioned space. Select all the rooms in the home, right click to open the Property Sheet, set all Supply Location and Return Location to Conditioned space.

Property Sheet › Duct Heat Loss Factor › Duct Loads › Supply Location, Return Location › Conditioned space

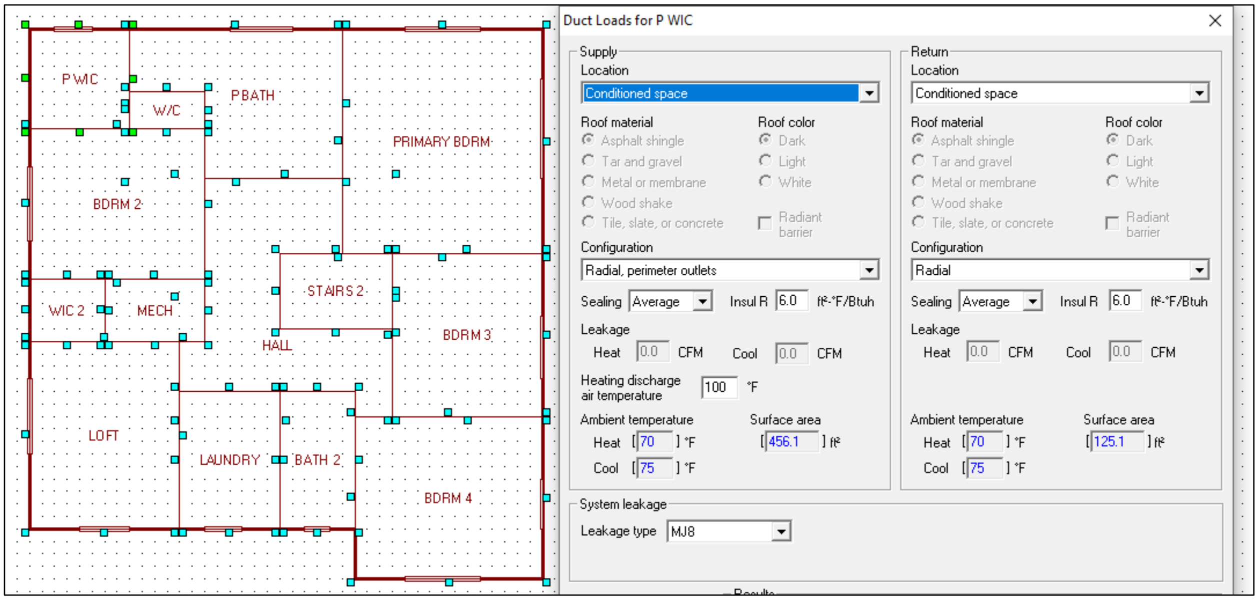


Figure 11. Set Supply Location and Return Location to Conditioned space.

Step 3: Select Rheia Duct System

From the drawing sheet, turn on the Ducts layer by checking the box in the far right of the screen. The AHU and conventional registers automatically appear on the drawing sheet.

To select the Rheia Duct System, right click on the AHU. In the Property Sheet, find the Rheia Duct System field and set the pull-down option to Yes. This automatically generates the manifold and changes the square diffusers to round, Rheia Ceiling Diffusers.

Property Sheet › General › Rheia Duct Design System › Yes

Tip: Ceiling Diffusers appear as the default in the Rheia Duct System. You'll locate the diffusers and specify types later in the design.

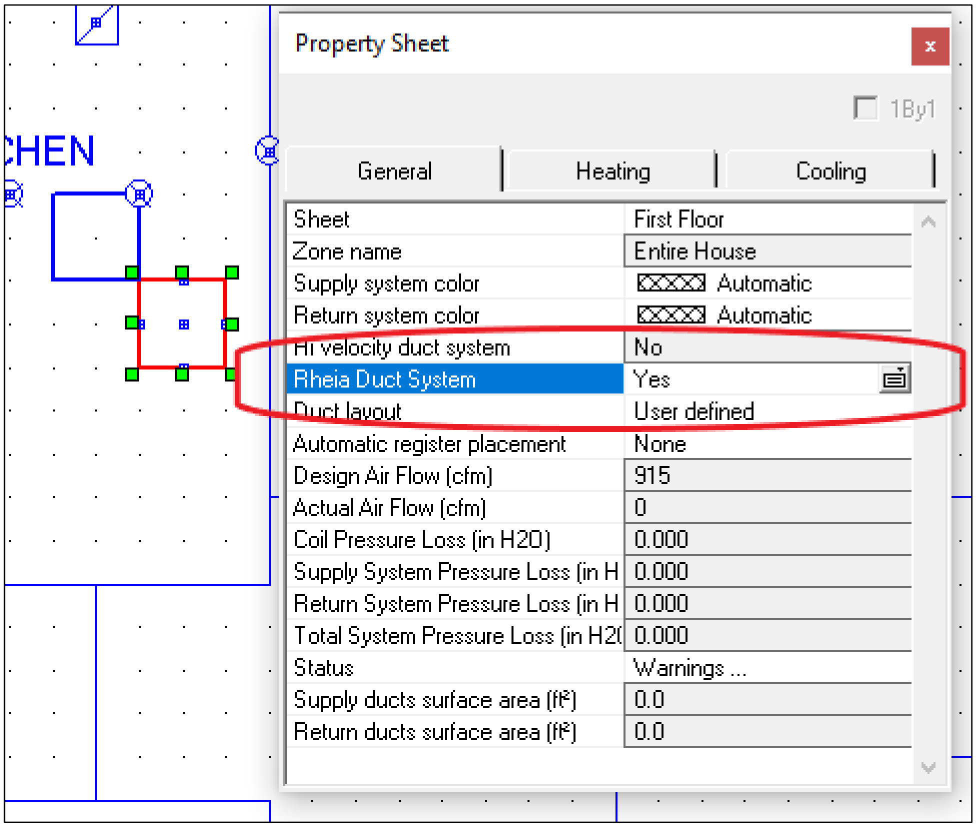


Figure 12. Set the AHU to be a Rheia Duct System.

Step 4: Relocate AHU and manifold

1. Turn on the View Snap Points button in order to make duct connections.

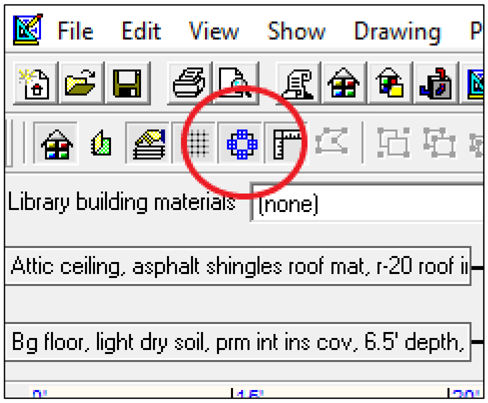


Figure 13: Connections can only be made if the View Snap Points button is clicked on.

2. Relocate the AHU by clicking and dragging it into the mechanical closet on the floor plan.
3. Relocate the manifold by clicking and dragging it into the mechanical closet as well.
    - For an upflow AHU, position the manifold next to the unit. In reality, the manifold will be connected directly above the AHU, but that cannot be displayed within this interface. Draw a short supply duct from the AHU to the manifold to represent the vertical duct.
    - For a downflow AHU, position the manifold on the floor below the unit and draw a riser to make the connection. For more information, refer to the section, Step 11: Add vertical ducts (risers).
4. Be sure to size the connecting duct correctly because it will be accounted for in the pressure loss calculation. The connecting duct will typically be the same dimensions as the AHU cabinet or supply air outlet, and it will appear as a full connection when the first diffuser-to-manifold connection is made.

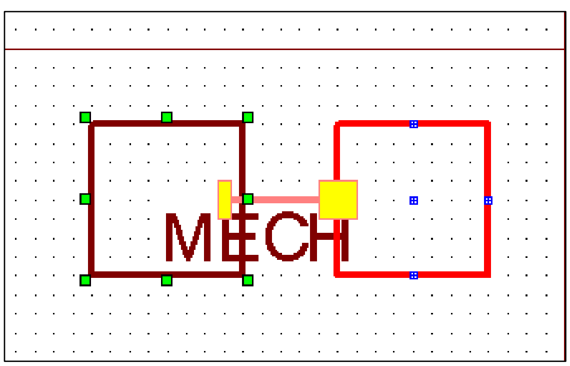


Figure 14. Draw a short supply duct to connect the manifold to the AHU. Size this duct correctly for accurate pressure loss calculation.

Tip: Later in the design process, you'll be able to increase the size of the manifold as needed to accommodate all duct connections.

Step 5: Select design mode: cooling, heating, or average

To determine how much air supply is required for each room, you'll need to select the design mode. Click the Duct Preferences button in the top center of the screen to open the Rheia Duct Preferences window. Find the Design Mode field at the top left and set the pull-down option to Cooling, Heating, or Average, depending on the mode most used in the market for this home.

- Select Cooling for a home in a predominantly cooling market such as Phoenix or Las Vegas. This mode provides target airflow to each room based on peak cooling load.
- Select Heating for a home in a predominantly heating market such as Minneapolis or Seattle. This mode provides target airflow to each room based on peak heating load.
- Select Average for a home in a market where both heating and cooling are important, such as Denver or Indianapolis. This mode provides target airflow to each room based on the average of peak heating and cooling loads.

Duct Preferences button › Rheia Duct Preferences › Design Mode › Cooling, Heating, Average

Tip: Later in the design process, you'll check each design mode to ensure the home can be balanced for every season.

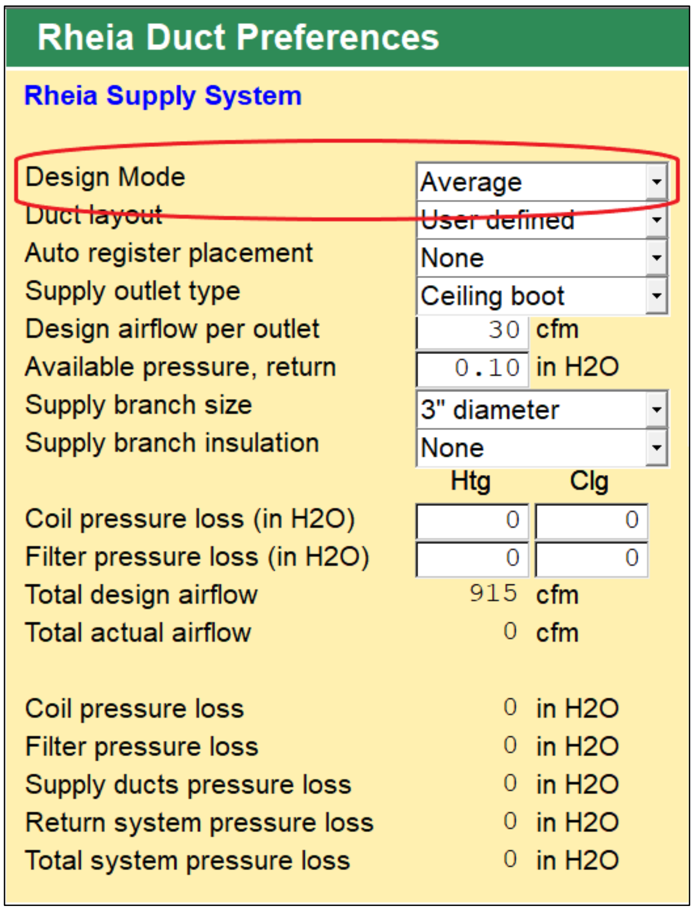


Figure 15. Set the Design Mode to Cooling, Heating, or Average, depending on the mode most used in the market for this home.

Step 6: Set the default duct size

Rheia offers two duct sizes, 3" diameter and 4" diameter. Within a run using 3" ducts or a run using 4" ducts, only two components are different: the flex duct itself and the ferrules. All other components (take-offs, elbows, couplers, boots, and diffusers) are the same for both duct diameters.

