
Design Guide

Small-DTM Duct Systems

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Table of Contents

INTRODUCTION	2
EQUIPMENT SELECTION AND SIZING	3
QUICK REFERENCE STEPS FOR SIZING AND SELECTION	8
SELECTION TABLE	9
ECODUCT SIZING FORM	10
THERMALDUCT SIZING FORM	11
ZONE COMFORT SIZING FORM	12
SCHEMATIC – TYPICAL CONNECTIONS	13

Please read this entire design guide before sizing and selecting **Small-D™** duct systems. Understanding the design process is the first step in achieving optimal performance.

INTRODUCTION

The **Small-D** Engineered duct system is designed for use with Ecologix small diameter / high velocity air handlers in hydronic systems such as boiler and combination space and water heating systems (Combo Systems).

The **Small-D™** duct system is much smaller than conventional ducting making it ideal for retrofit applications or where a conventional duct system would result in large bulkheads and wasted space.

The **Small-D™** duct system is capable of delivering even air distribution over multiple floors improving comfort. The unique duct system design allows for easy balancing between floors and ensures good air distribution to upper floors in multi level homes. For single zone systems, seasonal balancing is achieved by adjusting dampers for each floor at the air handler. For the **Zone Comfort** multi-zone system, balancing is continuously achieved by active temperature measurement of each zone.

EQUIPMENT SELECTION AND SIZING

Proper sizing of system components is crucial for proper operation.

The components of a typical Small D duct system are (refer to diagram, last page):

- Supply air plenum
- Supply air main ducts (mains)
- Supply air branch ducts (branches)
- Boots and grilles (outlets)
- Return air ducts

The key strategy for layout of a small D duct system is to take advantage of the smaller ducts and better air seal to provide a better balanced system over traditional branch and Tee low-pressure duct systems.

Provide single run mains without Tees where possible. (Avoid tees where possible) Provide separate mains to each floor where possible, even if it means running parallel mains side by side to feed different floors. Try not to supply two floors from one main.

Taking this approach of separating all key areas of the house onto separate mains will allow easy adjustment of air flows between floors and zones and keep main sizes to small diameters.

The use of standard 4x10 floor grilles as well as specialized 4" round and 4x4 square grilles gives the designer a huge range of choices for optimizing the air distribution in each room. Grilles can be located in floors walls and ceiling. The small D system gives excellent results with all ceiling or floor grilles but it is always best to locate both high and low grilles in a single room where practical for optimum occupant comfort.

Procedural steps are:

1. Select air handler and heat source type.
Obtain correct sizing form to fill out.
2. Acquire room-by-room heat loss / heat gain and fill information into sizing form.
3. Select air handler and record air handler data on sizing form.

4. Calculate Heating and cooling factors and minimum equivalent outlet requirements and record on heating form.
5. Select the type and number of grilles per room from sizing form.
6. Locate the equipment and grilles on the drawing.
7. Draw in the location of the mains.
8. Drawing in the branches using the tables provided to determine maximum flex duct length, minimum rigid duct lengths and branch sizes.
9. Use table 3 to determine sizes of mains.

Air Handler Type (step 1)

Select the type of air handler and the type of heat source you wish to use. For help in selecting the type of air handler you wish to use, refer to the "Air Handler Selection Summary" or Specification Sheets for each air handler. You can find the Air Handler Selection Summary, specification sheets and blank sizing table templates for download from the Ecologix web site:
www.ecologix.ca.

Heat loss (step 2)

Make sure a proper room-by-room heat loss and heat gain for the dwelling is calculated using HRAI, ASHRAE or other approved sizing method.

Air handler selection (step 3)

Select the desired air system that will meet 100%-140% of the heating load and 80%-120% of the cooling load.

If using a boiler system, select a boiler that has an output that meets or exceeds the heat loss of the space being heated. If the boiler is meeting additional loads, size the boiler to meet the total combined load.

For combo heating systems, use an approved sizing method such as the Unified Combo Guidelines published by HRAI.

In areas where the UCG or a local sizing code is not applicable, use the following method for sizing combo systems:

1. Select an air handler that meets or exceeds the calculated heat loss at the water heater operating temperature
Select a water heater with an output that is at least 120% of the heat loss. For operating temperatures above 130F (55C) an approved mixing valve must be specified to protect occupants from scalding. Refer to local codes for use of mixing valves on domestic systems.

