



YOUR ENVIRONMENT IS OUR BUSINESS.



Radiant Heating Installation Manual

For Residential and Commercial Installations

TABLE OF CONTENT

1. BEFORE YOU BEGIN		IN THE CARTON	2.5
1.1 The Roth Advantage	1.1	Materials	2.6
1.2 The PEX Advantage	1.1	Connections	2.6
1.3 Certifications, Approvals, and Codes	1.2	TECHNICAL DATA	2.6
1.4 Limited Warranty	1.2	HKV Heating Manifold	2.8
1.5 Receiving the Roth Components	1.3	GENERAL INFORMATION	2.8
1.6 Unit Conversions	1.4	IN THE CARTON	2.9
2. WORKING WITH THE ROTH PRODUCTS		Materials	2.9
2.1 Roth PEX Tubing	2.1	Connections	2.9
Selecting Barrier or Non-Barrier Tubing	2.1	TECHNICAL DATA	2.9
Sizes and lengths	2.1	Roth Manifold Cabinet	2.11
Table 2.1 – Roth PEX for barrier tubing	2.1	2" Copper Manifolds for Roth 5/8" & 3/4" Compression Valves	2.11
Table 2.2 – Roth PEX non-barrier tubing	2.2	2.3 Roth Fittings	2.11
Tubing storage and handling	2.2	Roth Fitting Assemblies	2.11
Bending, cutting, and fastening PEX	2.3	Roth G 3/4" Double Nipple	2.11
Repairing PEX	2.3	Roth PEX to copper Transitions	2.11
PEX limitations	2.3	Roth Fittings for 3/4" & 1" PEX	2.12
2.2 Roth Manifolds	2.5	Roth Compression Valves for 1/2", 5/8" & 3/4" PEX	2.12
HK Heating Manifold with adjustable flow control meters	2.5	3. TUBING INSTALLATION	
GENERAL INFORMATION	2.5	3.1 Preparing for installation	3.1

Roth Radiant Heating Installation Handbook

Insulation	3.1	Preparation	3.13
Floor Temperature Limitation	3.1	Panel Installation	3.14
Floor Coverings	3.1	THICKNESS & APPROX R VALUE	3.14
Getting the area ready for tubing	3.1	Screw locations for connecting Roth Panel System to Sub-floor	3.17
Tubing Layout Patterns	3.2	3.8 Comfort Zone or Heating Zone?	3.18
Tubing Loop Lengths	3.3	4. PRESSURE TESTING & SYSTEM START-UP	
Install Manifolds first	3.3	4.1 Pressure Testing the System	4.1
Before tubing is brought in	3.3	Roth pressure tester	4.1
Installing tubing	3.3	4.2 Filling the System	4.2
3.2 Slab Floors	3.4	Freezing conditions	4.2
3.3 Overpour on Insulation	3.5	Purging manifolds	4.2
Roth Tacker System	3.5	Filling the rest of the system	4.3
3.4 Overpour	3.6	Before starting the system	4.3
Roth Twin Fastener	3.6	4.3 Starting the System	4.3
Roth Compressed Air Stapler System	3.7	Starting up	4.3
Rapid Mounting Rail	3.7	About Balancing (without appropriate design)	4.3
3.5 Suspended Wood Floor with Alu Plates	3.8	About lag time	4.4
Sequence of Installation for Joist Heating Using Transfer Plates(for Floors 3.6 & 3.7)	3.9	5. INSTALLATION OF ELECTRICAL CONTROLS	
3.6 Suspended Wood Floor With Alu Plates From Below	3.11	5.1 General Information	5.1
3.7 Suspended Wood Floor With C-Fin Plates From Below	3.11	5.2 Roughing in thermostat and control wires	5.1
Roth Hole Punch Kit	3.11	5.2 Roughing in thermostat and control wires	5.1
3.8 Installation of Ceiling Heating	3.12	Roth Transformer 40 VA	5.1
Example	3.12	5.3 Roth Electronic Thermostats	5.2
Roth Radiant Floor Panel System for 3/8" & 1/2" Roth PEX Tubing	3.13	General Information	5.2
Modular, low-profile PEX tubing tracking system with integrated thermal isolation and aluminum heat diffuser	3.13	Mounting Location	5.2

Installing New Thermostat	5.2	General Information	5.18
Simple Wiring Without Junction Box	5.4	TC 62 Water Temperature Reset Chart	5.19
Simple Wiring Multiple Actuators	5.5	5.8 Roth Mixing Controllers	5.20
5.4 Electrical Junction Boxes	5.6	General Information	5.20
General Information	5.6	Roth Hydronic Controller 1050 with 4-Way Mixing Valve	5.22
Single Box Installation	5.6	Roth Hydronic Controller 1050 with Variable Speed Injection Pump	5.24
DHW Priority	5.6	Roth Hydronic Controller 1050 with 4-Way Mixing Valve and DHW	5.26
Sequence of operation single box	5.7	Roth Hydronic Controller 1050 with Variable Speed Injection Pump and DHW	5.28
Sequence of operation, DHW	5.7	Roth Hydronic Controller 1050 with 4-Way Mixing Valve, DHW and Hi-Temperature Zones	5.30
Mode Operation:	5.7	Roth Hydronic Controller 1050 with Variable Speed Injection Pump, DHW and Hi Temperature Zones	5.32
Specifications:	5.7	6. WATER TEMPERATURE CONTROLS & ACCESSORIES	
Wiring Diagram	5.8	6.1 Roth Shunt Systems	6.1
Wiring Diagram	5.9	Roth Shunt System	6.1
2 Roth Zone Control Plus with DHW Priority	5.10	Roth Manifold Shunts Capacities:	6.1
General Information	5.11	Mounting Instructions	6.1
General Information	5.16	6.1 Roth Shunt Systems	6.2
Installation Instructions	5.16	Adjustments	6.2
5.7 Roth Operators for 4-Way Mixing Valves	5.17	Maintenance	6.2
General Information	5.17	Mini Shunt System	6.4
Wiring Schematic	5.17	Roth Mini-Shunt Quick Sizing Chart*	6.4

Mounting Instructions	6.5	7.6 Boiler with Variable Speed Injection Pump	7.3
Power Requirements	6.5	7.8 Boiler with 2 Temperature Variable Speed Injection Pumps	7.4
Adjustments	6.5	7.9 Boiler with DHW, Air Handler and 4-Way Mixing Valve	7.5
Maintenance	6.6	7.10 Boiler with DHW, Air Handler and Variable Speed Injection Pumps	7.6
Mini-Shunt Pump Performance	6.6	7.11 Boiler with DHW, Air Handler, 4-Way Mixing Valve and Branch Style Zone Valves	7.7
6.2 Thermo-Mechanical Mixing Valves	6.7	7.12 Boiler with DHW, Base Board, 4-Way Mixing Valve and Branch Style Zone Valves	7.8
Aquamix R	6.7	7.14 Boiler with 4-Way Mixing Valve and Zone Pumps	7.9
Panel Heating Supply Temp. °F; Diagonal lines for Boiler temperatures (°F)	6.8	7.15 Boiler with Heat Exchanger and Variable Speed Injection Pump	7.10
Using the Chart:	6.8	7.16 Boiler with 2 Temperature Variable Speed Injection Pumps and Heat Exchanger	7.11
Roth Injection Valve and Controller	6.8	8. FORMULAS AND CHARTS	
6.3 Roth 4-Way Mixing Valves	6.10	8.1 Some useful formulas	8.11
6.4 Roth Differential Pressure Bypass Valves	6.10	See below table for Weights (lbs/100 ft.) and Volumes (gallons/100 ft.)	8.11
Sample schematic for differential pressure by-pass valve installation	6.11	8.3 Using Cv values for Pressure Loss Calculations	8.12
6.5 Roth Automatic Air Purgers	6.12	8.4 PEX and Copper (Class M) Pressure Head loss per 10 ft	8.13
7. MECHANICAL SCHEMATICS		8.5 Approximate calculation of Pressure Head Loss	8.13
7.1 General Notes	7.1	8.6 Floor coverings	8.14
7.2 Pipe Sizing	7.1	R-values	8.14
7.3 Water Heater with 3-Way Mixing Valve	7.2	Comments:	8.14
7.4 Boiler with 3-Way Mixing Valve	7.2	The impact of coverings' R-values	8.14
7.5 Boiler with 4-Way Mixing Valve	7.3	About Wood Floor Installations	8.15

Roth Radiant Heating Installation Handbook

1. BEFORE YOU BEGIN

1.1 The Roth Advantage

Since incorporating in 1947 in Buchenau, Germany, Roth Industries has become an industry leader for products in home improvement, such as floor heating, tubing installation systems and in plastics technology. Roth has over 1,100 employees worldwide, 8 manufacturing plants with 797,000 sq. ft. of building space on 143 acres of land. Roth's ISO 9001 certified PEX tubing manufacturing plant is one of the largest in Europe.

During the development of our systems, the main focus was to provide the customer with systems that could deliver rapid and problem free installations, longevity, components safe to handle and operate, minimum product waste and worry free reliable performance, all at a competitive price. The success during the last 50 years is the result of flexibility in products, targeted investments, and theme oriented solutions. Our growth stems from continuous research and development of new and innovative products. Manufacturing keys to success are a combination of know how, modern production sites and equipment, latest production technologies, and motivated personnel.

1.2 The PEX Advantage

Roth Heating Systems described in this Guide are based on the high quality PEX pipes crosslinked by electron beams, PEX-c. In manufacturing its PEX tubing, Roth controls every step in manufacturing, distribution and sales. Roth PEX tubing is rapidly becoming the material of choice for radiant heating installations. And there are many reasons for it!

- Corrosion free
- Proven long term strength - even at high temperatures
- Electron Beam crosslinked - no chemicals used
- Scaling virtually nonexistent - will not restrict flow over time
- Light weight - a coil of 600 ft. 1/2 in. PEX weighs only 32 lbs.!
- Flexible - tubing is easily snaked around objects in the path
- Abrasion resistant - no erosion inside - or wear outside
- Does not turn brittle - not even at 100°F below zero
- Withstands over 110 psi at 230°F (at system malfunction)
- Fast and easy to install - gain at no pain
- Prices do not flex - prices quoted can remain firm
- Environmentally friendly - burns into water and carbon dioxide
- Creep resistant - fittings remain tight over time
- Limited 25 year warranty - see details in warranty text
- Minimal waste with long coils

1. INITIAL CONSIDERATIONS

1.3 Certifications, Approvals, and Codes

Local code requirements may vary from state-to-state, or city-to-city. In many areas, there are few restrictions or code requirements for hydronic heating distribution systems, while in other areas specific listings or certifications may be mandatory. The user is obligated to check local codes and requirements and verify that Roth systems are accepted and meet the local requirements. We are highlighting the most important Roth certifications and listings below. Please contact us if you need more information regarding possible additional local approvals. Roth PEX tubing is subject to the most stringent Quality Control. Our Quality Assurance Laboratory is well equipped and our staff is dedicated to quality. The production plant carries an ISO 9001 Quality Assurance Certification (ISO stands for the International Standard Organization). At Roth, we are proud of this achievement; a quality seal that only few tubing manufacturers carry.

Our internal quality system is verified and supervised by independent third party inspectors. NSF International regularly inspects our production plant and attains samples to be tested at their laboratories.

Roth PEX tubing is manufactured to ASTM F 876/877 and to CAN/CSA B 137.5. In accordance with these standards, the tubing has a PPI (Plastic Pipe Institute) pressure rating of 100 psi at 180°F (and 80 psi at 200°F and 160 psi at 73.4°F). The actual pressure resistance for long term use is approximately twice as large (a double safety factor). Tubing with oxygen diffusion



Roth Radiant Heating Installation Handbook

barrier meets the stringent standard DIN 4726 for its diffusion resistance.

Roth barrier PEX tubing is certified by NSF International to carry the NSF-rfh mark, where the "-rfh" stands for "radiant floor heating". The tubing and fittings have been tested to NSF Standard 14 to meet the requirements of ASTM F 876/877, F1807 (when used with F 1807 fittings) Roth PEX tubing without barrier is certified by NSF International to carry the NSF-pw mark, where the "pw" stands for "potable water" and NSF-U.P. Code.

In addition to the tests above, these PEX tubes also meet NSF Standard 61, which outlines the requirements for health and toxicological aspects when used in domestic plumbing applications. CSA B137.5, Chlorine Resistance for Traditional Systems under F2023.

ICBO Evaluation Service, Inc. has listed: "Roth PEXc Tube and Fittings for Radiant Panel Heating and Water Distribution Systems". The report number is available for review at the ICBO web site: www.icbo.org, or can be ordered from Roth Industries, Inc.

Roth also carries a listing by IAPMO Research and Testing, Inc.; Report P-41891, PEX Water Distribution System. This approval is mainly related to Plumbing Systems, but in certain areas an IAPMO listing may be required or requested for heating tubing.

1.4 Limited Warranty

Valid for Roth PEX tubing and Panel Heating Components described in this publication, or in Roth Product & Design Manual, 1999. Roth Industries Inc. warrants to its "clients" that the Roth PEX tubing and other components listed in this publication, used for Roth Panel Heating applications, sold hereunder shall be free from defects in material and workmanship and that the components will conform to specifications stated in Roth Product & Design Manual This Limited Warranty shall expire after twenty-five (25) years for the Roth PEX tubing, and after Twenty Four (24) months for the other components when used for panel heating installations, from date of shipment by Roth unless otherwise specified in writing. Roth Industries Inc. further warrants that products listed are compatible with each other, but at the same time we disclaim warranty for claims related to compatibility with non-Roth products.

Components sold under this Limited Warranty must (1) be selected, designed, and installed according to the instructions in Roth Design Manual using appropriate trade workmanship and according to the local building code(s), (2) remain in their originally installed location, (3) are connected to appropriate water and power supplies, (4) show no evidence of tampering, mishandling, neglect, accidental damage, modification or repair without the approval of Roth or damage done to the product by anyone other than Roth.

Roth's sole obligation hereunder shall be, at its option, to issue credit, repair or replace any component or part thereof which is proved to be other than as warranted. No allowance shall be made to clients for transportation or labor charges unless such charges are authorized in writing in advance by Roth. Any repairs without the express written consent of Roth, shall render this Limited Warranty invalid. Warranty claims must be received by Roth within the applicable warranty period and within thirty (30) days from the cause for the claim occurred or was discovered. Upon receipt of prompt notice of a warranty claim, Roth shall have ten (10) business days in which to determine if it acknowledges responsibility for any asserted defects in material or workmanship and the appropriate action to be taken. This Limited Warranty and any claims arising from breach of warranty, or any other claim arising hereunder, shall be governed and construed under laws of the State of Delaware. No other persons than Roth employees have express or implied authority to bind Roth to any agreement or warranty of any kind without the express written consent of Roth.

DISCLAIMER OF WARRANTIES: ROTH DISCLAIMS ANY WARRANTY NOT PROVIDED HEREIN INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. IT IS EXPRESSLY UNDERSTOOD THAT ROTH IS NOT RESPONSIBLE FOR ANY CONSEQUENTIAL OR OTHER DAMAGES THAT MAY ARISE FROM USING ROTH SYSTEM COMPONENTS. DAMAGE RESULTING FROM WATER FREEZING IN THE TUBING DOES NOT CONSTITUTE A DEFECT IN MATERIAL OR WORKMANSHIP, AND SHALL NOT BE COVERED BY THIS WARRANTY. ROTH TUBING MAY NOT BE STORED IN DIRECT SUNLIGHT FOR ANY PERIOD LONGER THAN THREE WEEKS OR THIS LIMITED WARRANTY BECOMES INVALID. ROTH DISCLAIMS ANY STATUTORY OR IMPLIED WARRANTY OF HABITABILITY. ROTH FURTHER DISCLAIMS ANY RESPONSIBILITY FOR LOSSES, EXPENSES, INCONVENIENCES, SPECIAL, INDIRECT, SECONDARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THE ARTICLES SOLD HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

Roth Radiant Heating Installation Handbook

1.5 Receiving the Roth Components

When shipment from Roth (or from a Roth Distributor) arrives, please check for shipment damages and shortages. Freight damages or missing boxes must be claimed with the delivery driver right away. Check that all components required for the project are available. When parts need to be stored before installation, or in between projects, please keep all components indoors and in their original boxes, secure from moisture, weathering, and tampering. Roth PEX tubing must not be exposed to direct sunlight for extended periods of time. Short exposures (such as a week, or a few weeks) during installation does not pose a concern.

1.6 Unit Conversions

The table below provides some useful conversions between units frequently used. See also our Charts in Section 8 which provides useful formulas and tables for many situations. A third set of conversion results will easily be found: The 5th column unit (meter in first row) is converted to the 4th column (inch) by multiplying the two numbers and using this to multiply 5th column value.

	Inch/Pound units to Inch/Pound units			Units to Inch/Pound to Metric units		
	Multiply	By	To Receive	Multiply	By	To Receive
Length	Ft.	12	Inch	Meter	3.281	Ft.
	Yard	3	Ft.	Meter	1.094	Yard
	Mile	5,280	Ft.	Kilometer	0.621	Miles
Area	Sq. ft.	144	Sq. in.	Sq. meter	10.764	Sq. ft.
	Sq. yard	9	Sq. ft.	Sq. yard	1.197	Sq. meter
	Sq. mile	27,878,400	Sq. ft.	Sq. kilometer	0.386	Sq. mile
Volume	Cu. Ft.	1,728	Cu. In.	Cu. Meter	35.313	Cu. Ft.
	Cu. Yard	27	Cu. Ft.	Cu. Meter	1.309	Cu. Yard
	Cu. Mile	1.472E+11	Cu. Ft.	Cu. kilometer	0.240	Cu. Mile
	US gallon	0.134	Cu. Ft.	Liter	0.264	US gallon
Weight	Pound	16	Ounce	Kilogram	2.205	Pound
	Ounce	0.063	Pound	Kilogram	35.274	Ounce
	US ton	2,000	Pound	Metric ton	1.102	US ton
Speed	Mile/h	1.467	Ft./s	m/s	2.237	Mile/h
Force	Lbf	4.448	N	Kp	2.205	Lbf
Torque	Lbf*ft.	12	Lbf*in.	Nm	0.738	Lbf*ft.
Energy	Btu	252	Cal	K. Joule	0.948	Btu
	kWh	3,412	Btu	Hp/h	0.736	kWh

Power	Btu/h	0.252	Kcal/h	KW	3,412	Btu/h
	Btu/h	3.930E-04	Hp	Kp/s	33.462	Btu/h
Pressure	Psi	2.307	Ft. head	Bar	14.504	Psi
Conductivity	Btu/h*F*ft.	12.000	Btu*in/h*sq.ft.*F	W/m*C	0.576	Btu/*F*f
Heat output	Btu/(h*sq.ft.)	0.252	Kcal/(h*sq.ft.)	W/sq. m.	0.317	Btu/(h*sq.ft)
	To receive	By	Divide	To receive	By	divide
	Inch/Pound units to Inch/Pound units			Units to Inch/Pound to Metric units		
Time	Hour	3,600	Second	Year	8,766	hour
Temperature	-40 F	Equals	-40 C	6TC	1.800	6TF
	XF	$-40+(X+40)/1.8$	C	XC	$-40+(X+40)*1.8$	

2. WORKING WITH THE ROTH PRODUCTS

2.1 Roth PEX Tubing

Selecting Barrier or Non-Barrier Tubing.

Plastic tubing allows oxygen from the air to move through the tubing wall and dissolve into the circulating water. When the oxygenated water comes in contact with ferrous metals, corrosion will result. The diffusion rate is slow and only small amounts of oxygen will enter, but as years go by the accumulation of corrosion sludge may cause circulation disturbances and even component failure. There are three generally accepted methods available to prevent system disturbances related to oxygen diffusion:

1. Use tubing with oxygen diffusion barrier.
2. Use corrosion-resistant components.
3. Use corrosion inhibitors.

Method 1 is preferred in most conventional systems with cast iron or steel boilers and/or other corrodible components. Roth PEX Barrier Tubing exceeds the requirement for oxygen permeability described in the German standard DIN 4726 which is accepted as a guide also in North America.

Method 2 will allow PEX Tubing without barrier to be used but requires that all system components are made of corrosion resistant materials (such as copper tube boilers, bronze circulators, stainless steel heat exchangers, etc.).

Method 3 will also allow PEX Tubing without barrier, but this method should be used very restrictively. Corrosion inhibitors will be consumed and diluted over time and must be replaced. The building owner will be obligated to sample the system water for the effectiveness of its inhibitors at least on an annual basis, and add appropriate amounts of compatible inhibitors. Failure to do so may lead to aggressive pitting corrosion.

Sizes and lengths

Roth PEX barrier tubing is available in several sizes, and for each size we have several coil lengths. See below table.

Table 2.1 – Roth PEX for barrier tubing

Nominal Size	Outside Diameter	Inside Diameter	Min. bend radius; in.	Standard tubing lengths, ft. (for barrier tubing)
3/8	½	0.394	3	300, 1,000
½	5/8	0.475	3.75	300; 600; 1,000; 2,000
5/8	¾	0.584	4.5	450; 600; 1,600
¾	7/8	0.670	5.25	300; 500; 800; 1,000
1	1 1/8	0.867	6.75	300
1 ¼	40mm	1.280		330
1 ½	50mm	1.610		330

1/2" size tubing is the most commonly used size for residential applications, but 3/8" is sometimes used for small rooms/projects and 5/8" for larger. 5/8" and 3/4" is mainly used for commercial and snowmelt projects. 3/4", 1", 1 1/4" and 1 1/2" are often used as distribution lines.

Table 2.2 – Roth PEX non-barrier tubing

Nominal Size	Outside Diameter	Inside Diameter	Min. bend radius; in.	Standard tubing lengths, ft. (for NON-barrier tubing)
½	5/8	0.475	3.75	300; 600; 2,000
5/8	¾	0.584	4.5	450; 1,000; 1,000 UV
3/4	7/8	0.670	5.25	300; 1,000

Tubing storage and handling

All Roth PEX Tubing coils are delivered in cardboard boxes. Check boxes at delivery so possible freight damages are discovered. We prefer indoor storage and in the original boxes, secure from moisture, weathering, and tampering, but outdoor covered storage can be acceptable. Roth PEX tubing must not be exposed to direct sunlight for extended periods of time (one month). Short exposures (such as a week, or a few weeks) during installation does not pose a concern. Roth 5/8" and 3/4" black tubing will not be damaged by extended (UV) Ultraviolet exposure. PEX tubing will not become brittle at any temperature, so cold storage is permissible. PEX tubing will be somewhat stiffer at cold temperatures and tempered storage immediately prior to installation can therefore be an advantage. Roth PEX tubing is coiled with a very generous 16 in. inside diameter, so there is little memory effect (tubing that wants to stay bent) after uncoiling. Use of an uncoiler is important, it prevents twisting the tubing, so the tube can be rolled or coiled out. Roth Tubing Uncoiler is an excellent tool and will save labor cost during installation. Place Uncoiler away from the area to be installed and simply pull out tubing lengths (marked every 3 ft.) as needed.



The minimum bending radius for PEX (per ASTM F 877) is 6 times the outside diameter. These radii are included in Tables 2.1 and 2.2. When the tubing is installed at closer center distances than twice the bending radius, allow a so called "pear turn". Roth bend supports are used to fix the tubing in a 90° bend and to protect tubing at entry from manifold into floor. Our standard size is for tubing up to 5/8", but we also have supports for 3/4" and 1" Roth Metal Bend Supports are available for 1/2", 5/8", 3/4" and 1" sizes. Since the Support can be snapped onto tubing anywhere along the tubing length, it is ideal to provide a narrow bend anywhere required. Larger sizes require some force to be put into the support, and the tubing should be pulled around the groove to avoid kinking at installation. Roth PEX Fittings require that tubing has a square and smooth end, free from burrs and deformations. Use a Roth Tubing Cutter or a similar tool to accomplish this. It will cut all sizes up to 1" size. Extra cutting blades are available as spare parts.