Later in this design process you will evaluate and size each duct run. It will save you time to start the design with all 4" runs. Click the Duct Preferences button in the top center of the screen to open the Rheia Duct Preferences window. Find the Supply branch size field and select 4" diameter.

Duct Preferences button › Rheia Duct Preferences › Supply branch size › 3" diameter, 4" diameter

Tip: Once you are more experienced with the Rheia design process, you may find you prefer starting with 3" diameter ducts. This is also okay.

Tip: Do not set the Supply branch size to Auto diameter at this time. The Auto diameter setting will cause the software to operate slowly while you are drawing the duct system. If applicable, Auto diameter can be used in Step 13: Size the ductwork.

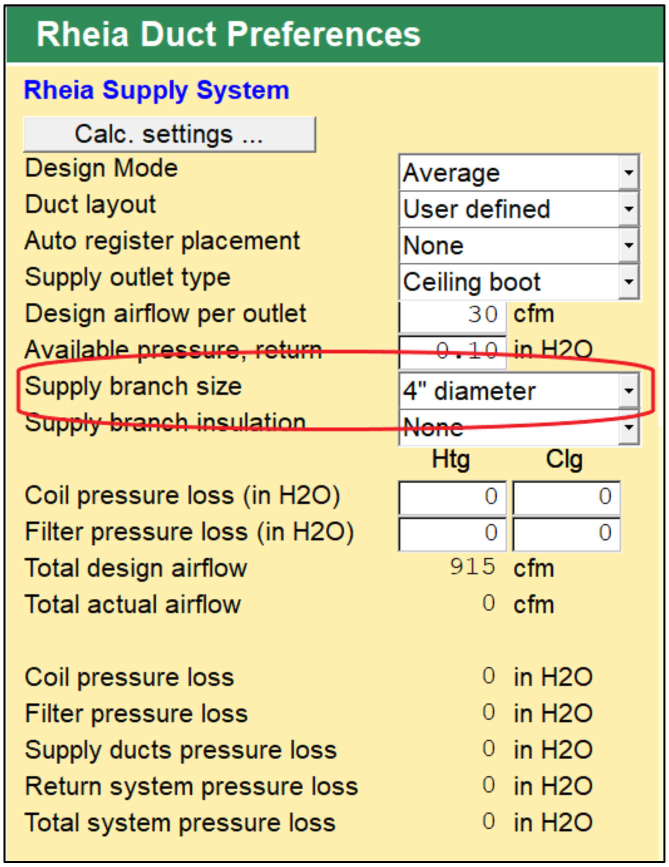


Figure 16: Set the Supply branch size to 4" diameter.

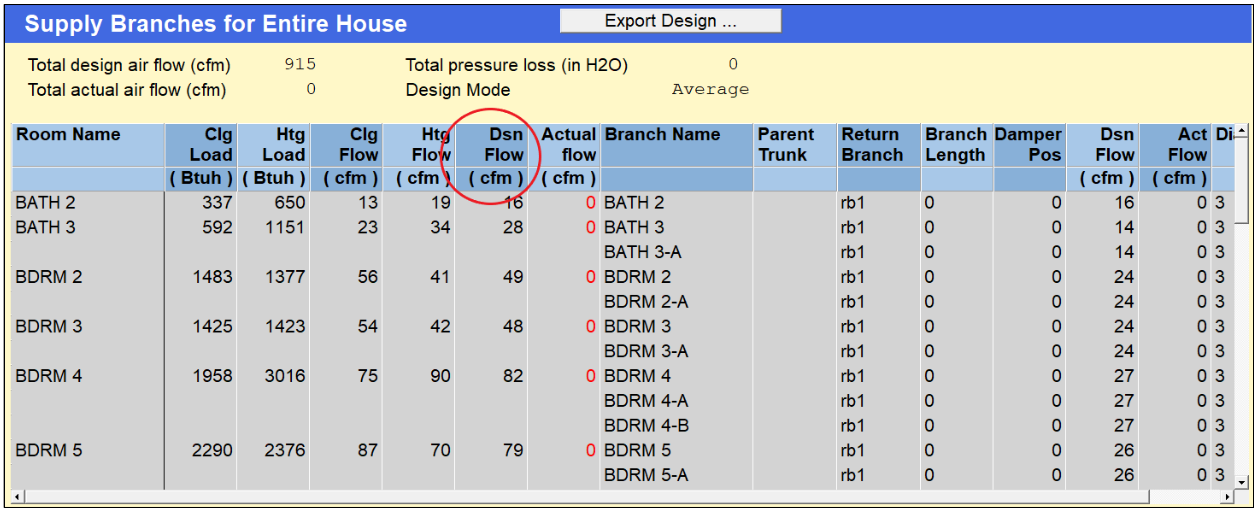
Step 7: Estimate number of diffusers per room

To see the target airflow for each room, click the Supply Branches button at the top center of the screen to open the Supply Branches window. Notice the Design Mode reflects what you've selected (Cooling, Heating, or Average). The Dsn Flow column lists the target airflow for each room.

- If the Design Mode is set to Cooling, the Dsn Flow column will equal the Clg Flow column.
- If the Design Mode is set to Heating, the Dsn Flow will equal the Htg Flow column.
- If the Design Mode is set to Average, the Dsn Flow column will equal the average of the Clg Flow and Htg Flow columns.

The Actual flow column remains 0 at this stage of the design; once duct runs are drawn and connected, the Actual flow column will show the predicted airflow for each duct run.

Notice the Supply Branches window is also where you will find individual damper positions and duct CFM. These will be used in Step 14: Evaluate airflows and Step 15: Evaluate pressure loss.



Supply Branches for Entire House

Export Design ...

Total design air flow (cfm) 915
Total actual air flow (cfm) 0
Total pressure loss (in H2O) 0
Design Mode Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
BATH 2	337	650	13	19	16	0	BATH 2		rb1	0	0	16	0	3
BATH 3	592	1151	23	34	28	0	BATH 3		rb1	0	0	14	0	3
							BATH 3-A		rb1	0	0	14	0	3
BDRM 2	1483	1377	56	41	49	0	BDRM 2		rb1	0	0	24	0	3
							BDRM 2-A		rb1	0	0	24	0	3
BDRM 3	1425	1423	54	42	48	0	BDRM 3		rb1	0	0	24	0	3
							BDRM 3-A		rb1	0	0	24	0	3
BDRM 4	1958	3016	75	90	82	0	BDRM 4		rb1	0	0	27	0	3
							BDRM 4-A		rb1	0	0	27	0	3
							BDRM 4-B		rb1	0	0	27	0	3
BDRM 5	2290	2376	87	70	79	0	BDRM 5		rb1	0	0	26	0	3
							BDRM 5-A		rb1	0	0	26	0	3

Figure 17. Supply Branches window displays the Design Mode you've selected (Average) and the target airflow per room.

To estimate the number of diffusers needed in each room, use the following rules of thumb:

Table 3. Rules of thumb for estimating diffusers

	3" diameter ducts	4" diameter ducts
Any duct run > 20 feet	30 CFM max	50 CFM max
Any duct run < 20 feet	40 CFM max	60 CFM max

Tip: These are guidelines. It is acceptable if the final design includes duct runs > 20 feet with airflows greater than 30 or 50 CFM (3" and 4" respectively); likewise, 40 or 60 CFM is not a hard maximum for duct runs < 20 feet.

Review the drawing sheet to verify that the number of diffusers shown in each room is accurate per the rules of thumb above. Add or delete diffusers as needed. Note that the number of diffusers determined at this early stage is only an estimate that you will adjust later in the design process.

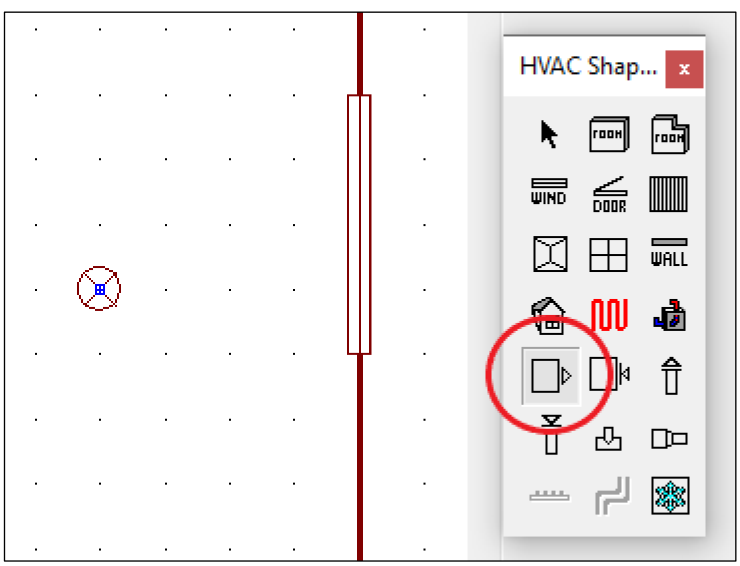


Figure 18. Add a diffuser to a room that requires more per the rules of thumb.

Step 8: Locate diffusers

The Rheia system has many more diffusers than a conventional system.

Rheia's high number of diffusers provides significantly better air mixing for more consistent comfort as compared to a conventional system. Use the duct routing strategy agreed upon with the builder and architect to space out the diffusers in each room, on ceilings, walls, and floors.

- For best comfort results, it's important to space out diffusers to ensure every portion of each room is receiving conditioned air.
- For best aesthetic results, carefully consider the lighting and architectural features of each room and locate the diffusers to be visually pleasing.

Tip: You will have an opportunity to fine-tune diffuser placement and evaluate throw once all duct connections are made and CFM is predicted per diffuser.

Step 9: Update outlet types

Once all diffusers are in place, verify each is set to the correct outlet type and change if necessary. Right click on a diffuser to open the Property Sheet and change the outlet type from the pull-down menu options.

- Set Ceiling Diffusers to Outlet type › Ceiling boot (This is the default.)
- Set Slotted Diffusers to Outlet type › Pass through boot when the duct is coming horizontally from a dropped ceiling or through the floor.
- Set Slotted Diffusers to Outlet type › High sidewall boot when the duct is coming up from within the wall to the boot.
- Set Floor Diffusers to Outlet type › Floor boot.

Property Sheet › Register details › Outlet type › Ceiling boot, Pass through boot, High sidewall boot, Floor boot

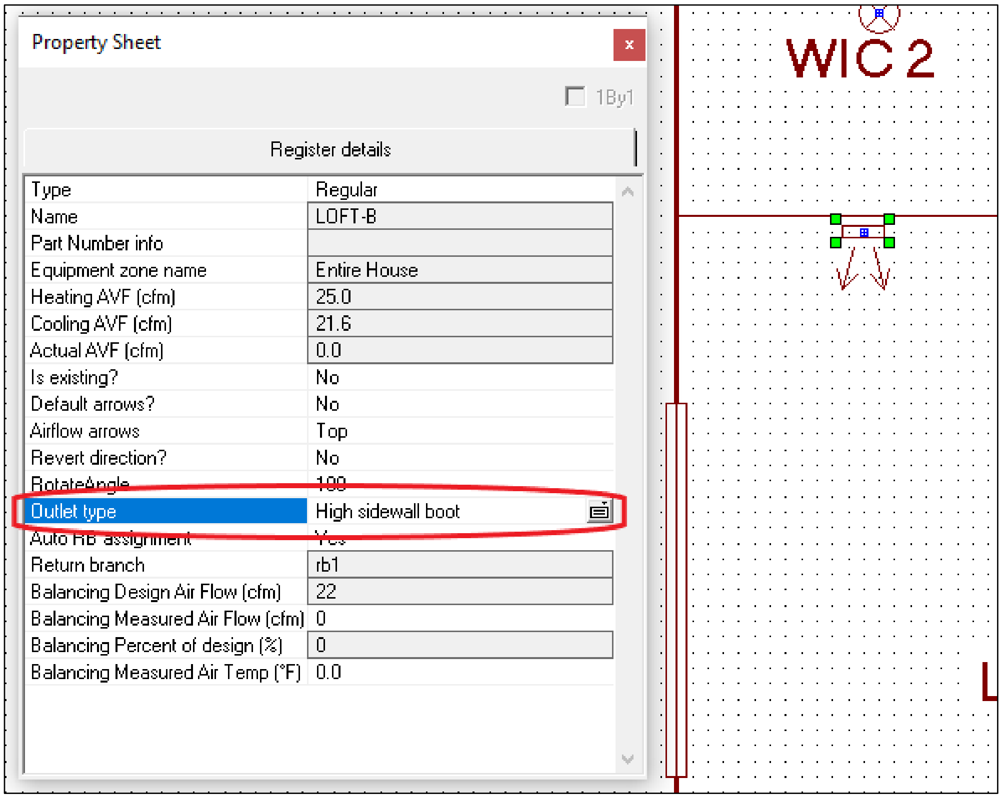


Figure 19. Change the diffuser outlet type from Ceiling boot (default) to Pass through boot, High sidewall boot, or Floor boot when needed.

