

# VRV REFERENCE GUIDE





## DAIKIN: THE PREMIUM BRAND INDUSTRY LEADER

Daikin Industries, Ltd. (DIL) is a global Fortune 1,000 company which celebrated its 90th anniversary in May 2014. The company is recognized as the largest HVAC (Heating, Ventilating, Air Conditioning) manufacturer in the world. DIL is primarily engaged in developing indoor comfort products and systems and refrigeration products for residential, commercial and industrial applications. Its consistent success is derived, in part, from a focus on innovative, energy-efficient and premium quality indoor climate and comfort management solutions.

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**LARGEST**   
MANUFACTURER  
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CONDITIONING SALES

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PRODUCES PRODUCTS IN OVER  
**60 COUNTRIES**  
SALES IN OVER 140

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*VRV*



# The Features of VRV

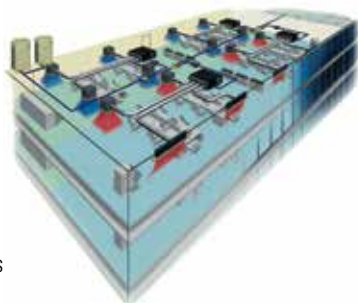
## *Features & Benefits to Using VRV*

A VRV system is similar to a chiller but circulates refrigerant to each zone instead of water

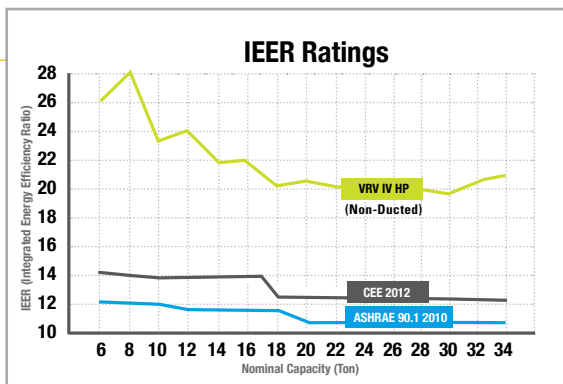
A VRV heat pump system has performance and design attributes similar to a 2 pipe chiller

A VRV heat recovery system has performance and design attributes similar to a 4 pipe chiller system

- Industry Leadership since 1982, VRV is a registered TM
- 8 development series and 4 generations of VRV technology
- Scalable project opportunities with modular design
- Broad coverage of most vertical markets and climates
- Tested and Rated in accordance with AHRI Std 1230
- Individual zone control for Advanced zoning capabilities
- Can operate up to 64 indoor fan coil units
- Auto charging function
- Continuous heating during defrost operation
- Flexible piping limitations to meet a variety of building needs
- Excellent energy efficiency, especially at part load conditions (IEER)
- Daikin's optimized scroll compressor designed for R-410A provides a quiet, reliable energy-efficient operation
- Anti-corrosion treatment standard on exterior metal parts and heat exchanger
- Fully compatible with the complete Daikin control suite including iTC, and iTM
- Tie in to open protocol Building Automation systems through LONWORKS® and BACnet® gateways
- 10-Year Limited Parts Warranty\*



\* Complete warranty details are available from your local Daikin manufacturer's representative or distributor or online at [www.daikincomfort.com](http://www.daikincomfort.com).





Take advantage of the VRV attributes	DORMS	OFFICES	MULTI FAMILY HOUSING	SCHOOL	RESTAURANT	RETAIL / STORES	BANK	HEALTHCARE	SKILLED CARE / ASSISTED LIVING	CHURCH	HOTELS	PUBLIC BUILDINGS
EFFICIENCY	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LEED, TAX CREDITS, ETC.	✓	✓	✓	✓				✓		✓	✓	✓
SOUND	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MAINTENANCE	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
INSTALLATION EASE	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ELECTRICAL BENEFITS	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
STRUCTURAL BENEFITS	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
1ST COST	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓

# Key Points for Selection

## Rules of Thumb to Optimize Selection

### VRV System Selection - Rules of Thumb

Unit Type	Selection Scope	Selection Approach
	<b>PEAK Load</b>	<b>Indoor units</b> should be sized to deliver the PEAK loads (total & sensible) of the area it is to serve, at the entering air design conditions determined by the building load calculations
	<b>BLOCK Load</b>	<b>Outdoor units</b> should be selected to meet the BLOCK Cooling & Heating capacities (Maximum Combined Peak Load at a given time of day) determined by the same LOAD Calculations

### VRV System Selection - Diversity / Connection Index

Diversity, and how much can be allowed, is subjective. VRV systems can be designed to take into account building & load zone diversity but the following defined limitations should be observed:

$$\text{Combination Ratio \%} = \frac{\text{Total capacity index of connected indoor units}}{\text{Capacity Index of the condensing unit}}$$



	VRV IV Heat Pump & Heat Recovery			VRV-III	VRV-S
System Limits	Using FXTQ	FXDQ, FXMQ, FXAQ	All other models	All Indoor Units	
Single	130%	200%*	200%*	> 130% thermo-ON	130%
Dual Module			160%*		N/A
Triple Module			130%		N/A

*\* On VRV-III, if systems operated >130% indoor unit thermo-ON, all FCU were set to low fan speed. On VRV IV this function can now be overridden at commissioning stage*

*\* For FXFQ 07, 09 connection ratio is limited to 130%*

Indoor Unit Size	07	09	12	15	18	24	30	36	48	54	72	96
Indoor Unit Capacity Index	7.5	9.5	12	15	18	24	30	36	48	54	72	96

## VRV System Selection - Avoid the common pitfalls

Common Mistake	Best Practice
Thinking VRV is just a “big” multi split DX system	VRV is a chiller circulating refrigerant instead of water
It’s a Zoning system thus an Indoor unit in EVERY room	Design VRV systems using same approach as VAV or WSHP
VRV is a “Ductless System”	More than 55% of units used in North America are Ducted types!
Upgrade Indoor Units to the next capacity size	Use accurate load calc values and trust selection software
Optimum selection of Controls is not important	Be knowledgeable on controls capabilities – minimize BAS or even elimination of BAS is often possible
The entire application needs to be VRV	Use VRV where it makes sense for the customer & project

# Capacity Range & Operating Limits

## ODU Capacity Range & Piping Limitations

### Outdoor Unit Range

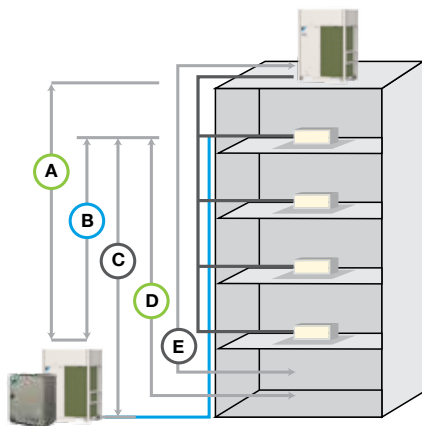
**VRV IV**

Capacity MBH (Tn)	Voltage	Type	# of Modules	# of Compressors	Index Range MIN - 130% - MAX	Max. # IDU
36 (3)	1/208-230/60Hz	HEAT PUMP			18 - 43	6
48 (4)					24 - 62	8
72 (6)					36 - 93 - (144)	12
96 (8)	3/208-230V/60Hz 3/460V/60Hz	HEAT RECOVERY	1	1	48 - 124 - (192)	16
120 (10)				2	60 - 156 - (240)	20
144 (12)			2	2	72 - 187 - (288)	25
168 (14)				3	84 - 218 - (312)	29
192 (16)			3	3	96 - 249 - (384)	33
216 (18)				4	108 - 280 - (432)	37
240 (20)			4	4	120 - 312 - (480)	41
264 (22)				5	132 - 343 - (528)	45
288 (24)			5	5	144 - 374 - (576)	49
312 (26)				6	156 - 405 - (624)	54
336 (28)			6	6	168 - 436 - (672)	58
360 (30)				7	180 - 468 - (720)	62
384 (32)			7	7	192 - 499 - (768)	64
408 (34)				8	204 - 530 - (816)	64
432 (36)			8	8	216 - 562 - (864)	64
456 (38)				9	228 - 593 - (912)	64