Repairing PEX

Although Roth PEX tubing is very flexible and normally can accept a bending radius tighter than indicated, a kink might accidentally occur. Since PEX has a strong thermal memory, it is normally possible to repair a kink in the following way: Keep the kinked portion straight and heat it carefully using a hot air gun (not an open flame). Move the hot air gun around the kinked area so that all sides become evenly heated. In order to avoid overheating, adjust the distance of the hot air gun so you make sure that the hot air hitting the tubing does not exceed 340°F. When the tubing temperature exceeds 265°F it will turn transparent (material crystals dissolve) and the kink will disappear. Let the tube cool down undisturbed (water may be used for faster cooling) and the kink is now repaired.

Tubing cracks or cuts cannot be repaired by its thermal memory, but the damaged part must be cut out and a repair coupling must be installed (see section on PEX fittings). The location of the repair coupling should then be registered, and if the coupling will be embedded in concrete wrap a 5" section of the pipe/coupling with a one pipe size larger foam pipe insulation. Then a thin plastic cover, in order to increase future accessibility and to protect the coupling from chemicals in the concrete.

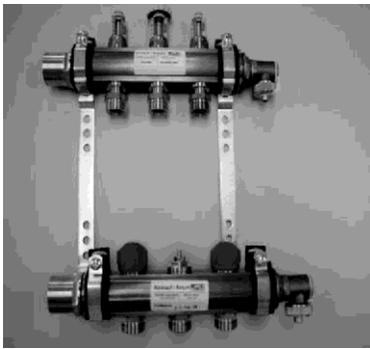
PEX limitations

- Roth PEX Tubing covered by this publication are intended for Roth Radiant Panel Heating Systems as described herein, only. Contact Roth before using it for other applications, or for other medium than water/antifreeze solutions.
- See information about maximum pressures and temperatures and approvals on page 1.2.
- The PEX ASTM F 877 Standard Specification outlines that PEX tubing can accept a 110 psi pressure at a temperature of 230°F for 30 days. However, this should not be understood as a tubing rating but only as information about tubing capability at a system malfunction.
- See information on Oxygen Diffusion on page 2.1.
- See information on limitation of exposure to sunlight on page 2.2
- See information on freezing in embedded tubing on page 4.2.
- Use only fittings provided by Roth and described in this handbook for connecting Roth PEX tubing.
- See information on Warranties on page 1.3
- PEX expansion (when not restricted) is 1.1 in. per 10°F per 100 ft.
- Soldering of metal fittings in the same water line may not be done closer than 18 in. from an installed PEX fitting.

- Follow all local codes



2.2 Roth Manifolds



HK Heating Manifold with adjustable flow control meters

GENERAL INFORMATION

The Roth Heating Manifold with adjustable and closable flow indicators is made of heavy-walled, corrosion resistant brass alloy, 30 mm (1.2") inside dimension, with a 27.5 mm (1.1") flat gripping surface. The manifolds are available with 2-10 connections (except 9) for heating circuits. The manifolds have 1" G female threads on both ends so the piping connections can be made on either the left or right side.

- The supply manifold has flow indicators that have built-in adjustment and stop valves for adjusting the flow rate of each heating loop. The indicator is scaled from 0.02 to 1.5 US gal/min (0.1 to 6.0 l/min). The flow indicators are 2.17" (55 mm) on center.
- The return manifold has valve assemblies that can be used for isolation or for mounting thermostat-controlled electric actuators. The protective cap can be used to close this valve by completely tightening the cap. The valve assemblies are 2.17" (55 mm) on center.
- The drain and vent valve assemblies and supply/return adapters can be installed on either end of the manifold as required by the installation. The drain assembly can be rotated for easy purging of the air in the tubes.

IN THE CARTON

The manifold is shipped assembled to the mounting brackets with rubber vibration isolators. Also included:

- (2) Loose drain and vent valves, to be assembled at the time of installation. Each drain valve has a removable cap with integral key for the valve stem.
- (2) Loose 1" G MPT x 1" F sweat / 1 1/4" M Sweat adapters for supply and return piping connections
- Labels to identify the rooms served by each loop
- **Roth compression or press fitting assemblies for the tubing connections are not included and must be ordered separately.**

Roth Radiant Heating Installation Handbook

Materials

- Galvanized Steel Mounting Brackets
- Rubber Vibration Isolator Pads
- Brass Supply & Return manifold

Connections

- Supply & Return manifolds have 1" G female threads for piping adapter or drain/vent valve connection at either the left or right end of the manifold.
- 3/4" G male threaded Euro-conical connections for Roth Heating System PEX tubing. Fitting assemblies are not included and are purchased separately.
- Threaded connections for the Roth Valve Actuators, M30 x 1.5 mm

Manifold	Approx. length inches	Part Number
HK2	10 ¼" (261 mm)	2315006872
HK3	12 ½" (318 mm)	2315006873
HK4	14 ½" (369 mm)	2315006874
HK5	16 ¾" (426 mm)	2315006875
HK6	18 ¾" (477 mm)	2315006876
HK7	21" (533 mm)	2315006877
HK8	23" (585 mm)	2315006878
HK10	27 ¼" (693 mm)	2315006880

TECHNICAL DATA

Height: 15" (380 mm)

Depth: 3 1/2" (89 mm)

Max Operating Temperature:

160°F (70°C) continuous

Max Operating Pressure:

30 psi (2.1 bar) continuous

Recommended Test Pressure:

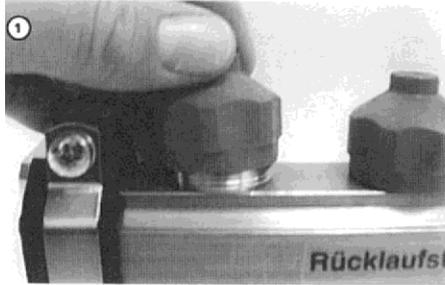
45-60 psi (3.1-4.1 bar)

Please note: Because air test pressures are far in excess of normal operating pressures, small leaks can take a relatively long time to register on the test gauge. It is recommended that a leak detection solution be applied to all fittings on the manifold after the system is pressurized to locate any small leaks that may have occurred during shipping of the manifold or installation of the tubing.

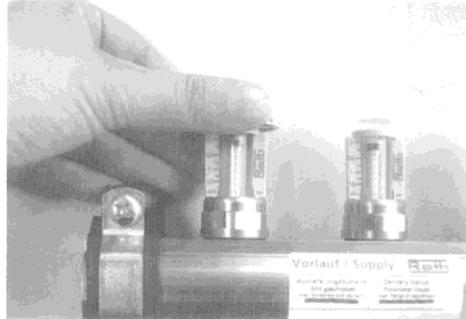
Roth Radiant Heating Installation Handbook

* Overall length includes the sweat adapter and the drain/vent valve assembly attached to the manifold.

IMPORTANT: Filling and purging the heating loops should be done with the flow from the supply manifold, through the loops, to the return manifold and purged through the drain and vent valve in the return manifold !



Loosen the protective cap on the actuator valve of the circuit you are adjusting until the cap is on the valve only one or two turns. This will open the valve for that loop.



The required flow is set with the enclosed removable adjusting knob on the top of the flow indicator in the supply manifold. Turn the knob until the red indicator in the sight glass is at the correct flow, clockwise to decrease flow and counter-clockwise to increase flow. There are approximately 4 turns from fully opened to fully closed. Turning the cover with the scale will not adjust the flow. Flow adjustment can be accomplished only by turning the knob placed on the top of the flow indicator. The circuit can be purged of air in the full open position and set to the correct flow rate afterwards. The circuit can be positively shut off by turning the knob fully clockwise to purge each loop, one at a time, or to isolate a loop that has been damaged.



The valve is opened by removing the cap from the drain and using the key built into the cap to turn the valve stem. Purge the air from each circuit with the drain valve until the fluid flows clear, without any air bubbles. At this time the drain valve should be turned off. Repeat this procedure for each heating circuit on the manifold. When all circuits are properly purged, replace the drain valve cap. If actuator motors are used in your system, they may be installed on each valve as you complete the purge process and preliminary flow adjustment. If there are any circuit connections on the manifold that are not used, the return valves should be closed by tightening the protective cap completely, closing the valve in the flow indicator by turning the knob fully clockwise and installing a loop cap #1135000354) on the unused loop connections.

After you have completed purging each manifold, the system can be started up. Be sure to perform all safety and operation checks required for your heating equipment and control system. While the system is operating and with all zones calling for heat, check to see that each circuit has the correct required flow rate and make any necessary adjustments. After you have verified the correct flows, you can set the thermostats to the desired temperature.

If actuators are not used on a loop, replace the protective caps by fitting them *loosely* on the valves. ***If the caps are screwed on tightly you will close the valve and there will be no flow in that circuit! NO FLOW = NO HEAT!***

HKV Heating Manifold



GENERAL INFORMATION

The Roth Heating Manifold is made of heavy-walled, corrosion resistant brass alloy, 30 mm (1.2" Deep) inside dimension, with a 27.5 mm (1.1") flat gripping surface. The manifolds are available with 2-10 connections (except 9) for heating circuits. The manifolds have 1" G female threads on both ends so the piping connections can be made on either the left or right side.

- The supply manifold has adjustable (Allen wrench) internal flow fittings, which are 2.17" (55 mm) on center.
- The return manifold has valve assemblies that can be used for isolation or for mounting thermostat-controlled electric actuators. The protective cap can be used to close this valve by completely tightening the cap. The valve assemblies are 2.17" (55 mm) on center.
- The drain and vent valve assemblies and supply/return adapters can be installed on either end of the manifold as required by the installation. The drain assembly can be rotated for easy purging of the air in the tubes.

Roth Radiant Heating Installation Handbook

* Overall length includes the sweat adapter and the drain/vent valve assembly attached to the manifold.

IMPORTANT: Filling the loops should be done only through the supply manifold and purging air from the tubing should be done only through the drain & vent valve on the return manifold!



The required flow is set with a 6 mm hex key in the top of the flow indicator in the supply manifold by turning the key until the red indicator in the sight glass is at the correct flow. There is approximately 1/2 turn from fully opened to fully closed. The circuit can be purged of air in the full open position and set to the



Loosen the protective cap on the actuator valve of the circuit you are adjusting until the cap is on the valve only one or two turns. This will open the valve for that loop.

After you have completed purging each manifold, the system can be started up. Be sure to perform all safety and operation checks required for your heating equipment and control system. While the system is operating and with all zones calling for heat, check to see that each circuit has the correct required flow rate and make any necessary adjustments. After you have verified the correct flows, you can set the thermostats to the desired temperature.

If actuators are not used on a loop, replace the protective caps by fitting them loosely on the valves. **If the caps are screwed on tightly you will close the valve and there will be no flow in that circuit! NO FLOW = NO HEAT!**



The valve is opened by removing the cap from the drain and using the key built into the cap to turn the valve stem. Purge the air from each circuit with the drain valve until the fluid flows clear, without any air bubbles. At this time the drain valve should be turned off. Repeat this procedure for each heating circuit on the manifold. When all circuits are properly purged, replace the drain valve cap. If actuator motors are used in your system, they may be installed on each valve as you complete the purge process and preliminary flow adjustment.

Roth Manifold Cabinet



Use our Cabinet when the manifold is surface mounted and you need to protect it from abuse and tampering. The measurements are: Width: 27 1/2 in. for the smaller version (for up to 6 Tubing loops, and 35 1/2 in. for the

Roth Radiant Heating Installation Handbook

larger (up to 8 loop Manifolds). Height: 30 in. Depth: 5 1/8 in. It is intended for surface mount. The cabinet is made out of galvanized steel and has supports inside to mount the manifold. The front panel is locked with a key (two keys included).

2" Copper Manifolds for Roth 5/8" & 3/4" Compression Valves



These Roth manifolds are intended for 5/8" & 3/4 in. PEX Tubing. The Roth Compression Valve (see next page) with Ball Valve or Ball Valve and Balancing Valve are sweat into the manifold branches. Our standard length is 18 branches, but we will custom cut to your request. Branches are 4" apart. Use 2" sweat adapters for connections. 2" Coupling size End Caps for the manifolds are also available. They are equipped with a 1/8" Tap for Vent and a 1/2" FIP for Fill and Drain.

2.3 Roth Fittings

Roth Fitting Assemblies



Roth Fitting Assemblies for HKV, HK manifold are purchased separately. They are also used with Nipples and Transitions as described below and as a spare part when Fittings are accidentally damaged or lost. Available for 3/8", 1/2" & 5/8" PEX tubing. Directions: Square cut pipe. Slide on nut followed by compression ring. Push insert into tube as close to bottoming out as possible. Tap with piece of wood if necessary. Slight chamfering inside end of tube aids insertion. Push tube toward fitting while hand tightening nut. Torque nut to at least 10 ft.-lbs., re-torque 15 min. later.

Roth G 3/4" Double Nipple



Repair accidentally damaged 3/8", 1/2", or 5/8" PEX tubing with the Roth G 3/4" Double Nipple and two Fitting Assemblies.

Roth PEX to copper Transitions



Use Roth Transition pieces with Roth Fitting Assembly to convert from Roth PEX 3/8", 1/2" or 5/8 in. tubing to 3/4" & 1/2" copper pipes. It will have 3/4" Fitting OD and 1/2" Copper Sweat inside. Earlier model: OD is male into 3/4" copper Class M.

Roth Fittings for 3/4" & 1" PEX



Common fittings for Heating applications is our Female Sweat Adapters. They are available for 3/4" and 1" Copper pipes for 3/4" & 1" PEX Tubing sizes. The Crimp Rings are sold separately and are not included.

Roth Compression Valves for 1/2", 5/8" & 3/4" PEX



Compression Fittings with Ball Valves are available for 5/8" & 3/4" PEX Tubing. The other side is a 3/4" copper size. All Brass construction. It is often used with copper manifolds (see previous page) for snowmelt systems. It is available with (as pictured) and without Flow Balancing Valve. Cv is 6.6 at fully open. Open protective brass cap to set balancing 20% spindle with an allen wrench. The chart indicates the flow as a percentage at number of turns full turns from closed valve.

3. TUBING INSTALLATION

3.1 Preparing for installation

Insulation

Verify that insulation in accordance with the design is installed. Insulation of floors provides additional benefits for radiant floor heating. Since the floor is warmer than conventional systems we do not want to lose this heat to the ground or let it go in unwanted direction, direct the heat upwards by insulating below. For slab on grade (or below grade) the insulation must meet the local code for its compression strength. The load is dependent on the slab thickness, but also possible structural loads for the actual building. We recommend to always install edge and perimeter (4 ft.) insulation. Under slab insulation is essential when the ground water level is close (8-12 ft. down) or when the base is not well drained. Likewise, if bedrock is close it has the capability to draw a lot of heat, so insulation is important. Insulation Under-slab is advantageous since it will always decrease the response time to heat requirement changes, but if above mentioned criteria is met; under slab insulation will not contribute much to lowering the heating cost over a heating season. Dry dirt, gravel, sand and similar base materials will provide quite good insulation by themselves.

Floor Temperature Limitation

The general recommendation (see page 8.6 for wood floors 80° limit; consult manufacturers for special materials) is that the floor surface should not exceed 84°F in areas where people spend considerable time. However, less frequently occupied areas can be allowed surface temperatures of up to 89°F without negative effect. Such areas are, for example, the 3 ft. perimeter of most rooms, entry's, hallways, bathrooms, laundries, etc. We learn (see section 8) that we achieve approximately 2 Btu/(h x sq.ft) for each 1 °F in temperature difference between air temperature and floor temperature. That means that we have a limit of (14 x 2 =) 28 Btu/(h x sq.ft.) heat output for the areas with the 84°F limit at 70°F room temperature. However, since occupants in radiant floor heated rooms experience more warmth at same air temperature than in conventional systems, the design indoor temperature is often set to around 66°F, this limitation will change to (18 x 2 =) 36 Btu/(h x sq.ft) for most residential applications. Still, it may be a good advice to utilize the perimeter area (allowed a floor temperature of 89°F) for higher outputs in rooms with high demands. See layout pattern recommendations on next page.

Floor Coverings

The practice of installing thick, plush carpeting stems from forced air heated rooms where the floor was normally the coldest spot in the room. Thick carpets provided insulation and made those floors more acceptable. Radiant floors are warm and

Roth Radiant Heating Installation Handbook

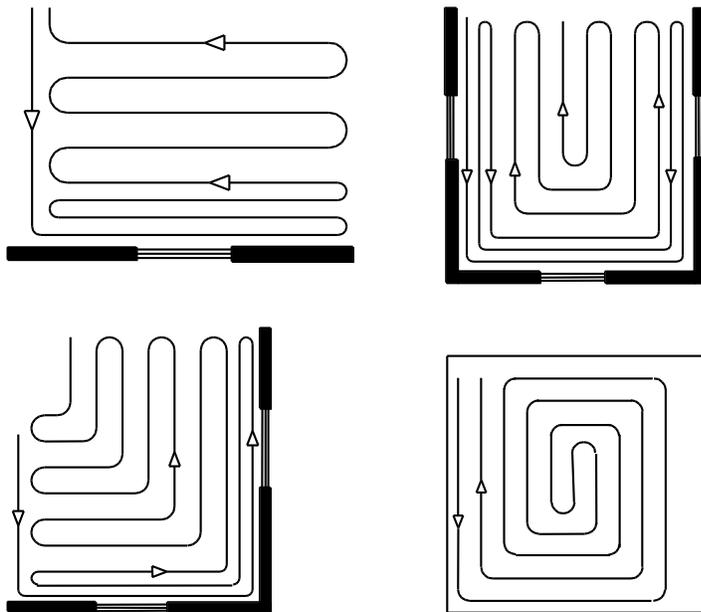
comfortable by nature. Carpeting is not required to keep the chill away. It's the opposite! Thick carpeting (and padding) will provide a heat transfer barrier and require increased water temperatures. See page 8.5 for R-values of many floor materials.

Getting the area ready for tubing

A tubing layout drawing should normally be available at the jobsite. At least, a sketch showing the area consider maximum tubing lengths for the heat requirement of the area at selected tubing center distance in order to avoid that the head pressure loss for loops become unacceptably high. See section 8.5 for a simple method to calculate head loss. Compare the suggested layout to the actual room. There might be slight changes made to the design that warrant some changes to the loop layout. There is little gain to installing tubing under cupboards and various equipment or appliances. Consider removing tubing from such areas (if so designed), since these areas may also increase the risk for tubing damage caused by nailing, screws, etc. Review the room for directions of high heat losses. The warmest tubing (the supply side) should be placed closest to the outside walls. See tubing layout examples below. At several or large windows, you may consider using a closer tubing center distance for a few tubing turns (for example 6" on center where the rest of the room has 12" on center). It is a good practice to indicate how the tubing should run using spraypaint. Show turning points and indicate center distances and locations where appropriate to make the actual installation "a breeze".

Tubing Layout Patterns

In the examples to the left, the walls with windows indicated are the only outside walls. The runs of tubing toward the outside walls have closer center distance (for example 6", where the other runs are 12" on center) and these runs are supply tubing with the warmest water. This is good practice. For the remainder of the room tubing runs are parallel to the longest wall in order to minimize the number of turns to speed up the installation time.



Tubing Loop Lengths

Shorter loop lengths must be selected for smaller tubing sizes. Here is a rough guideline for max. loop lengths: 3/8" - 150 ft.; 1/2" - 250 ft.; 5/8" - 350 ft.; 3/4" - 450 ft. Possible loop lengths are dependent on several parameters, so we strongly suggest that you use the calculation method in section 8.5.

Install Manifolds first.

Roth Radiant Heating Installation Handbook

Roth manifolds are described in Section 2, and the guidelines given there should be followed. For example, suitable locations for manifolds are utility rooms, closets, wardrobes and cupboards. Manifolds can also be surface mounted using a Roth manifold cabinet, or it can be built inside a 4" or 6" studwall (equipped with access doors). If walls are not yet built where manifolds should be located, a temporary support frame can be built to hold the tubing ends firmly in correct position.

Before tubing is brought in.

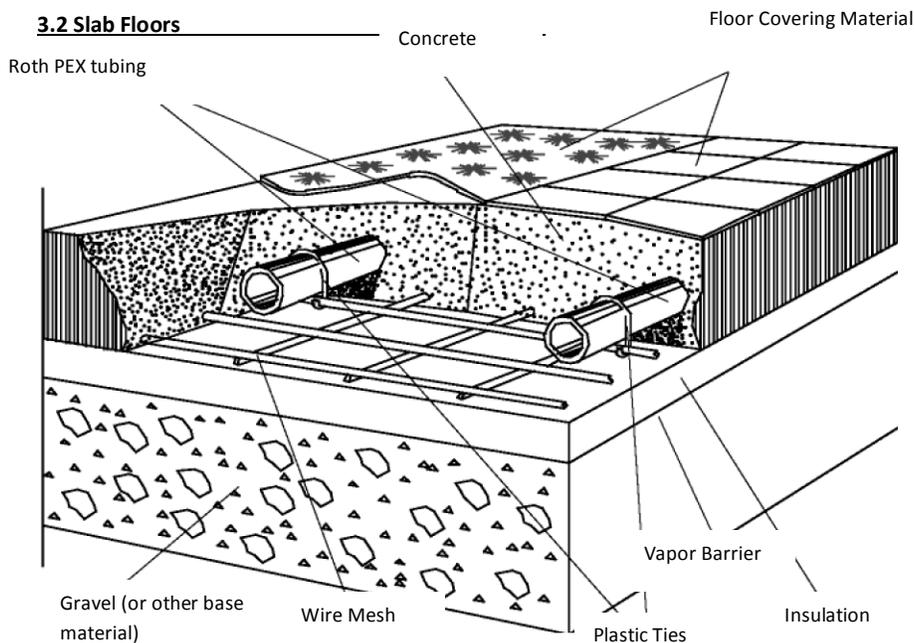
It is very important to clean the installation area prior to the tubing being brought in. Remove debris and inspect for nails, screws, sharp edges and other objects that could have potentially damage PEX tubing. Apply protective boards where such objects can't be removed.

Installing tubing

Review Section 2 for advice on installing PEX tubing and utilizing Roth accessories, tools, fittings, etc. Study advice regarding installation for each kind of floor or ceiling construction on the next-coming pages. Here are some general suggestions, independent of construction method:

- Install nailing guards where future nailing is like l y. Such areas could be where tubing passes doorway s, where cupboards may be installed, where walls may be added, at manifolds where many tubes are concentrated, or where additional installations will take place.
- Record all changes to tubing routing/location as compared to existing tubing layout plan. It's advisable to photograph or video tape the finished installation prior to covering the tubing.
- Note the exact length of each installed tubing loop. Running footage length can be read on tubing for every three feet.
- Label each tubing loop end for its area coverage. An ink marker pen can be used for temporary marking on tubing. The Roth manifold box includes labels to be placed on the manifold for permanent identification of loops.
- Do not overlap tubing in poured floors. This is accomplished by planning the runs back to the manifold and so that loops are in order to their corresponding manifold branch.
- Install sleeving or conduit around tubing in poured floors where it has to pass control or expansion joints. Such sleeving should be minimum 1 ft. long and it's ID minimum 1/2" larger than the tubing OD. For commercial and industrial installations tubing (in conduit/sleeve) could be routed down into the sand/gravel below the concrete at passage of such joints.
- Long leaders may be insulated if they are not designed to contribute to heat output.

3.2 Slab Floors



See Section 4.1 on pressure testing

Roth Radiant Heating Installation Handbook

CONCRETE: Typical thickness is 3 - 5 in., but 6 in. and heavier is common at commercial and industrial installations. Tubing will normally be located around 2.5 in. down in the concrete. See Section 4 for pressure testing, and freezing conditions; and page 2.2 for UV protection.