Step 10: Route ducts from the manifold to the diffusers

Rheia is a home run system, which means every duct connects from the manifold directly to a boot and diffuser. At its core, this is a four-step process, as shown below. Before beginning to draw any ducts, it's most efficient to quickly read the process below. Then, thoroughly read the additional duct routing scenarios specific to using Rheia, including: ducts making hard 45° and 90° turns, ducts through open-web trusses and I-joists, and routing ducts to Floor Boots.

1. On the main toolbar, click the Drawing pull-down menu and find the Split intersected ducts option. Uncheck this option to ensure that you are not combining any ducts while drawing them.

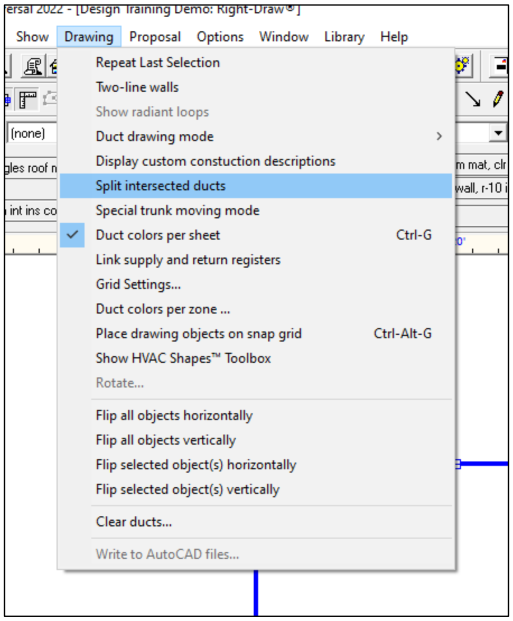


Figure 20. On the Drawing menu pull-down, uncheck Split intersected ducts option.

2. Draw duct connections from the manifold to each individual diffuser. A duct can begin at any point within the manifold. First, draw a straight line between the manifold and diffuser. Next, use the edit points tool to fine-tune the duct routing; this will ensure the static pressure calculator is more accurate.

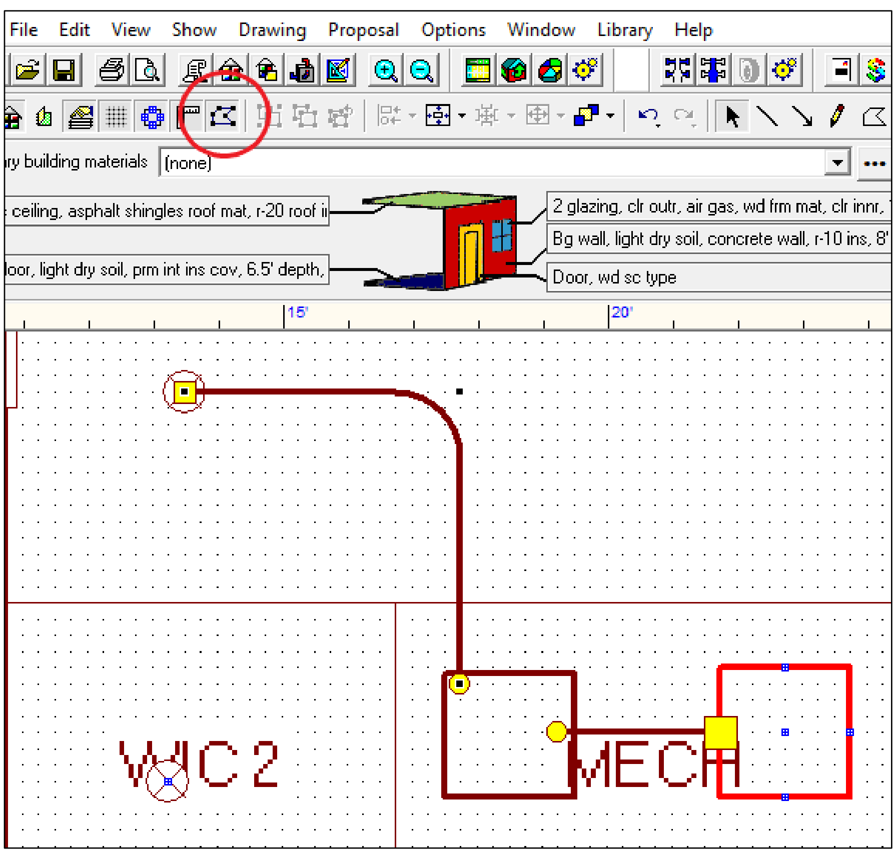


Figure 21. Draw a duct connection and manipulate the edit points to accurately show how the duct will be routed.

3. Repeat all the supply duct connections to each diffuser. Once a duct is connected, you can turn on the Duct Notation layer to see the predicted CFM at the diffuser.
4. Only when necessary to accommodate all duct connections, increase the size of the manifold using the tabs along its border. Be conservative—do not make the manifold larger than necessary or it will negatively affect the duct lengths' accuracy.

It's important to draw the ducts as you intend for the contractor to route them during installation. Follow the design strategy agreed upon with the builder and architect—use dropped ceilings or other pre-defined pathways and pay attention to all framing and structural members.

Tip: Do not be alarmed if the initial CFM is high; this is expected. After all ducts are connected the CFM shown will be accurate for the system.

Tip: As duct runs are drawn, components such as Manifold Take Offs, Ferrules, and Couplers are automatically added to the Bill of Materials (BOM) as needed, although these will not display in the drawing sheet.

Drawing ducts for hard 45-degree and 90-degree turns

If a duct needs to make a hard 45° or 90° turn around a framing or a structural member, draw a duct to that point, then draw a second duct to make the hard turn. When two ducts are drawn in this way, a Rheia elbow fitting is automatically generated as part of the duct run. Depending on the angle of the connection, either one 45° Elbow or two 45° Elbows (for a 90° turn) will be added to the BOM.

Refer to the information provided in the When to Include Elbows in a Design document found at https://www.rheiacomfort.com/resources/designers for guidance on when to use elbow fittings and when to use sweeping bends.

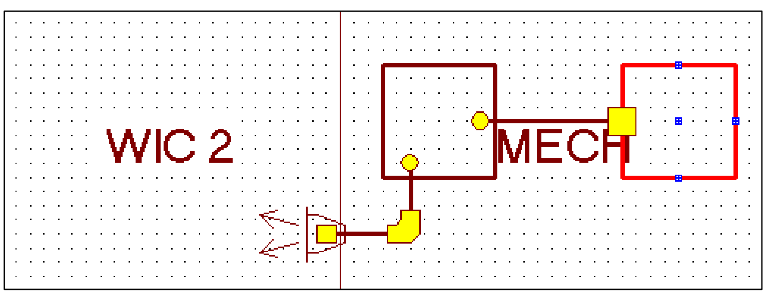


Figure 22. Drawing a 90° turn between the manifold and WIC 2 automatically generates Rheia 45° Elbow components.

Drawing ducts through an open-web truss floor system

In an open-web truss floor system, Rheia ducts can easily sweep between the trusses; no Elbows are needed. To draw ducts running through open-web trusses, draw a straight line between the manifold and diffuser. Then use the edit points tool to fine-tune the duct routing.

Tip: It is important to add sweeping bends using the edit points to most accurately estimate how the ducts will be run. Even in open-web trusses, the duct must turn around the webbing and cannot run in a straight line. The design software calculates every foot of duct and every bend, so adding these bends now will help the software calculate the system more accurately.

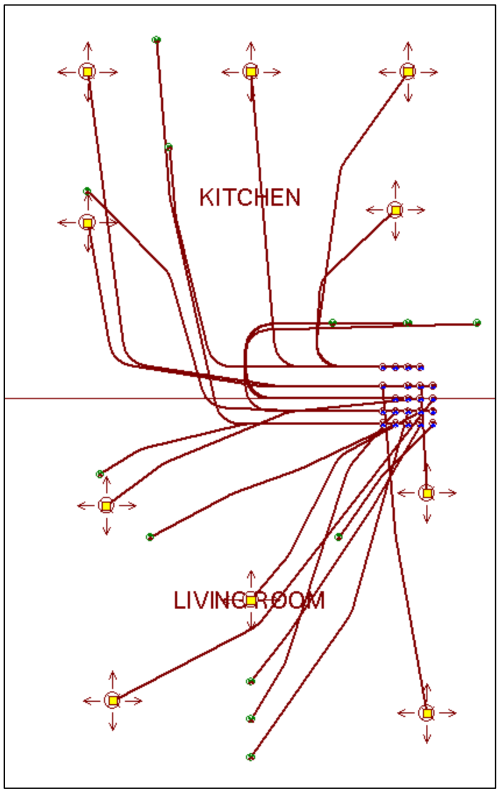


Figure 23. Rheia ducts easily sweep through open-web truss floor systems.

Drawing ducts through an I-joist floor system

In an I-joist floor system, route Rheia ducts parallel between the joists and turn 90° to continue perpendicular as needed. Some of these turns can use sweeping bends while others must use elbow fittings. Refer to the information provided in the When to Include Elbows in a Design document found at https://www.rheiacomfort.com/resources/designers for guidance.

Connecting ducts to Floor Boots

To connect a duct to a Floor Boot, begin by having the first floor and second floor displayed on the drawing sheet. Set the outlet type and locate the diffuser in the desired location. Then draw a duct on the floor below that terminates at the location of the Floor Boot on the floor above, taking care to follow best practices for sweeping bends or elbow fittings. Accurately line up the duct to the diffuser. A riser is not needed to connect to a Floor Boot.

Tip: Rheia recommends using High Sidewall Boots rather than Floor Boots because High Sidewall Boots provide superior air delivery into the room by mixing the air better and eliminating drafting. Floor Boots risk being covered by homeowner furniture, thus blocking airflow. Consider using Floor Boots only if there is no interior wall to locate a High Sidewall Boot, or if the builder prefers it.