### VRV VIII

Capacity	Voltage	Type	# of Modules	# of Compressors	Index Range	Max. # IDU
72 (6)	3/208-230V/60Hz 3/460V/60Hz	Unified HP or HR	1	1	36 - 93	12
84 (7)			1	1	42 - 109	14
144 (12)			2	2	72 - 187	20
168 (14)			2	2	84 - 218	20
216 (18)			3	3	108 - 280	22
252 (21)			3	3	126 - 327	32

## Refrigerant Piping Limitations



Liquid Line Max (feet)	VRV-IV Heat Pump	VRV-IV Heat Recovery	VRV-WIII Water Cooled	VRV-S Heat Pump
<b>A</b> Vertical Drop	164 (295)*	164 (295)*	164	164
<b>B</b> Between IDU	100	49 (100)†	49	49
<b>C</b> Vertical Rise	130 (295)*	130 (295)*	130	130
<b>D</b> From 1st Joint	130 (295)**	130 (295)**	130 (295)**	130
<b>E</b> Linear Length	540	540	390	492
Total Network	3280	3280	980	984

*\*Setting adjustment on condensing unit required.*

*\*\*Fan coil distance differentials need to be met*

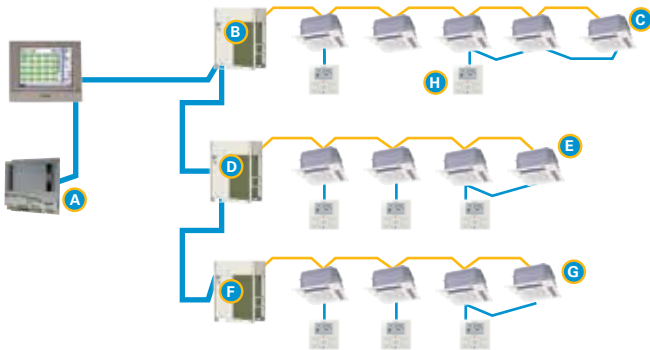
*†Noise considerations to be mitigated with setting adjustment on ODU when pipe length from ODU to IDU exceeds 390ft.*

# Capacity Range & Operating Limits (cont.)

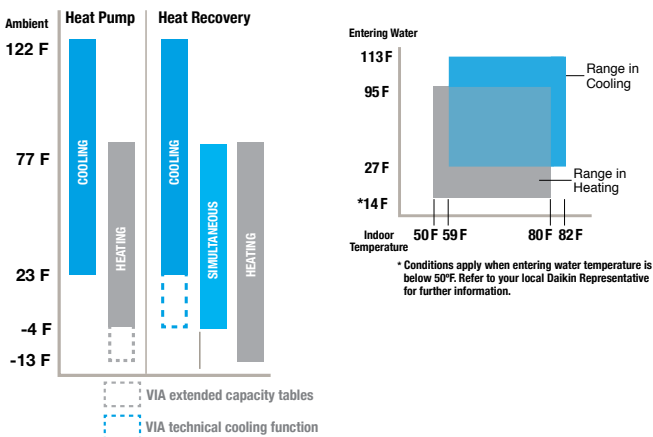
Communication Wiring should be 18-2AWG stranded,  
no polarity, no shielding

maximum linear distance = 3280ft, maximum total distance = 6560ft

- Maximum linear distance in the example below is the longest of either (A) to (C), (A) to (E), (A) to (G) or (C) to (G)
- Maximum total distance is (A to F) + (B to C) + (D to E) + (F to G)
- Each local controller (H to C) can run up to a distance of 1640ft


























## Temperature Limits



# Indoor Unit Range

Sizes & Accessories Available of all IDU's

A Complete Line up of VRV Indoor Units

TYPE	MODEL		UNIT SIZES						
Round-flow Ceiling mounted cassette	FXFQ-T			07	09	12	15	07-Size Available	
				18	24	30	36		
				48					
4 way blow ceiling mounted cassette	FXZQ			07	09	12	15	= Pump Options	
				18					
Under Ceiling Mounted Cassette	FXUQ			18	24	30	36		
Slim Ducted Ceiling Concealed	FXDQ			07	09	12		= Filter Options	
				18	24				
DC Ducted Concealed Ceiling	FXMQ_PA			07	09	12	15	= Filter Options	
				18	24	30	36		
				48	54				
Large Capacity Ceiling Concealed	FXMQ_M						72	96	= OA Connection
Flat Panel Wall Mounted	FXAQ			07	09	12		= OA Connection	
				18	24				
Ceiling Suspended	FXHQ					12		= Pump Included	
					24		36		
Floor Mounted	FXLQ			18	24			= Pump Included	
Concealed Floor Standing	FXNQ					12		= Filter Included	
				18	24				
Multi Position AHU	FXTQ					12		= Filter Included	
				18	24	30	36		
				48	54				

42 model available in this family








## Indoor Unit Range (cont.)

Optional Indoor Unit Accessories available to enhance your Daikin VRV solution:

Options	FXAQ	FXDQ	FXFQ-T	FXHQ	FXLQ	FXMQ-PA	FXMQ-M	FXNQ	FXTQ	FXZQ	FXUQ
MERV 8 Filters							✓				
MERV 13 Filters			✓			✓	✓				
Economizer Option						✓	✓				
DZK (Zoning Kit)						✓					
OA Connection Kit			✓							✓	
AUX Heat Adaptor PCB		✓	✓	✓	✓	✓	✓	✓	STD	✓	✓
Humidifier Adaptor PCB		✓	✓	✓	✓	✓	✓	✓	STD	✓	✓
Electric Heater Kits									✓		
Self Cleaning Filter (VRV IV only)			✓								
Presence Sensor			✓								✓

# Solutions for Ventilation

Range & Limitations of our Ventilation Options

CFM	0	500	1000	1500	2000	2500	3000	5000	7500	10000+	
Daikin	VAM -300-1200 Energy Recovery Ventilator										
	FXMQ_MF OA Processing										
	Applied AHU Integration Kit (2 -8ton)				Interlaced Coil (Up to 16-ton)			 			
Daikin Applied	Destiny AHU Only 600-15000 cfm options										
	Vision AHU Only 900-100,000 cfm options										
	Rebel Rooftop (DOAS) 6-15 tons – 900 - 5500 cfm										
									Maverick II Rooftop (DOAS) 15-75 Ton or 4500 - 23,000 cfm		

Coming in 2015

SYSTEM OVERVIEW

SYSTEM SELECTION

DESIGN OPTIMIZATION

CONTROLS AND STANDARDS

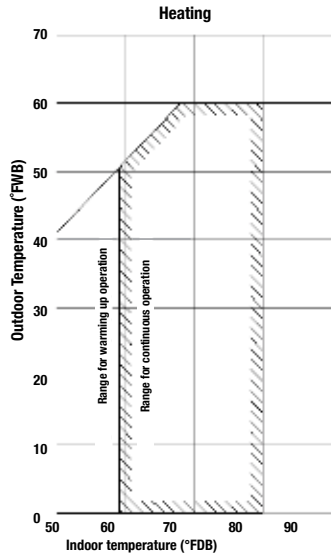
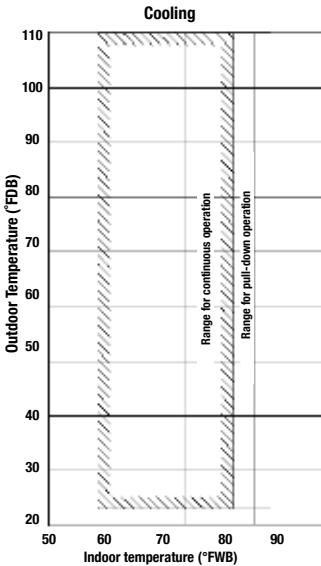
# Solutions for Ventilation

## Ventilation Air % – Rule of Thumb

Typically Daikin equipment has been applied using a standard rule of thumb that a maximum of 20% OA should be used for ducted fan coil units (FXMQ, FXDQ and FXNQ). However, this practice is not always applicable as this rule of thumb is based upon introducing OA at nominal conditions.

### Basic Rules

- 1. COOLING:** Any percentage of OA can be used as long as the resulting mixed air is between 57 and 77°FWB and 80% RH or lower.
- 2. HEATING:** Any percentage of OA can be used as long as the resulting mixed air is between 59 and 80°FDB and 80% RH or lower.



