MITSUBISHI ELECTRIC

CITY MULTI

LEV Control Box and Valve Assemblies

PAC-AH001-1, PAC-LV24/48/60/96/120AC-1

APPLICATION GUIDE

Table of Contents

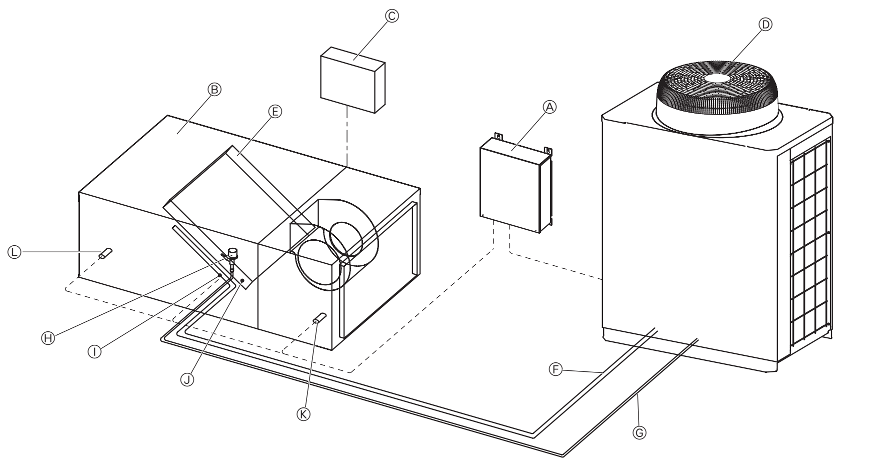
1. Features

The LEV Kit is an interface to connect all CITY MULTI® outdoor unit (except PUMY)[1] to air handlers produced by other manufacturers. These air handlers can be used with or without other CITY MULTI® Indoor units.

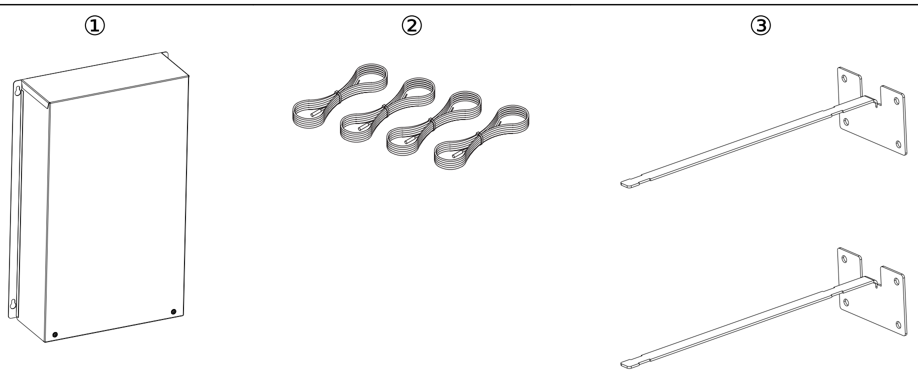
The LEV kit can be used with air handlers for room temperature control or DOAS systems for discharge temperature control.

The LEV kit can be used with all CITY MULTI® Control options. CN105 connections (thermostat interface adapter) for return air temperature control only.

The LEV kit can be used with a 0 – 10 VDC input for set point control from other devices.



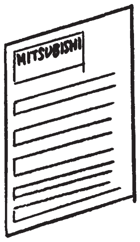
Ⓐ Air handling unit controller PAC-AH001-1
Ⓑ Air handling unit (field supply)
Ⓒ Controller (field supply)
Ⓓ Outdoor unit
Ⓔ Heat exchanger (field supply)
Ⓕ Gas Pipe (field supply)
Ⓖ Liquid Pipe (field supply)
Ⓗ LEV Assembly
Ⓘ Thermistor (gas pipe)
Ⓙ Thermistor (liquid pipe)
Ⓚ Thermistor (suction air)
Ⓛ Thermistor (discharge air)



① AHU Control Box
② Thermistor
③ Thermistor Bracket
④ Installation Manual
⑤ Rubber Bushing (x7)
⑥ Cover Lanyard

[1]Refer to Outdoor Units - 2.1. AHU Controller Specifications [7]