Substitutions

This duct-sizing guide is specifically engineered to work with the following Ecologix air handler types:

- Silent Duct
- Eco-Duct
- RE series air handler
- Thermal-Duct
- HPAH air handler
- DXAH air handler
- Zone Comfort

Any listed air handler may be substituted for another in any installation provided the performance tables indicate that the capacities of the new unit are equal to or exceed the space heating and cooling load for the number of grilles selected. The number of grilles required is unique to each model.

Precedence

Please refer to the installation instructions or Specification sheets for the air handler when selecting the air handler size. When a conflict arises from tables shown in installation instructions, specification sheets, price books or other published Ecologix documents, the document with the most recent publish date should be taken as correct.

For documents of the same date, the specification sheet takes precedence over the installation instructions, which takes precedence over this design guide. This design guide takes precedence over the price book or any other Ecologix document of the same or older publish date.

Interpolation

Interpolation is allowed between heating or cooling capacity number shown in the air handler performance tables found in the air handler specification sheets.

For tables 2 and 3, interpolation between lengths in tables is acceptable.

Calculating the Heating Factor and Cooling Factor (step 4)

From the air handler performance tables determine the heating capacity at the inlet water conditions. Divide the heating capacity by the number minimum of branches. This number is the Heating capacity per outlet or heating factor (H_f).

$$H_{\text{factor}} = \text{Heating output} / (\text{Min. \# of branches})$$

For cooling loads use the same procedure as for heating except using the C_{factor} Where:

$$C_{\text{factor}} = \text{cooling capacity} / \text{Min. \# branches}$$

Note: for Zone Comfort the cooling factor is fixed at 2000 to allow for adequate airflow when 1,2 or 3 zones are open.

Calculating the Required Heating and Cooling outlets

Calculate the number of 3" branches required per room by:

$$\text{Outlets heating} = HL_{\text{room}} / H_{\text{factor}}$$

$$\text{Outlets cooling} = HG_{\text{room}} / C_{\text{factor}}$$

where:

$$H_{\text{factor}} = \text{heating factor}$$

$$HL_{\text{room}} = \text{heat loss per room}$$

$$C_{\text{factor}} = \text{cooling factor}$$

$$HG_{\text{room}} = \text{heat gain per room}$$

Record the results of the calculation for each room on the sizing form.

Outlet and branch selection (step 5)

All sizing room-by-room branch sizing starts with the assumption that the number of branches per room is based on branches equivalent to 3" flexible duct branches that are each 12.5 feet long. During the selection process you will adjust the number of actual branches used based on branch length, use of rigid duct, and your desire to group branches to reduce the number of outlets per room.

For each air handler there is a specification sheet that lists the minimum number of 3" branches that are required.

Select the equivalent number of 3" grilles per room that will be supplied. The number of grilles must exceed 100% of the heating grille requirement and at least 80% of the cooling grille requirements to ensure adequate air flow per room

Choose the style location and size of grille(s) for use in each room. Branch ducts can be 2", 3", 4" or 5". Two 2" runs can be supplied in place of a single 3" run. Two 3" runs can be combined into one 4" run. One 5" run is equal to 4 equivalent 3" runs. In the sizing form, fill in the equivalent number of 3" grilles per room based on the choice of outlet (Table 1)

When using 4"x4" boots and universal round grilles, care must be taken to avoid areas where the air stream may impinge on a stationary person or may strike a desk or table. Install grilles in low traffic areas.

When installing universal round grilles in the ceiling, a restraint wire is required to avoid damage should the grille fall.

Plastic 4" round diffuser style grilles should be located as high wall or ceiling. Low wall placement is acceptable for basement or first

floor rooms. This style grille should never be used as a floor grille.

5" ducts shorter than 12.5 feet of flex duct should not be connected to 4x10 boots with a residential grille due to the potential for grille-generated noise. For 5 inch branches less than 12.5 feet of flex or 24 feet of rigid duct, commercial style 6x10 or larger wall, ceiling or floor grilles should be used.

Standard branch length is 12.5 equivalent feet. For runs longer than 12.5 feet, rigid duct may be used. Use Table 3 and 4 to determine the proportioning of flex and rigid duct for each branch

Allow space for bends in flex ducting to be 8" radius or greater where possible. Adjustments in branch length must be made for tight bends in flex ducting in accordance with table 4.

Duct lengths less than 6 feet are not recommended.

Use 12.5 foot branch runs for each outlet where practical. For grille locations that are close to main duct runs, extend the flex duct past the grille opening, install a 180-degree bend and return to the grille location.