**Note:** Space temperature sensing should be done via the room zone controller or remote sensor kit if a “mixed air” approach is taken.



## OA / Ventilation considerations

Method	Scope	Options	EA Limits	Connection Limits
Direct	<ol style="list-style-type: none"> <li>Untreated ventilation is supplied directly to the indoor unit</li> <li>Small projects where low CFM volumes are required</li> <li>Projects with budget constraints</li> <li>Suitable for mild climates</li> </ol>	FXMQ FXDQ FXNQ FXTQ FXFQ FXZQ	Cooling: 57°–77°FWB  Heating: 59°F–80°FDB	<ol style="list-style-type: none"> <li>Units with OA connection (Ducted, Cassettes)</li> <li>Consider Booster Fan &amp; OA % scope</li> </ol>
Integrated	<ol style="list-style-type: none"> <li>Pretreated ventilation is supplied directly to the indoor unit</li> <li>Small to medium applications</li> <li>Suitable for all climates</li> <li>Allows for sharing load between ventilation system and VRV system</li> </ol>	VAM FXMQ-MF EKEXV	5°F–122°FDB  23°FDB–90°FWB (50°FDB–82°FWB)  MCB=50°FDB–77°FWB FCB=23°FDB–95°FDB	No Limits  50 - 100 - (130)% 10 - 30 - (50)%  MCB = 50 - 110% FCB = 90 - 110%
Separate (de-coupled)	<ol style="list-style-type: none"> <li>Pretreated ventilation directly to the space</li> <li>Suitable for all applications and climates</li> <li>Allows for sharing load between ventilation system and VRV system</li> <li>Most flexible layout</li> </ol>	EKEXV  Destiny Vision Rebel Maverick	MCB=50°FDB–77°FWB FCB=23°FDB–95°FDB  <b>Select options based on manufacturer guidelines.</b>  <b>Integrate controls where it makes sense.</b>	MCB = 50 - 110% FCB = 90 - 110%

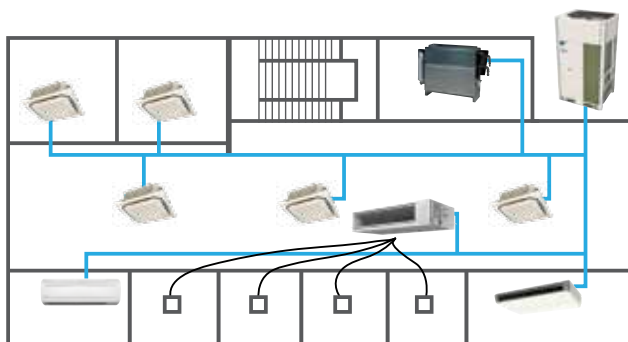
*VRV*

SYSTEM SELECTION



## Indoor Unit Considerations

*Features & Benefits of each IDU type*



One of the first considerations at VRV design stage is to decide what fan coil units best serve the project. If FCU type has not been specified, each area to be conditioned should be looked at separately.




Where specific FCU requirements have not been established, listed here are some of the main criteria to consider:

**DUCTED** units offer the ultimate in flexibility of design, air distribution and integration of ventilation. It also tends to be the most expensive installed cost option. However cost can be minimized by serving multiple rooms with a single unit - the loss of individual room units can be countered with thoughtful control design.

### Considerations:

- Is there a ceiling void space?
- What is the height of the void space?
- What level of ESP is likely to be required
- Is there a requirement to introduce ventilation into the space via the FCU?
- What level of control is required?

**Note:** Multiple rooms can be served by one unit (See DZK control section)

Ducted Range		Model	Height	Max. WG	Typical O.A.
	<b>FXMQ-PA</b>	07 ~ 15	11 13/16"	0.40"	20% of unit AFR
		18 ~ 48		0.80"	
		54		0.56"	
	<b>FXDQ</b>	07 ~ 12	7 7/8"	0.12"	
		18 ~ 24		0.17"	
	<b>FXMQ-M</b>	15	18 1/8"	0.8"	
		72 ~ 96		0.95" (1.1" 230V)	
<b>Application Examples:</b>	<b>FXMQ-P</b>	Most applications – multiple room zoning			
	<b>FXMQ-M</b>	Large open plan areas – high ESP requirements			
	<b>FXDQ</b>	Bulkheads – hotels – assisted living			




## Indoor Unit Considerations

**CASSETTE** provide the best combination of economic installation with a good level of flexible project design. Fresh air supply is possible but limited

**Note:** In hard-board ceilings, service hatches are required

### Considerations:

- Is there a ceiling void space?
- What is the height of the void space?
- What type of ceiling (grid or hardboard)?
- Is there a requirement to introduce fresh air?

Cassette Range		Model	Height	Air Throw	Typical O.A.
	<b>FXZQ</b>	All	11 13/16"	12ft (per outlet)	3% of unit AFR
	<b>FXFQ</b>	09 ~ 30	9 11/16"	12ft (per outlet)	20% of unit AFR*
		36 ~ 48	11 5/16"		
	<b>FXUQ</b>	18 ~ 24	7 13/16"	12ft (per outlet)	N/A
		30 ~ 36	7 13/16"	14ft (per outlet)	



\*requires outdoor air kit

Application Examples:	FXZQ	small offices – 2' x 2' ceiling grids
	FXFQ	large open plan areas – shallow void spaces
	FXUQ	retail outlets – restricted or no void spaces

**CONCEALED** units offer the opportunity to hide away the equipment when there is no ceiling void but the client does not wish to use exposed units or else has similar equipment existing and sees the benefit of retro fitting with minimum disruption and expense. In areas where heating is the primary role of the system, floor standing units are sometimes installed around the perimeter of a building for optimum air flow.

### Considerations:

- Is there an existing unitary type system?
- Is heating the primary requirement?
- Does the client prefer not to 'see' the units?
- Is there a requirement to introduce fresh air?

Concealed	Model	Height	Max. WG	Typical O.A.	
	<b>FXNQ</b>	All	24	Minimal	10% AFR*
	<b>FXTQ</b>	12 - 18	46 3/4"	0.50"	20% AFR
		24 - 54	53 1/4"		
<b>Application Examples:</b>	FXNQ	Perimeter heating – hallways			
	FXTQ	Condo's – closet spaces – retrofits			




\*Via underside - no duct

## Indoor Unit Considerations (cont.)

**EXPOSED** units usually offer the client the most economical installed cost solution on a VRV system. These types of units are most often used when there are budget constraints or where an area has no void space/enclosure to conceal other unit types. None of these units have integral condensate pumps fitted.

### Considerations:

- How big is the space?
- Where can the unit be located?
- Is piping / condensate run clear?
- Is the client accepting of exposed units?

Exposed Units	Model	Approx. Air Throw	Max. WG	Typical O.A.	
	<b>FXHQ</b>	<b>All</b>	<b>20'</b>	<b>N/A</b>	<b>NONE</b>
	<b>FXAQ</b>	<b>All</b>	<b>13'</b>		
	<b>FXLQ</b>	<b>All</b>	<b>7'</b>		

<b>Application Examples:</b>	<b>FXHQ</b>	<b>Classrooms – retail – restaurants</b>
	<b>FXAQ</b>	<b>Hotels – small offices</b>
	<b>FXLQ</b>	<b>Perimeter heating – condos – churches</b>



# Zoning VRV systems with DZK

## VRV Meets VAV - Features & Benefits



### DZK - Daikin Zoning Kit

The DZK solution increases the flexibility of VRV applications by allowing multiple zones to be served by one indoor unit fan coil while still providing individual temperature control.

Up to 6 separate dampers supply variable air flow to the zones in response to individual zone thermostats.

### Zoning Box

The zoning box is a plenum with motorized dampers that constantly modulate the conditioned air flow into each zone through standard ductwork, in response to the demand from the individual zone thermostat.



### Main Thermostat

The main thermostat is a wired color touch display master unit used to configure the DZK system. It can also be used as the thermostat for one or all of the zones.