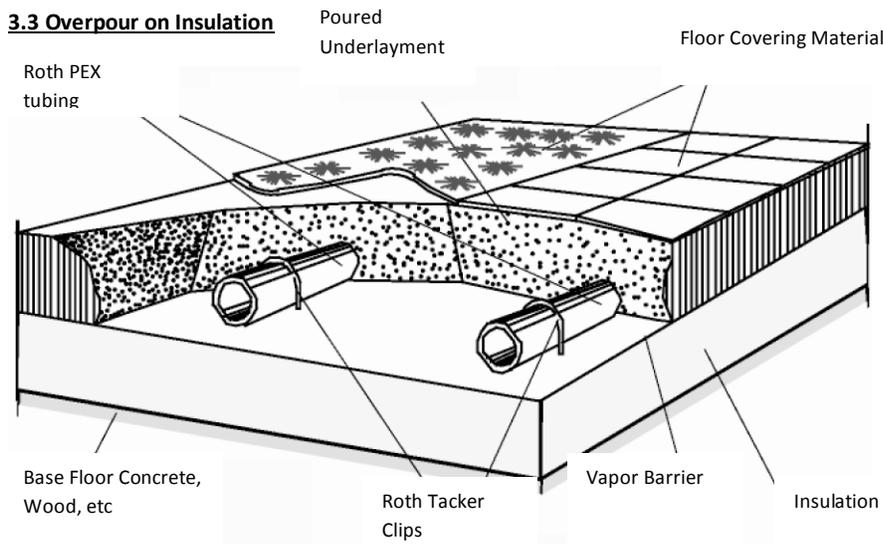
WIRE MESH: Use mesh or rebar as specified for the project. It should be at least 0.5 in. up into the concrete.

INSULATION: Edge and Perimeter insulation is a minimum requirement to avoid excessive heat loss. Insulation of the entire slab is recommended (see Section 3.1). Insulation must be of approved type, typically 1 - 2 in. of extruded Polystyrene foam. Consult local building codes.

TUBING CENTER DISTANCE: A center distance of 12 in. is optimal for most projects but closer spacing is often used at high heat requirements or for greater comfort. 18 in. is used for some commercial jobs.

ROTH PLASTIC TIES: The Plastic Ties are clean, light, free from sharp edges, require no tools, are fast to use, and fit all rebars or meshes. Wrap end of Tie around the tubing and the bar, then pull it through the hole until tight. Cut excessive end lengths where it could exceed concrete level. The ribbed strip will hold tubing with appropriate strength. Tie the tubing every 3 feet when concrete thickness over the tubing is minimum 2 in., otherwise every 2 ft. also use air pressure testing. At tubing turns, secure tubing at the beginning, middle, and end of the turn. One package of Ties (100 units) will often be ample for 300 ft. of tubing (200 ft. at thin overpours).

3.3 Overpour on Insulation



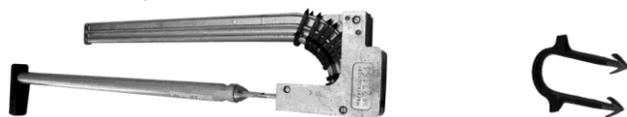
GYPSUM BASED OR CONCRETE OVERPOUR: Normal thickness of 1 1/4 - 2 in. The minimum layer thickness over the tubing is 3/4 in. Tubing must be secured to the floor every 3 ft. - closer at shallow overpours (plus in beginning, middle, and end of each 180° turn). Some gypsum products may be more crack-resistant than concrete. Consult manufacturers for suitable type and workmanship.

INSULATION: Extruded Styrofoam or Polyurethane insulation with adequate density approved for concrete overpour. The insulation will not only restrict heat loss, but will also be a sound barrier.

TUBING CENTER DISTANCE: A center distance of 12 in. is adequate for many projects but closer spacing is used at high heat requirements, or for greater comfort.

BASE: Existing concrete floor or suspended floor (with adequate strength for overpour).

Roth Tacker System



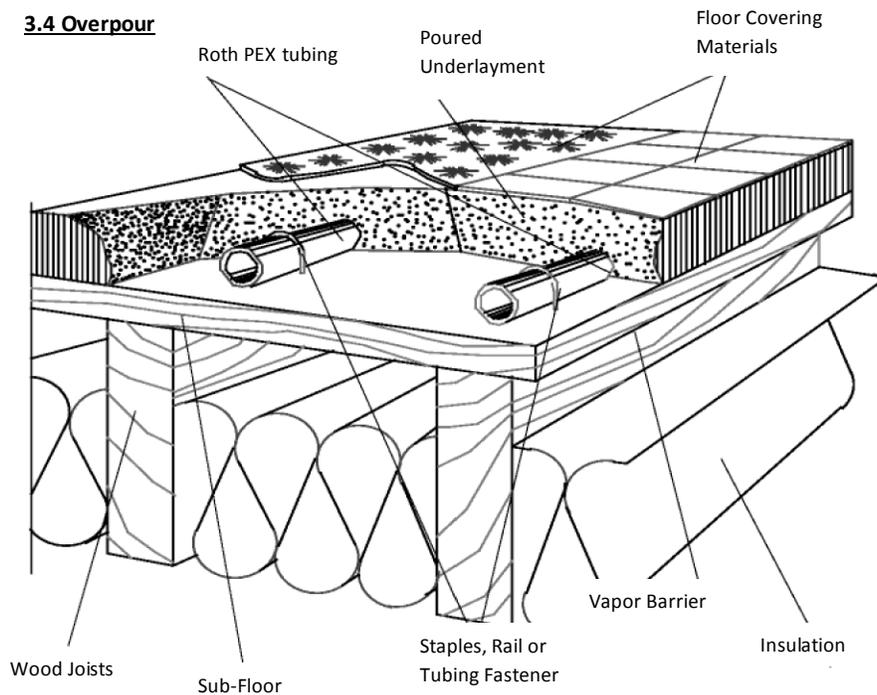
Roth Original-Tacker is a semiautomatic stapler used to fasten PEX tubing (3/8 to 5/8 in.) to extruded Polystyrene or PU insulation boards of minimum 1 1/2 in. thickness.

The Tacker magazine is filled with 30 plastic Clips which are stapled over the tubing every 3 - 5 ft., and at tubing turns. Installer

Roth Radiant Heating Installation Handbook

walks in upright position and releases Clips into the boards by pressing down the extended handle. The Tacker Clips come 300 to a box; sufficient for 10 loads.

3.4 Overpour



GYPSUM BASED OR CONCRETE OVERPOUR: Normal Thickness of 1 1/4 - 2". The minimum layer thickness over the tubing is 3/4 in. Tubing must be secured to the floor every 3 ft. - closer at shallow overpours (plus in beginning, middle, and end of each 180° turn). Some gypsum products may be more crack-resistant than concrete. Consult manufacturers for suitable type and workmanship. Tubing should be pressure tested during the pour. See Section 4 on pressure testing.

INSULATION: Recommended for most installations to reduce downward heat loss. 3.5 in. R-11 fiberglass is frequently used.

TUBING CENTER DISTANCE: A center distance of 12 in. is adequate for many projects but closer spacing is used at high heat requirements, or for greater comfort.

Roth Twin Fastener



Tubing fasteners hold Roth PEX Tubing tight to wood based sub-floors and boards. They can be used with gypsum based aggregates or concrete overpours in wood subfloor constructions. One package of Twin Fasteners (100 units) will normally be adequate for over 300 ft. of tubing. The Twin Fastener fits all PEX Tubing sizes up to 3/4".

Roth Compressed Air Stapler System



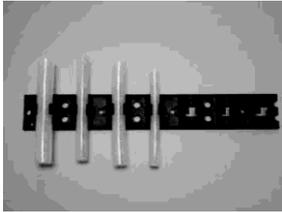
The Roth pneumatic Stapler provides a rapid installation method at overpours over suspended wood floors. The Stapler is equipped with Front and Rear Blocks that fit over Roth PEX Tubing. It's equipped with a safety so staples cannot be fired when not in place. This kit also includes an extension, allowing the installer to walk in upright position while fastening tubing. The staples for this installation method are 1 1/4 in. long. When used without the Tubing kit, the Stapler is a conventional staple gun. 5/8 in. staples are adequate to use when fastening Roth Alu Panels to wood boards (see next pages), or to fasten Roth Two-Groove Alu Panels to sub-floor from underneath (in-between joists or trusses). When fastening

Roth Radiant Heating Installation Handbook

Tubing to Polystyrene (or Polyurethane) insulation the preferred method/tool is Roth Original-Tacker System.

Warning: Staple guns can be dangerous or even deadly when used improperly. Use professional workmanship and follow all safety instructions delivered with these tools.

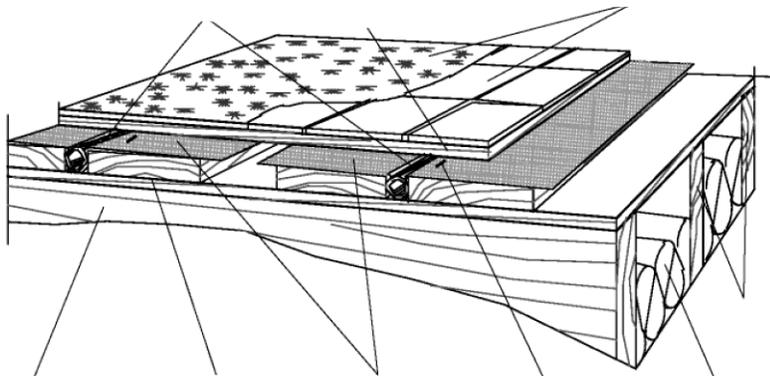
Rapid Mounting Rail



Use the Rapid Mounting Rail to install 1/2 in. PEX tubing fast, secure and esthetically appealing in overpours of concrete or gypsum based concrete. The Rail is fastened to insulation, wood or concrete every 3 to 5 ft. using appropriate pins, nails, screws or glue. PEX tubing snaps easily into the pre-cut Rail grooves. Rail length are 3.4 ft. and 1.25 in. high. Grooves are 4 in. on center to allow for several tubing distances. Quantity required depends on overpour thickness (more for thin overpours) but 33 ft. per 100 sq.ft. is a typical consumption. Rails are packaged 30 to a bundle (adequate for around 300 sq.ft.)

Note: Pour must be a minimum of 3" when rails are used.

3.5 Suspended Wood Floor with Alu Plates



WOOD BOARDS: Install 1 x 6 in. or 1 x 4 in. wood sleepers at 6" average center distance, leaving 1" opening for Plate groove between every 2nd board.

ROTH SINGLE GROOVE ALU PLATES: The plates are 24" (2 ft.) long and 10 1/4" wide and are installed 12" on center as illustrated.

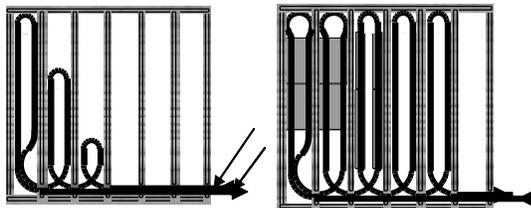
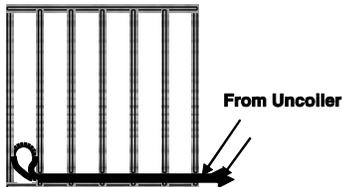
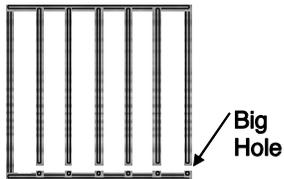
STAPLES: Apply staples 6" on center on one side of groove, only, while pushing groove towards wood board. Thermal expansion and contraction of the tubing may occasionally cause some noise. Avoid this by applying a small bead of silicon caulk in the groove before snapping in the tubing. Use reset controls.

Sequence of Installation for Joist Heating Using Transfer Plates (for Floors 3.6 & 3.7)

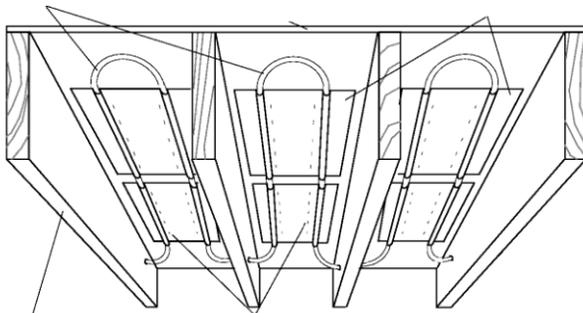
1. Drill holes through joists
2. Pull tubing to bay 1 and back to manifold
3. Connect to manifold
4. Pull tubing off uncoiler to next bays
5. Repeat

Roth Radiant Heating Installation Handbook

6. Cut and connect tubing end to return manifold



3.6 Suspended Wood Floor With Alu Plates From Below



PREPARING THE AREA: Inspect the area where tubing should be installed. There should not be any nails, screws, etc. that could harm the PEX tubing. Do not nail in the floor after the tubing is installed.

ROTH DOUBLE GROOVE ALU PLATES: The plates are 24" (2 ft.) long and 14" wide so they fit in between joists or truss that are 16" on center. Tubing center distance is 8". If joist center distance is 12", our single groove Alu Plates may be used. Two persons are normally required for installation. Avoiding noise: see previous page.

STAPLES: Apply 5/8" staples 4" on center along grooves on plate inside. Additional staples may be added as required afterwards on the outside of the grooves.

INSULATION: Insulation is installed afterwards to reduce downward heat loss. 3.5 in. R-11 fiberglass wool is frequently used.

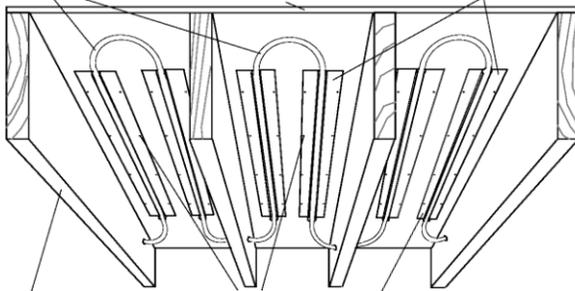
DRILLING HOLES: When joists are used, it is necessary to drill holes for tubing. Make holes sufficiently large; many codes allow for 2 7/8". Holes in middle of the joists, or somewhat higher, should not impact on their strength as applied here, but we recommend to check with local building code. See figure on page 3.9 on sequence of installation. That tubing routing is preferred over above illustration.

ALTERNATE METHOD: PEX tubing may be installed without utilizing any plates to distribute heat (so called "staple-up" installation). For the same water temperature, the heat output will be approximately half of what is achieved with plates, so

Roth Radiant Heating Installation Handbook

this method is only for limited heat requirements. Roth's Rapid Mounting Rail (see 3.7) can be cut and utilized as fasteners (possibly together with our Twin Fasteners - see 3.6). Roth Pneumatic Stapler (see 3.7) is also used for this application.

3.7 Suspended Wood Floor With C-Fin Plates From Below



PREPARING THE AREA: Inspect the area where tubing should be installed. There should not be any nails, screws, etc. that could harm the PEX tubing. Do not nail in the floor after the tubing is installed.

ROTH C-FIN ALU PLATES: The plates are 48" (4 ft.) long and 4" wide so 2 rows of plates fit in between joists or truss that are 12" or 16" on center. Tubing center distance is 6" or 8" respective. The plates are comparatively stiff and easy to install by one person. The 1/2" tubing is easily snapped into the groove afterwards, using a palm nailer or mallet. **FASTENING.** There is a suitable hole-puncher available from Roth so regular 5/8" wood-screws can be utilized. Alternatively, self-drilling screws can be used for fastening

INSULATION: Insulation is installed afterwards to reduce downward heat loss. 3.5 in. R-11 fiberglass wool is frequently used.

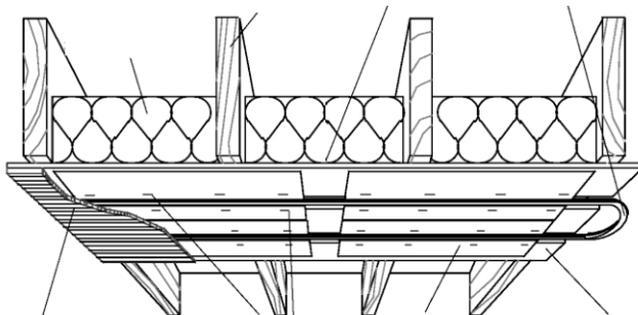
DRILLING HOLES: For joists constructions it is necessary to drill holes for tubing. See previous page on making holes through joists. See figure on page 3.8 on sequence of installation. That tubing routing is preferred over above illustration.

Roth Hole Punch Kit



Roth Hole Punch Kit is used to punch holes in the Roth C-Fin Alu Plates. It is a Light Duty Portable Punch rated for up to 1.2 tons punching power. It is hand operated and easy to carry in the pocket, on a belt or in a tool box. Hardened, achined bearing surfaces are used in the tool to provide dependable long life. The tool has a standard 1 3/4 inch throat depth. The tool comes in a durable plastic box with following round punch and dies: 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, and 9/32

3.8 Installation of Ceiling Heating



ROTH SINGLE GROOVE ALU PLATES: The plates are 24" (2 ft.) long and 5" wide and are installed 12" on center as illustrated. See also figure at bottom of this page. First apply staples on one side of the groove, only. After 1/2" PEX Tubing is snapped into place, the second row of staples (on other side of groove) is applied.

Roth Radiant Heating Installation Handbook

INSULATION: Thickness towards roof is normally considerably thicker than illustration indicates. Follow local codes. Always insulate in ceilings in between living areas to control heat transfer direction. The insulation will also act as a sound barrier.

TUBING & ALU PANELS: Skip tubing and panels where electrical cables or fixtures will be installed. Do NOT puncture tubing when fastening Gypsum Boards.

You will achieve greatest comfort and lowest water temperature when most of the ceiling is utilized for heating, but cost is saved when only a part of the ceiling is utilized for heating.



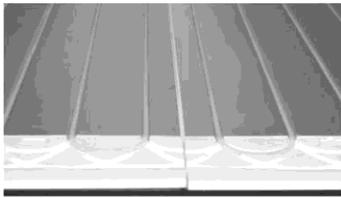
Example

The Alu Panel Grove is guided by every second 1 x 4 in. board (8" on center) and on alternating sides in this example. Boards could also be arranged 6" on center.

Cut boards short to allow for tubing turns at wall (see page 3.9)

Roth Radiant Floor Panel System for 3/8" & 1/2" Roth PEX Tubing

Modular, low-profile PEX tubing tracking system with integrated thermal isolation and aluminum heat diffuser



The Roth Radiant Floor Panel System is an easily assembled PEX tubing track system that allows simple installation of hydronic radiant floor heating over an existing subfloor. The system is designed around a 90 psi (6.3 kg/ cm²) high density polystyrene foam field panel with a bonded 24 ga. aluminum sheet on top. The foam provides thermal insulation below the panel and the aluminum provides even heat distribution focused directly at the finished floor material. The low profile of this product allows for easy retrofit and the light weight makes it easy to use in new construction. The 2' x 4' (61 cm x 122 cm) field panels make installation faster than other available products. The field panels have tracks that allow the tubing to be snapped in (no adhesive is required) on either 6" (15.25 cm) or 12" (30.5 cm) centers. Radius panels for return bends and twin tube transition panels, to route tubing to the heated area, are included with each box of the Floor Panel System. Additional radius panels are available separately, if needed.

The Floor Panel System for 3/8" PEX tubing is 3/4" (1.9 cm) thick and provides an approximate downward insulation value of R=3.7. The Floor Panel System for 1/2" PEX tubing is 1" (2.5 cm) and provides an approximate downward insulation value of R=4.5. The full-face aluminum sheet on the field panel provides heating characteristics similar to a lightweight concrete over-pour, but at lower fluid temperatures and with faster pick-up times.

Preparation

The heat loss calculations with a tubing layout should be performed for every system prior to installation. Always coordinate the installation of any radiant floor heating system with the flooring contractor to ensure that any special requirements, such as nailing strips, underlayment, etc., are agreed to and planned for prior to installation. The floorsurface should be repaired as needed to correct any irregularities and provide a smooth, level, clean and dry surface. There should be no level changes greater than 0.02"/ft (~2 mm/m). Follow manufacturer's instructions for any patching product that is used. "Dry fit" the panels according to your tubing layout plan. Any nail strips for hardwood or carpet tack strips should be included at this point. Field panels should be staggered to avoid continuous joints. Panels can be easily cut with a reciprocating saw and a fine-toothed metal blade or a circular saw with a fine toothed panel blade. Cut from the foam side and be sure to clean all edges of burrs. If a

Roth Radiant Heating Installation Handbook

water-tight membrane is needed, it should be installed above the Floor Panel System. Transition panels can be used as filler pieces around the perimeter or in any other areas if needed.

Panel Installation

After the layout has been checked and corrected, the panels are secured to the subfloor with either counter-sunk screws or an adhesive compatible with foam board products. Adhesive may be applied with a caulking gun or from bulk containers with a notched trowel. Place the panels and allow the adhesive to cure according to the manufacturer’s directions. Be aware that different adhesives have different curing times and temperature and humidity conditions will have a direct affect on the curing time. When using screws to secure the panels, use a minimum of eight (8) screws per field panel. Be sure that the screw heads are flush (countersunk) to avoid any surface irregularities. After the panels are set, thoroughly clean and vacuum the surface to remove any foreign objects from the panels prior to installation of the tubing. The tubing can be installed by starting with one end at the manifold and uncoiling the tubing following the pre-planned layout. The tubing can be easily set into the groove by stepping on it or using a block of wood and a hammer. Avoid denting the aluminum face. The tubing should be pulled tightly around the return bends of the radius panels during installation. We also recommend using some silicone adhesive to secure the tubing in the transition panels since it does not snap in as it does in the field panels. When the tubing installation is complete, install the finished floor underlayment as needed for your flooring material. We recommend that an underlayment product be used on all applications with carpeting, sheet vinyl and tile (ceramic and vinyl) to provide a stable base and mechanical protection for the tubing. Many wood flooring products do not require any underlayment material, but this should be discussed with the flooring installer. Underlayment material should be stable under the temperature and humidity conditions expected for your system. Products such as untempered hardboard are not recommended for use as underlayment since they may deform in moist conditions. After the underlayment has been installed the system should be run at approximately 140oF (60oC) for approximately one half hour to allow the tubing to settle into the panel. Finish the underlayment seams according to manufacturer’s instructions and install the finished floor material. Refer to the installation instructions (Roth document 5.A) for additional information prior to starting your project.