④



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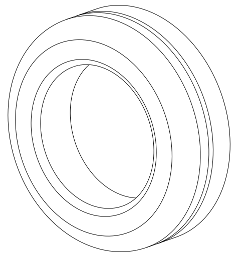

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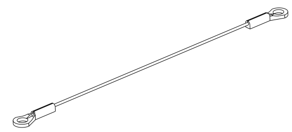


2. Specifications

2.1. AHU Controller Specifications

<table>
<tr><th colspan="3">Model</th><th colspan="3">PAC-AH001-1</th></tr>
<tr><td colspan="3">Power Supply</td><td colspan="3">208/230 VAC, 60 Hz, 1-Phase</td></tr>
<tr><td colspan="3">External Finish</td><td colspan="3">Galvanized Steel Plate</td></tr>
<tr><td colspan="2">Power Input</td><td>kW</td><td colspan="3">0.012</td></tr>
<tr><td colspan="2">Current</td><td>A</td><td colspan="3">0.055</td></tr>
<tr><td rowspan="3">Dimension</td><td>Height</td><td rowspan="3">in (mm)</td><td colspan="3">19.5 (496)</td></tr>
<tr><td>Width</td><td colspan="3">12.8 (326)</td></tr>
<tr><td>Depth</td><td colspan="3">4.7 (119)</td></tr>
<tr><td colspan="2">Control Box Net Weight (without packaging)</td><td>lbs (kg)</td><td colspan="3">11.5 (5.2)</td></tr>
<tr><td colspan="3">IP class</td><td colspan="3">00</td></tr>
<tr><td colspan="2">Operational Temperature Range</td><td>°F (°C)</td><td colspan="3">-4 to 115 (-20 to 46)</td></tr>
<tr><td colspan="3">Fuse</td><td colspan="3">SOC, MQ4</td></tr>
<tr><td colspan="3">Outdoor Units</td><td>J Models:
PUHY-P-T(Y)JMU-A(-BS)
PURY-P-T(Y)JMU-A(-BS)
PUHY-HP-TJMU-A(-BS)</td><td>K Models:
PUHY-P-T(Y,Z)KMU-A(-BS)
PURY-P-T(Y,Z)KMU-A(-BS)
PURY-HP-T(Y)KMU-A-H</td><td>L Models:
PUHY-P-T(Y,Z)LMU-A(-BS)
PURY-P-T(Y,Z)LMU-A(-BS)
PQHY-P-T(Y,Z)LMU-A
PQRY-P-T(Y,Z)LMU-A
PQHY-P-T(Y,Z)LMU-A1
PQRY-P-T(Y,Z)LMU-A1</td></tr>
<tr><td colspan="3">Refrigerant Type</td><td colspan="3">R410A</td></tr>
<tr><td colspan="3">Installation manual</td><td colspan="3">PA79D271H01</td></tr>
</table>