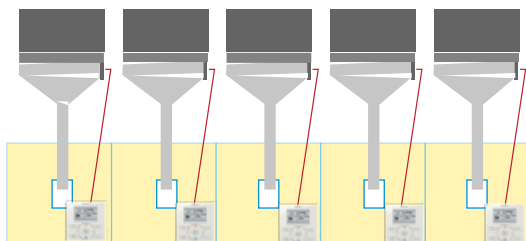
### Zone Thermostat

The zone thermostat is a wireless, battery powered, touch display unit that is used for one zone. Each zone thermostat monitors and allows the user to select a comfortable room temperature, and program or adjust the control functions for the room.



## Zoning VRV systems with DZK (cont.)

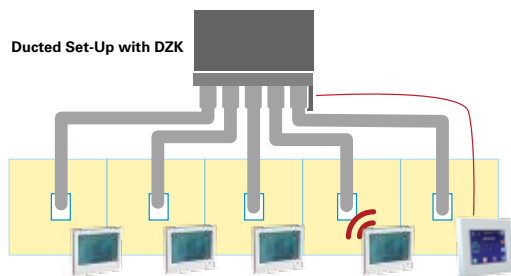
Standard Ducted Set-Up



### Advantages

- Reduces system hardware cost - fewer Indoor units required
- Increases comfort levels by allowing more individual zone control
- Reduces installation expense and maintenance costs
- Reduces the amount of refrigerant required in the installation
- Increases the flexibility of the VRV application design

Ducted Set-Up with DZK



Product Reference	Zoning Box Range			
	DZK030E4	DZK030E5	DZK048E4	DZK048E6
Compatible Ducted Unit	FXMQ15PA ~ FXMQ24PA		FXMQ30PA ~ FXMQ54PA	
No. of Air Duct Outlets	4 x $\varnothing 8''$	5 x $\varnothing 6''$	4 x $\varnothing 8''$	6 x $\varnothing 6''$
Number of Zones	2 to 4	2 to 5	2 to 4	2 to 6

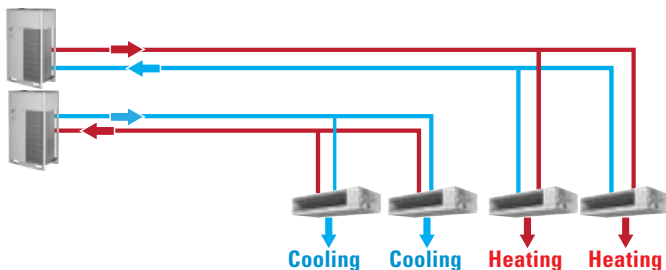
**Note:** The FXMQ indoor unit must still be connected to a BRC1E72 room controller

# Heat Pump or Heat Recovery?

## The Various Heat/Cool Changeover Options

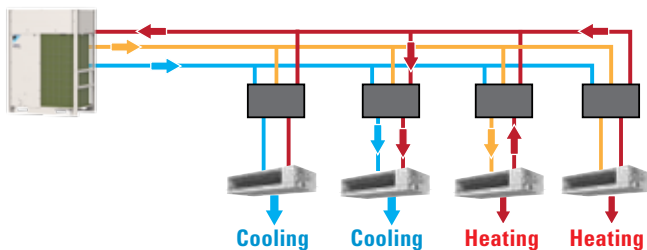
### Heat Pump

- The 2 pipe Heat Pump system is the equivalent of a 2-pipe chilled water system
- A heat pump system provides the means of heating OR cooling at any given time
- Multiple heat pump systems can be zoned and will work independently of each other
- When demand is met by an indoor unit the unit will work on fan only or the fan will cycle on/off until demand returns or mode change occurs



### Heat Recovery

- The 3 pipe Heat Recovery system is the equivalent of a 4-pipe chilled water system
- A heat recovery system has the ability to provide simultaneous heating AND cooling
- When both heating and cooling occur simultaneously, system and building energy can be better utilized
- When demand is met by an indoor unit the unit will work on fan only or the fan will cycle on/off until demand returns



## Heat Pump or Heat Recovery? (cont.)

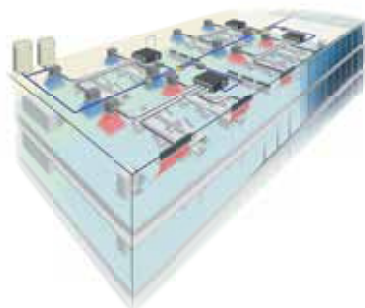
### Should I Use Heat Pump or Heat Recovery?

There are **three** main factors that dictate whether a HP or HR system should be selected. **All** these factors should be considered in each case to determine an appropriate selection:

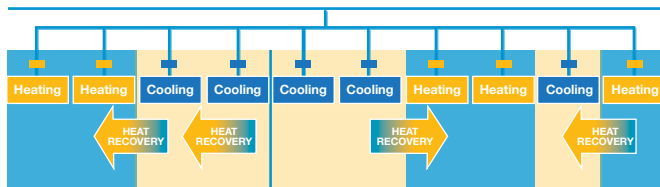


**GEOGRAPHY** The location of the project will often dictate what type of system will be required. Projects in temperate climates tend to use Heat Recovery due to the changeable load demands that can occur through the course of a day. However areas with defined seasons or little demand for simultaneous heating or cooling throughout the year will usually utilize Heat Pump.

**BUILDING LAYOUT** Sites with open plan areas and/or similar orientation will often be satisfied by a heat pump system, irrespective of geography. On the other hand, if the site has many aspects, individual rooms and/or heat loads, this may define the client requirement toward heat recovery. Differing internal room load demands may see the need for cooling for longer periods of the year.



**OCCUPANCY** The type of end user will often trump any other consideration. Typically a multi-tenanted site will require a heat recovery system as the ability for individual mode control is paramount. Typical examples of this include hotels, assisted living, condos as well as offices. It is always important to establish from the outset if an office application is to have multiple tenants.



*Ultimately there are many applications where the answer will be both Heat Pump AND Heat Recovery*

# Air Cooled or Water Cooled?

## Factors that Benefit the use of VRV-W

Air to air VRV systems make up the majority of VRV installations This is due to the following:

- Ease of installation (no water system required)
- Less initial capital costs

However Water Cooled VRV can have certain advantages:

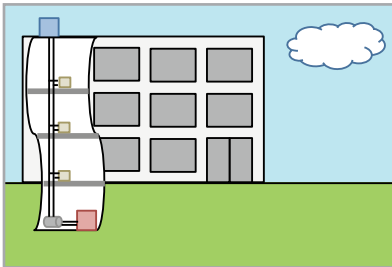
- Greater energy efficiencies
- Localized CU installation (reduced pipe runs)

These advantages come in to play when the following are present:

- An existing chilled water loop
- Extreme ambient conditions
- An ability & desire to utilize a local geothermal source



## Water Cooled VRV - Existing Water Loop

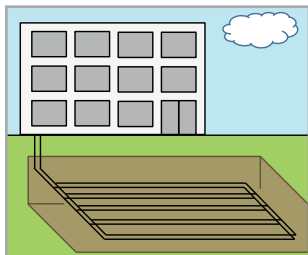


Bell & Tower Water Loop

By utilizing an existing water loop in the building, the advantages of greater energy efficiency can be promoted without having to offset capital costs. In addition VRV-W CUs are usually located locally to the area they are serving and will typically attach to the water loop already

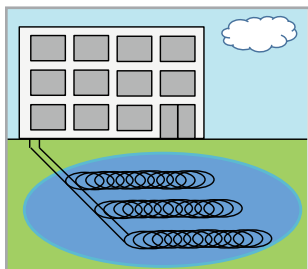
running through the building. This negates the need to run copper piping through risers to a remote plant space (be aware that VRV-W CUs are internal mounting units).

## Water Cooled VRV - Geothermal



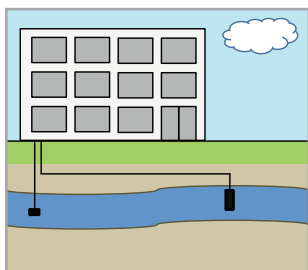
*Closed Loop Buried in Ground*

A ground-source VRV heat pump system combines the advantages of both technologies into one system, making it one of the most efficient HVAC systems available and achieving savings over either GSHP or VRF on their own. The constant ambient conditions below ground also ensure that these savings are realized year round.



*Closed Loop in Surface Water*

There are two main types of systems: closed loop and open loop. Closed loops bury water pipes either in solid ground or in a water source (like a pond or lake). An open loop draws from groundwater, like a well, and returns it back to source.