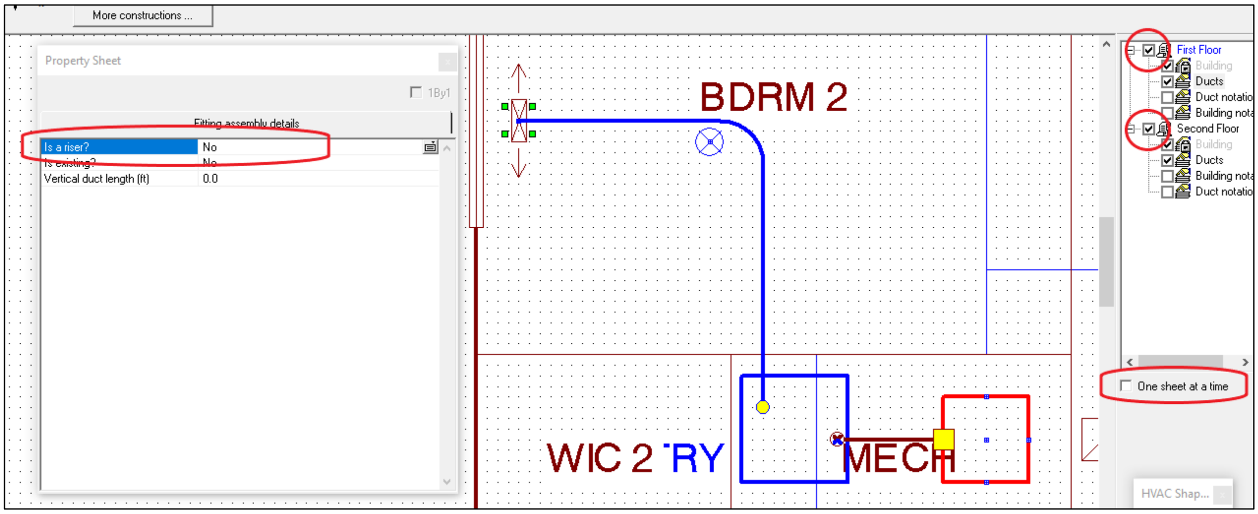


Figure 24. Draw a duct from the manifold to the location of the Floor Boot above. The connection is automatically made when the endpoint of the duct lines up with the Floor Boot.

Step 11: Add vertical ducts (risers)

Many designs will require vertical ducts (risers) running from one floor to another. Locate risers in either a chase or an interior wall, depending on the design strategy agreed upon with the builder and architect. To add a riser, draw a duct from the manifold to the location of the riser, following best practices for sweeping bends or elbow fittings. Then, follow these steps to set the riser specifics in the Property Sheet.

1. Right click on the duct endpoint to open Property Sheet > Fittings. Find the Is a riser? field. Click the pull-down menu and change to Yes.
2. Edit the Vertical duct length field to show the actual length for this duct.
3. Edit the Elbow location field to match the design intent. Some risers will require an elbow component to transition from horizontal to vertical while others can use a sweeping bend. Refer to the information provided in the When to Include Elbows in a Design document found at https://www.rheiacomfort.com/resources/designers for guidance.
4. Edit the Starting sheet and Ending sheet fields so the riser appears on the correct sheets per the design intent.

Once a riser is created, it will automatically appear on the drawing sheets indicated as the Starting sheet and Ending sheet in the Property Sheet.

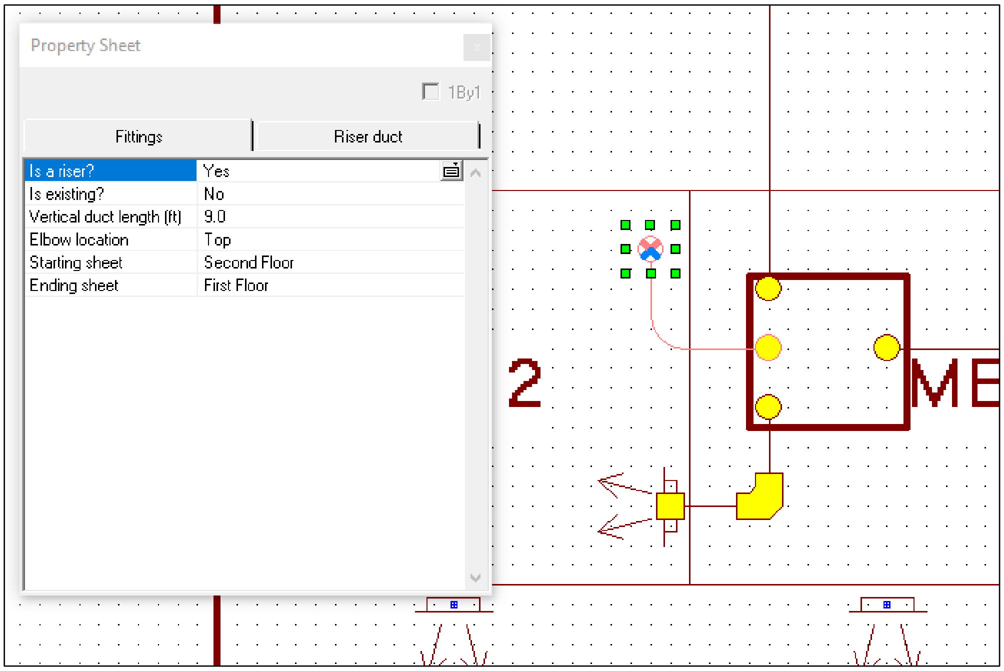


Figure 25. Property Sheet example for setting vertical duct (riser) options.

Another common instance for needing a riser is when making a connection to a High Sidewall Boot. In that case, draw a riser on the floor below using the previously mentioned steps. Once the riser is generated, drag the riser to the location of the High Sidewall Boot on the floor above. Once the connection is made properly, the CFM will appear. Select None in the Elbow location field because no elbow is needed at the boot connection or at the bottom of the riser as the duct transitions up into the wall.

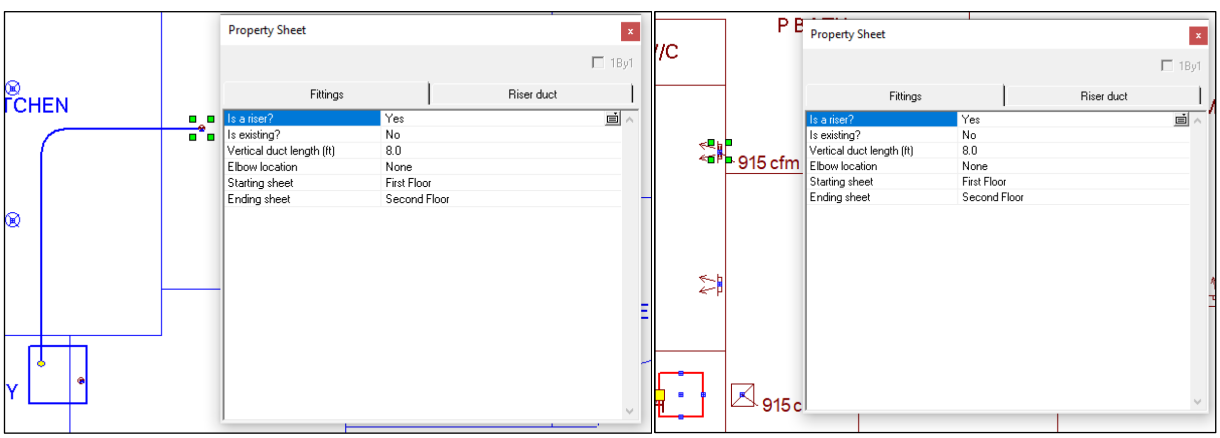


Figure 26. Example for making a riser connection to a High Sidewall Boot.

Tip: Set the vertical length of the riser connecting to a High Sidewall Boot to the same distance as the ceiling height. High Sidewall Boots terminate approximately one foot below the ceiling and the riser begins approximately one foot below the floor. The vertical length will be the same length as the ceiling height.

Step 12: Draw the return system

The return system will use conventional materials; Rheia does not currently offer any return components. To achieve maximum overall performance from a Rheia system, we recommend:

- Central return with jump ducts and transfer grilles into bedrooms
- Return components sized larger than in conventional designs to reduce static pressure on the overall system. This allows for extra pressure loss in the supply ducts.

Step 13: Size the ductwork

Earlier in the design process, you set the Supply branch size to 4" diameter. Now it is time to optimize the design for cost efficiency and performance by sizing each duct for 3" or 4". You have two ways of specifying this. You can manually set each duct run and segment of each duct run, or you can use the Auto diameter setting.

For more information on the cost savings of using 4" ducts, refer to the information provided in the Value Engineering document found at https://www.rheiacomfort.com/resources/designers.

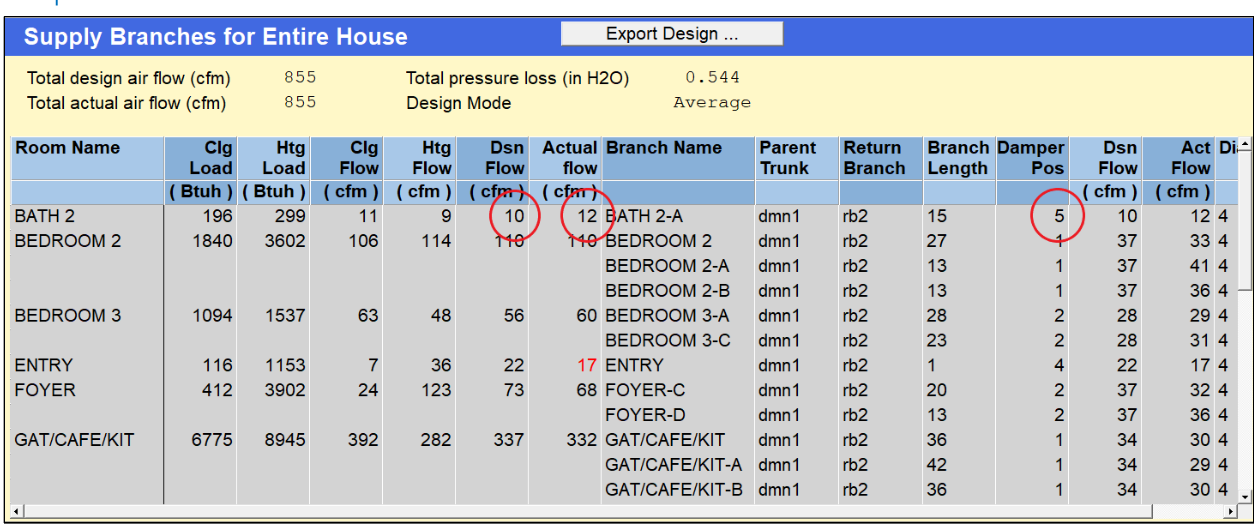
Tip: If you choose the Auto diameter setting, you must double-check all duct diameters to ensure an optimized design.

Manually setting combination of 3" and 4" ducts

When you set the Supply branch size in Step 6, each duct run drawn matches the size you set. You will now review the design CFM per room and identify which 4" diameter runs to replace with 3" diameter runs.

1. Click the Supply Branches button at the top center of the screen to open the Supply Branches window.
2. Review the columns for Dsn Flow, Actual flow, and Damper Pos. Identify any duct with a design airflow of less than 30 CFM or a damper position of 3 or greater. These rooms can be adequately served by a 3" run and will typically be smaller rooms such as bathrooms and closets.

   Tip: You will have an opportunity to change additional duct runs later, when evaluating airflows and pressure loss.



Supply Branches for Entire House

Export Design ...

Total design air flow (cfm) 855
Total actual air flow (cfm) 855
Total pressure loss (in H2O) 0.544
Design Mode Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
BATH 2	196	299	11	9	10	12	BATH 2-A	dmn1	rb2	15	5	10	12	4
BEDROOM 2	1840	3602	106	114	110	110	BEDROOM 2	dmn1	rb2	27	1	37	33	4
							BEDROOM 2-A	dmn1	rb2	13	1	37	41	4
							BEDROOM 2-B	dmn1	rb2	13	1	37	36	4
BEDROOM 3	1094	1537	63	48	56	60	BEDROOM 3-A	dmn1	rb2	28	2	28	29	4
							BEDROOM 3-C	dmn1	rb2	23	2	28	31	4
ENTRY	116	1153	7	36	22	17	ENTRY	dmn1	rb2	1	4	22	17	4
FOYER	412	3902	24	123	73	68	FOYER-C	dmn1	rb2	20	2	37	32	4
							FOYER-D	dmn1	rb2	13	2	37	36	4
GAT/CAFE/KIT	6775	8945	392	282	337	332	GAT/CAFE/KIT	dmn1	rb2	36	1	34	30	4
							GAT/CAFE/KIT-A	dmn1	rb2	42	1	34	29	4
							GAT/CAFE/KIT-B	dmn1	rb2	36	1	34	30	4

Figure 27. Check the Supply Branches window to identify rooms with low design airflow or high damper position.