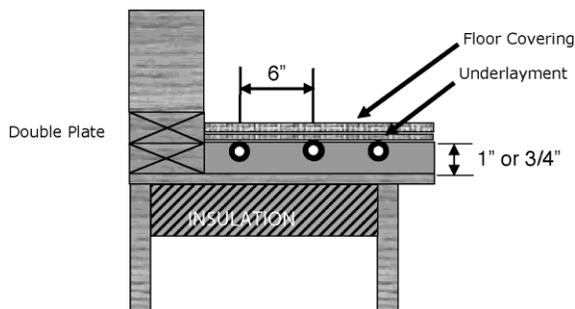
THICKNESS & APPROX R VALUE

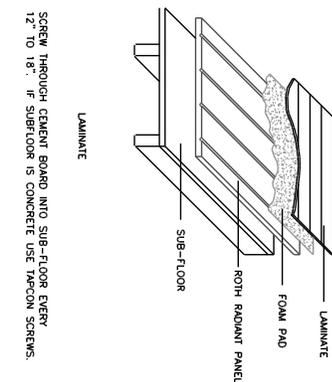
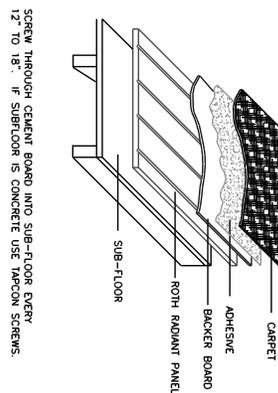
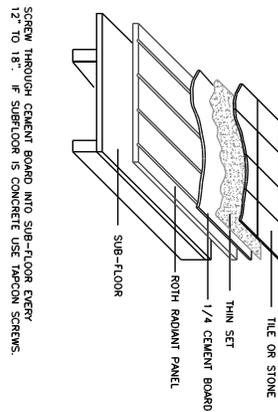
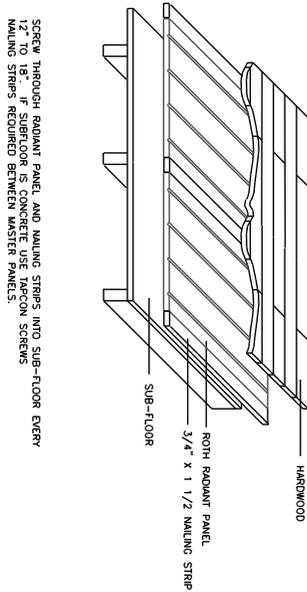
Panel System for 3/8” Roth PEX 3/4” (1.9 cm) thick R=3.7

Panel System for 1/2” Roth PEX 1” (2.5 cm) thick R=4.5

MASTER CARTON CONTENTS		DIMENSIONS
Field Panels	10/box	
Radius Panels*	6/box	2’ x 8” (61 cm x 20.3 cm)
Transition Panels**	12/box	2’ x 4” (61 cm x 10.2 cm)
Approx. Coverage 96 ft.2/ 8.9 m2		

COMPRESSIVE STRENGTH 60 psi (6.3 kg/cm2)



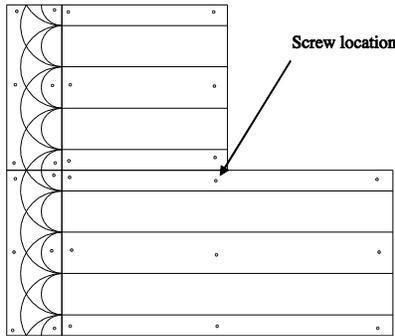


Screw locations for connecting Roth Panel System to Sub-floor.

Screw locations for connecting Roth Panel System to Sub-floor. One should use an appropriate washer for the radius panel and transition panel. Each full master panel should have a minimum of 9 anchor points. Half panels should have a minimal of 6 anchor points. Transition panels and radius panels were appropriate.

Roth Radiant Heating Installation Handbook

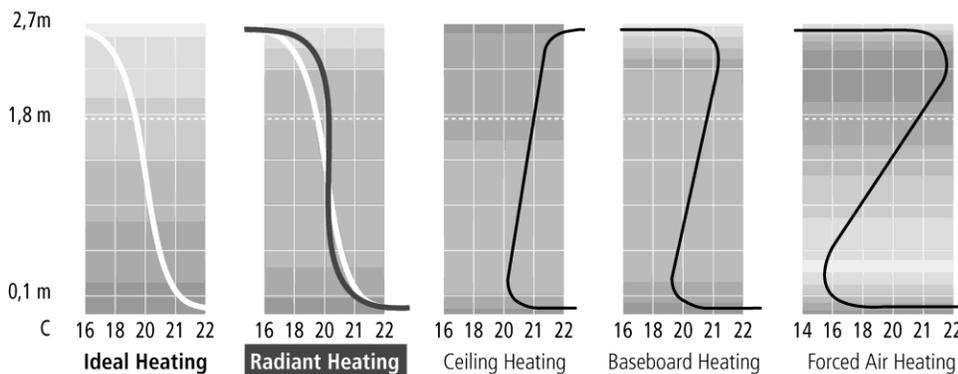
Screw type(s) should be based on sub-floor material.



3.8 Comfort Zone or Heating Zone?

Radiant Floor Heating provides the ultimate comfort close followed by ceiling heating. The owner has probably selected this system to be able to enjoy the comfort and for attaining all its advantages. Tubing should be installed, minimum 12" on center, in all areas of occupancy. However, there may be situations where the heat requirement is low, ultimate comfort of its other not of essence - everywhere, and the owner may want to save costs. In all situations it is important to make an exact heat loss calculation followed by an appropriate design. Roth Radiant Design Software is the ultimate tool for this. Tubing spacing may be increased in some of the above situations. At those occasions we always recommend to have the closest spacing towards the outside wall and then gradually increase it, inwards. Certain areas in commercial or industrial projects may even have areas in the center of the building that does not need any heat. For suspended wood floors we recommend our systems with Omega plates or C-Fins as described on previous pages. Omega plates can not be installed at tubing turns. The heat throughput through the areas not covered by plates (but tubing, only) is approximately 50% of the throughput where plates are installed. Tubing should still be installed where there are no plates. See also bottom of page 3.9. Roth is not in favor of "staple-up" installations where no plates are utilized since this method will require considerably increased water temperatures. This will cause more heat losses in unwanted directions, and will also decrease the possibilities to utilize future or alternative energy resources (those are often not available for high water temperatures). Heat output may also become insufficient if future owners increase carpeting/padding, etc. Ceiling heating may provide largest flexibility regarding the area coverage. Ceiling surface temperatures approaching 100°F are acceptable, providing considerable heat outputs. Such heated ceiling areas will radiate out heat to a considerable larger floor area below, making it warm and comfortable. Opposite to floor constructions, it is not worth installing tubing where there are no plates since the heat output downwards would be minimal. By varying the area coverage at ceiling heating installations, the heat output intensity to various rooms/zones can be designed within wide ranges - at the same water temperature in all loops. Conventional methods for Zoning are described in section 5. Ceiling heating may be able to provide the largest potential (lower cost than "staple-up") for economy installations. However, we mainly recommend it for highest level (or at least upper level) rooms, only. Floors in these rooms have heated areas underneath - so there is no "cold floor" issue. For bare or tiled concrete slabs, floor heating is obviously preferred.

TEMPERATURE PROFILE IN RESIDENTIAL BUILDINGS

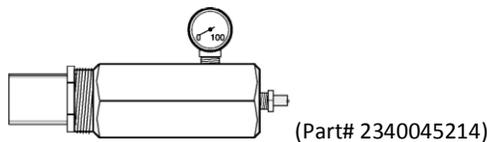


4. PRESSURE TESTING & SYSTEM START-UP

4.1 Pressure Testing the System

Heating distribution pipes must be tested, inspected, and approved before concealing the system. We recommend all Roth PEX tubing be tested to a pressure of 40 to 60 psi. 100 psi is OK if required by an inspector or by local codes. The PEX tubing is pressure rated at much higher pressures than common in heating systems or at conventional pressure testing (see page 1.2). Our recommendation is to perform a 60 psi. hydrostatic test if weather permits (no risk for freezing) or otherwise a 60 psi. air pressure test for a minimum of 24 hours before the pour and during the pour to be maintained until 24 hours after the pour. On a system that is not to be encapsulated in a thermal mass (such as concrete) we recommend a 24 hour test at 60 psi. hydrostatic or air test before the floor is closed and tubing made inaccessible.

Roth pressure tester



Roth Pressure Tester has a copper male fitting adapter which will sweat right into the Roth manifold copper adapter. The pressure gauge has a scale from 0 to 100 psi. When air is used as pressure medium, use the Schrader valve on the Tester to fill. When water is used as pressure medium, the Pressure Tester may be attached to the Return manifold while a garden hose is connected to the fill valve on Supply manifold. Purge air through the Return manifold fill valve. Since the fill valve bib has short threads - double up on washers when attaching the hose.

Roth has several other products available to make the testing easier. Please contact our technical department if you have any questions or a special application that you feel this test kit would not be applicable to.

Note 1: The air or water in the pipe will expand and contract with ambient temperature changes. To lose a few pounds of pressure over night and gain a few pounds during the day is not uncommon. Once again if you have any questions please contact our technical service department.

Note 2: If you can't hold pressure your first step should be to inspect and then test all fittings in the system for leaks. Spray soap to detect bubbles.

Note 3: Compressed air can contain considerably amounts of energy. Use professional workmanship and care when working with air under pressure.

Note 4: When Glycol is used, regular white Teflon tape should not be utilized for sealing. Yellow or pink Teflon Tape is compatible.

4.2 Filling the System

Freezing conditions

When water freezes it expands approximately 4%. The force of this expansion can exceed thousands of atmospheres if it is hindered. A water filled hole in a solid rock can make it shatter when freezing. Roth PEX tubing is flexible and an expansion of 4% will not harm the tubing. When such expansion is not restricted, repeated freezing is not a concern for PEX tubing. On the other hand, when tubing is buried in concrete or similar overpour the expansion is restricted and failure is certain! Ice will first form at a few places most exposed to the cold. The water in between will be trapped and as the frozen sections increase the pressure in the not yet frozen water will increase virtually without limit. There will be a weakest point in the concrete somewhere along the actual section (a void or other imperfection) and the concrete will crack at this location. The tubing will be forced into the crack by the enormous water pressure and break to release the pressure. Failure will be likely independent of tubing material. Typically, there will be several, or even many failure locations for each tubing loop at freezing. This is a catastrophe and it can not be allowed to happen. There is no guarantee that such a system can be securely repaired, so it should be abandoned or completely replaced. Where there is a risk for freezing appropriate antifreeze must be applied. 30 -

Roth Radiant Heating Installation Handbook

50% Propylene Glycol is often used since it is environmentally friendly. The water /glycol solution can be mixed in a barrel and pumped into the system when filling - with the drain hose going back to the same barrel. Mix more as required. Accidentally frozen non-buried tubing will thaw and can be commissioned again. However, since fittings can not expand like PEX, damage to these may occur, so they must be inspected before pressure is applied. If frozen tubing must be forced to thaw only very gentle heating of tubing surface is recommended (around 200 °F max. temperature).

Purging manifolds

If the system was pressure tested by air, the system needs to be filled with water. If pressure test was made with water, below method may already have been applied.

We assume that the Roth manifolds are isolated by valves. As a first step, close these valves. When filling the system, it is important to completely purge the air. This is most easily done if each manifold is filled and purged separately. That is why each Roth manifold comes equipped with fill/ drain valves and connections for hose. Connect the Supply manifold to your water source via a hose. (Note that you may need to double up on washers since the fill valve bib has short threads.). Connect the Return manifold bib via another hose to a drain (or buckets if not available).

For Roth HKV manifolds, open all the return valves and close all but one supply valve. Now, open the discharge valve and then the fill valve (note that the top of the protective brass cap is a key to the valve) and let water run to drain until there is no air bubbles visible through the PEX tubing, and there is no noise from air going through valves. Close the first loop's return valve and then it's supply valve before opening the next loop's supply valve and repeat the procedure. Continue until all loops are filled and then close the manifolds drain and fill valves. Open the manifold vent to allow any trapped air out. Additional water may be needed to be added (opening the fill valve again). Repeat above procedure for all Manifolds in the system.

Filling the rest of the system

After manifolds are filled and purged from air you may wish to fill other parts of the system through the manifold(s). If so, loop valves should be closed during this procedure. Follow a similar procedure (exact advice can not be provided since it depends on the system design and equipment.) Such parts of the system should be filled slowly (so no pressure surges can damage components) until most of the air is gone. Then flow may be increased to flush out bubbles and air pockets. However, the installer must control the supply water so that the pressure in the system is never increased over the rating of its components, relief valves, etc. Our Spirovent and Spirotop will remove remaining air (see page 5.6).

Before starting the system

Note that concrete normally requires a 4-week curing period. (For Gypsum based overpours, please contact supplier). Applying heat during this period may dry out the concrete prematurely and result in less strength. At subfreezing temperatures, 60°F water temperature could be circulated in the buried tubing during the cure period - if approved by the installer.

4.3 Starting the System

Starting up

Once the system is filled, isolation valves may be opened. At loss of pressure when opening such valves, slight refill may be required. If pressure loss continues there may be a leak, and it must be found and sealed before continuing. Supply Manifold loop valves should be opened and return valves set in position as per design (turns from closed). See next page if design is missing.

Circulation pumps should be switched on for a minimum of 20 minutes to purge air from circulator. Electronic controls may be made operational, or may be made operational sometime later (depending on what is most suitable for the actual system). Controls related to safe operation of the system must be activated. After possible additional air purging the heat source may be started. Pressure will increase as water heats up, so the system pressure should be watched. Small amounts of water may be needed to be discharged to keep the system pressure at the design level. As water heats up, additional air will be released and may require more air purging.

Roth Radiant Heating Installation Handbook
About Balancing (without appropriate design)

In many designs, the temperature drop over individual loops is selected to be approximately the same. If this is the case, this may be utilized for preliminary manifold loop balancing. Measure supply and return temperatures over each loop and compare them. You will be able to very roughly sense the temperature drop over each loop by simply grabbing around manifold supply and return PEX tubing. Manifolds equipped with Roth Temperature & Flow Gauge will provide for exact flow balancing. Adjust loop return valves to achieve correct balancing between individual loops.

When applicable, the flow to various system sections must also be balanced - so that no part of the system "takes over" more than it should. Use appropriate valves to achieve system balancing as intended. Valve operators, such as Roth Operators for HKV manifolds are normally applied after initial flow balancing. Make them operational if not already done. Other controls not yet activated should now be started.

About lag time

Poured thermal masses, as the name indicates, can contain a lot of stored heat. The thicker the concrete layer - the more thermal mass. Depending on boiler sizing, it may take some time to bring this mass up to intended temperature. Days or even weeks are not unusual. The concrete may still contain moisture that will also take substantial heat to dry out. This is the nature of the construction material and should not be considered as negative. When the temperature is reached it will also stay and compensate for sudden drops in outdoor temperature, etc.

Since the concrete takes much heat to warm, there is typically a slow rise in its temperature. This is also good for the concrete itself, since the concrete temperature increase should be limited to 10°F per day during the start-up period. If boiler sizing provides heat to exceed this increase - the installer must make sure that the rule is enforced.

5. INSTALLATION OF ELECTRICAL CONTROLS

5.1 General Information

Following is a list of Roth electrical components and their current draw requirements:

Part#	Description	Draw (VA)
2340065174	Roth Electronic Thermostat-heat only	1.8VA
2340065274	Roth Electronic Thermostat-heat/cool	1.8VA
2340065154	Valve Operator w/ end-switch (4-wire)	6.0VA
2340055354	Thermal Valve Operator (4-wire)	3.0VA
2340055115	3/4" Zone Valve w/ end-switch (4-wire)	6.0VA
2340055116	1" Zone Valve w/ end-switch (4-wire)	6.0VA

5.2 Roughing in thermostat and control wires

Follow local codes and building practices when roughing in thermostat or control wires. Please read thermostat or control instructions carefully for selection of proper style and gauge wires. To accommodate any future change in the style or type of thermostat, we highly recommend pulling at least 4 to 6 wires to any thermostat location. Most thermostats require 18 or 22 gauge wire. We suggest to utilize 18/5 as a minimum.

Roth Transformer 40 VA



We provide a standard type transformer for powering thermostats and Valve Operators or Zone Valves. It reduces 110/120 VAC to 24 VAC (50/60 Hz). The draw capacity is maximum 40 VA, so it is adequate for around 5 sets of Operators/ Thermostats (depending on type used). Multiple Transformers can be hooked up in parallel. Note that our Electrical Junction Boxes (see Section 5.4) have transformers built in.

5.3 Roth Electronic Thermostats



Part #: 2340065274 & 2340065174

Description: Heat Only & Heat/Cool
Electronic Thermostats
(Non-programmable)

General Information

The Roth electronic non-programmable thermostats combine contemporary styling, electronic accuracy and operational simplicity to provide close temperature control on a variety of heating applications. They feature a large LCD window displaying equipment status, operating mode, and room temperature to an accuracy of 1/5 of a degree. The set point is displayed and changed by simply pressing one of the set-point buttons up or down. Installation is made easy since all field wires are mounted to the separate wall plate. These Thermostats are available in two versions: Heating only, or Heating and Air-conditioning. The unit requires two wires for the heating control (and 4 wires at heating & cooling control). See installation instruction (included with the thermostat) for controlling A/C. Use maximum 6 Thermostats (Heating Zones) with each Roth 40VA transformer.

Mounting Location

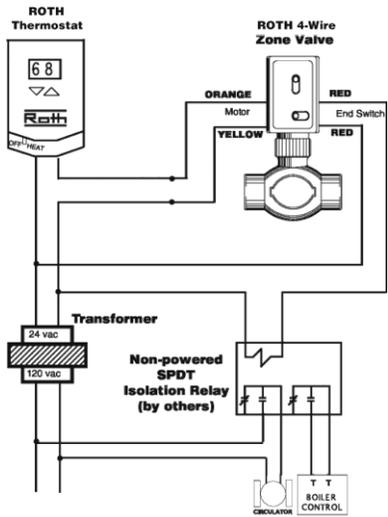
Mount the thermostat 4 - 5 feet above the floor in a location where it will be exposed to average room temperature. DO NOT mount the thermostat where it will be affected by a source of heat such as lamps, sunlight, fireplaces, pipes, register etc. Also, do not mount it behind a door or in an alcove. These locations will inhibit the thermostat's ability to accurately control room temperature.

Installing New Thermostat

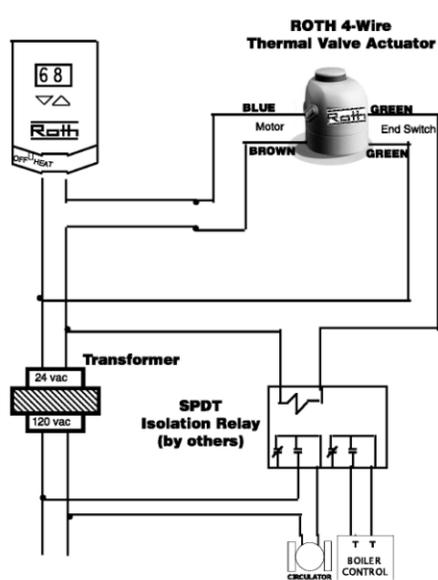
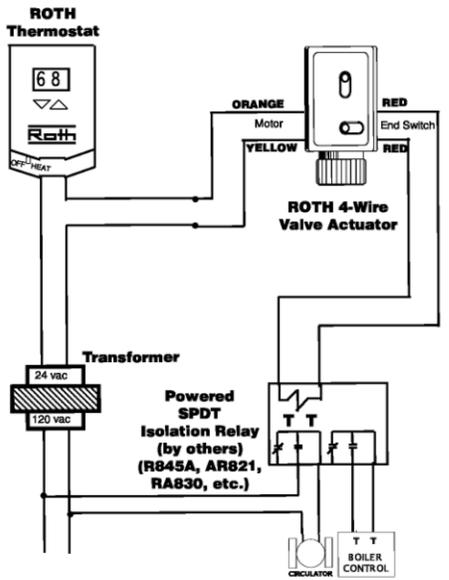
1. See mounting hole dimension illustration on "Installation Instruction Sheet" (included in the box) and locate mounting holes on wall.
2. Separate the thermostat base from the cover.
3. Holding thermostat base (and adapter plate if used) in one hand, feed the wires through the center hole and connect wires to terminal block as shown in the wiring diagram on page 2 of the "Installation Instruction Sheet".
4. Mount thermostat base (and adapter plate if used) onto wall. Make sure terminal screws are tight and wires are nestled neatly in terminal guides.
5. Mount thermostat cover onto base by snapping it into place. 6. Remove blue plastic sleeve by battery clip. For more details

Roth Radiant Heating Installation Handbook

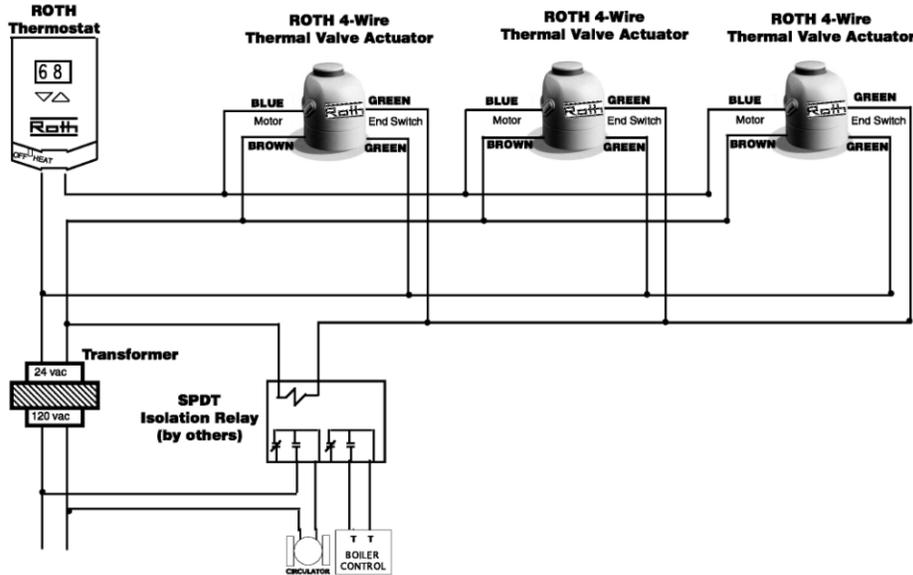
refer to the "Installation Instruction Sheet" that comes in the thermostat box.



Simple Wiring Without Junction Box



Simple Wiring Multiple Actuators



5.4 Electrical Junction Boxes



Part #: 2340066275

Description: Roth Zone Control Plus (controls 6 zones w/priority)

General Information

The Zone Control Plus is designed to control up to 6 heating zones, or if the priority switch is turned on, the box controls 1 priority zone (using the #6 zone block) and 5 heating zones. Each box comes equipped with 2 40VA transformers for a total of 80 VA for operation of components attached to the box and an isolated relay that sends a boiler demand signal to the boiler (terminals: main end switch). A relay also can control the operation of a radiant system pump. The Zone Control Plus also has the capability of providing DHW priority for the whole system (including the use of multiple boxes). Each box is equipped with a normal open or normal closed relay switch, allowing for pump and domestic hot water control.

See Applications in Section 5.8

Single Box Installation

- A. On each zone block connect a two wire thermostat or aqua stat to terminals T-T.
- B. Connect the two motor power control wires from thermal zone valve or valve actuators to be controlled by that thermostat to terminals 1 - 2. Connect the end-switch wires to 3 - 4. If multiple wires zone valves or valve actuators are needed for that zone, gang all of the wires to the same terminals. **NOTE: THE MAXIMUM DRAW FROM A SINGLE ZONE BLOCK IS 10 VA.**
- C. Connect the two end-switch wires from the zone valve or valve actuators to terminals 3 - 4. If multiple zone valves or valve actuators are needed for that zone, gang all of the wires to the same terminals.

Roth Radiant Heating Installation Handbook

- D. Follow directions listed in A, B & C for additional zones on the same box.
- E. Connect Line Power to the two each of the transformers (same source can be used to power multiple boxes).
- F. Connect the boiler demand wires to the main end switch, terminals

DHW Priority

Zone Block #6 is assigned as the priority block. If DHW priority is required, set the priority switch from OFF to ON

- A. On zone block #6, connect the two wires from the aquastat to terminals T-T.
- B. If a zone valve is used to control the flow to the DHW tank, connect the two motor control wires from the zone valve to terminals 1 - 2. **NOTE: THE MAXIMUM DRAW FROM A SINGLE ZONE BLOCK IS 10 VA.**
- C. Connect the two end-switch wires from the zone valve to terminals 3 - 4.
- D. If a circulator is used for the DHW, utilize an isolation relay connected External End Switch. (see wiring schematic.)