*Open Loop using Ground Water*

## Air Cooled or Water Cooled? (cont.)

### Design Criteria:

Water loop design is by the engineer however two facts are needed from Daikin - the minimum & maximum entering water temperatures (*27°F/113°F Cooling ~ 14°F/95°F Heating*) and an acceptable water flow rate (*13.2gpm to 39gpm per module Boiler & Tower System ~ 21gpm to 39gpm per module on a Geothermal System*).

\*(Be aware that conditions need to be met when EWT for heating is required below 50°F – seek assistance for these applications)

When VRV is to be applied with an open loop system, a 3rd party heat exchanger is required to ensure the plate heat exchanger of the VRV condensing unit works on a closed loop system.

The VRV condensing units have a heat output of approx. 2400btu's. Where multiple units are placed in an enclosed area, any potential heat build up must be addressed (either with adequate ventilation or even a fan coil unit).

From the CU pipe connection to the fan coils, the equipment, controls & selection process is identical to air cooled VRV.



DESIGN OPTIMIZATION

DAIKIN



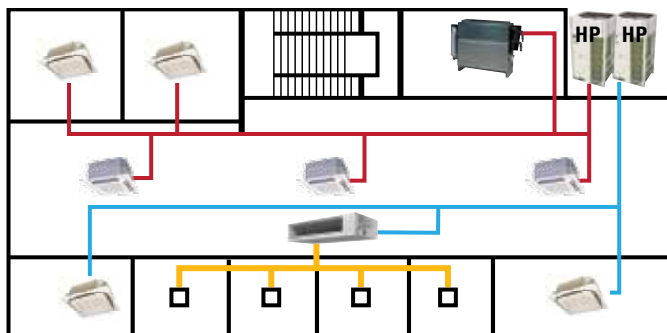
# System Zoning

*Guideline to Optimized Zoning of Systems*



## Typical Zoning of Heat Pump

When more than one system is required, it is good practice to zone units that are positioned on the same orientation or are subject to common load profiles. This maximizes the scope for correct heating/cooling demands to be met.

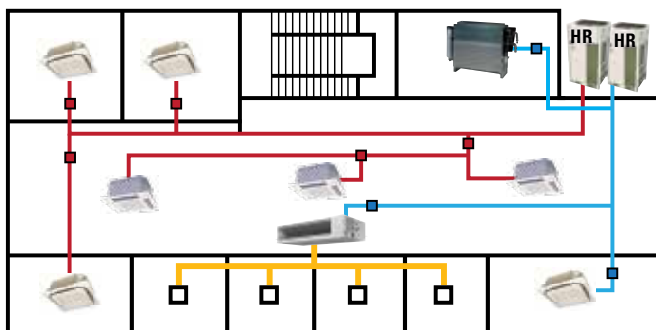




## Typical Zoning of Heat Recovery

Conversely, with heat recovery it is better to ensure that units on different orientations are matched together. This ensures more potential for heat recovery to occur at any given time and thereby optimizing energy savings.

**Note:** FCU Performance is not affected by varying indoor unit combinations.



**Note:** Changing systems from HR to HP through the design process is not uncommon. It does NOT affect initial indoor unit selection; however, re-zoning of fan coil units is usually required.

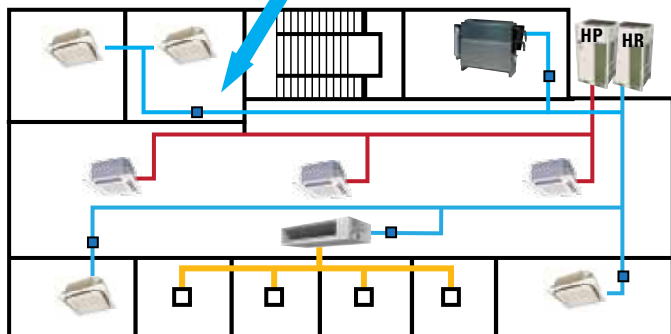
## System Zoning (cont.)



### Optimized (mixed)

It is important to avoid defining a project as a 'heat recovery job' or 'heat pump job'. There are often applications where a mixture of both types is the best design practice - and can reduce costs to the client.

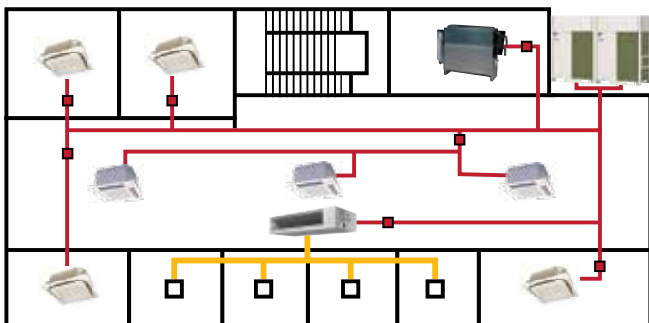
**Note:** The use of heat recovery does not always mean a branch selector box for each for each indoor unit or even each area – this is a good way to reduce costs further without compromising flexibility.





## When to use MULTIPLE MODULES

There are several advantages to linking VRV condensing units together: Less piping & total refrigerant needs, superior efficiencies due to more outdoor unit heat exchange surface area at partial load and a greater likelihood of heat recovery (on 3-pipe) to occur due to increase in varying zones on the system.



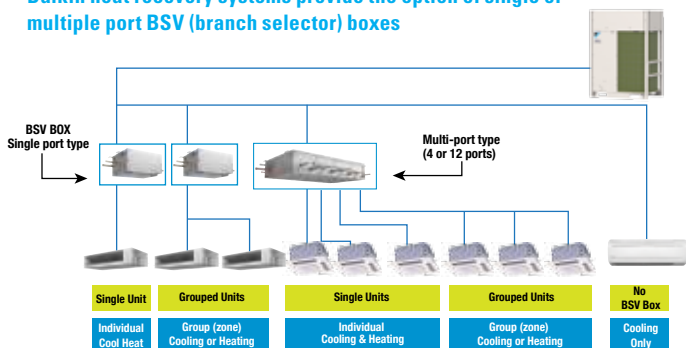
**Note:** This design option is often overlooked due to refrigerant limitations in small spaces set by ASRAE Std. 15

Current ASHRAE Std.34 Regulations: 26lbs of R410A refrigerant per 1000ft<sup>3</sup> (0.026lbs/ft<sup>3</sup>) in normal occupancies.









# Branch Selector Boxes

## Overview of BSV Box Range & Features

Daikin heat recovery systems provide the option of single or multiple port BSV (branch selector) boxes



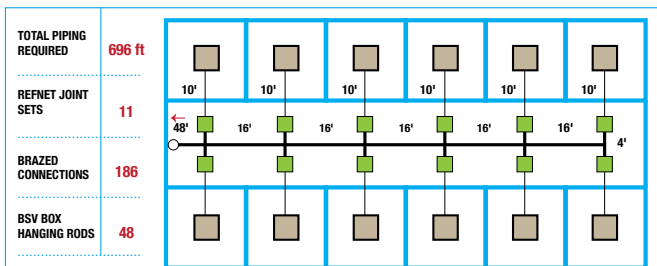
**Note:** When multiple units are grouped together on a single port, although a single heat/cool zone is created, units still operate independent of each other irrespective of whether they are grouped together on one room controller or individual controllers.

Model		Max units per Port	Max capacity per port
<b>BSVQ36</b>		<b>4</b>	<b>36 MBH</b>
<b>BSVQ60</b>		<b>8</b>	<b>60 MBH</b>
<b>BSVQ96</b>		<b>8</b>	<b>96 MBH</b>
<b>BS4Q54</b>		<b>5</b>	<b>54 MBH</b>
<b>BS6Q54</b>		<b>5</b>	<b>54 MBH</b>
<b>BS8Q54</b>		<b>5</b>	<b>54 MBH</b>
<b>BS10Q54</b>		<b>5</b>	<b>54 MBH</b>
<b>BS12Q54</b>		<b>5</b>	<b>54 MBH`</b>

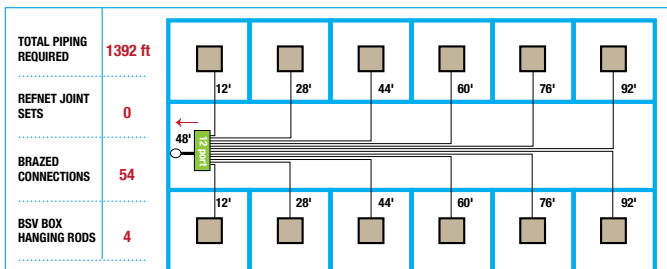
# Single or Multi BSV Boxes?