3. Make a list of these rooms so you can systematically check the entire duct design, one run at a time, and set each run to 3” diameter duct as needed.
4. To change a duct run from 4” diameter to 3”, right click that duct run to open the Property Sheet. Change the Supply duct size field to 3” diameter. Property Sheet › Duct details › Supply duct size › 3” diameter

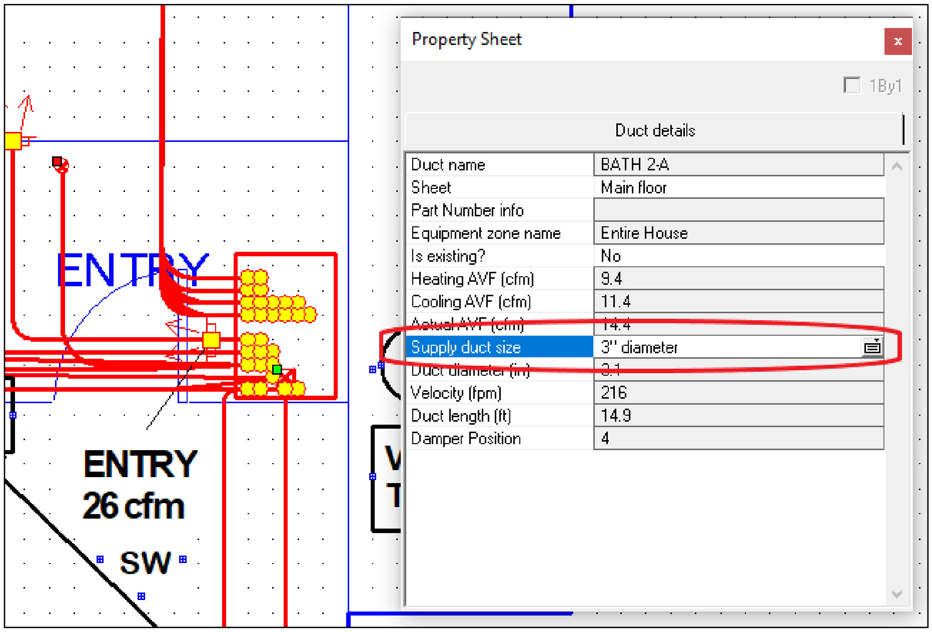


Figure 28. Change the duct diameter for a duct run or duct segment by changing the Supply duct size in the Property Sheet.

5. For duct runs that are comprised of multiple segments, such as a run with an elbow, select and change each segment separately. Property Sheet › Duct details › Supply duct size › 3” diameter.
6. Similarly, for duct runs with multiple segments such as a horizontal run to a riser, you’ll need to specifically change the riser within the Riser duct tab of the Property Sheet. Property Sheet › Riser duct › Supply duct size › 3” diameter.

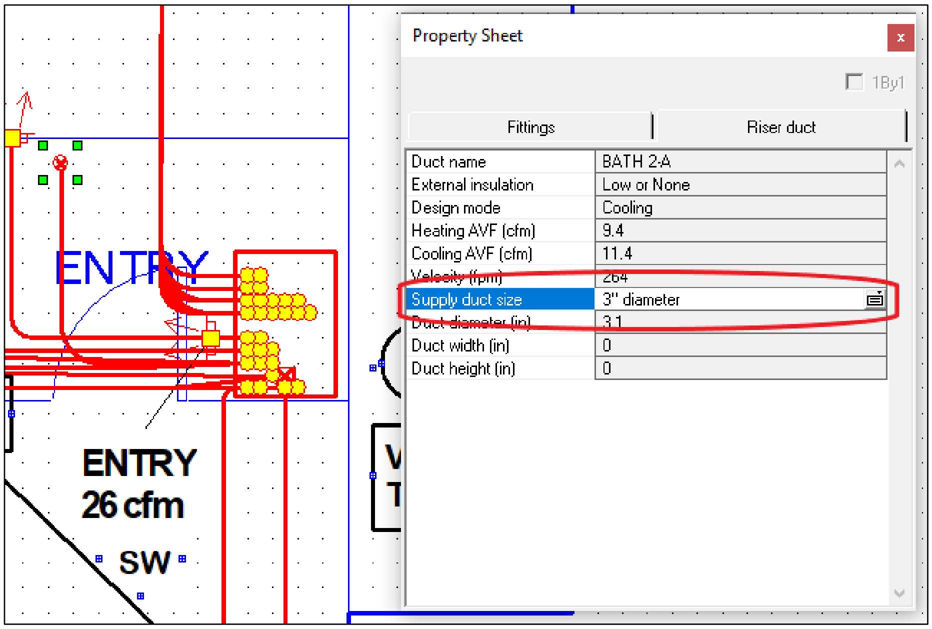


Figure 29. Change the size of a riser by changing the Supply duct size in the Property Sheet.

7. Finally, any riser duct routed up through a 2x4 wall must be changed to 3" diameter because 4" ducts cannot fit within a 2x4 wall. In the instance that an interior wall houses several riser ducts that would benefit the system by remaining 4" diameter, consider requesting that the builder or architect change this wall to be 2x6.

Using Auto diameter to determine combination of 3" and 4" ducts

When you set the Supply branch size in Step 6, each duct run drawn matches the size you set. To automatically determine which 4" diameter runs to replace with 3" runs, use the Auto diameter setting in the Rheia Design plugin. This setting uses an algorithm to determine the optimum size for the most efficient design based on the layout of the ducts drawn.

To automatically re-size the ductwork, change the Supply branch size field on the Duct Preferences sheet to Auto diameter.

Duct Preferences button › Rheia Duct Preferences › Supply branch size › Auto diameter

Rheia Duct Preferences

Rheia Supply System

Calc. settings ...

Design Mode	Average	
Duct layout	User defined	
Auto register placement	None	
Supply outlet type	Ceiling boot	
Design airflow per outlet	30	cfm
Available pressure, return	0.15	in H2O
Supply branch size	Auto diameter	

	Htg	Clg
Coil pressure loss (in H2O)	0.13	0.18
Filter pressure loss (in H2O)	0.15	0.15

Total design airflow	855	cfm
Total actual airflow	855	cfm
Coil pressure loss	0.180	in H2O
Supply ducts pressure loss	0.196	in H2O
Return system pressure loss	0.180	in H2O
Total system pressure loss	0.557	in H2O

Figure 30. Have the software automatically size each duct by setting the Supply branch size to Auto diameter in the Duct Preferences Sheet.

Once Auto diameter is selected, the software changes some duct runs to 3" diameter. All updated diameters are displayed for each room in the final column (Diam) of the Supply Branches window. If a given duct run contains multiple diameters, such as a 3" riser from a 4" horizontal segment, both diameters are shown.

Supply Branches for Entire House Export Design ...

Total design air flow (cfm)	855	Total pressure loss (in H2O)	0.557
Total actual air flow (cfm)	855	Design Mode	Average

Room Name	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Diam
BATH 2	299	11	9	10	12	BATH 2-A	dmn1	rb2	15	5	10	12	3
BEDROOM 2	3602	106	114	110	95	BEDROOM 2	dmn1	rb2	7,20	1	37	29	3,4
						BEDROOM 2-A	dmn1	rb2	13	1	37	35	3
						BEDROOM 2-B	dmn1	rb2	7,6	1	37	31	3,4
BEDROOM 3	1537	63	48	56	58	BEDROOM 3-A	dmn1	rb2	28	1	28	28	3
						BEDROOM 3-C	dmn1	rb2	23	1	28	30	3
ENTRY	1153	7	36	22	18	ENTRY	dmn1	rb2	1	4	22	18	4
FOYER	3902	24	123	73	88	FOYER-C	dmn1	rb2	20	1	37	40	4
						FOYER-D	dmn1	rb2	13	1	37	48	4
GAT/CAFE/KIT	8945	392	282	337	336	GAT/CAFE/KIT	dmn1	rb2	36	1	34	31	4
						GAT/CAFE/KIT-A	dmn1	rb2	42	1	34	30	4
						GAT/CAFE/KIT-B	dmn1	rb2	36	1	34	31	4

Figure 31. The Supply Branches window displays the duct diameter in the final column.

Double-check that each duct run is the optimum diameter for airflow delivery by following the same process that you use for double-checking manually sized ducts. Also, verify that the risers within 2x4 walls are set as 3" diameter. The Auto diameter setting does a good job of specifying each duct, but the quality of the design is still the designer's responsibility.

Tip: If you have specified a riser that you wish to be 4" diameter and it is within a 2x6 wall, navigate to the Property Sheet for the riser and you can override the Auto diameter by changing the Supply duct size to 4" diameter.

Property Sheet › Duct details › Supply duct size › 4" diameter

Step 14: Evaluate airflows

Evaluating airflows in each room is important at this stage in the design. Below is an explanation of how Rheia components work to fine-tune airflow, and the process you can follow to make this evaluation and changes in your design.

Built-in, manual dampers

All Rheia supply duct runs terminate in a combination boot assembly with diffuser. One major difference between Rheia boot assembly/diffuser and a conventional supply register is that every Rheia boot assembly contains an internal, manual damper meant to be specified during design and verified during commissioning, rather than be randomly adjusted by the homeowner.

Dampers can be set in five positions. Damper position 1 is fully open, and damper position 5 is fully closed. The damper blade is oval, while the neck where it sits is circular. This means that even in the fully closed position (5), there is a gap between the blade and sides of the boot. This gap is intentional; it allows a small amount of air (~15 CFM) to flow through the duct and prevent whistling.

To balance the system airflow, Rheia Design plugin automatically calculates the optimum damper position of each diffuser based on design CFM for that diffuser. The Rheia calculation differs from a traditional ACCA Manual D calculation in this way: whereas a Manual D calculation determines the minimum duct sizes to meet the design CFM per room, the Rheia calculation evaluates each duct run length and components, determines the damper positions, then predicts the airflow going through each duct run based on the total design airflow. Because of this, the CFM shown at each diffuser on the drawing sheet will adjust as you add, delete, or modify any duct runs, including relocating diffusers within a room.

How to evaluate airflow within your design

To evaluate whether the airflows in each room are adequate, follow these steps:

1. Click the Supply Branches button at the top center of the screen to open the Supply Branches window.
2. Compare the Actual flow column to the Dsn Flow column for each room on the plan. In rooms where the actual flow is less than 20% below the design flow, actual flow appears in red. Some criteria require a tighter tolerance than 20%, so be sure to look at each room when evaluating.
3. Where airflow is inadequate (red), you have these options for adjusting:
   - Add ducts to key rooms using information in the section, Step 16: Add and delete ducts to meet airflow and pressure loss needs.
   - Change the duct run from 3" diameter to 4" to increase airflow.

Supply Branches for Entire House Export Design ...

Total design air flow (cfm)	915	Total pressure loss (in H2O)	0.835
Total actual air flow (cfm)	915	Design Mode	Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
BATH 2	382	704	15	21	18	19	BATH 2	dmn1	rb1	27	5	18	19	3
BATH 3	720	1472	27	44	36	37	BATH 3	dmn1	rb1	38	1	36	37	3
BDRM 2	1563	1470	60	44	52	49	BDRM 2	dmn1	rb1	18	4	26	25	3
							BDRM 2-A	dmn1	rb1	23	4	26	24	3
BDRM 3	1514	1525	58	45	51	49	BDRM 3	dmn1	rb1	50	4	26	22	3
							BDRM 3-A	dmn1	rb1	57	3	26	27	3
BDRM 4	1975	3036	75	90	83	56	BDRM 4-A	dmn1	rb1	72	1	41	27	3
							BDRM 4-C	dmn1	rb1	63	1	41	29	3
BDRM 5	2366	2568	90	76	83	84	BDRM 5	dmn1	rb1	45	4	28	23	3
							BDRM 5-A	dmn1	rb1	35	3	28	31	3
							BDRM 5-C	dmn1	rb1	40	3	28	30	3
FOYER	482	1825	18	54	36	39	FOYER	dmn1	rb1	16	5	18	19	3

Figure 32. In this example, Actual flow for BDRM 4 is inadequate (red) because it is less than 20% below the Dsn Flow. All other rooms are within tolerance.