Shorter duct lengths can be achieved by looping the flex duct. (Table 3&4),
Ex: Using table 4, a 6 foot length of flex duct can be looped to equal 12.5 equivalent feet.
Flex Length = 6.5 feet
360 degree loop @ 8" radius = 6 feet
Branch duct equivalent length = 12.5 feet

It is recommended to use (Table 5) only when a reduced airflow per grille is desirable (small rooms) or to calculate the flow reduction effect of longer runs where it is undesirable to increase the duct size. Extremely long runs can be accommodated if necessary by de-rating the airflow in each branch and adding branches to a room.

Supply air Plenum

Provide a supply air plenum that is the same dimensions as the outlet flanges of the air handler and at least 24 inches long.

A smooth, square-to-round transition may be used in place of the supply air plenum for horizontal installations where there is only one supply main.

For vertical applications where the air conditioning coil is installed in the supply air plenum, the cooling coil must be supported at least 4 inches above the heating coil face on brackets or channel to ensure unimpeded airflow through the heating coil.

Plenum takeoffs may either be mounted on the end of the plenum or the sides of the plenum, but not both. Spin in collars or transition takeoffs may be used, but not both.

Supply mains (Step 6)

Provide parallel main ducts to each floor or zones rather than the traditional trunk and branch distribution systems. Provide volume dampers in each supply main. Make sure the volume dampers are properly labeled and within the mechanical room.

Where individual main ducts per floor are not practical, it is acceptable to combine the top and second floor into one zone or the basement and first floor into one zone off of one main duct.

Size the supply main ductwork (Table 2) based on main length. Do not include lengths of branches or main plenum. Include equivalent lengths for fittings and transitions (table 6). Total length is the sum of actual and equivalent lengths. In ducting layouts where the supply main splits, each duct must be sized using the total length. The duct sizes shown are minimums. Larger ductwork may be used.

Supply mains may be round duct or square with equivalent area. The aspect ratio for square ducts (wide dimension over short dimension) shall not exceed 2.5 to 1.

Acceptable fittings (supply mains)

Bullhead tees are acceptable provided they are not reducing fittings. Reducers can be located downstream from the bullhead tees.

For difficult to fit configurations, it is acceptable to transition from round to square and back to round duct, provided all transitions are tapered smooth fittings to minimize transition loss.

Return air duct

Return sizing method 1

Determine the amount of supply air for each floor and provide return air equal to or greater than the supply air. You may reduce the air requirements on the floor where the air handler is located by up to 50% provided that excess air is added to return grilles on other floors or zones.

Size all return grilles so the velocity through the grille is less than 400 fpm based on the grille free area or 50% of the total area of the return grille.

For return air runs where the airflow path is less than 50 linear feet from the air handler, the airflow velocity shall not exceed 800 fpm (4.0 M/s).

For return air runs where the airflow path is greater than 50 and less than 100 linear feet from the air handler, the airflow velocity shall not exceed 600 fpm (3.0 M/s).

For return air runs where the airflow path is greater than 100 and less than 150 linear feet from the air handler, the airflow velocity shall not exceed 400 fpm (2.0 M/s).

Return sizing method 2

The return air duct may be sized for a total pressure drop of 0.15" w.c. Using conventional sizing methods and installed in

accordance with HRAI guidelines or equal. If the heating capacity exceeds the heat loss by 10% or greater, the return air may be designed at 0.20”w.c.

Connection to Existing Systems

Single zone systems

A small-D air handler can be used in place of a conventional air handler where there is ductwork already existing. It is acceptable to have a mixture of small D sized ducts and conventional duct in the duct system provided care is taken in how the sizing is applied.

- The air handler can be substituted for a conventional air handler or furnace using the existing supply and return ducts without need to calculate duct sizing provided the airflow selected for the new air handler does not exceed the airflow of the existing system.
- An air handler can be selected that has a higher air flow than the original equipment but the sizing process in this guide must be followed to ensure that the number of equivalent attached branches equals or exceeds the minimum required for the air handler and that the conventional supply air trunks equal or exceed the sizing requirements for mains described in this design guide.
- Existing perimeter branch ducts can be used as branch ducts in a Small-D system connected to mains sized in accordance with this guide. Where possible, branches from separate floors should be connected to separate mains. When connecting to

existing ductwork, do not add new branches sized in accordance with this guide to any mains that are attached to existing ductwork.

- Small-D branches and existing duct branches can be connected to the same Supply plenum of a small-D air handler provided the branches are on separate mains and a damper is supplied in each main for balancing.