## Optimized Selection of BSV Boxes

When selecting **HEAT RECOVERY BRANCH SELECTOR BOXES** there is a limitless number of ways to group indoor units



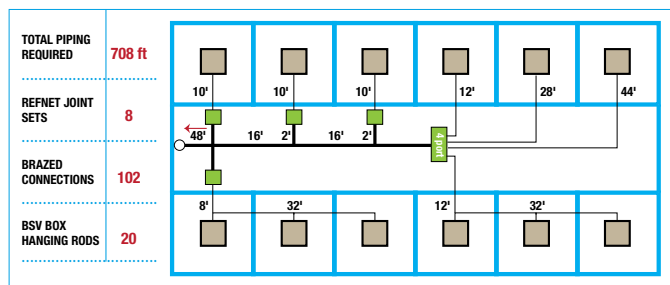
Using single port boxes provides the ultimate in flexibility for branch box location. This method ensures a much reduced total piping. It also significantly reduces the amount of refrigerant required in the system – critical if the allowable level of refrigerant is a major factor



...however, if it is possible to incorporate multiport boxes, a reduction in installation costs can be realized. This example, using a single 12 port multi-box, requires no refnet joints and demonstrates a marked reduction in brazed connections and hanging rods



## Single or Multi BSV Boxes? (cont.)



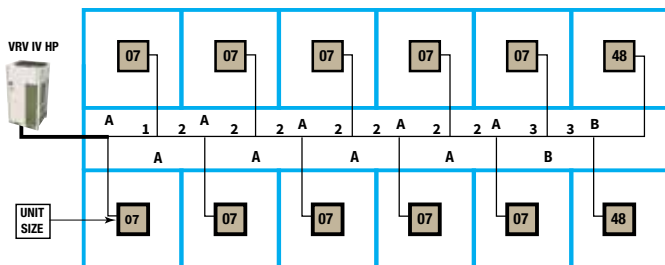
As shown in this scenario, being able to select single or multiple BSV boxes, in addition to zoning some units together on a single port, Daikin heat recovery allows the ultimate in flexibility, even on a single system.



# Piping Sizes and Optimization

## Tips to Reducing Pipe & Joint Sizes

A factor not often considered before installation is establishing an optimum pipe route. This can be due to the limited choice of riser or outdoor unit location. However, establishing an optimum pipe route and order of unit attachment can realize significant reduction in both pipe & REFNET joint sizes.



Piping Required*	REFNETs Required
2 sets of - 3/4 & 5/8	9 sets of size <u>72</u>
7 sets of - 3/4 & 1/2	2 sets of size <u>33</u>
2 sets of - 3/4 & 3/8	0 sets of size <u>22</u>
0 sets of - 5/8 & 3/8	

Shown here and on the following page are two options of piping connection for the same scenario. Pipes & joints are sized for units being served 'downstream'. By simply having the main pipe from the outdoor unit cut in at a different location on the circuit, there is a marked decrease in joint & pipe sizes and therefore install costs.

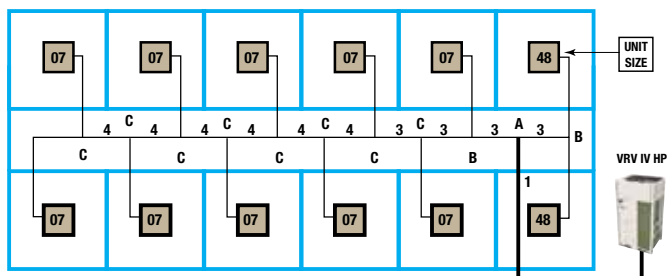
Refnet Size
<b>A</b> KHRP26M72TU
<b>B</b> KHRP26A33T
<b>C</b> KHRP26A22T



Pipe Sizes*
1 3/4 & 5/8
2 3/4 & 1/2
3 3/4 & 3/8
4 5/8 & 3/8

\*Pipes to fan coil not included

## Piping Sizes and Optimization (cont.)



Piping Required*	REFNETs Required
1 set of - 3/4 & 5/8	1 set of size <b><u>72</u></b>
0 sets of - 3/4 & 1/2	2 sets of size <b><u>33</u></b>
4 sets of - 3/4 & 3/8	8 sets of size <b><u>22</u></b>
6 sets of - 5/8 & 3/8	

Smaller Diameter Pipes = Reduced Cost

Reduced Refnet Sizes = Reduced Cost

### Points of Note

- The options shown do not indicate a right and wrong way to install – both are fine as long as limitations are kept
- Optimization is a benefit however pipe routes are often dictated by route limitations on site
- The VRVXpress selection tool provides the ability to check this information, very easily, at design stage
- These recommendations apply to both Heat Pump & Heat Recovery
- BE AWARE: VRVXpress automatically generates default piping schematics
  - These show FCU's in a simple linear arrangement based on the order they were added to the ODU on the selection tool
  - In this scenario, pipe & joint sizes listed are based on the default entry
  - Should accurate pipe & joint data be required, manipulation of the piping layout drawing of VRVXpress is necessary

# Outdoor Unit Installation Space

## Minimum Space Requirements

**At concept stage** one of the most common requirements, especially in built up areas, is to establish that there is space to fit the outdoor equipment. The 'de-centralized' nature of VRV provides a great deal of flexibility however the multitude of service space combinations in the engineering book still do not cover fully the bespoke nature of project application. Therefore it is important to have a grasp of minimum space requirements.

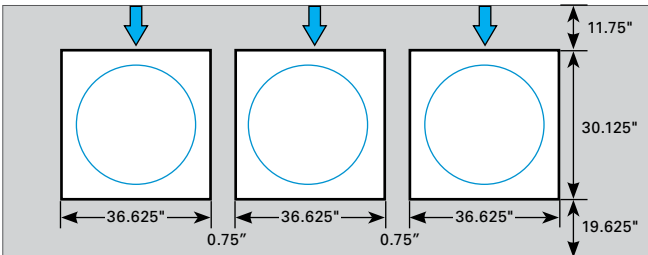
The 3 criteria to overcome are:

### AIR STARVATION • SHORT CIRCUITING • SERVICE SPACE

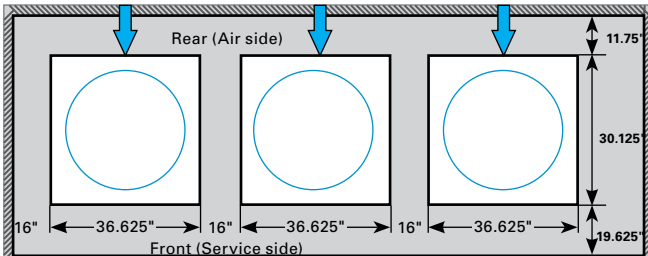
**There are two constants regardless of the application, system type or series:**

VRV ODU's require a minimum of **11.75"** (300mm) **at the Rear** (or air side) of the unit

VRV ODU's require a minimum of **19.625"** (500mm) **at the Front** (or service side) of the unit



scenario 1



scenario 2

Enclosed space

## Outdoor Unit Installation Space (cont.)

The complexity of design comes in to play when multiple units are to be installed into a restrictive area. The space between units in scenario 1 above are minimal and is only required to avoid any possible issues of vibration. However when wall heights exceed those shown in the data book (as they usually do) rather than move units away from the wall, the better practice (if the space allows) is to move the units further apart from each other. The distance can vary according to a number of factors however 16" between units will cover most all scenario's.

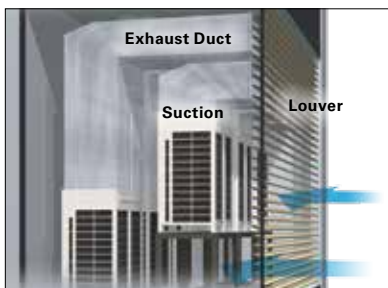
Therefore, a great rule of thumb to see that a space is suitable for VRV equipment is: **12" x 16" x 20"** (300mm x 400mm x 500mm).