Step 15: Evaluate pressure loss

You will determine the acceptable system pressure loss based on the design criteria and equipment manufacturer's published data for the specific AHU.

1. Use your Manual S calculation to determine the target CFM for the AHU.
2. Use the equipment manufacturer's performance data for the AHU to look up the external static pressure. For example: Your Manual S calculation indicates 915 CFM is required to meet the heating and cooling loads and sensible heat ratio. Looking at the performance data from the equipment manufacturer in the following figure, you can select a unit with an external static pressure of 0.7".

AIR DELIVERY - CFM (BOTTOM RETURN WITH FILTER)

UNIT SIZE	WIRE LEAD COLOR	SPEED TAPS 2, 3 (Function)	EXTERNAL STATIC PRESSURE (IN.W.C.) 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
026E14--10	Black	Cooling. Do not use for heating	1045	1010	975	935	895	855	810	760	715	670
	Yellow	Alt Cooling or alt Heating	820	770	730	680	630	585	530	480	435	385
	Orange	Alt Cooling or alt Heating	655	600	550	495	435	385	335	265	–	–
	Blue 7	Heating or alt Cooling	605	545	490	435	375	335	255	–	–	–
	Red 7	Alt Cooling. Do not use for heating	480	415	360	305	235	–	–	–	–	–
040E14--10	Gray	Cooling. Do not use for heating	1050	1025	1000	975	950	920	895	870	845	820
	Yellow	Alt Cooling. Do not use for heating	920	890	860	830	805	775	745	715	690	660
	Orange	Alt Cooling or alt Heating	735	700	665	630	595	555	525	490	450	415
	Blue	Heating or alt Cooling	695	660	625	590	555	515	480	445	405	370
	Red 7	Alt Cooling. Do not use for heating	540	495	455	410	365	320	280	235	–	–
040E17--12	Gray	Cooling. Do not use for heating	1180	1140	1100	1055	1010	960	915	860	805	735
	Yellow	Alt Cooling. Do not use for heating	880	845	810	780	745	710	675	640	600	570
	Blue	Heating or alt Cooling	650	610	560	515	470	435	395	360	325	265
	Orange 7	Alt Cooling. Do not use for heating	525	460	405	350	320	275	210	–	–	–
	Red 7	Alt Cooling. Do not use for heating	515	420	350	310	270	205	–	–	–	–

Figure 33. In this example, if 915 CFM is required, select an AHU with external static pressure of 0.7".

3. Open the Rheia Duct Preferences window to review the pressure loss calculation. The Total system pressure loss is displayed, as well as the breakdowns for Coil pressure loss, Filter pressure loss, Supply ducts pressure loss, and Return system pressure loss.

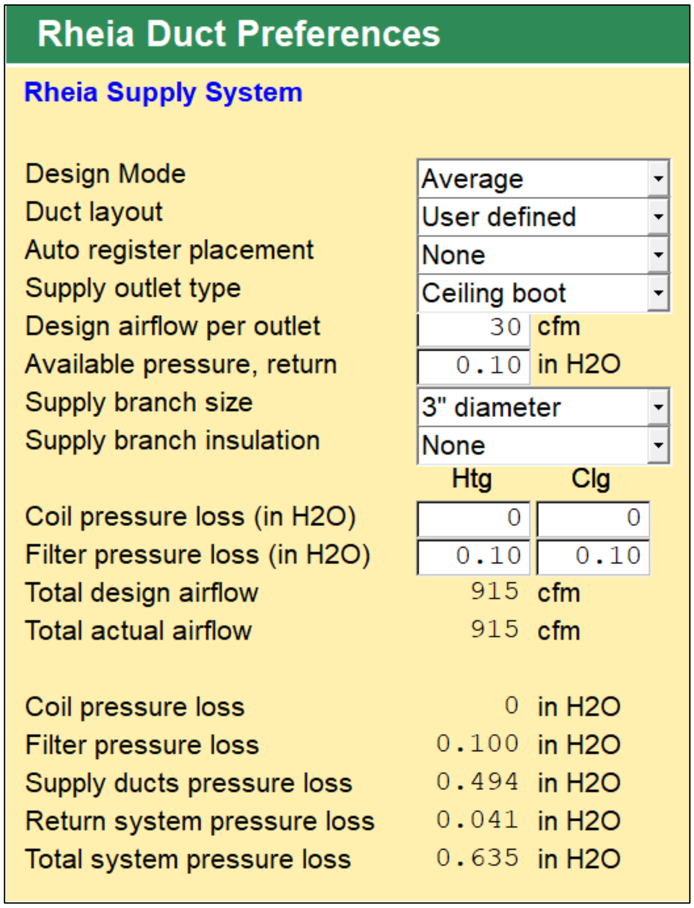


Figure 34. Rheia Duct Preferences window showing system pressure loss.

4. Look up the Coil pressure loss using the manufacturer's performance data.
    - For a heat pump air handler, the coil is built into the unit, so the coil pressure loss remains zero, as shown in Figure 34. Some equipment manufacturers have wet coil adjustment factors for heat pump air handlers. Consider this when determining the coil pressure loss for cooling.
    - For a gas furnace, find your selected DX Coil and design CFM. If the target CFM is between two values, interpolate to get the correct values, as shown in Figure 35. There are many online interpolation calculators you can use. Enter the Dry value in the Htg. field and the Wet value in the Clg field, as shown in Figure 36.

UNIT SIZE	Standard CFM										
	400	500	600	700	800	900	1000	1100	1200	1300	14
1814										Dry	
	0.078	0.114	0.156	0.198	0.253						
										Wet	
	0.096	0.138	0.183	0.213	0.277						
1917										Dry	
	0.042	0.060	0.080	0.102	0.128						
										Wet	
	0.055	0.076	0.104	0.127	0.158						
2414										Dry	
	0.070	0.103	0.143	0.182	0.233	0.290	0.354				
										Wet	
	0.089	0.128	0.171	0.214	0.269	0.336	0.413				
2417										Dry	
	0.048	0.068	0.090	0.112	0.140	0.170	0.203				
										Wet	
	0.064	0.091	0.122	0.150	0.188	0.224	0.263				
3014										Dry	
	0.065	0.097	0.135	0.173	0.223	0.278	0.339	0.405	0.478		
										Wet	
	0.078	0.114	0.160	0.206	0.260	0.321	0.388	0.461	0.540		
3017										Dry	
	0.042	0.060	0.080	0.102	0.128	0.157	0.188	0.222	0.259		
										Wet	
	0.055	0.076	0.104	0.127	0.158	0.190	0.225	0.266	0.309		

Figure 35. Our target 915 CFM falls between two equipment published airflows (900 and 1000). Use the stated Dry and Wet values for those two airflows and interpolate to get the correct Dry and Wet values for your design. In this case, Dry 0.16 and Wet 0.20.

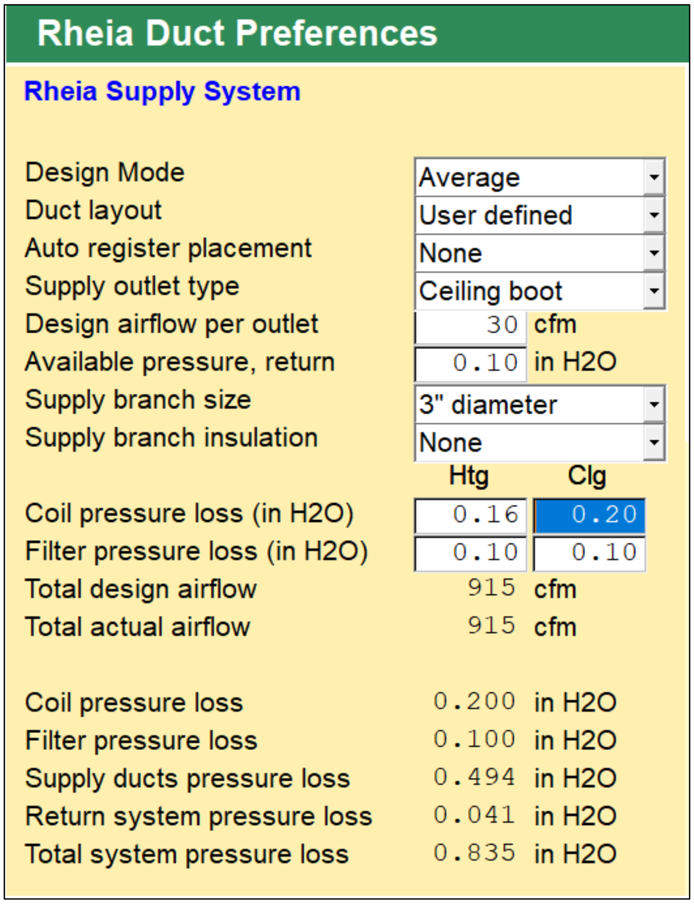


Figure 36. Enter the Dry value (0.16 in this example) in the Coil pressure loss Htg field. Enter the Wet value (0.20 in this example) in the Coil pressure loss Clg field.

5. Now that all data has been calculated and entered, compare the Total system pressure loss (0.835”) with the desired external static pressure from the equipment manufacturer’s performance data (0.7”), as determined earlier. In this example, you can see the Total system pressure loss is higher than the desired value.
    - If the Total system pressure loss is slightly higher or lower than the target value, look back at the performance data of the AHU and determine if the airflow will be acceptable at this static pressure.
    - If the Total system pressure loss is significantly higher than the target value as it is in this example, add ducts to the design to reduce the static pressure. Rooms with dampers in the 1 position (fully open) would be ideal candidates for an additional duct. As an alternative to adding ducts (and cost), find more direct routing for the existing ducts—decreasing duct lengths and/or number of bends will decrease the static pressure. Duct routing changes may require additional coordination with the builder and architect. In rooms that need higher airflow, changing 3” diameter duct runs to 4” diameter where possible can also help reduce static pressure.
    - If the system pressure loss is significantly lower than the target value, delete ducts from the design to increase the static pressure. Rooms with multiple ducts and dampers in the 3, 4 or 5 position (fully closed) could have a duct removed. Also, in rooms that need lower airflow, duct runs can be changed from 4” diameter to 3” diameter to increase static pressure.

Step 16: Add and delete ducts to meet airflow and pressure loss needs

It is the designer's role to optimize the system design to reach acceptable performance criteria while minimizing system cost and installation time. In general, use the minimum number of supply ducts to hit performance targets.

Tip: Several iterations of adding or deleting ducts may be required to get to the correct airflows and system static pressure.

If it is necessary to add ducts to or delete ducts from the design, follow the steps below.

Add supply ducts to meet airflow needs

If certain rooms have inadequate airflow, or if the system pressure loss is determined to be too high, you can add ducts to key rooms. First, identify duct runs with low airflow and then identify dampers that are in the 1 position (fully open).

1. Open the Supply Branches window. Compare the Dsn Flow to the Actual flow columns.
2. When Actual flow is less than 80% of the Design airflow, the Actual flow value will appear in red, as shown in the figure below. In this specific example, because Bedroom 4 has a Design flow of 83, the Actual flow should be no lower than 66.4 (80% of 83). The Actual flow is only 56, therefore, it shows up as red. If no values appear in red, continue to step 6.

Supply Branches for Entire House Export Design ...