Multi-zone (Zone Comfort)

It is very common for Zone Comfort air handlers to be retrofitted to an existing duct system to replace a single zone furnace or air handler. Typically the existing supply trunk in the basement of the home is removed and replaced by three round duct mains that are connected to the existing perimeter duct. In some cases the existing supply air trunks of the home can be separated into two or three discrete sections. In this case the existing supply trunks can be used as the supply air distribution mains. If the total system airflow exceeds the airflow of the original system, ducts sizes must be checked to make sure they meet or exceed the minimum number of equivalent 3 inch branches for the air handler and that the mains are adequately sized.

Where an addition is added to a house it is acceptable to have zones of Small D duct and zones of conventional duct. Care must be taken not to mix the systems on any one zone as described above in “single zone systems”.

QUICK REFERENCE STEPS FOR SIZING AND SELECTION

1. Obtain room by room heat loss / heat gain
2. Determine operating water temperature for boiler or water heater.
3. Select an air handler from table 1 that exceeds the required capacity for heating and cooling.
4. Transfer heating & cooling capacity, nominal airflow and minimum outlets from table 1 into the Sizing form.
5. Calculate H-factor and C-factor for system on Sizing form.
6. Fill in Sizing form with room names and room-by-room heat losses and heat gains.
7. Calculate the minimum grilles per room required for heating and cooling, filling in the appropriate columns in the Sizing form.
8. Select the equivalent number of 3" grilles per room that will be supplied. The number of grilles must exceed 100% of the heating grille requirement and at least 80% of the cooling grille requirements to ensure adequate air flow per room.
9. From Table 1, select the type of branch kits to be supplied and fill in the right hand columns in Sizing form.
10. Prepare a layout drawing locating the appropriate number of grilles per room. You may add or combine grilles to suit the layout. The grille type on the Sizing form should be updated to reflect the installation choice.
11. Sketch the mains from the air handler to the rooms providing one main per floor. The basement and first floor may be combined on one main provided the number of grilles for the basement is small, or the basement is an unfinished space. Top floor grilles should not share a main duct with other floors if possible.
12. Measure the length of each branch run and the number of elbows or tight bends. Use table 3 and 4 to determine the minimum length of rigid duct for branches over 12.5 feet. Mark the minimum length of rigid duct on the drawing.
13. For long runs the airflow per branch may be de-rated based on table 5 or the duct size may be increased as per table 3.
14. For extremely short runs or rooms with small air flow requirements the branch runs may be shortened and an equivalent length may be added to the branch by "looping" the duct. One 180 bend is adequate to make a 6to8 foot run have the same equivalent length as a 12.5 foot piece of flex with no tight bends.
A 360 bend on a 12.5-foot length will reduce the airflow by ½ for small rooms such as bathrooms or closets that may require less than 20 cfm.
15. Select the supply air main sizes based on the number of attached grilles using Table2. Add the fitting lengths to the actual main duct length for each main to determine which column of the table to use.
16. Design the return air by conventional methods using 0.15" w.c. If the heating capacity exceeds the heat loss by 10% or greater, the return air may be designed at 0.20" w.c.
17. The attached tables apply to Ecologix small diameter duct systems only. The following air handlers may be used: ZoneComfort, EcoDuct, HPAH, DXAH, RE series air handler, Silent Duct, Thermal Duct.

Table 1 - Grille Types

TYPE	Grille style	Round Duct	3"equivalent
2.0	2" nozzle	2"	0.5
3.1	4" universal round grille	3"	1
3.2	4"x4" aluminum square grille	3"	1
3.3	4"x4" steel square grille	3"	1
3.4	4" plastic round diffuser	3"	1
3.5	3x10 boot & grille	3"	1
3.6	4x10 boot & grille	3"	1
4.1	4" plastic round diffuser	4"	1.5
4.2	4" universal round grille	4"	2
4.3	3x10 boot & grille	4"	2
4.4	4x10 boot & grille	4"	2
4.5	commerical grille	4"	2
5.1	4x10 boot & grille	5"	3.6
5.2	6x10 min. commerical grille	5"	4

Table 3 - Branch Duct Lengths - quick selection

		Total Measured Length						
		12.5	15	18	21	25	40	50
Equal to 1 12.5 ft run, 3" flex duct	3" Flex	12.5	9	6	3			
	3" Rigid		6	12	18	25		
	4" Flex						8	
	4" Rigid						32	50
Equal to 2 12.5 ft runs, 3" flex duct	3" Flex							
	3" Rigid							
	4" Flex	12.5	9	6	3			
	4" Rigid		6	12	18	25	8	
	5" Rigid						32	50