Sequence of operation single box

When there is a call for heat from a thermostat at terminal T-T, terminals 1 - 2 gets 24v power to open either the zone valve or valve actuators. Once the valve is fully open, the end-switch in the valve will close and complete the circuit at terminals 3 - 4. This will energize the relay completing the circuit at the main end switch turning on the boiler and also completing the circuit at the Extra end switch starting the Radiant pump.

Sequence of operation, DHW

When a priority call for heat is detected at terminals T-T on zone block #6, the zone valve connected to terminals 1 - 2 will open and as soon as the end-switch will close, the circuit at terminal 3 - 4 will be completed turning on the boiler and pump as described in previous section. At the same time the box will close all zone valves or valve operators connected to zone blocks 1 - 5 in that box until the DHW is satisfied. Once it's satisfied, all valves will be operational again. When a circulator is used on the priority zone instead of a zone valve, jumper 3 – 4 of the priority zone.

Mode Operation:

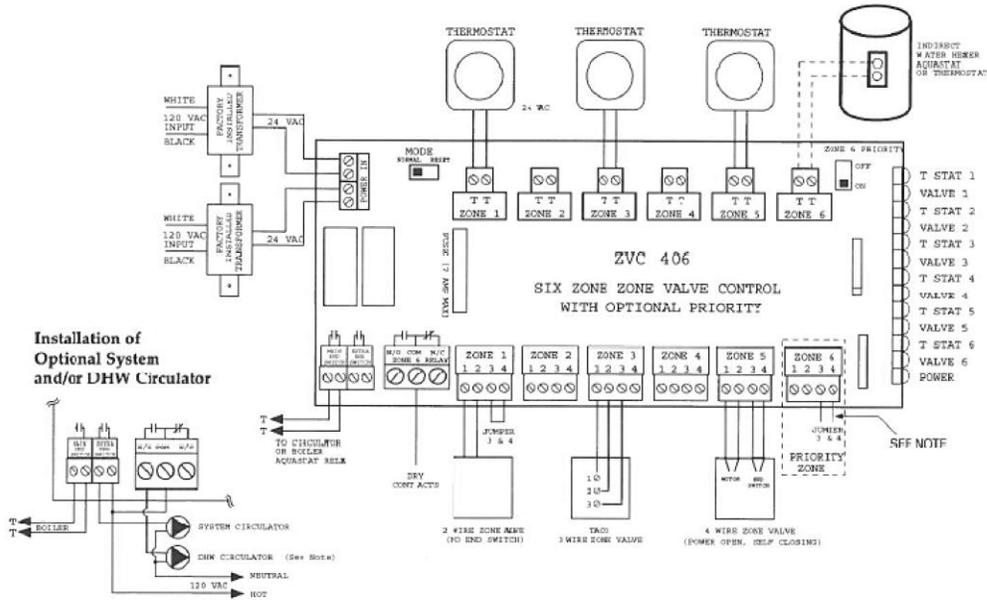
When the mode switch is set to NORMAL, the end switch relay will be energized if any zone is in operation. When the switch is set to RESET, the end switch relay will only be energized if the priority zone is in operation.

Specifications:

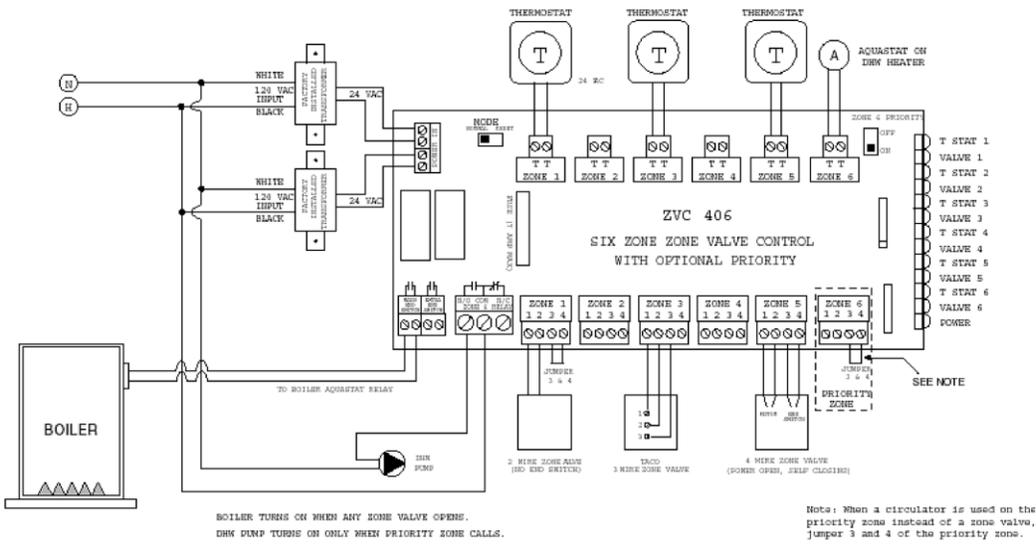
Transformer Voltage	Max Output @ 24 VAC	Width	Height	Depth
120 VAC input	80 VA	11 1/4"	7 1/2"	3"

All Zone Valve Controls are relay type DPDT and have a single phase motor rating per zone of 1/4 hp(5A) @ 120 VAC

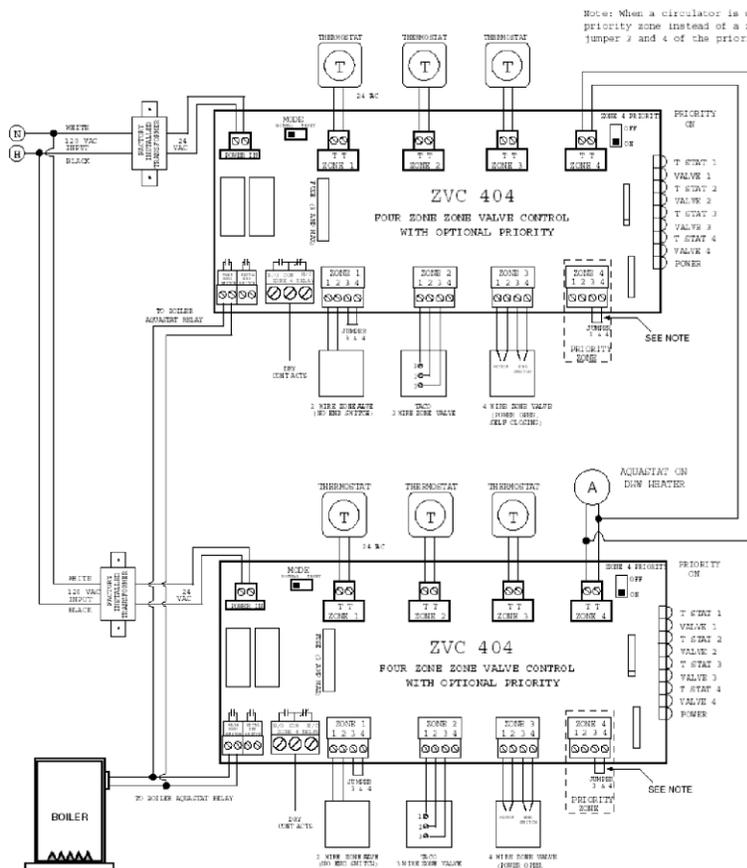
Roth Radiant Heating Installation Handbook
Wiring Diagram



Wiring Diagram



Roth Radiant Heating Installation Handbook
2 Roth Zone Control Plus with DHW Priority



5.4 Electrical Junction Boxes (continued)

Part #: 2340067274

Description: Roth Pump Control Plus (controls up to 6 pumps w/priority)

General Information

Roth Pump Control Plus has the casing similar to the Zone Control Plus, so we are instead displaying a typical wiring diagram for it, see on page 5.10. This Multiple-zone relay incorporates up to six double pole/single throw zone relays to provide a convenient and cost effective way to control up to six circulators and a boiler operating control in a multi-zone hydronic heating system. Field selectable priority for zone #1 eliminates the need for additional relays to provide domestic hot water priority. The Multi-zone relay save hours in installation time and provide a clean and professional installation. LED status indicators visible on the right side of the case allow easy system setup and troubleshooting. A 15 VA transformer is included. 6 standard Integral Circulator Relays are included,.

Single Box Installation

- A. On each zone block connect a two wire thermostat or aquastat to terminals T-T.
- B. Connect the zone pump for zone #1 to terminals H - N. Follow directions listed in A & B for additional zones on the same box.

Roth Radiant Heating Installation Handbook

- C. Connect Line Power to the terminals labeled INPUT 120 volt
- D. Connect the boiler demand wires to the ISOLATED END SWITCH, terminals X1 - X2.

DHW Priority

Zone Block #6 is assigned as the priority block. If DHW priority is required, set the priority switch from OFF to ON

- A. On zone block #6, connect the two wires from the aquastat to terminals T-T.
- B.
- D. If a circulator is used for the DHW, utilize an isolation relay connected External End Switch. (see wiring schematic.)
- A. On zone block #6, connect the two wires from the aquastat to Terminals T-T.
- B. Connect the DHW pump to terminals H – N Zone 6.

Sequence of operation, DHW

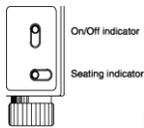
When a priority call for heat is detected at terminals T - T on zone block #1, the DHW pump connected to terminals C1 - C1 and the boiler will be energized as described in previous sections. At the same time the box will turn off all zone pumps connected to zone pump terminals 2 - 6 in that box until the DHW is satisfied. Once it's satisfied, all pumps will be operational again. If Priority Plus is selected, the call for heat from the DHW can last no more than one hour. At that point the rest of the system is energized again and illuminating the yellow LED indicating some is wrong with the DHW. This will protect the system from a possible freeze-up.

Specifications:

Transformer Voltage	Max Combined load	Width	Height	Depth
120 VAC input	20 amps	11 3/4"	7 1/2"	3"

All switching relays are relay type DPDT and have a thermostat current of .18, and have a single phase rating per zone 1/3 hp(7.2A) @ 120 VAC

5.5 Roth Manifold Valve operators



Part #: 2340055154

Description: Motorized; 4-Wire w/end-switch

General Information

The 4-wire Valve Operator is installed onto the HKV supply manifold valve for electronic control of the water flow. A Thermostat will give signal to the Operator to turn on and turn off the water flow in tubing loops. The Operator needs 24 VAC, 60 Hz and draws 0.25 Amps. The Operator has four electrical connections: two red wires (end-switch) for auxiliary boiler/pump control (24 VAC T -T circuit with Operator rating 5 Amps. resistive and 3 Amps. inductive), one orange wire and one yellow wire to power the valve open. The two indicators on valve face displays that valve is open and that the operator is correctly seated.

Installation Instructions

1. Remove the black plastic knob on the manifold supply valve.
2. Thread on the valve operator onto the manifold supply valve threads.
3. Tighten the collar until the seating indicator matches up with the mark on the face under the indicator.
4. Connect the Orange and Yellow wires to terminals 1 - 2 on the Roth Zone Control Plus or Roth Pump Control Plus. Or, connect the orange wire to the thermostat and the yellow wire to the transformer.

Roth Radiant Heating Installation Handbook

5. Connect the two red wires (end-switch) to terminals 3 - 4 on the Roth Zone Control Plus or Roth Pump Control Plus. Or, directly to an isolation relay or the T-T terminals on the boiler. Please see wiring schematics samples on page 5.4

5.5 Roth Manifold Valve operators



Part #: 2340055354

Description: Thermal; 4-Wire w/end-switch

General Information

The 4-wire Thermal Valve Operator is installed onto the HKV supply manifold valve for electronic control of the water flow. A Thermostat will give signal to the operator to turn on and turn off the water flow in tubing loops. The operator needs 24 VAC, and draws 2 Amp immediately when turned on, which then decreases to a fraction thereof as a continuous load. This version is very compact, just slightly over 2" high. That makes it best suited for manifold installations inside 4" a stud wall cavity and inside the Roth Manifold Cabinets. The top knob is an indicator showing if the valve is open or closed. At delivery the top knob is in "up" (open) position for easy installation. After start-up the normal (no current) position is closed (knob down). The Operator is easily removed by pressing both sides of the shackle and lifting. Operator has four electrical connections: two green wires (end-switch) for auxiliary boiler/pump control, one blue wire and one brown wire to power the valve open.

Installation Instructions

1. Remove the black plastic knob on the manifold supply valve.
2. Thread on the plastic valve operator collar onto the manifold supply valve threads.
3. Snap on the valve head.
4. Connect the blue and brown wires to terminals 1 - 2 on the Roth Zone Control Plus or Roth Pump Control Plus. Or, connect the blue wire to the thermostat and the brown wire to the transformer.
5. Connect the two green wires (end-switch) to terminals 3 - 4 on the Roth Zone Control Plus or Roth Pump Control Plus. Or, directly to an isolation relay or the T-T terminals on the boiler. Please see wiring schematics samples on page 5.4 and 5.5

5.6 Roth Zone Valves



Part #: 2340055115 & 2340055116

Description: 3/4" & 1" Zone Valves (4-Wire w/end-switch)

General Information

The Motorized Zone Valve is equipped with the 4-wire Motorized Valve Operator described in section 6.4. A Thermostat will give signal to the Operator to turn on and turn off the water flow to the Zone. The zone valve is used to control a larger zone by controlling either a complete manifold or a copper main feeding several manifolds. The zone valve can also be used to control baseboard, indirect water tanks, unit heaters or air handlers. The 3/4 in. valve has a C value of 5.8 and the 1 in. has a C=7. The valve has a built in plug for pre-balancing of the zone (instructions included in box). Piping connections are 3/4 or 1 in. sweat. The zone valve operator needs 24 VAC, 60 Hz and draws 0.25 Amps. The operator has four electrical connections: two red wires (end-switch) for auxiliary boiler/pump control (24 VAC T-T circuit with operator rating 5 Amps. resistive and 3 Amps. inductive),

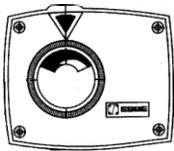
Roth Radiant Heating Installation Handbook

one orange wire and one yellow wire to power the valve open. The two indicators on valve face displays that valve is open and that the operator is correctly seated.

Installation Instructions

1. Remove the operator from the valve body.
2. Sweat the valve body in desired pipe location.
3. Thread on the valve operator onto the valve body threads.
4. Tighten the collar until the seating indicator matches up with the mark on the face under the indicator.
5. Connect the Orange and Yellow wires to terminals 1 - 2 on the Roth Zone Control Plus or Roth Pump Control Plus. Or, connect the orange wire to the thermostat and the yellow wire to the transformer.
6. Connect the two red wires (end-switch) to terminals 3 - 4 on the Roth Zone Control Plus or Roth Pump Control Plus or, directly to an isolation relay or the T-T terminals on the boiler. Please see wiring schematics samples on page 5.3

5.7 Roth Operators for 4-Way Mixing Valves



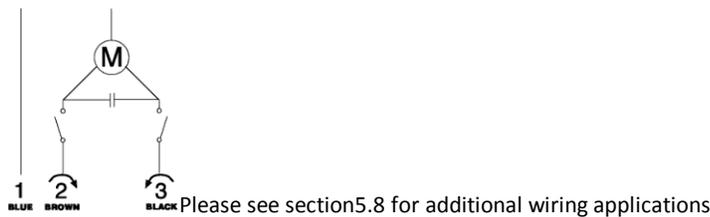
Part #: 2340065288

Description: Actuator VM 62

General Information

This compact control motor is designed to operate the Roth 4-way valves up to and including the 2" size, and is fully compatible with the Roth Mixing Controllers further described later in sections 6.7 & 6.8 . The operating range of 90° corresponds to the maximum turn of the 4-way valves (fully open to completely closed). The valve can be manually operated by the knob on the front when not controlled by separate regulator. The unit runs on 24 V AC and draws 6.5 Watts. A 60 in. cable for connection to transformer is included. The maximum torque provided is 45 in.lb. The running time to achieve the full 90° turn is 1.7 minutes. Installation instructions are included in the box. See page 6.4 for compatible 4-way valves. Please call Roth for larger size actuators.

Wiring Schematic



5.7 Roth Operators for 4-Way Mixing Valves



Roth Radiant Heating Installation Handbook

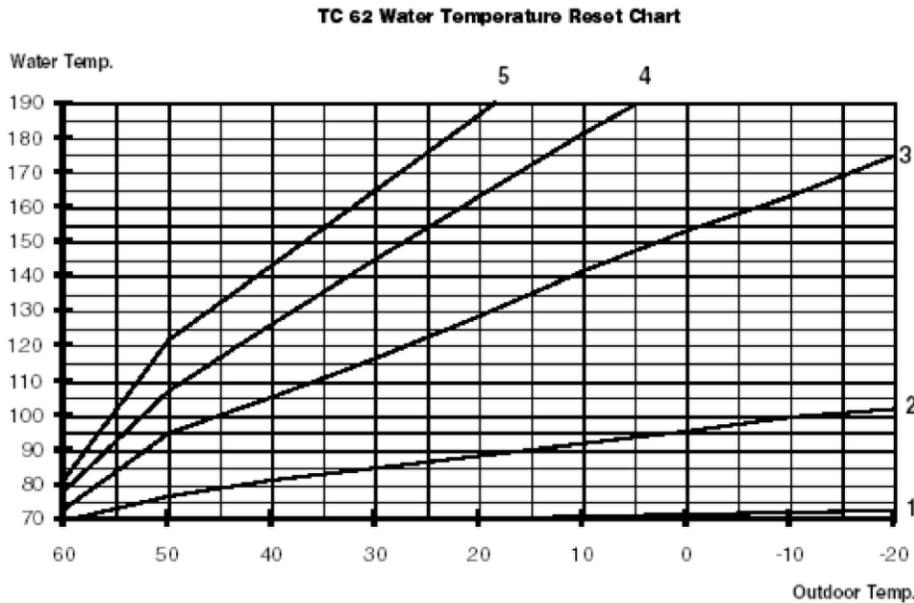
Description: Actuator TC 62 equipped w/ outdoor reset controller

General Information

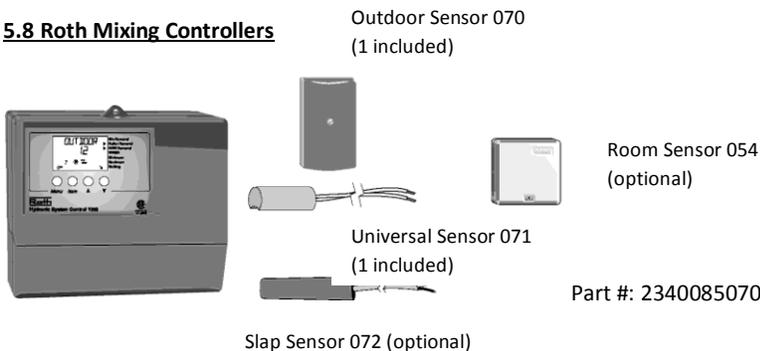
The TC62 is the VM62 actuator with an outdoor reset controller built right into the front cover! The outdoor temperature sensor is included and comes with 48 ft. of wire and adapter to plug right into the TC62. The supply water temperature sensor is also included, although cable length is only 6 ft. Power cord supplied is also 6 ft. The actuator can be used with all Roth 4-way valves up to 2" size. See page 6.4. The A-dial is the reset curve selector. The B-dial can be used to move the curve up to 11°F up or down to fine-tune the response at various temperature conditions. The C-dial is where the maximum water temperature limit is set, anywhere between 90 and 190°F. Note that the unit can also be used as a constant supply water temperature controller by disconnecting the outdoor sensor. Use the C-dial to set the selected temperature at this option. Room Sensor is optional and may be purchased separately. It would change the water temperature 4° F for every 1°F in difference to set room temperature. It comes with plug and 48 ft. cable.

See the chart on next page to select the response to outdoor temperature.

TC 62 Water Temperature Reset Chart



5.8 Roth Mixing Controllers



Description: Roth Hydronic Controller 1050

General Information

Roth Radiant Heating Installation Handbook

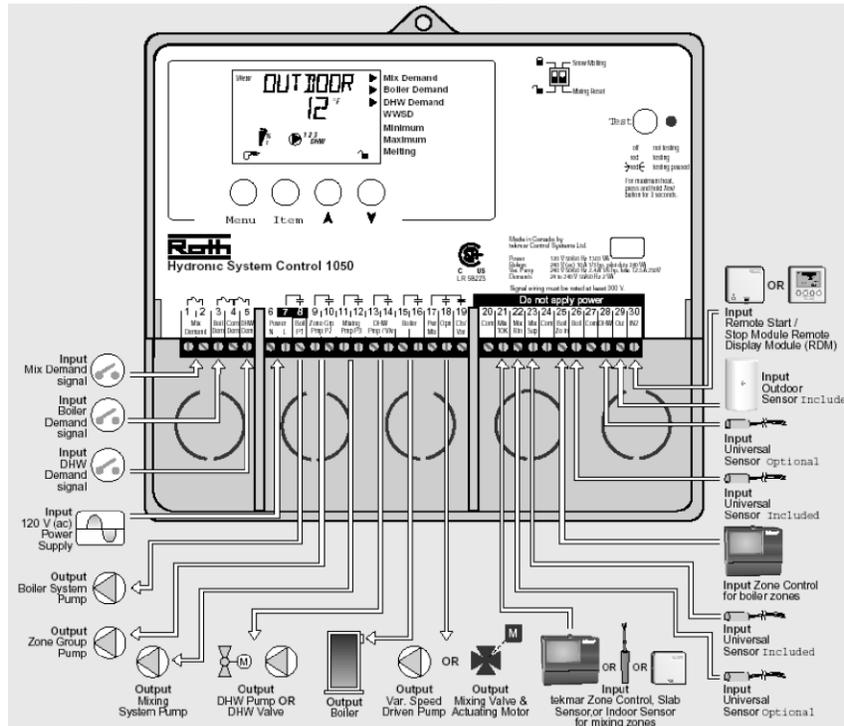
The hydronic System Control 1050 is a general purpose reset control for hydronic systems. The 1050 incorporates a boiler reset control, a DHW control, a high temperature loop control and a mixing control into a single unit. The control is designed for a two temperature hydronic system using either conventional thermostats or Tekmar zone controls. In both instances, a Characterized Heating Curve is used to match the system supply water temperature to the type of terminal units used in the heating system. The control has output contacts for operation of a primary loop pump, a secondary loop pump, a DHW pump or valve, a mixing device, a mixing system pump, and a single boiler. When Used in a single boiler application, the 1050 operates the boiler at a temperature that is sufficient to satisfy the loads that are currently calling for heat and ensures that the boiler operates above the boiler minimum supply temperature. If used in a multiple boiler application, the 1050 can be used in conjunction with a tekmar boiler staging control for multiple boiler reset.

The 1050 is capable of providing intelligent DHW operation and priority when using either a DHW valve or a DHW pump. Either a conventional DHW aquastat can be used to control the DHW tank temperature or a tekmar Universal Sensor 071 can be connected directly to the 1050 to control the DHW tank temperature. For a mixing device, the 1050 is capable of using either a variable speed injection pump or a floating point action mixing valve actuator. The 1050 is also capable of utilizing either a Remote Display Module or a Snowmelt Enable Kit. The Remote Display Module allows for remote monitoring and/or adjustment of the 1050 for up to 500 ft. away.