Total design air flow (cfm) 915 Total pressure loss (in H2O) 0.835
Total actual air flow (cfm) 915 Design Mode Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
BATH 2	382	704	15	21	18	19	BATH 2	dmn1	rb1	27	5	18	19	3
BATH 3	720	1472	27	44	36	37	BATH 3	dmn1	rb1	38	1	36	37	3
BDRM 2	1563	1470	60	44	52	49	BDRM 2	dmn1	rb1	18	4	26	25	3
							BDRM 2-A	dmn1	rb1	23	4	26	24	3
BDRM 3	1514	1525	58	45	51	49	BDRM 3	dmn1	rb1	50	4	26	22	3
							BDRM 3-A	dmn1	rb1	57	3	26	27	3
BDRM 4	1975	3036	75	90	83	56	BDRM 4-A	dmn1	rb1	72	1	41	27	3
							BDRM 4-C	dmn1	rb1	63	1	41	29	3
BDRM 5	2366	2568	90	76	83	84	BDRM 5	dmn1	rb1	45	4	28	23	3
							BDRM 5-A	dmn1	rb1	35	3	28	31	3
							BDRM 5-C	dmn1	rb1	40	3	28	30	3
FOYER	482	1825	18	54	36	39	FOYER	dmn1	rb1	16	5	18	19	3

Figure 37. When Actual flow is less than 80% of Dsn Flow, Actual flow value will appear in red, indicating the airflow is too low.

3. It's at your discretion to determine if airflow is acceptable based on homeowner expectation, local code, Energy Star requirements, or any other factors.
4. To add a duct, follow the steps in these sections again: Step 8: Locate diffusers, Step 9: Update outlet types, Step 10: Route ducts from the manifold to the diffusers.
5. For each duct added, check the airflows to each room to ensure all are within an acceptable range.
6. If the airflows in each room are within the acceptable range and the system pressure is still too high, review the values in the Damper Pos column. These are the damper positions (1 through 5). Look for a room that has multiple ducts at damper position 1 (fully open). In this instance, the software is most likely closing off other rooms' dampers to balance the airflow. Adding another

duct to this room will trigger the software to recalculate the damper positions in other rooms to be more open, reducing the overall system pressure.

Supply Branches for Entire House Export Design ...

Total design air flow (cfm) 915 Total pressure loss (in H2O) 0.857
Total actual air flow (cfm) 915 Design Mode Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
							LOFT-A	dmn1	rb1	11	4	24	25	3
							LOFT-B	dmn1	rb1	25	4	24	23	3
P BATH	1131	1676	43	50	46	37	P BATH-A	dmn1	rb1	27	1	46	37	3
P WIC	646	1234	25	37	31	31	P WIC-A	dmn1	rb1	26	3	31	31	3
PANTRY	51	319	2	9	6	19	PANTRY	dmn1	rb1	16	5	6	19	3
PRIMARY BDRM	3173	3459	121	103	112	97	PRIMARY BDRM	dmn1	rb1	54	1	37	31	3
							PRIMARY BDRM-E	dmn1	rb1	46	1	37	33	3
							PRIMARY BDRM-[	dmn1	rb1	42	1	37	34	3
STUDY	1486	2433	57	72	64	62	STUDY	dmn1	rb1	8	5	21	19	3
							STUDY-A	dmn1	rb1	14	5	21	19	3
							STUDY-B	dmn1	rb1	17	4	21	24	3
WIC 2	114	356	4	11	7	18	WIC 2	dmn1	rb1	24	5	7	18	3

Figure 38. In this example, the Primary BDRM has all dampers in position 1 (fully open) which is likely closing dampers in other rooms, causing system pressure to be too high. To reduce overall system pressure, add a duct to the Primary BDRM to trigger the system to recalculate damper openings in other rooms.

7. To add a duct, follow the steps in these sections again: Step 8: Locate diffusers, Step 9: Update outlet types, and Step 10: Route ducts from the manifold to the diffusers.
8. For each duct added, check the Total system pressure loss to ensure it is within an acceptable range.
9. Be sure to re-space the remaining diffusers as needed for maximum comfort and aesthetics.

Remove supply ducts if possible

If the Total system pressure loss is too low, review the damper positions and delete ducts from key rooms to increase the static pressure following these steps.

1. Open Supply Branches for Entire House window and review all the values in the Damper Pos column.
2. Look for any rooms with several dampers set at higher numbers, for example, position 3 and 4 (mostly closed), as shown in Figure 39.
3. Delete a duct from this room to increase the system pressure. On the drawing sheet, simply click the duct to select it, then delete.
4. For each duct you delete, check the Total system pressure loss to ensure it is within an acceptable range.
5. Be sure to re-space the remaining diffusers as needed for maximum comfort and aesthetics.

Supply Branches for Entire House Export Design ...

Total design air flow (cfm) 915 Total pressure loss (in H2O) 0.644
Total actual air flow (cfm) 915 Design Mode Average

Room Name	Clg Load (Btuh)	Htg Load (Btuh)	Clg Flow (cfm)	Htg Flow (cfm)	Dsn Flow (cfm)	Actual flow (cfm)	Branch Name	Parent Trunk	Return Branch	Branch Length	Damper Pos	Dsn Flow (cfm)	Act Flow (cfm)	Di
BDRM 5	2366	2568	90	76	83	85	BDRM 5	dmn1	rb1	45	1	28	27	3
							BDRM 5-A	dmn1	rb1	35	1	28	30	3
							BDRM 5-C	dmn1	rb1	40	1	28	28	3
FOYER	482	1825	18	54	36	39	FOYER	dmn1	rb1	16	4	18	19	3
							FOYER-A	dmn1	rb1	13	4	18	20	3
GREAT ROOM	3638	2952	139	88	113	120	GREAT ROOM	dmn1	rb1	15	4	23	19	3
							GREAT ROOM-A	dmn1	rb1	23	3	23	26	3
							GREAT ROOM-B	dmn1	rb1	33	3	23	24	3
							GREAT ROOM-C	dmn1	rb1	24	3	23	26	3
							GREAT ROOM-D	dmn1	rb1	30	3	23	25	3
KITCHEN	2077	2364	79	70	75	70	KITCHEN	dmn1	rb1	18	1	37	35	3
							KITCHEN-B	dmn1	rb1	18	1	37	35	3

Figure 39. In this example, Great Room has five ducts with dampers in higher positions (mostly closed). Delete a duct run from this room to increase the total system pressure loss.

Also consider deleting ducts in rooms that have low design airflow requirements (<10 CFM). Having a supply in a small room that does not require much air will add unnecessary cost and throw the system further out of balance. Rooms with low design airflow requirements are highlighted in yellow on the Supply Branches window, as seen in Figure 38 for the Pantry (6 CFM) and WIC 2 (7 CFM).

Tip: In lieu of adding or deleting an entire duct run, changing a duct from 3" diameter to 4" diameter or vice versa can make a smaller change to the airflow in that room and overall static pressure.

Tip: Several iterations of adding or deleting ducts may be required to get to the correct airflows and system static pressure.

Step 17: Evaluate throw

Evaluating diffuser throw and fine-tuning diffuser placement is important at this stage in the design. To do so, follow these steps:

1. Once all duct connections are made, the predicted CFM is displayed at each diffuser on the drawing sheet. The CFM output of each diffuser determines how much throw is expected.
2. Find the throw per boot/diffuser combination on the Rheia Performance Data Sheets at https://www.rheiacomfort.com/resources/designers.
3. Verify that the throw is reaching the exterior wall(s). Exterior walls and windows are the primary source of heat gain/loss into the home. Floor Boots should be placed near an exterior wall underneath a window as long as the homeowner will not likely place furniture there.
    - When evaluating High Sidewall Boot with Slotted Diffuser or Pass-through Boot with Slotted Diffuser, make sure the linear throw at the given CFM is enough to reach the exterior wall it is aiming towards. If exterior walls are not being reached, consider spacing out diffusers onto other interior walls to reach all areas of the room.

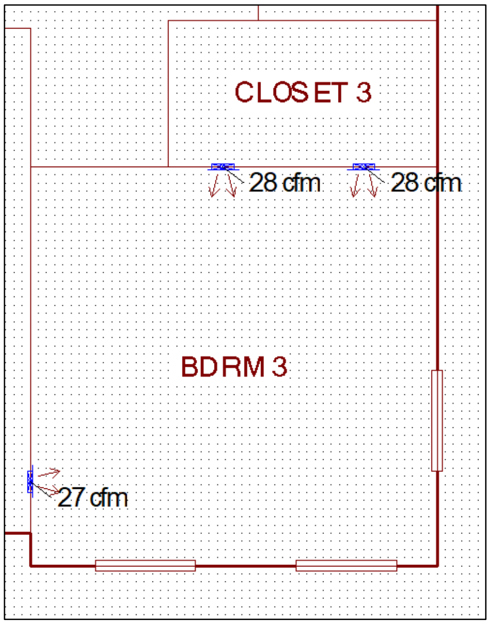


Figure 40. Example of High Sidewall Boots spaced out to reach all areas of the room.

- When evaluating Ceiling Boot with Ceiling Diffuser, be sure each is spaced far enough apart so the throw does not overlap with other ceiling diffusers. Also verify that all ceiling diffusers are located close enough to exterior walls for the throws to reach the walls.

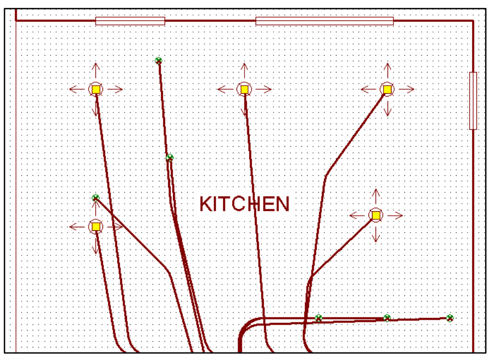


Figure 41. Example of Ceiling Boots spaced out to reach all areas of the room.

4. Adjust placement of diffusers as needed to ensure air reaches every area of the room.

Tip: Rheia's high number of diffusers provides significantly better air mixing for more consistent comfort, as compared to a conventional system. For best comfort results, it's important to space out diffusers to ensure every portion of each room is receiving conditioned air. For best aesthetic results, also carefully consider the lighting and architectural features of each room.

Step 18: Check design modes

In Step 5 you selected the design mode (cooling, heating, or average) depending on the mode most used in the market for this home. If the dominant need is cooling or heating and the opposite mode is rarely used in the given market, skip this step and move on to Step 19.

In markets where heating and cooling are both needed, the designer should check each design mode based on the criteria set forth in Steps 14 through 17. This will enable the contractor or homeowner to rebalance the home twice a year for seasonal needs, meeting Manual J room-by-room airflows without exceeding the equipment static pressure. To check each design mode, follow these steps.

1. Choose a design mode to check first (cooling, heating, or average). Complete Steps 14 through 17 at the given design condition, ensuring your design meets airflow and static pressure requirements. Add or delete ducts as needed.
2. Change the design mode to one that you've not checked. Complete Steps 14 through 17 again, however, do not delete any duct runs during this review. Deleting a duct run in one design mode might compromise the performance of the design in another mode, therefore, only add ducts if needed to meet airflow and static pressure requirements.
3. Change the design mode to the final one to be checked, and repeat Steps 14 through 17, again only adding ducts, not deleting.

Step 19: Generate orientation-specific designs.

When designing with Rheia, we strongly recommend that you specify a design for each floorplan orientation. The following are three approaches to orientation-specific design, organized from most desirable to least desirable.

Tip: From the designer's standpoint, it's also useful to know that with the Rheia Design plugin you can easily generate these eight designs at the end of the design process.

Specific equipment, specific duct design per orientation

Use this option to generate eight unique designs for one floorplan that are specific to the home's orientation (N-NE-E-SE-S-SW-W-NW). This is the best approach. Manufacturer's equipment and duct runs will be customized per floorplan, which will provide better system performance and save money.

1. Open the Drawing window. Click the N (North) arrow on the compass.
2. Select specific equipment, airflows, and duct design for this orientation following the processes included in this manual.
3. Save the North orientation file.