- Notes: 1) Flex duct lengths shown are maximums. Rigid duct lengths are minimums.
 2) 2 feet of rigid pipe can be substituted for 1 foot of flex pipe of any one size.
 3) 1 branch @ 4" replaces 2 branches @ 3". 1 branch @ 5" replaces 4 branches @ 3"
 4) Intepolation is allowed for any table on this page
 5) Any combination of duct sizes and boots may be used in one room provided the total equivalent number of branches matches the design
 6) Tables 2,3,4,5&6 may be applied to HPAH, DXAH, EDHV, RE and ZC duct systems only
 7) Table 3 is a guide only. Many other combinations of duct exist for the lengths shown

Table 2 - Supply Main Sizing

Main Duct (inches)	Maximum Main Duct Length (Equivalent)							
	25	50	75	100	150	200	300	400
	Number of 3" Branches							
4	2	2	1	1	0	0	0	0
5	5	3	2	2	1	1	1	0
6	7	5	4	3	2	2	1	1
7	10	8	6	5	4	4	2	1
8	13	12	9	7	5	5	3	3
9	16	15	13	9	8	8	5	4
10	20	20	18	13	10	10	7	5
12	28	30	26	22	18	18	10	8
14	38	40	38	34	28	28	16	12

Table 4 - Equivalent Lengths for Bends

Bend Radius	3" Duct			4" Duct		
	90	180	360	90	180	360
12"	0	0	0	0	0	0
8"	0	3	6	0	3	6
4"	3	6	12	3	6	12
Rigid 90	3	6	-	3	6	-

Table 5 - Flow

3" Flex Duct Equiv. Length	Multiplier (M)					
	6	12.5	15	20	25	>25
Factor (Cond. Space)	1.25	1	0.8	0.6	0.5	N.R.
Factor (uncond. space)	1	0.8	0.6	0.5	0.4	N.R.

Table 6 - Main duct fittings

Main Duct	Fitting Equivalent Length (feet)							
	45	90	reducer	bullhead tee	TEE WYE		TEE	
					thru	branch	thru	branch
4	2	4	5	45	2	5	5	10
5	2.5	5	5	45	2	5	5	10
6	3	6	5	45	2	5	5	10
7	3.5	7	5	45	2	5	5	10
8	4	8	5	45	2	5	5	10
9	4.5	9	5	45	2	5	5	10
10	5	10	5	45	2	5	5	10
12	6	12	5	45	2	7	5	15
14	7	14	5	45	2	7	5	15

ECODUCT SIZING FORM

221 Holiday Inn Drive, Cambridge Ontario N3C 3T2

Phone: 519-658-4330

E-mail: info@ecologix.ca

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Web: www.ecologix.ca

Inlet water temperature

Selected Equipment

Selected Cooling Coil

minimum outlets

Heating capacity (Btu/Hr)

Cooling Capacity (Tons)

Air Flow (cfm)

PROJECT: _____

Selected	Maximum	Required

Selected	Maximum	Required

Nominal	Heating	Cooling

total gain

Room	Floor	(HL)	(CL)	(Oh)	(Oc)	(Ot)	(M)	Branch Kit(s) Selected				Note Number	
		Heat Loss	Heat Gain sensible	Outlets (heating)	Outlets (cooling)	Outlets selected	Multiplier	2"	3"	4"	5"		
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
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25													
Total													

Notes

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THERMALDUCT SIZING FORM

221 Holiday Inn Drive, Cambridge Ontario N3C 3T2

Phone: 519-658-4330
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E-mail: info@ecologix.ca
 Web: www.ecologix.ca

Inlet water temperature
 Selected Equipment
 Selected Cooling Coil

Fan Speed: high med low

minimum outlets

PROJECT: _____

Heating capacity (Btu/Hr)		
Selected	Maximum	Required

Cooling Capacity (Tons)		
Selected	Maximum	Required

Air Flow (cfm)		
Nominal	Heating	Cooling

total gain

Room	Floor	(HL)	(CL)	(Oh)	(Oc)	(Ot)	(M)	Branch Kit(s) Selected				Note Number	
		Heat Loss	Heat Gain sensible	Outlets (heating)	Outlets (cooling)	Outlets selected	Multiplier	2"	3"	4"	5"		
1													
2													
3													
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5													
6													
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Notes

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SCHEMATIC – TYPICAL CONNECTIONS