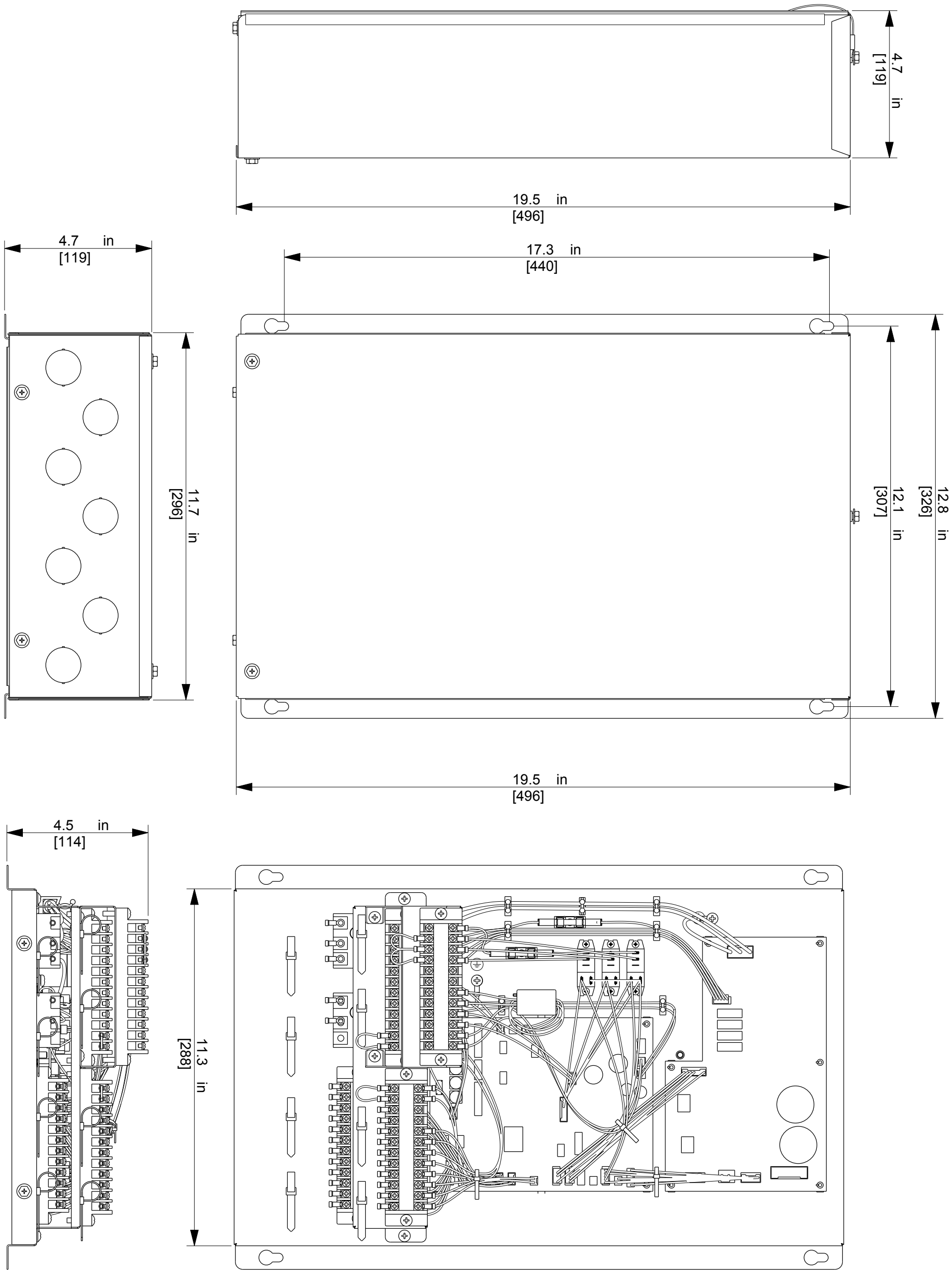
2.2. LEV Assembly Specifications

Model		PAC-LV24AC-1	PAC-LV48AC-1	PAC-LV60AC-1	PAC-LV96AC-1	PAC-LV120AC-1
LEV Model		EFM-40	EFM-80	EFM-A0	EFM-80 (x2)	EFM-A0 (x2)
LEV Motor		12VDC Stepping motor drive (0~1400 pulse) Lock nut fastening torque: 14 N·m				
Cable Length	ft [m]	16 [5]				
Connection Pipe Diameter	in (mm)	3/8 (9.52)			1/2 (12.7)	

LEV Assembly Model	Design Capacity Range [Btu/h]	Capacity Code Setting [Ton]
LEV PAC-LV24AC-1	4,800 - 24,000	0.5, 0.7, 1, 1.25, 1.5, 2
LEV PAC-LV48AC-1	24,000 – 48,000	2.25, 2.5, 3, 4
LEV PAC-LV60AC-1	48,000 - 60,000	4.5, 5
LEV PAC-LV96AC-1	60,000 - 96,000	6, 8
LEV PAC-LV120AC-1	96,000 - 120,000	10
LEV PAC-LV96AC-1 (x2)	120,000 - 192,000	12, 14, 16
LEV PAC-LV120AC-1 (x2)	192,000 - 240,000	18, 20