### Think of the service engineer!

- The minimum service space (20") allows for the removal of a compressor however if rows of units are to be located in one area then place the units front to front and allow 40" between each row (24" air side to air side).
- The minimum space between units of 0.75" can make removing the top plate awkward. If space allows, always leave at least 4" between units (although this is not a necessity).

### Mechanical Rooms & Acoustic Enclosures

- The same space rules apply in enclosed areas however the air side of a unit can be positioned closer than 12" to a louvered wall. Each unit has a maximum static pressure of 0.32"
- Short circuiting and air starvation must also be addressed. This is specially so when units are to be situated behind acoustic louvers and when multiple units are to be positioned together in a single enclosure.

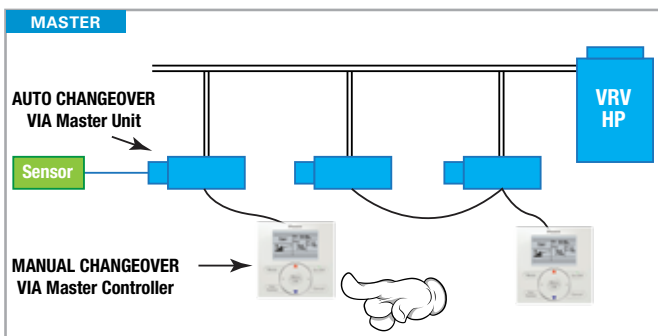


# Heat Pump Changerover

## The Various Heat/Cool Changerover Options

There are no less than **six** ways to provide heat/cool changerover on a heat pump system. Most of these also apply to heat recovery FCU's grouped on a single port of a BS Box (think of the BS box as a mini heat pump system).

The **voting system** is the latest mode control development and unique to Daikin.

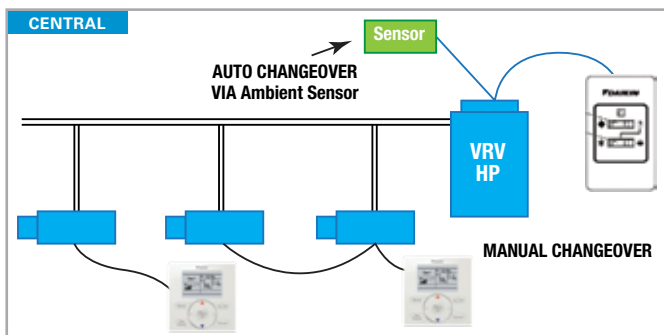


**Master Unit:** The simplest way to address heat / cool changerover **automatically** is to nominate a master unit. When the unit's return air sensor measures outside the temperature set point limitation, the unit switches itself and all other units on the system to the different mode.

**Master controller:** Similar to the option above except mode selection is made **manually** by via a designated master controller. Again, all other units on the system then switch mode in unison.

**Note:** A common pitfall is to elect an area that is not in constant use or has no easy access (e.g. managers office) In both options above, if the unit isn't running then mode change is not possible without the intervention of some form of central control.

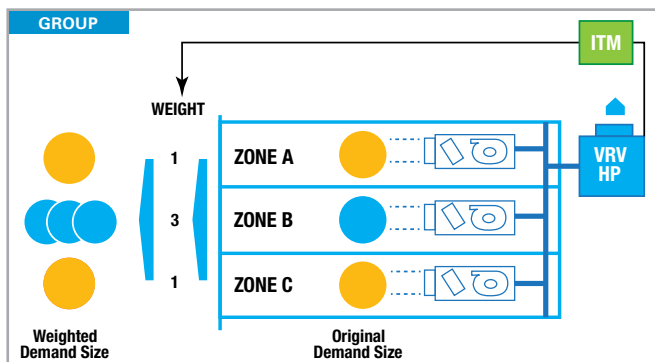
## Heat Pump Changeover (cont.)



**Summer / Winter Switch:** A Daikin supplied switch is attached to “ABC” terminals on the external unit to allow manual changeover from a central location. This is commonly found on sites with facilities managers or multi-tenant sites such as hotels where heat pump was installed in an exclusively cooling region.

**3rd Part Ambient Sensor:** This option was developed to provide an automatic version of the summer winter switch. A remote ambient sensor will dictate when mode change occurs. Occasionally used in temperate climates where budget constraints push the application towards heat pump but is an option rarely seen in this market.

**Note:** Both the central mode control options above are only utilized on heat pump systems.



**Averaging Sensors:** Historically, a popular method is to elect all units to act as joint 'master' units. Automatic mode change occurs when the majority of units demand it.

**Voting System:** The most flexible auto change over is the voting system. Changeover operates by continually calculating the demand load of each room by measuring the temperature differential of the set point against the room temperature. Modes are regularly changed accordingly.

This method can be tailored on each application by 'weighting' the demand of a room based on its importance. Note that this method can be used for units grouped together on a single port of a heat recovery system.

**Note:** With ALL options above, when a system mode is changed, the units on the system are not forced into heating or cooling. If there is no demand in the room for the mode that has been selected, the unit(s) will run in fan only mode.

*VRV*



CONTROLS & STANDARDS

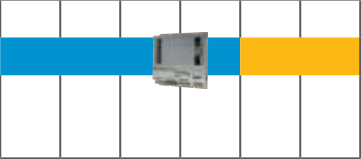


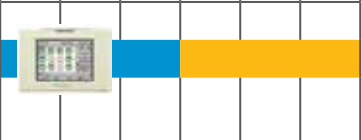

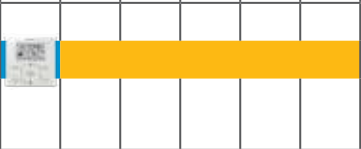
**DAIKIN**




# Controls Portfolio





Range of Zone and Centralized Controllers

Scalable controls offering to match a building's requirement

<b>BACnet® Open Protocol</b>							<b>DMS502B71 BACnet® Interface</b> <i>(Shown with optional DAM411B51 expander)</i>
<b>LonWorks® Open Protocol</b>							<b>DMS504C71 LonWorks® Interface</b>
<b>Advanced Multi-Zone Control</b>							<b>DCM601C71 Intelligent Touch Manager</b> <i>(Shown with Optional D3-Plus Adaptor)</i>
<b>Advanced Multi-Zone Control</b>							<b>DCS601C71 Intelligent Touch Controller</b> <i>(Shown with Optional D3-Plus Adaptor)</i>
<b>Multi-Zone Control</b>							<b>DCS302C71 Centralized Remote Control</b>  DCS302C71 x 2 for 128 Indoor Groups
<b>Individual Zone Control</b>							<b>BRC1E72 Remote Controller</b> <b>BRC2A71 Simplified Remote Controller</b> Wireless Remote Controls
<b>Indoor Unit Groups</b>	<b>1</b>	<b>64</b>	<b>128</b>	<b>256</b>	<b>512</b>	<b>1024</b>	<b>Groups = Individual Zone Controllers</b>

 = Indicates that requirements can be met with the application of multiple devices

## Project requirements drive the controls selection process





Project Requirements	Daikin VRV Controls			
	 BRC1E72 Navigation	 BRC2A71 Simplified	 DCS302C71 Centralized	 DCS301C71 Unified
Simple individual zone control	•	•		
Independent Cool and Heat setpoints	•			
Individual zone control with weekly programmable scheduling	•			
Multi-zone control without scheduling functions				
Basic central point on/off control of all air handling units			•	•
Advanced multi-zone control of small to medium size projects			•	•
Advanced multi-zone control of large commercial projects			•	
Advanced multi-zone control with scheduling logic and calendar				
Automatic cooling/heating changeover for heat pump systems	•			
Single input batch shutdown of all connected air handlers				
Web browser control and monitoring via Intranet and Internet				
E-mail notification of system alarms and equipment malfunctions				
Multiple tenant power billing for shared condenser applications				
Temperature set-point range restrictions	•			

\*Requires one or more DEC102A51-US2 Digital Input/Output units.

■ Native application or feature for this device.