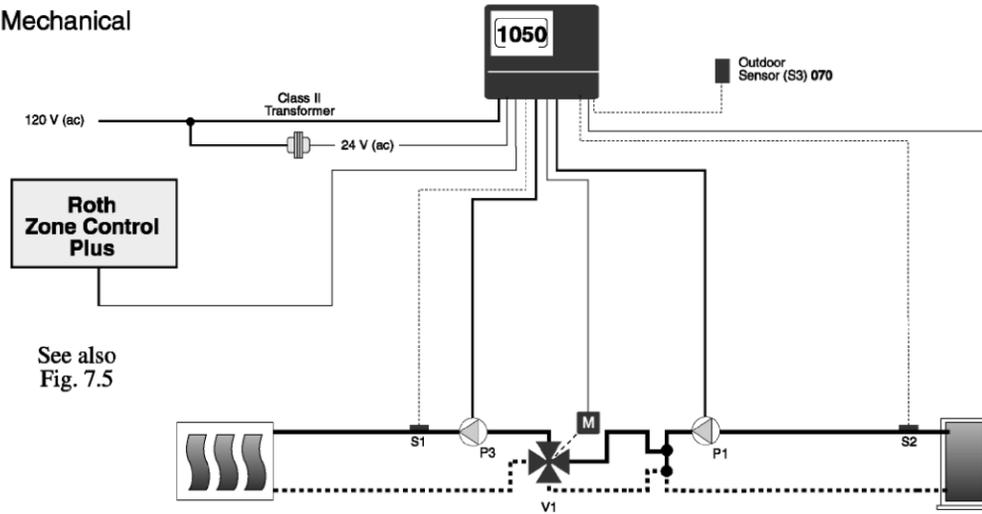
The Snowmelt Enable Kit is used only in conjunction with the snow melting mode of operation and allows for the user to remotely start and/or stop the snow melting system as well as adjust the running time of the system. One outdoor sensor 070, two universal sensors 071, one Remote Start/Stop Module 039 and complete technical info is included.

Roth Hydronic Controller 1050 with 4-Way Mixing Valve



Roth Radiant Heating Installation Handbook
Roth Hydronic Controller 1050 with 4-Way Mixing Valve

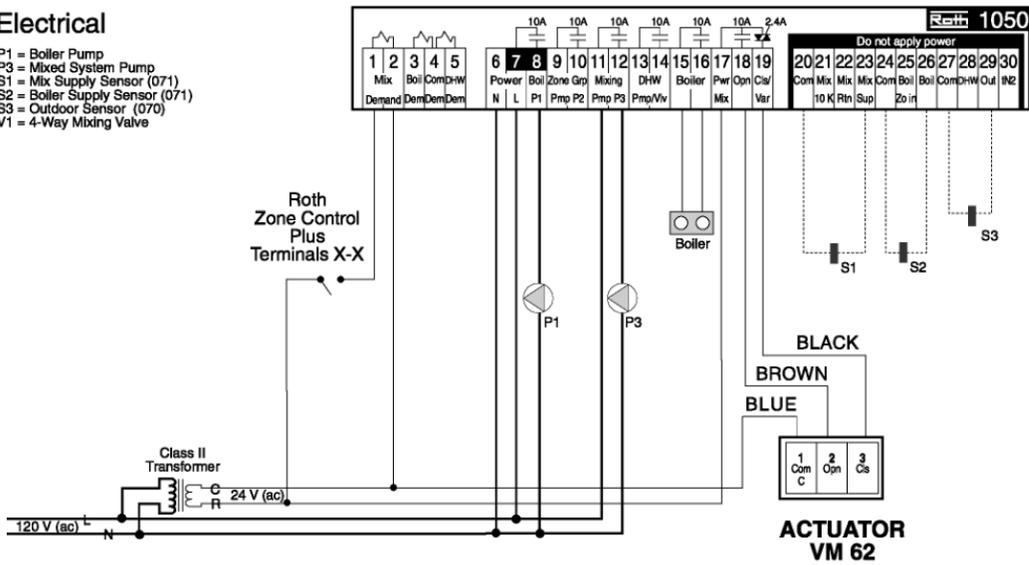
Mechanical



See also
Fig. 7.5

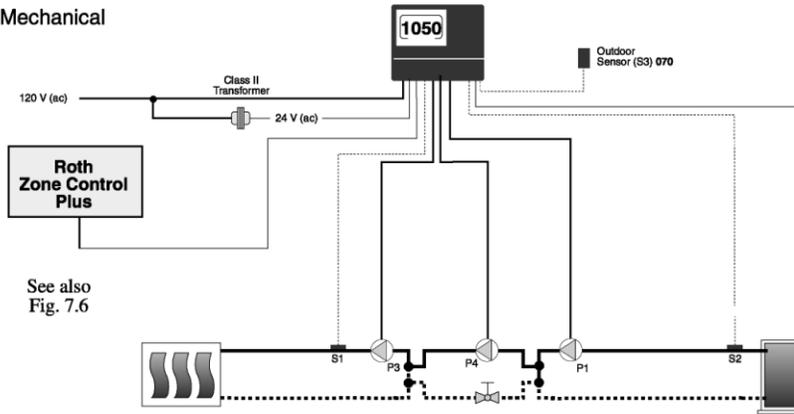
Electrical

- P1 = Boiler Pump
- P3 = Mixed System Pump
- S1 = Mix Supply Sensor (071)
- S2 = Boiler Supply Sensor (071)
- S3 = Outdoor Sensor (070)
- V1 = 4-Way Mixing Valve



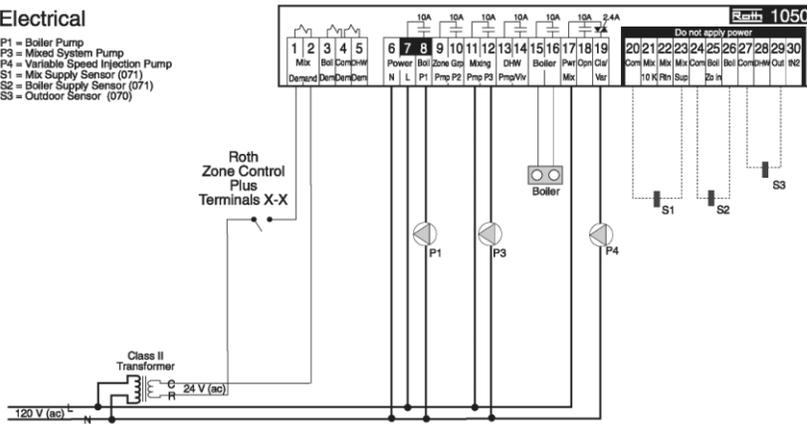
Roth Radiant Heating Installation Handbook
Roth Hydronic Controller 1050 with Variable Speed Injection Pump

Mechanical



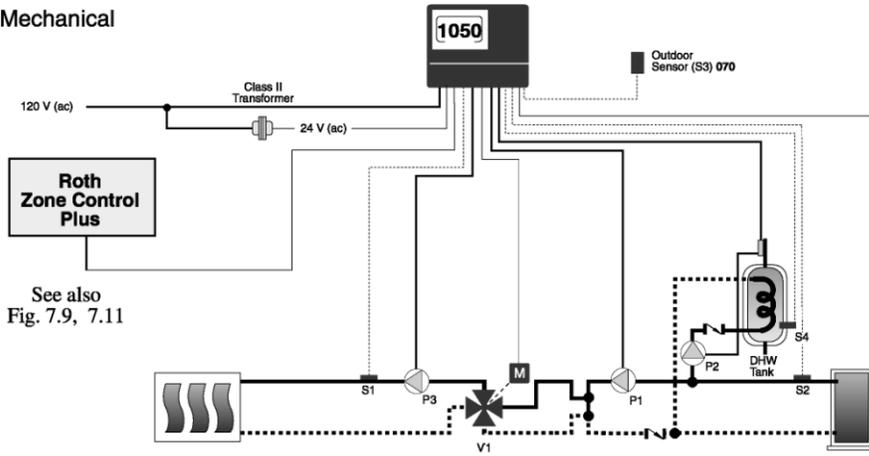
Electrical

- P1 = Boiler Pump
- P3 = Mixed System Pump
- P4 = Variable Speed Injection Pump
- S1 = Mix Supply Sensor (071)
- S2 = Boiler Supply Sensor (071)
- S3 = Outdoor Sensor (070)



Roth Radiant Heating Installation Handbook
Roth Hydronic Controller 1050 with 4-Way mixing Valve and DHW

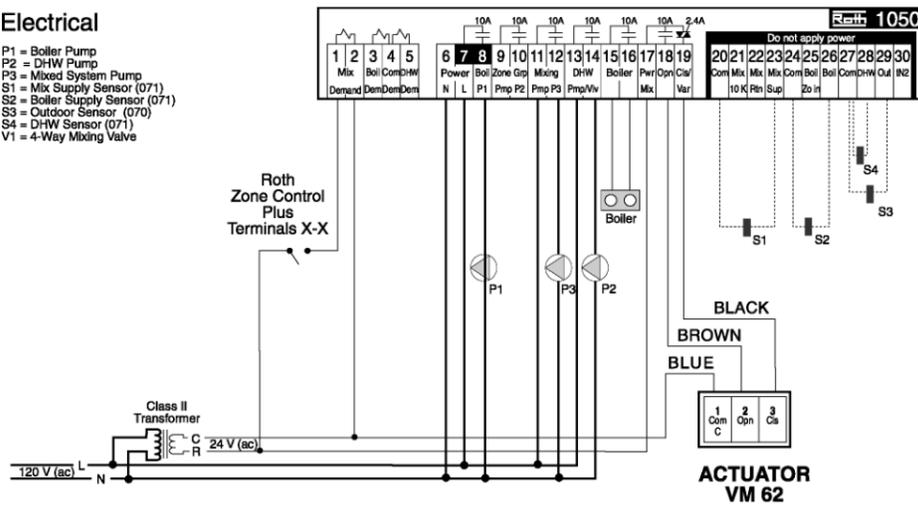
Mechanical



See also
Fig. 7.9, 7.11

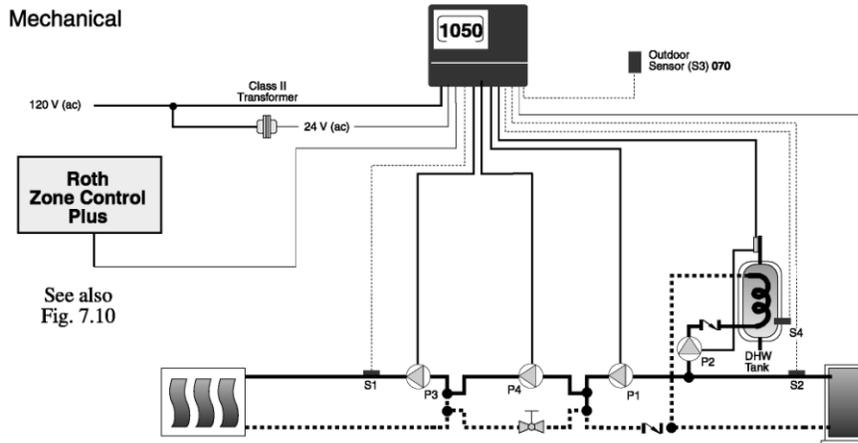
Electrical

- P1 = Boiler Pump
- P2 = DHW Pump
- P3 = Mixed System Pump
- S1 = Mix Supply Sensor (071)
- S2 = Boiler Supply Sensor (071)
- S3 = Outdoor Sensor (070)
- S4 = DHW Sensor (071)
- V1 = 4-Way Mixing Valve

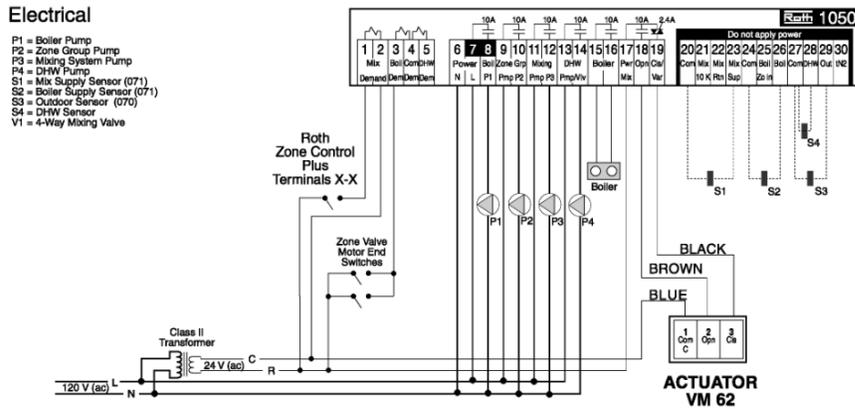


Roth Radiant Heating Installation Handbook
Roth Hydronic Controller 1050 with Variable Speed Injection Pump and DHW

Mechanical

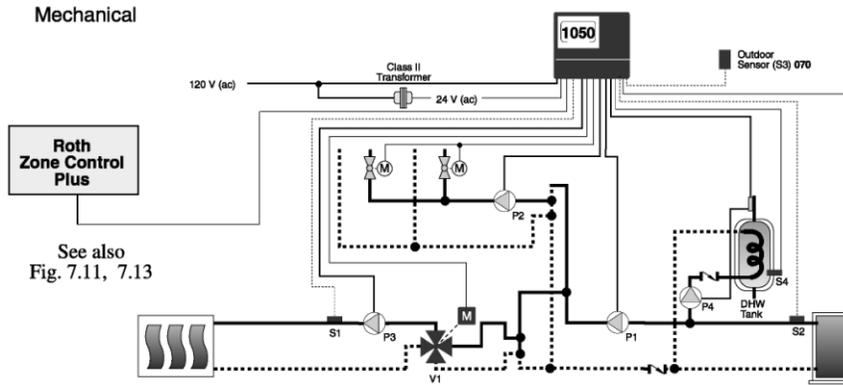


Electrical



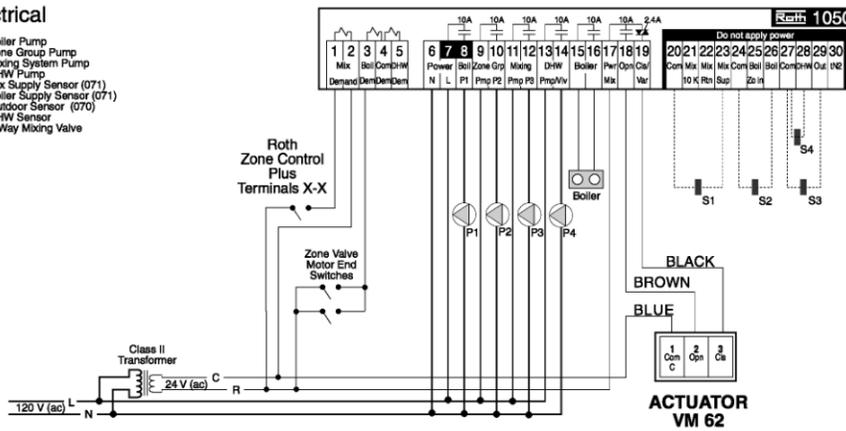
Roth Radiant Heating Installation Handbook

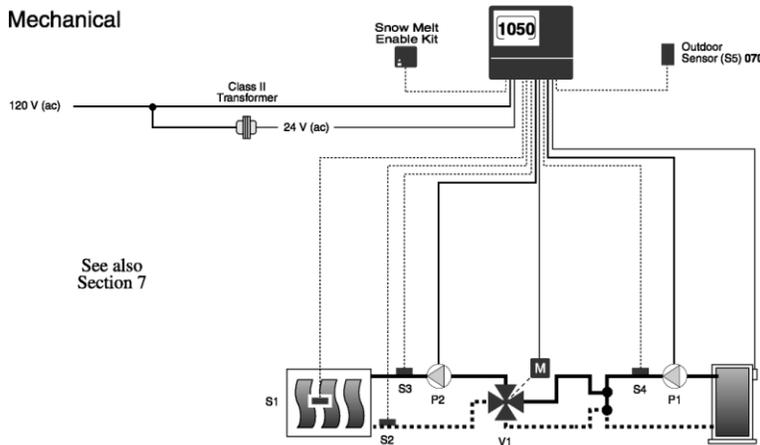
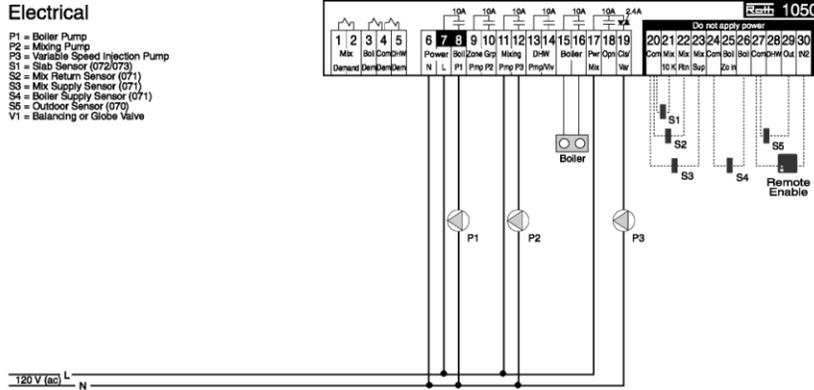
Roth Hydronic Controller 1050 with Variable Speed Injection Pump, DHW and Hi-Temperature Zones



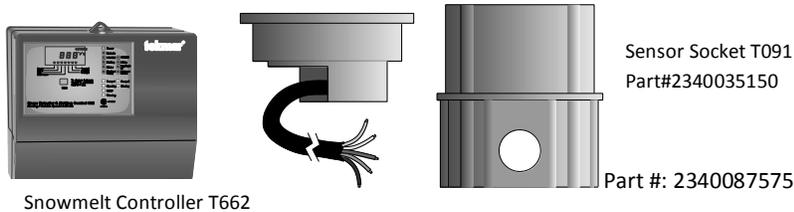
Electrical

- P1 = Boiler Pump
- P2 = Zone Group Pump
- P3 = Mixing System Pump
- P4 = DHW Pump
- S1 = Mix. Supply Sensor (071)
- S2 = Boiler Supply Sensor (071)
- S3 = Outdoor Sensor (070)
- S4 = DHW Sensor
- V1 = 4-Way Mixing Valve





5.8 Roth Mixing Controllers Snow/Ice Sensor T090 Part#2340046120



Description: Automatic Snowmelt Controller T-662 & Sensor

General Information

The automatic snowmelt controller is a microprocessor based control which activates and controls the rate of heat delivery to a snow melt system. The T662 is capable of maintaining an idling slab temperature to save energy and to ensure faster response. The Snow/Ice sensor detects moisture and temperature and will engage the snowmelt mode once moisture is detected at 32 degrees (installer selected) or below. The T 662 can also be programmed to shut down the system at warm weather. The versatile control has three modulating outputs to control the heat delivery for most pump and/or valve arrangements. For a

Roth Radiant Heating Installation Handbook

mixing device, the T662 is capable of controlling either a variable speed injection pump or a floating point action mixing valve actuator. Protection of both the snow melt slab and the boiler is achieved through several safety features. Faster pickup times are also ensured through a viscosity compensation function which optimizes the rate of heat delivery to the slab during start up. The device combines all the necessary features to make snow melting safe and trouble free. The Snow/Ice Sensor and the Sensor Socket are NOT included with the T-662 but must be purchased separately. Installation and wiring instructions are included in the box.

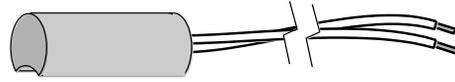


Outdoor Sensor 070

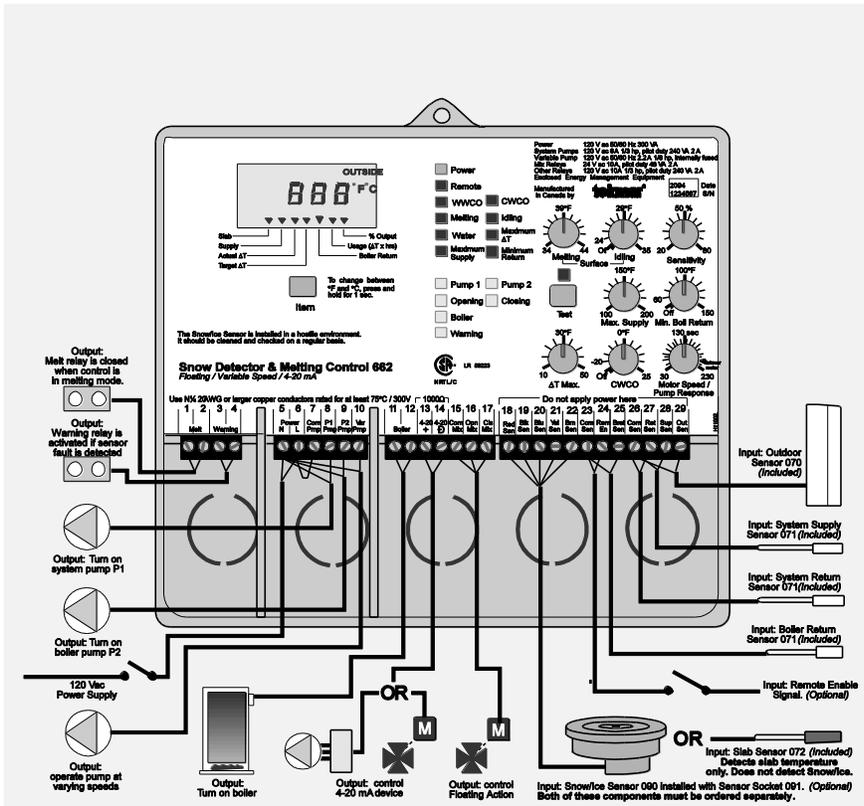
Slap Sensor 072



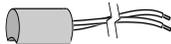
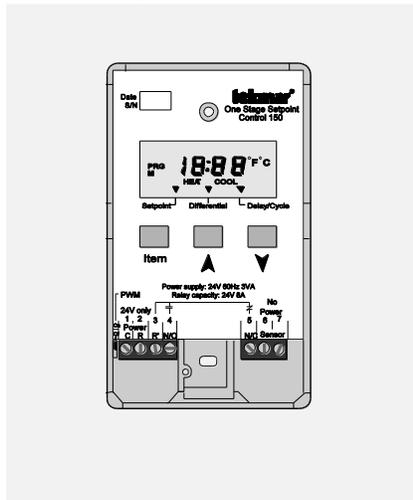
Universal Sensor 071



Automatic Snowmelt Controller T 662 with Snow/Ice sensor



5.9 Roth Set-point Controller



The universal Sensor T 071 (one included) has a zinc sleeve for fast response and a wide operating range. This sensor can be used in a multitude of applications.

The One Stage Set-point Control T 150 is a microprocessor-based control that can be programmed to maintain a fixed Set-point temperature by cycling a heating or cooling device using either bang-bang or Pulse Width Modulated (PWM) output control. This reliable and versatile control has a very wide set-point range, an adjustable differential and time delay that makes it usable in many different applications. The control has a digital LCD window that normally shows the actual sensor temperature and can be used to view the set-point as well as the other programmed settings. A Universal Temperature Sensor T 071 is supplied with the control. The wire to the sensor may be extended up to 500 ft. (150m) by standard 18 AWG low voltage wire. The display will indicate a sensor fault whenever the sensor is either open or short circuited.

The Slab Temperature Sensor T 072 has a PVC plastic sleeve which is designed for use in soils or concrete. This is an optional alternative to T 071 for use with T 150 when applicable. It is supplied with 20 ft. of 2 conductor cable

6. WATER TEMPERATURE CONTROLS & ACCESSORIES

6.1 Roth Shunt Systems



Roth Shunt System

Preassembled, manually adjusted, proportional temperature mixing station with built-in, multi-speed system circulator and system high temperature protection.

Roth manifold shunts were developed to make it easy to add hydronic radiant floor heat to existing, high temperature hydronic heating systems. They can be used singly or in multiples to supply separate temperatures to different types of heat emitters in new or existing systems. The built-in system circulator allows these shunts to be used with any boiler system and constant circulation at low temperature provides even heat to the space. When used with an outdoor reset control on the boiler, such as the Roth 1050, these shunts will provide weather-responsive system temperatures to the radiant heat manifolds. They can be used with optional devices, such as zone valves to supply multiple manifolds or manifold actuators to control each loop, to



Roth Radiant Heating Installation Handbook

provide heat in zoned systems. The shunts are provided with system supply and return thermometers and adapters to connect directly to the Roth manifold assemblies.