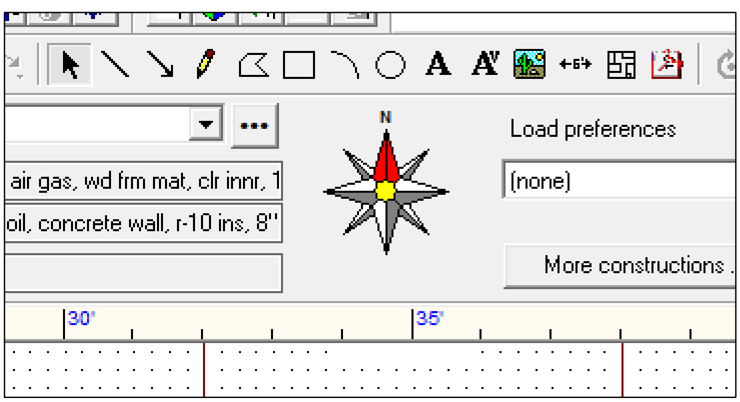


Figure 42. Select N on the compass to begin working on the North orientation.

Repeat these steps to generate designs for each of the remaining orientations of the floorplan. When finished, you will have eight files. The differences among some plans will be drastic in tonnage, airflow, and duct counts, while the differences for other plans could be slight. These specifics are what generate the best performing system for the cost.

Single equipment, specific duct design per orientation

Use this option if the builder is willing to allow multiple duct designs but unwilling to have different equipment for a given floorplan. This is a middle-of-the-road approach that can save some costs.

1. Select equipment and airflows based on the worst-case orientation by double clicking the yellow dot in the middle of the compass.
2. Open the Drawing window. Click the N (North) arrow on the compass.
3. Evaluate only the airflows and pressure drops at for the North orientation. Add or delete ducts as needed.
4. Save the North orientation file.

Repeat these steps to generate designs for each of the remaining orientations of the floorplan. When finished, you will have eight files. There will be little difference among the plans except for possibly a duct or two in some rooms.

Single equipment, single duct design

Use this option if a builder will accept only one equipment spec and one duct layout per floorplan. This is the least desirable approach, and it's based on the worst-case scenario.

1. Double click on the yellow dot in the center of the compass. RSU will evaluate all eight orientations and automatically select the worst-case scenario for total cooling load or heating load.
2. Complete a Manual S and select equipment and overall airflow that satisfies all orientations.
3. Open the Drawing window. Double click on each of the eight directional arrows to change among orientations. At each orientation, evaluate each room for airflow and overall system pressure loss. Add ducts or change duct sizes to rooms as needed until all orientations are within acceptable ranges. Do not delete ducts from one orientation to the next because the duct design must satisfy all orientations.
4. Save the single file that satisfies all orientations for this floorplan.

Tip: Generating a design that meets the criteria for all orientations will result in extra duct runs in some rooms. Also, your static pressure in some orientations may be significantly lower than the target static pressure from the equipment selection. These results are all okay.

Tip: Even with a single duct design, Rheia Verify will balance the home to the specific orientation it is on a given lot.

Step 20: Design the manifold

Once all room airflows and the total system pressure loss are within the acceptable ranges, it is time to design the manifold. At this stage, you will know the exact number of ducts that need to connect to each face of the manifold. Use this information and the Rheia Manifold Design Manual found at www.rheiacomfort.com/resources/designers to design the manifold.

Step 21: Create final drawing using CAD

Use a CAD program or the drawing window within RSU to draw the final design so it's easy to see all supply and return components in conjunction with all architectural and lighting elements. Because the backgrounds received from builders and architects have varying degrees of detail, it will be up to you to determine the best way to complete this final CAD drawing. Your CAD drawing must reflect all the orientations you're specifying—either as eight separate files or as options within a single file.

Contractors and the commissioning technician will use this drawing for their work, therefore, Rheia recommends having conversations with these groups to discuss how you can present the information to best serve them.

Tip: The accuracy and detail of this drawing is critical during installation and commissioning. The more specific information you can provide, the more likely the installed system will match your design intent.

Provide detail to locate diffusers

Your CAD drawing should graphically show the diffusers in aesthetically pleasing locations and provide the contractor with the information needed to properly locate the diffusers in the home. Some important details to include:

- Draw the lighting in the backgrounds and center the diffusers around the lighting.
- Dimension the diffusers off the walls.
- Dimension the diffusers off each other.
- Draw framing in the background for reference.

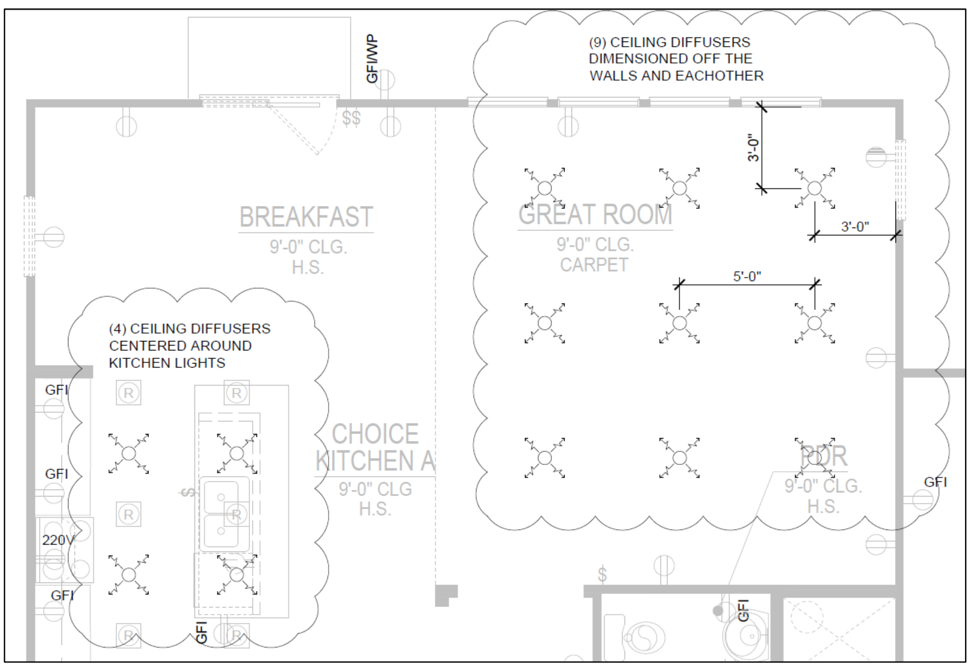


Figure 43. Example CAD drawing shows Ceiling Diffusers evenly spaced around lighting and dimensioned off the walls and each other.

Once all diffusers are drawn in relation to architecture and lighting, compare their locations to the layout you created with the Rheia Design plugin. If diffusers were adjusted by a few inches to a few feet in the CAD drawing, this is not a problem. If diffusers had to move more than a few feet, update the layout in the Rheia Design plugin to match the CAD drawing. Then, double-check the airflows and pressure losses to ensure they are still within acceptable ranges.

Clearly label the duct diameters of each duct run

If a design is using 3” or 4” diameter ducts only, simply add a note on the plan to indicate all runs use 3” or 4” only. If the design uses a combination of 3” and 4” ducts, each run must be clearly labeled so the contractors can install the correct sizes in the correct locations per the design intent.

When there are too many lines next to one another to label the ducts clearly, Rheia recommends labeling the diffuser with the duct size for easy identification.

Tip: Other methods can be used for identifying duct sizes, such as using solid lines for 3” diameter and dashed lines for 4”. Just be sure it is consistent and clear on the plans.

Tip: Avoid using different colors to identify duct diameters. Contractors usually print plans in black and white and will not be able to see the different colors from those prints.

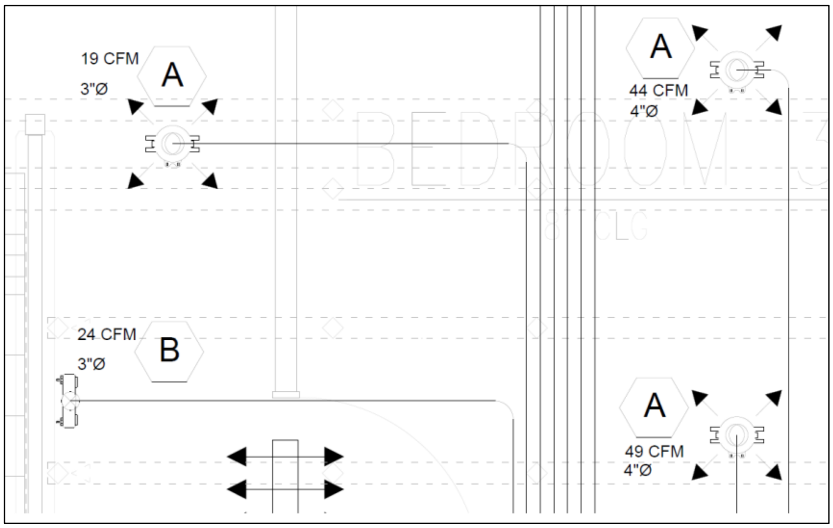


Figure 44. Clearly identify the duct diameter by labeling the diffuser with 3” or 4” accordingly.

Include final manifold design

Your CAD drawing should include the manifold design that you created using the Rheia Manifold Design Manual. This is key because the contractor will use this design to fabricate the manifold and drill the holes for take offs.

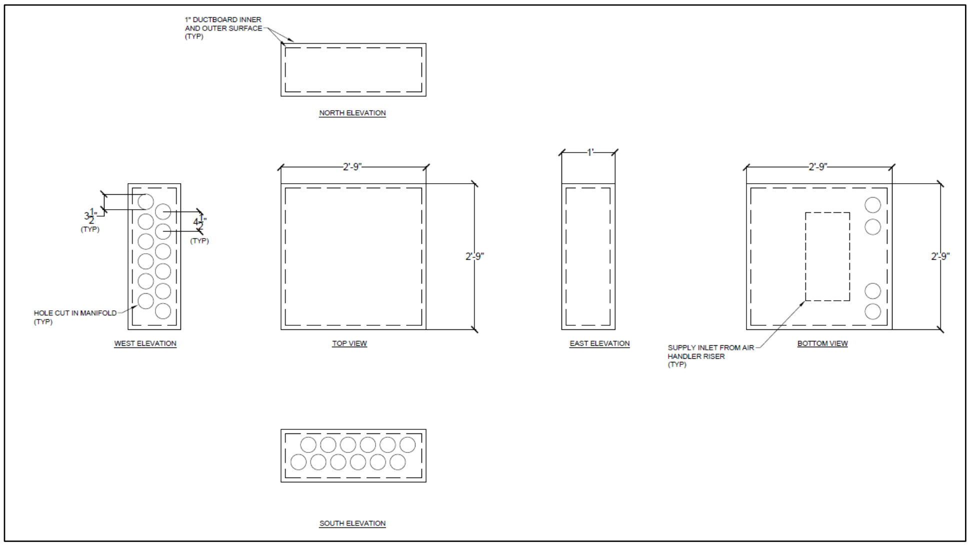


Figure 45. Example of final manifold design

Once your CAD drawing is complete and includes all orientations you have specified, verify that it matches the drawing from the Rheia Design plugin.

Step 22: Export the design as JSON file

Your final step is to export the finished drawing from the Rheia Design plugin. The Rheia Manage database and Rheia Verify mobile app will both use the exported file.

1. Open the Supply Branches window.
2. Click Export Design button in the upper right to open the Save As window.
3. Name this file in a way that references the floorplan design.
4. Choose JSON as the file type.
5. Save this file on your server or hard drive in an easily accessible location.
6. Upload this file to the Rheia Management Portal and associate it with the given Builder, Subdivision, Community, and Plan. For more information on the Rheia Management Portal, see the Rheia Manage: Designer Responsibilities document at www.rheiacomfort.com/resources/designers.