□ Dependent upon capabilities of the third party energy management system

## Project requirements drive the controls selection process (cont.)

Project Requirements	Daikin VRV Controls			
	 Intelligent Touch Controller	 Intelligent Touch Manager	 BACnet Interface	 LonWorks Interface
Independent Cool and Heat setpoints	•	•		
Individual zone control with weekly programmable scheduling	•	•		
Basic central point on/off control of all air handling units	•	•		
Advanced multi-zone control of small to medium size projects	•	•	•	•
Advanced multi-zone control of large commercial projects	•	•	•	•
Advanced multi-zone control with scheduling logic and calendar	•	•	•	•
Automatic cooling/heating changeover for heat pump systems	•	•	•	•
Single input batch shutdown of all connected air handlers	•	•	•	•
Web browser control and monitoring via Intranet and Internet	•	•	•	•
E-mail notification of system alarms and equipment malfunctions	•	•	•	•
Multiple tenant power billing for shared condenser applications	•	•		
Temperature set-point range restrictions	•	•	•	•
Graphical user interface with floor plan layout		•	•	•
Start/stop control of ancillary building systems*	•	•	•	•

\*Requires one or more DEC102A51-US2 Digital Input/Output units.

■ Native application or feature for this device.

■ Dependent upon capabilities of the third party energy management system

# Local Control Options

## Features & Benefits of the Room Controller

### BRC1E72 - Navigation Room Controller

Daikin room controllers offer a vast array of features that provide the ultimate in flexibility and benefits that many other manufacturers' are unable to offer.

#### Features & Benefits:

- Up to 16 indoor units are controllable in one group
- 2 controllers can combine for dual operation
- Backlit LCD display in English, French, or Spanish
- Temperature sensor with configurable offset
- Display of temperature and set point in 1°F increments
- Three display modes Detailed, Standard and Simple
- Dual set points (individual cooling and heating set points)
- Independent cool/heat setback set points (unoccupied period)
- Auto cool / heat changeover mode
- Automatic adjustment for Daylight Savings Time (DST)
- 48 hour clock/calendar backup (in case of power failure)
- Constant fault monitoring and indication
- Limit selectable operation modes
- Ability to remove display functions on screen
- Compatible with previous VRV series models



## Local Control Options (cont.)

### 'Field Set' Features

#### ■ 7 day Schedule

Up to 5 actions per day  
(5+2 or 5+1+1 or everyday)  
outside hours time clock override  
(from 30 min to 3 hrs)

#### ■ Temperature Limiting

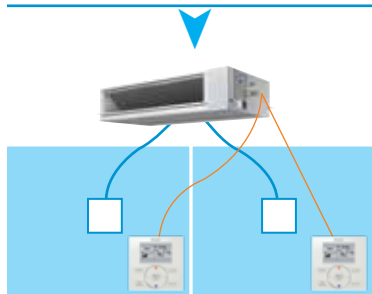
*Two options:*  
pre-set upper & lower limits (any level)

#### ■ Control Lockout

*Two options:*  
full lockout of room controller (read only)  
on / off control allowable only

A major feature is the ability to have a single ducted unit serve two areas and still provide individual control to the users in both zones

The controllers operate on the basis of last command priority



In addition, there are many applications where the Navigation Remote controller will provide the level of control that historically have required some form of central control to administer:



BRC1E72RM



BRC1E72RF



BRC1E72RMF

Where the client demands 'simple' control, six fascia options are available. All have combinations of on/off temperature fan or mode control.

**Note:** The new sensing, self cleaning cassette unit requires a BRC1E52A7 version of this controller

# Codes & Standards

## Some Key Considerations

Category	Key Codes/ Standards	Situation for VRV
Safety and Electrical	<p>UL 1995 Nat'l Electric Code NFPA 90A, 90B</p> <p>ASHRAE Std 15 Canada: B52</p>	<p>Daikin systems are UL 1995 certified. Install per NEC guidelines.</p> <p>Daikin systems comply via UL 1995. Std is applicable for APPLICATION, Not equipment.</p> <p>RcL not to exceed 26lbs/1000cuft (13lbs in restricted/institutional occupancies).</p>
Efficiency & Performance	<p>AHRI Std 1230 ASHRAE Std 90.1</p> <p>ASHRAE Std 62</p>	<p>Daikin VRV is tested and rated to AHRI Std 1230.</p> <p>Daikin VRV performance ratings exceed ASHRAE Std 90.1 2010.</p> <p>Daikin VRV systems can be configured to satisfy ASHRAE Std 62 (Ventilation, IAQ) requirements.</p>
Federal Trade Commission	<p>Buy America Act Trade Agreements Act</p>	<p>U.S. DOE has issued waiver for Ductless and VRV products.</p> <p>All projects need to be confirmed through the Daikin legal dept. who can formally issue waiver notice and explanation for compliance purposes</p>
Installation & Application	<p>Int'l Building Code</p> <p>Int'l Energy Conservation Code</p> <p>Int'l Mechanical Code</p>	<p>Wind Loads – Use tie down drawings Seismic – Use OSHPD certification</p> <p>Economizer – Use optional accessory Insulation – Use ¾" thick Armaflex</p> <p>Condensate – Units with Pump &amp; Float Switch are OK. Ductless units no need for secondary pan if level sensor used. Ventilation – similar to ASHRAE Std 62. Refrigeration – fittings used must be UL 1995 which Daikin's are.</p>
Local Code	Code Adoption Varies	Local Code can introduce additional considerations on top of the national codes so always confirm requirements.

## Tips, Tricks & Reference

### *Some Key Considerations*

- Always refer to the Engineering Data, Installation Manual and Service Manual for detailed explanation and specification for VRV products.
- Utilize VRV Xpress selection software to ensure equipment selections are in accordance with all limitations and system capabilities.
- Maximize the use of Daikin City portal to auto generate submittal packages and streamline project management, update and quoting (where applicable).
- If a document says do SOMETHING – then do it, If it says DON'T DO SOMETHING – then DON'T do it.
- If a document is NOT telling you to do something – Then its NOT NECESSARY to do it (regardless of what might be normal for a U.S. piece of equipment).
- If it says ALWAYS REFER/COMPLY TO \_\_\_\_\_ CODE – then always refer/comply to \_\_\_\_\_ code – Local Codes when specified always trump installation instructions.
- Recommendations for optimum piping design (No Drier, 40" between REFNET etc) are not rules – they are recommendations that can help prevent issues in certain circumstances.
- If in doubt – never be afraid to ask and seek clarification



## Where to find official information?

Product Detail		Design Guide	Eng. Data	IOM	Submittal	Option Handbook	SVM	Sales Bulletin
<b>Features</b>	<b>Summary</b>	◆	◆					◆
<b>Specification</b>	<b>Summary Table</b>		◆	◆			◆	◆
	<b>Electrical</b>		◆	◆	◆		◆	
<b>Drawings</b>	<b>Dimension</b>		◆		◆		◆	
	<b>Piping</b>		◆		◆		◆	
	<b>Wiring</b>		◆				◆	
<b>Performance</b>	<b>Capacity Correction</b>		◆		◆			
	<b>Piping</b>		◆		◆			
	<b>Airflow / ESP</b>		◆		◆			
	<b>Sound Level</b>		◆		◆			
<b>Installation</b>	<b>Piping</b>		◆	◆				
	<b>Wiring</b>		◆	◆				
	<b>Fundamentals</b>		◆	◆				
	<b>Sizing &amp; Charging</b>		◆	◆				
<b>Operation</b>	<b>How to use</b>			◆				
	<b>Controls</b>	◆	◆	◆				◆
<b>Accessories</b>	<b>Specification</b>		◆			◆		◆
	<b>Installation</b>					◆		◆
<b>Characteristics</b>	<b>Functions</b>	◆					◆	
<b>Set-up, Commissioning &amp; Service</b>	<b>Test Operation</b>			◆			◆	
	<b>Troubleshooting</b>						◆	
	<b>Flow Charts</b>						◆	
	<b>Replace Procedure</b>						◆	



*VRV*



[www.daikincity.com](http://www.daikincity.com)

Learn more about Daikin's products and technology and gain access to a vast variety of information, tools and resources with the Daikin City portal.

**For more information:**

Sales and Technical Support: 1-866-4-DAIKIN

[www.daikincomfort.com](http://www.daikincomfort.com)



Our continuing commitment to quality products may mean a change in specifications without notice.  
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PM-DVRV 12-14