Roth Manifold Shunts Capacities:

3/4" (5.8cv) model: 3,000 sq ft (279 sq m)*

1" (7.0cv) model: 4,000 sq ft (372 sq m)*

* These ratings are based on a heat demand of 15 btu/hr per sq. ft. (47 watts per sq. m.) at a 15 oF (8.5 °C) temperature difference, when using 100% water. Capacities must be decreased when using glycol solutions or a lower temperature difference.

Mounting Instructions

The manifold shunts are designed to be mounted on the left side and connected directly to a single Roth manifold set. Optionally, they may be installed at a remote location and piped to one or more manifold sets. The shunts can also be mounted in a Roth Recessed Cabinet (see separate instructions with the cabinet) on the left side of the manifold. In all cases the circulator must be mounted with the shaft in a horizontal position. The motor shaft must never be in a vertical position (either up or down).

We recommend using a circuit setter or balancing valve at each manifold when a shunt serves more than manifold or there is more than one shunt used in a system. This will provide a means of balancing the flow to multiple manifolds. Always follow good piping practices and local codes.

Adjustments

Before start-up, be sure the system is flushed and purged. Set all thermostats to call for heat with all zone valves and actuators open, if used. Adjust the boiler operating temperature and reset curves (if applicable) per manufacturer’s instructions, but the boiler supply temperature must be at least as high as the system design temperature for the shunt system. Set the 3-way valve to the “0” position.

- Start the boiler and allow it to reach operating temperature.
- Set the shunt circulator speed you estimate the system will require based on the size of the area you are heating and the maximum capacity of the shunt. For example: for a relatively large area use speed 3 or for a small area use speed 1.
- Set the thermostatic valve for the maximum allowable system temperature, based on your floor construction, and lock the valve. See the instructions included with the valve for this procedure.
- Open the 3-way valve to the “1” position and check the system supply temperature. Allow a few minutes, as needed, for the system temperature to stabilize.
- Continue to open the 3-way valve in small increments, as above, until you reach the desired system temperature for the heat emitter.
- Adjust the circulator speed as needed to achieve the desired temperature difference between system supply and return. Remember that the shunt capacity is based on a 15 btu/hr per square foot load at a 15oF temperature difference. A smaller temperature difference will decrease the area coverage or btu/hr per square foot and a larger temperature difference will increase coverage or btu/hr per square foot.

Maintenance

Be sure to check boiler supply temperature and system supply and return temperatures at the beginning of every heating season. If the boiler does not have an outdoor reset control, adjustments can be made to the 3-way valve to increase or decrease system temperature as needed. Consult with your heating contractor prior to making any adjustments. Do not override the system high temperature limit device unless your heat emitters are capable of using the same temperature fluid as your maximum boiler temperature!

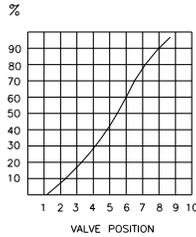
TECHNICAL DATA

	Manifold Shunt 5.8	Manifold Shunt 7.0
Part Number	17US1000.001	17US1000.002
Max Operating Pressure	100 psi / 6.9 bar	100 psi / 6.9 bar

Roth Radiant Heating Installation Handbook

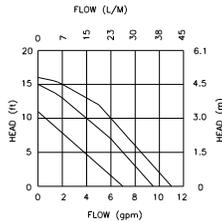
Max Boiler Supply Temperature	210 °F / 99 °C	210 °F / 99 °C
Boiler Side Connections	3/4" NPT	1" NPT
System Side Connections	3/4" swt / Manifold Adapter (incl.) 1" swt / Manifold Adapter (incl.)	
Max System Temp w/Hi-Limit	122 °F / 50 °C (approx.)	122 °F / 50 °C (approx.)
ELECTRICAL DATA	110v/1ph, 1/25th hp, 0.74a, 85w 110v/1ph, 1/25th hp, 0.74a, 85w	

Mixing Valve Flow Diagram



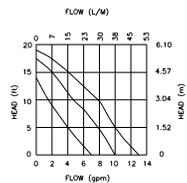
% Hot Side Mix at Valve Position

5.8 Shunt Pump Performance



Grundfos UPS15-42F

7.0 Shunt Pump Performance



Grundfos UPS15-58

Available system head at a given flow rate (all losses beyond shunt)*

Mini Shunt System



Part#: 2375000103

Roth Mini-Shunts were developed to make it easy to add hydronic radiant floor heat, or floor warming, to small areas such as bathrooms or kitchens, where there is an existing, high temperature, hydronic heating system. The shunt is mounted in or adjacent to the space that it is serving and can be used with 3/8", 1/2" or 5/8" Roth O2 barrier pex tubing. They have a remote, capillary bulb space temperature sensor that operates the mixing valve. The built-in system circulator allows these shunts to be used with any hot water heating boiler system and constant circulation at low temperature provides even heat to the space.

Roth Radiant Heating Installation Handbook

The Mini-Shunt is connected to a single heating loop. It can be connected to a two loop system if the optional two loop adapter kit (Roth part# 2372100020) is used.

Roth Mini-Shunt Quick Sizing Chart*

PEX Size	Installation Method	Area Covered	Loops**	Spacing	PEX Length
3/8"	Concrete or Thin Slab	110 ft2 (10.2 m2)	1	8" (20.4 cm)	180' (55 m)
3/8"	Concrete or Thin Slab	220 ft2 (20.4 m2)	2	8" (20.4 cm)	360' (110 m)
3/8"	Roth Floor Panel System	110 ft2 (10.2 m2)	1	6" (15.2 cm)	260' (79.2 m)
3/8"	Roth Floor Panel System	220 ft2 (20.4 m2)	2	6" (15.2 cm)	520' (158.5 m)
1/2"	Concrete or Thin Slab	220 ft2 (20.4 m2)	1	12" (30.5 cm)	260' (79.2 m)
1/2"	Concrete or Thin Slab	440 ft2 (40.8 m2)	2	12" (30.5 cm)	520' (158.5 m)
5/8"	Concrete or Thin Slab	270 ft2 (25.1 m2)	1	12" (30.5 cm)	295' (90 m)
5/8"	Concrete or Thin Slab	540 ft2 (50.2 m2)	2	12" (30.5 cm)	590' (180 m)

* These ratings are based on a heat output of ~25 btu/hr per ft2 (~79 watts per m2) at a 20 °F (11 °C) temperature difference, when using 100% water. Actual output varies with tubing size/length, flow rates, fluid temperatures, floor coverings, etc. Capacities must be decreased when using glycol solutions or a lower temperature difference.

** Use of two loops requires an optional adapter kit (Roth Part# 237210020)

Mounting Instructions

The Mini-Shunt is supplied with a wall mounting bracket. It should be installed above the heated floor with the boiler side connections and pump motor in a horizontal position. In all cases the circulator must be mounted with the shaft in a horizontal position (either left or right facing). The motor shaft must never be in a vertical position (either up or down). As with all motors, be sure to consider noise or vibration when selecting the location. Additional vibration isolation may be desirable.

The Room Temperature Sensor supplied with the Mini-Shunt has a 16' (4.9 m) capillary tube. Select a pump location that will allow the sensor to be mounted in a good spot in the heated space. Select a sensor location that will provide an accurate average temperature reading. As with any thermostat, avoid areas in direct sunlight or excessive moisture.

If you are using two heating loops, Roth part number 2372100020 will be needed to connect the loops. This is an optional item and must be ordered separately.

Power Requirements

The Mini-Shunts is supplied pre-wired with a 40" (1 m) power cord and grounded 3-prong plug. A standard, grounded 110v/1ph electrical outlet within cord reach provides the power (see chart below for actual power requirements).

Adjustments

Before start-up, be sure the system is flushed and purged of air. Adjust the boiler operating temperature and reset curves (if applicable) per manufacturer's instructions, but the boiler supply temperature must be at least as high as the system design temperature for the shunt system. Leave the cap on the thermostatic valve head on the pump in the fully open position (screwed down fully clockwise). Do not install the thermostatic operator at this time.

- Start the boiler and allow it to reach operating temperature.
- Turn the Mini-Shunt on and allow the system to run for about 10-20 minutes and fluid temperatures to stabilize. The system supply temperature should now be 95 - 105°F (35 - 40°C). Please note that the internal high temperature limit will prevent the

Roth Radiant Heating Installation Handbook

system supply from exceeding approximately 115°F (46°C). Allow the system to operate until the floor temperature is approximately 68°F (20°C) before making the next adjustment.

- When the floor is approximately 68°F (20°C) you can make the final supply temperature adjustments. Check the floor system supply temperature. If the temperature is too high, you can adjust the flow on the boiler side with the enclosed 2.5 mm hex wrench at the valve under the boiler return connection. This valve is normally in the fully open position when the Mini-Shunt is shipped.
- Remove the plastic cap and mount the thermostatic head on the valve body of the Mini-Shunt and turn the top of the head to set the desired space temperature. The room temperature range is approximately 50 - 78°F (10 - 26°C). The "5" setting is approximately 68°F (20°C).

Maintenance

Be sure to check boiler supply temperature and system supply and return temperatures at the beginning of every heating season. Check the room temperature and adjust the thermostatic operator as needed. Consult with your heating contractor prior to making any adjustments to the boiler system.

TECHNICAL DATA Mini-Shunt

Part Number 11750001.03

Max Operating Pressure 100 psi / 6.9 bar

Max Boiler Supply Temperature 200 °F / 93 °C

Boiler Side Connections 1/2" copper (female sweat)*

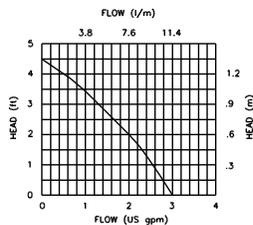
System Side Connections 3/8" to 5/8" Roth PEX tubing*

Max System Temp w/Hi-Limit 115 °F / 46 °C (approx.)

2-Loop Adapter (part number) 11721000.20

ELECTRICAL DATA 110v/1ph, 1/30th hp, 0.23a, 25w

Mini-Shunt Pump Performance



Heat output from hydronic heating systems can be varied in two ways, only.

These methods are:

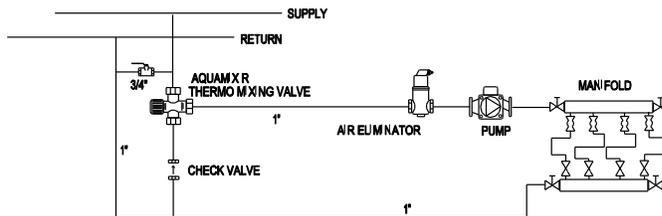
- 1- Restriction (including shutting off) amount of flow through the radiant loops, or
- 2- Mixing water of different temperatures to reach a new temperature. The two methods are often combined to achieve best results. Roth HKV Manifolds include Loop Supply and Return Valves which are examples on method 1. Supply Valves and Zone Valves can be equipped with operators that shut system sections off and on at intervals as controlled by Room Thermostats (or other sensors) as described in previous section. Mixing Devices can be capable of supplying individual water temperatures to various parts of the system, which temperature demand may be quite different for several reasons. In this section we describe the mixing devices that we currently offer. Roth Air purgers and By-pass Valves are also described. Contact us for advice on additional products that you may need.

6.2 Thermo-Mechanical Mixing Valves



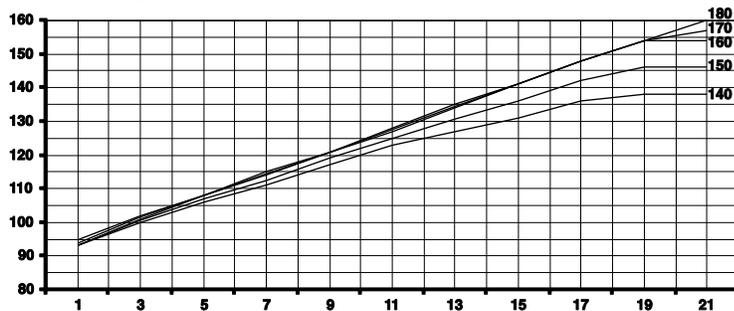
Aquamix R is a self regulating mixing valve that reduces water temperature from the heat plant down to the temperature required for the heating circuit(s) or manifold(s). Features include the possibility to lock in a specific temperature or temperature range (within its capacity - see below). Aquamix R can be installed in any position. The Cv value is 3.5. This Cv value gives very reasonable pressure head losses at flows of up to 4 or even 5 gpm (see Section 9), which is an adequate flow for many manifolds.

We provide the 1 in. size, only, because the pressure head loss is larger for smaller models. One single model provides mixed temperatures between 75°F and 160°F. Use the chart on next page to find the correct valve setting. The Aquamix R connections are 1 in. swt with union nuts.



6.2 Thermo-Mechanical Mixing Valves (continued)

Panel Heating Supply Temp. °F; Diagonal lines for Boiler temperatures (°F)



Valve setting

Using the Chart:

- Find the supply water temperature required at left
- Move horizontally right until the intersection with heat plant water temperature.
- Go down vertically and read the Aquamix R Valve setting.

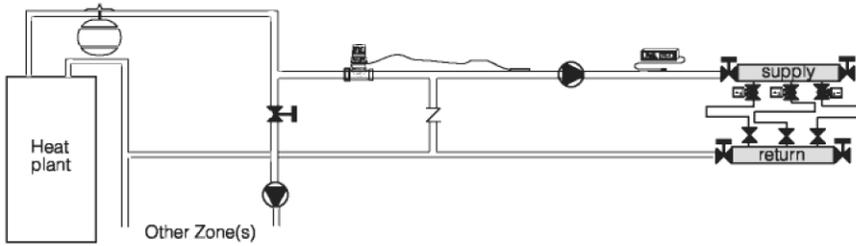
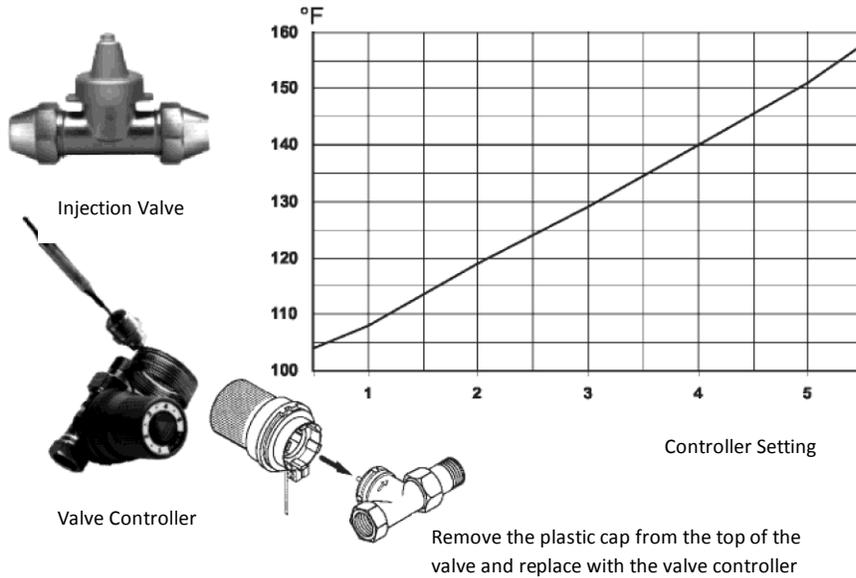
Note: The chart is valid for 60°F return water temperature. Decrease the Supply Temperature required by 1°F for each 10°F higher water return temperature (increase for return temperatures higher than 60°F.) Example: Your Boiler temperature is 180°F and the manifold controlled by Aquamix needs 130°F. The return temperature is 120°F (6T = 10°F). Since that is 60°F higher than the chart valid temperature, you should decrease the Supply temperature wanted of 130°F by 6°F to 124°F before using the chart. The result of using the chart is that the Valve Setting should be 10. Always use a thermometer to determine actual temperature and to adjust the setting correspondingly. The Valve has two additional positions below setting "1" to allow temperatures as low as 80°F.

Roth Injection Valve and Controller

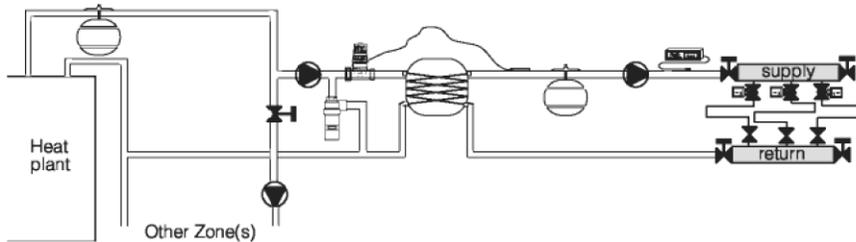
The injection (two-way) valve controller has a remote capillary sensor (up to 5 ft. away). It will sense the supply temperature in the secondary circuit and allow the correct flow through the valve to maintain the set temperature. At installation, the plastic

Roth Radiant Heating Installation Handbook

cap of the two-way Injection Valve is removed and replaced by the Injection Controller. The sensor is, for example, taped to a supply copper pipe. Insulation is wrapped around and taped secure. The sensor must be installed horizontally or downwards, only. The supply temperature should be at least 25°F over the set closing temperature. Use chart on next page to find the setting. The operating range is 104 - 158°F (call for other ranges). Always use thermometer to adjust setting. The 3/4" Valve comes with solder unions and has a C of 5.9 and the 1" Valve has NPT threads and a C of 9.3 which will allow a generous injection flow.

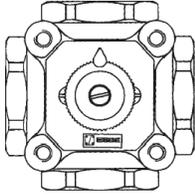


The Roth injection valve with controller will let appropriate amount of water from the boiler through to maintain set temperature in the radiant circuit. Depending on the design of other zones, additional valves may be useful to balance pressure differences.



The secondary circuit may be isolated via a heat exchanger. That circuit could be a garage or a snowmelt area where antifreeze is added to the water.

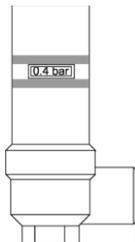
6.3 Roth 4-Way Mixing Valves



Our mixing valves have compact design, providing good control characteristics and reliable operation. Sizes 3/4" to 1 1/4" are brass with sweat connections, while 1 1/2" & 2" sizes are steel with female NPT threads. The valves are equipped with a knob for manual operation, but are normally replaced with one of the electronic valve operators: Actuator VM 62 or TC 62 (see section 5.6). The VM 62 actuator would need a Roth Mixing Valve Controller as described in section 5.7. The 4-way valves have double mixing function, i.e. a portion of the hot water from the boiler is always mixed with the return water. This results in a higher return water temperature than can be achieved with a 3-way valve, thereby reducing the risk of shocking or condensing the boiler. The pressure losses are low. C-values are as follows: 3/4" - 4.7; 1" - 9.3; 1 1/4" - 21.0; 1 1/2" - 35.0; 2" - 50.0

Larger sizes (flanged) are also available (call).

6.4 Roth Differential Pressure Bypass Valves

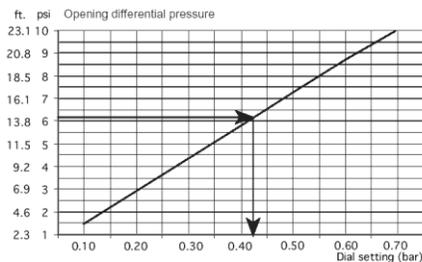


Roth Differential Pressure Bypass Valves sense the differential pressure over the heat distribution system. When the pressure drop over the circuit(s) exceeds the value that is set on the Valve, it will start to open, and at a slightly higher pressure (2 psi ~ 5 ft.) become completely open. Differential pressure control is an important and often neglected part of hydronic circuits. Closing zone valves increase the head pressure in the system and will increase the flow through remaining open valves. In some systems the excess head pressure may even force valves open. If flow is completely stopped, some pumps can be damaged. If the system has outdoor reset control or other supply temperature control and the flow stops, the trapped water will cool down and the temperature controller will react by opening the mixing valve. This can cause a surge of hot water through a system when zone valves open.

The Roth Differential Pressure Bypass Valve alleviates these problems by maintaining a continuous flow in the system.

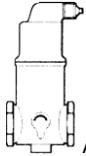
We suggest that you set the Bypass Valve on an opening pressure slightly above the system design pressure drop over actual circuits. The setting should always be well below (2 psi ~ 5 ft.) the maximum pressure that the pump can provide.

6.4 Roth Differential Pressure Bypass Valves (continued)



Roth Differential Pressure Bypass Valves are fully self contained and opening differential pressure is set by turning the top of the valve. The actual setting is visible (in bars of pressure difference) in windows on both sides of the top. Use below chart to convert to psi or ft. of head. The Valves are available in two sizes, both with NPT female threads. Use the 3/4" size for throughput flows of up to 8 gpm, and the 1" for flows up to 17 gpm. For larger systems, use multiple bypass valves.

6.5 Roth Automatic Air Purgers



Air trapped in hydronic systems can cause circulation disturbances, noise, component wear, pressure surges and poor system operation. It is essential to vent out all air at system start-up, but since air will be released when water heats up (cold water can dissolve more air than hot water), even the most thorough venting is not enough. New air bubbles will form. Roth recommends installing automatic air vents in all systems. The Spirovent is intended to be installed in the primary system flow after the boiler, so that it can trap and release all bubbles generated when water is heated. The automatic air vent is guaranteed not to leak and can only be closed by the installer for a pressure test. Threaded connection is available for that purpose. It's 1/2" bottom drain plug can be used to connect an expansion tank.

All sizes are female NPT and have following Cv ratings:

3/4" - 14; 1" - 22; 1 1/4" - 40; 1 1/2" - 55. Call for larger sizes.

Spirotop has the same automatic air vent guaranteed not to leak as Spirovent. It is designed to be installed in system high points where air may be trapped when flow is reduced. Spirotop will reduce cumbersome repeat bleeding at start-up and at system maintenance. Female 1/2" NPT thread.

7. MECHANICAL SCHEMATICS

7.1 General Notes

This section depicts a variety of concept mechanical piping schematics. They are intended to be used only as guides, so essential components have been omitted for purpose of clarity, for example, thermal traps, isolation valves, fills and drains or actual distances are not shown. Roth highly recommends all mechanical piping to be performed by a licensed trade professional. Actual systems must follow local codes, trade and safety practices.

If your application is not shown in this section, please call us at 1-888-266-7684, and we can assist you in creating a custom schematic for you.

7.2 Pipe Sizing

Sizing the pipes around the boiler and for the radiant system requires that you know the total net BTUH to be delivered and the temperature drop (delta T) allowed for both the primary side (boiler) and the secondary side (radiant). To figure out the flow required based on BTUH, use following formula: $GPM = NET\ BTUH \div \Delta T \div 500$. Typical temperature drop for a boiler can be 20° F - 40° F. Please refer to the manufactures recommendations for boiler used in your project. While a radiant system typically uses between 10° F - 20° F. Below is a rule of thumb chart for sizing copper pipe based on GPM.

GPM	Pipe Size
0 – 4	3/4"
4 – 8	1"
8 – 15	1 1/4"
15 – 25	1 1/2"

This ensures that the water is below 7 ft/s. At velocities of 7 ft/s or greater, the water actually starts to erode the copper pipe and fittings and could cause a leak within a fairly short time period. It is however recommended to keep velocity less than 4 ft/s to eliminate noisy pipes.

At injection pump control systems there are special considerations. Use following definitions:

Q = Design Heating Load (Btu/h)

GPM = Flow rate (gpm)

Ts = System design operating temp. (°F)

Tb = Boiler design operating temp. (°F)

6Ts = System design temperature drop (°F)

DIFR = Direct Injection Flow Ratio (a unitless ratio)

DIGPM = Design Injection Flow Rate (gpm)

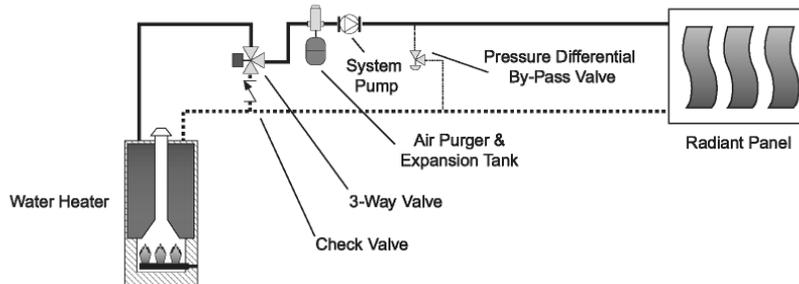
Equations:

$$GPM = Q / (500 \times 6Ts)$$

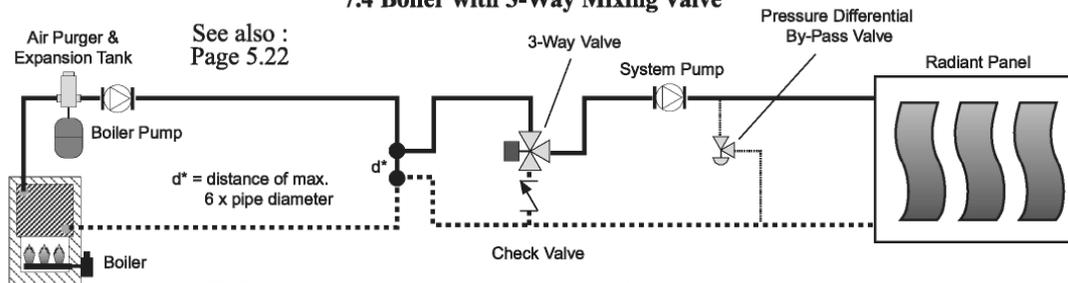
$$6Ts = Q / (500 \times GPM) \quad DIFR = 6Ts / (6Ts + Tb - Ts) \quad DIGPM = GPM \times DIFR$$

The DIGPM is used to size the Injection Pump and Pipe size. Please refer to section 8 for more information on flow and pressure drop.

7.3 Water Heater with 3-Way Mixing Valve

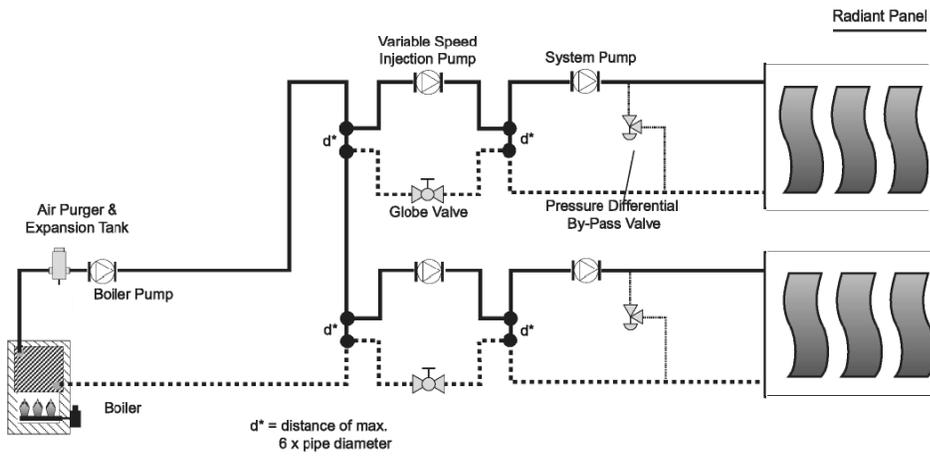


7.4 Boiler with 3-Way Mixing Valve



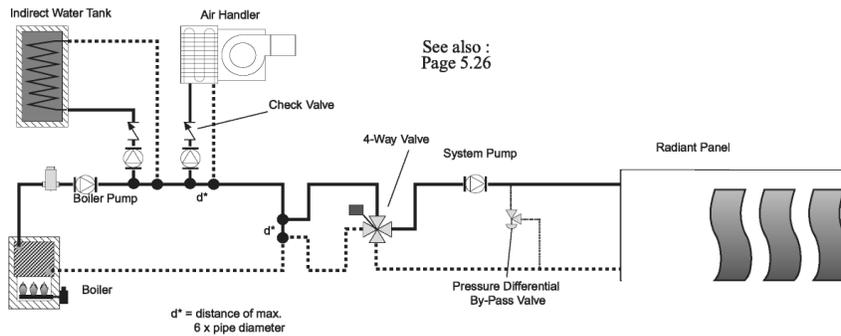
NOTE: This is a concept drawing and is not to be used for construction.
Mechanical installations should be made by a licensed trade professional.

7.8 Boiler with 2 Temperature Variable Speed Injection Pumps



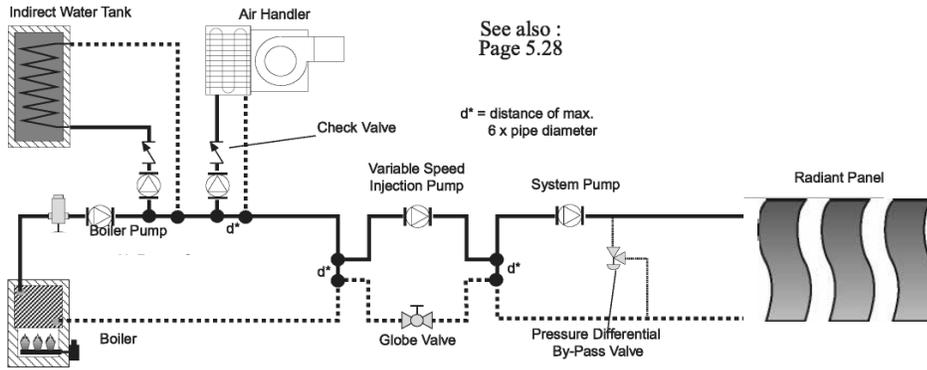
NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

7.9 Boiler with DHW, Air Handler and 4-Way Mixing Valves



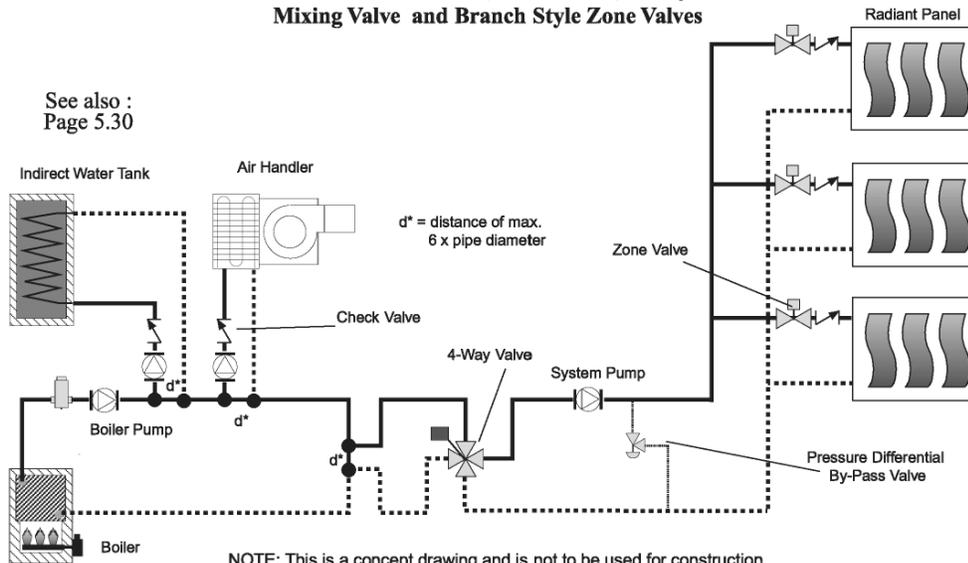
NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

7.10 Boiler with DHW, Air Handler and Variable Speed Injection Pumps



NOTE: This is a concept drawing and is not to be used for construction.
Mechanical installations should be made by a licensed trade professional.

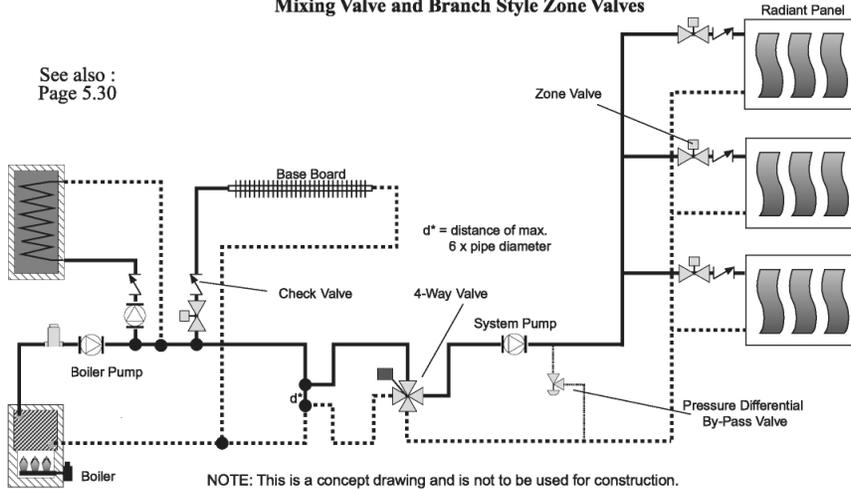
7.11 Boiler with DHW, Air Handler, 4-Way Mixing Valve and Branch Style Zone Valves



NOTE: This is a concept drawing and is not to be used for construction.

7.12 Boiler with DHW, Base Board, 4-Way Mixing Valve and Branch Style Zone Valves

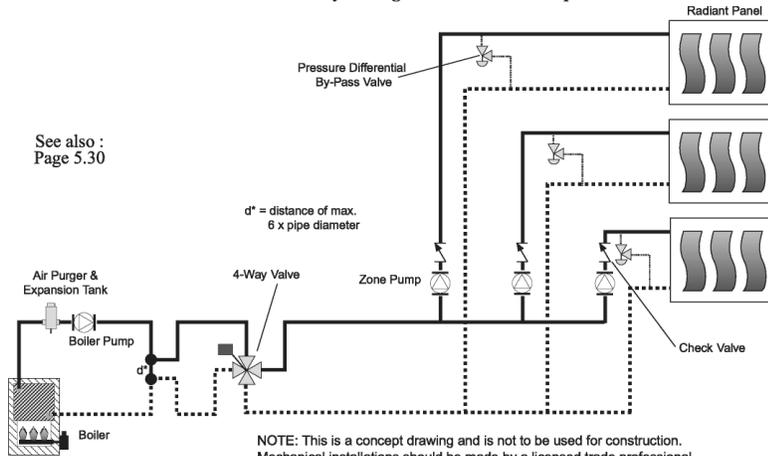
See also :
Page 5.30



NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

7.14 Boiler with 4-Way Mixing Valve and Zone Pumps

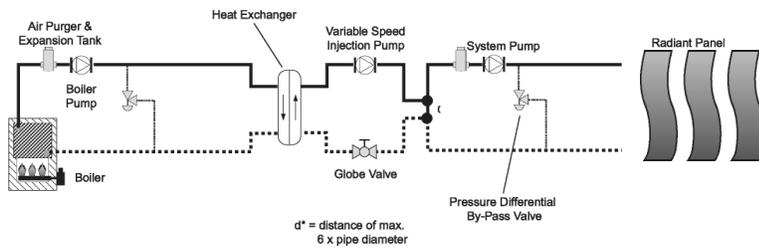
See also :
Page 5.30



NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

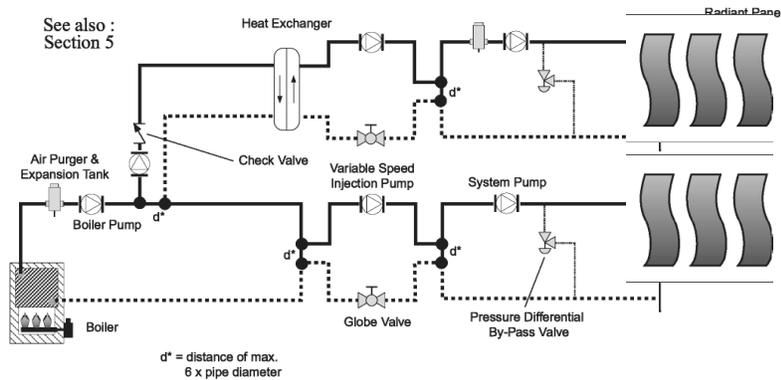
7.15 Boiler with Heat Exchanger and Variable Speed Injection Pump

See also :
Page 5.36



NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

7.16 Boiler with 2 Temperature Variable Speed Injection Pumps and Heat Exchanger



NOTE: This is a concept drawing and is not to be used for construction. Mechanical installations should be made by a licensed trade professional.

8. FORMULAS AND CHARTS

8.1 Some useful formulas

Floor surface temp. (approx.):

$$4T_{air} + \text{Heat Intensity} \div 2 \text{ (Heat Intensity expressed as Btu / (h x sq.ft.))}$$

For snowmelt, use 2.2 instead of 2 in above formula - at no wind. For snowmelt at 10 mph wind, use 3.7 instead of 2 in above formula. For ceiling heating, use 1.3 (instead of 2) in above formula.

Heat delivered in Btu/h:

$$500 \times \text{GPM} \times 64T$$

(GPM is the flow; 64T is the temperature drop over the system reviewed)

See below table for Weights (lbs/100 ft.) and Volumes (gallons/100 ft.)

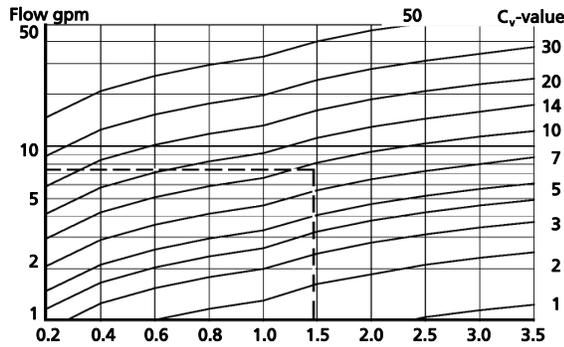
Table 8.1

Nominal size	PEX Tubing		Copper Pipe (Class M)	
	Weight	Volume	Weight	Volume
3/8	4.1	0.50	14.5	0.83
1/2	5.3	0.92	20.4	1.32
5/8	7.5	1.34		
3/4	10.1	1.84	32.8	2.69
1	16.8	3.04	46.5	4.54
1 1/4			68.2	6.81
1 1/2			94.0	9.51

2			146	16.50
---	--	--	-----	-------

The volumes above may be used to calculate total water content in a system, e t c . , but also to find water velocity in tubing. Multiply the Volume above by 0.6 to find the flow (gpm) for the velocity 1 ft./sec.

8.3 Using Cv values for Pressure Loss Calculations



The pressure drop for hydronic heating components are normally described by their Cv value. The Cv value describes at what flow (in gpm) the pressure drop over the component will be 1 psi (equal to 2.31 ft. of head). The Cv value is practical since there is also a formula to calculate the pressure drop at other flows. However, the formula is not very exact and provides only the approximate pressure loss, but this is normally adequate for sizing most systems.

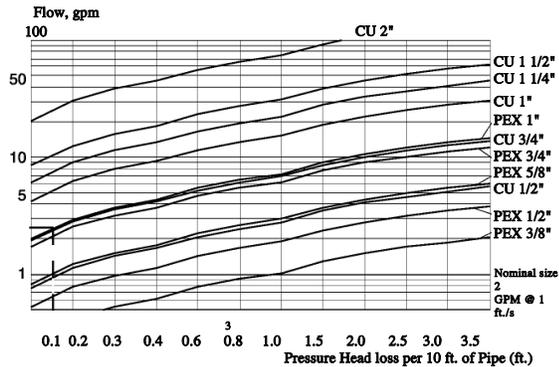
$$6P \text{ (psi)} = (\text{GPM} / \text{Cv})^2 \text{ or } 6P \text{ (ft.)} = (1.52 \times \text{GPM} / \text{Cv})^2$$

The second formula is charted above, and an example is included: Start with the flow of 7.5 gpm through the component at left. Go right until you meet with the Cv value of 9 for the component. Go straight down and read the pressure head loss 1.5 ft. Below table (8.2) lists many Cv. Although we have provided the Cv values for Pipe/Tubing we recommend that you use the chart on next page since it is more accurate.

Values. Component	Cv	Pipe/Tubing	Cv
Aquamix R; 1"	3.5	3/8" PEX; 10 ft	1.6
Powertrack; 3/4"	5.8	8 1/2" PEX; 10 ft	2.9
Powertrack; 1"	7	5/8" PEX; 10 ft	4.5
Injection Valve; 3/4"	5.9	3/4" PEX; 10 ft	9.3
Injection Valve; 1"	9.3	1" PEX; 10 ft	11
4-way Mixing Valve; 3/4"	4.7	3/4" CU Class M; 10 ft.	12
4-way Mixing Valve; 1"	9.3	1" CU Class M; 10 ft.	23
4-way Mixing Valve; 1 1/4"	21	1 1/4" CU Class M; 10 ft.	34
4-way Mixing Valve; 1 1/2"	35	1 1/2" CU Class M; 10 ft.	47
4-way Mixing Valve; 2"	50		114

Roth Radiant Heating Installation Handbook

8.4 PEX and Copper (Class M) Pressure Head loss per 10 ft.



Above chart displays the pressure drop for commonly used pipe and tubing in radiant heating systems for a wide range of flows. Application example: For a snowmelt system with 3/4" PEX the flow per loop is 2.5 gpm. The chart gives us approximately 0.16 ft. of head per 10 ft. of tubing. If the tubing loop length is 400 ft., the pressure drop will be (40 x 0.16 =) 6.4 ft.

8.5 Approximate calculation of Pressure Head Loss

Pressure head loss for PEX tubing can quite easily be approximately calculated. This method will give somewhat high results at comparatively high flows, but it is good to be on the conservative side. Table 8.3:

1: Nominal size	2: GPM @ 1 ft. /s	3: Constant
3/8	0.30	0.0159
1/2	0.55	0.0117
5/8	0.81	0.0095
3/4	1.10	0.0083
1	1.82	0.0064

- 1: Divide area heat req. (Btu/h) by 500
- 2: Divide the result by 6T to find flow, GPM
- 3: Divide GPM by column 2 value to find ft./s
- 4: Multiply ft./s by itself.
- 5: Multiply this result by column 3 value
- 6: Multiply by tubing length to get head loss

Example: You wish to install a 1/2" tubing loop in a 10 x 21 ft. room that has the longer wall exposed to the outside. 12" on center distance would give 9 tubing runs that each are 20 ft. long along the room (since you run the tubing 6" from the wall). You wish to put in 3 extra runs along the outside wall making the 6 first runs having a center distance of 6". The room heat requirement is 4,000 Btu/h and max. pressure loss is 6 ft.

1 + 2: Divide 4,000 Btu/h by 500 and then by 6T of 10°F to get a result 0.8 GPM 3: Divide 0.8 GPM by 0.55 from column 2 to get 1.45 ft./s
 4: 1.45 x 1.45 = 2.10 5: 0.0117 x 2.10 = 0.0245. This is the head loss (ft.) per ft. of tubing. 6: 240 ft. of tubing times 0.0245 is 5.9 ft. OK!

8.6 Floor coverings

Roth Radiant Heating Installation Handbook

R-values

Below table provides approximate R-Values for commonly used materials in sq.ft x h x °F / Btu. Values are approximate and should be verified with manufacturer's for exact calculations.

Table 8.4

Material / Thickness	1/8"	¼"	½"	3/8"	¾"	1"
Concrete						
Vinyl	0.2					
Ceramic Tile	0.2	0.4	0.6	0.8		
Wood	0.2	0.4	0.6	0.8	1.2	1.6
Carpets						
Synthetic	0.6	1	1.2	1.4	1.8	2.2
Wool	0.9	1.4	1.7	2	2.5	3
Cushion						
Urethane		1.1	1.6	2.1		
Hair/Jute/Fiber		1	1.5	1.9		
Waffle Rubber		0.6	1	1.3		
Slab Foam Rubber		0.3	0.5	0.6		

When materials are used on top of each other (such as Carpet + Cushion) their respective R-Values should be added.

Comments:

Rubber Tile has somewhat higher R-Values while dense Ceramic may have somewhat lower. Harder (denser) wood may have somewhat lower values. Wood laminates (which are normally quite compatible with radiant floors) have somewhat lower value than provided data. Some plush synthetic carpets may have values approaching Wool. Generally, comparatively dense materials have normally lower R-values than the standard.

The impact of coverings' R-values

Q/R	0.5	1	1.5	2	2.5
10	5	10	15	20	25
15	7	14	22	29	37
20	8	18	28	38	48
25	10	23	35	48	60
30	11	26	41	56	71
35	13	30	48	65	83

Roth Radiant Heating Installation Handbook

Above table displays approximately how much the water temperature has to be increased because of the effect of the covering material's R-Value. Left Column is the Heat Output in Btu/(h x sq.ft. x °F) and the Top Row is the R-Value of the floor covering. The temperatures are compared to no covering material at all (such as painted concrete, etc.). Derived from page 8.2 formulas.

About Wood Floor Installations

Wood floors can be successfully installed and maintained over radiant floors. The single most important consideration is the moisture content of the wood prior to installation. Wood boards or laminates may be seemingly well packaged and appear to be dry at arrival. Still, the boards may contain substantial amounts of excessive moisture. The water content must be less than 6% when installed. The wood floor should not be installed until the building has dried out completely, so the recommended timing is after the radiant floor heating system has been in operation for some time (a week, or more). The boards to be installed should be placed on the radiant floor, using spacers between all boards to allow air to circulate in between to remove excessive moisture. Forced circulation of the air will speed up the process. The storage time is dependent on the environmental conditions (temperature, humidity) and the boards characteristics (thickness, type of wood, starting moisture content) but could be between 3 to 21 days. The only safe way to know is to measure the moisture content. There are simple equipment and method descriptions available at dealers and professional installers. If above advice are followed there should be no problems with wood floors over radiant, but here are some additional pointers: High, or uneven temperatures should be avoided. So the heating control should not be on/off valves, but rather modulating controls that always provides "just enough" water temperature (typically equipped with outdoor reset control). You may also consider a shorter center distance between the tubing (such as 6 or 8 inches) to provide a very even surface temperature. For other materials we had a floor surface temperature limitation of 84°F (or 89°F where people do not stay for extended periods). But for wood floors the limitation should be around 80°F. This limits the heat output to around 30 Btu/sq.ft. at 65°F room temperature (20 Btu/sq.ft. for 70°F) for rooms with wood flooring. For higher heat outputs supplemental heat distribution may be required.

Thick boards at solid wood flooring will restrict heat and require a larger temperature difference to be established over the board. This increases the risk for uneven dryness within the wood and corresponding risk for warping or cupping. So we suggest restricting the thickness to below 3/4" at solid wood flooring. Laminated wood floors and similar "engineered wood" flooring are becoming increasingly popular and can be used with less restrictions than solid wood flooring in radiant systems. For solid wood floors Oak, Mesquite, Teak, Walnut, and Cherry are most stable. For less stable wood materials board widths of maximum 2 1/4" are recommended. Keeping both width and thickness of boards down will help to keep the floor beautiful over the years!



Roth's success is the result of product flexibility, targeted investments and theme-oriented solutions. Our growth stems from continuous research and the development of new and innovative products. The keys to our success in manufacturing include know-how, modern production sites and equipment, the very latest production technologies, and highly motivated personnel.



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