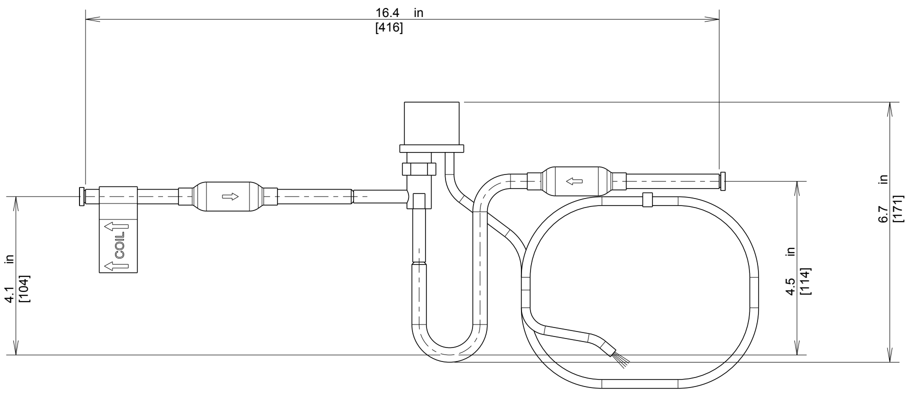
3. Dimensions

3.1. AHU Controller Dimensions

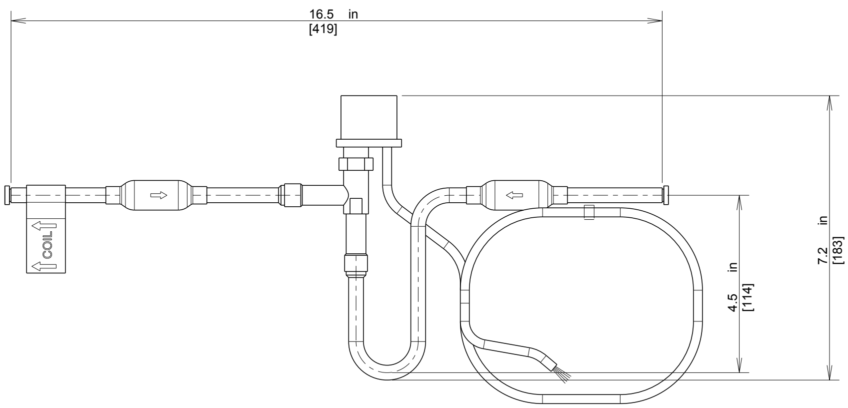


3.2. LEV Manifold Dimension

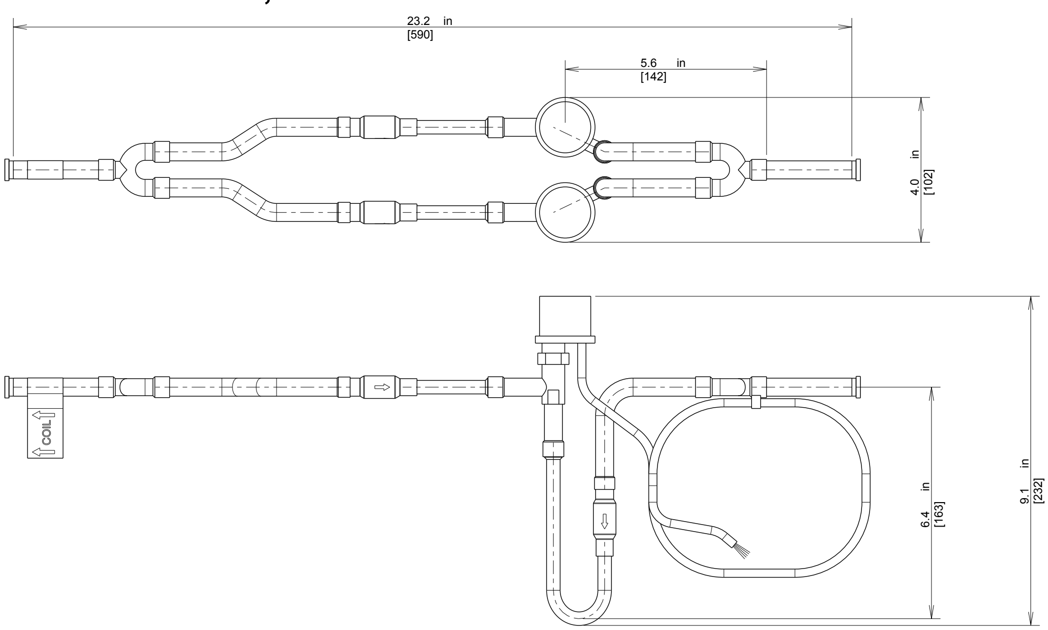
PAC-LEV24AC-1



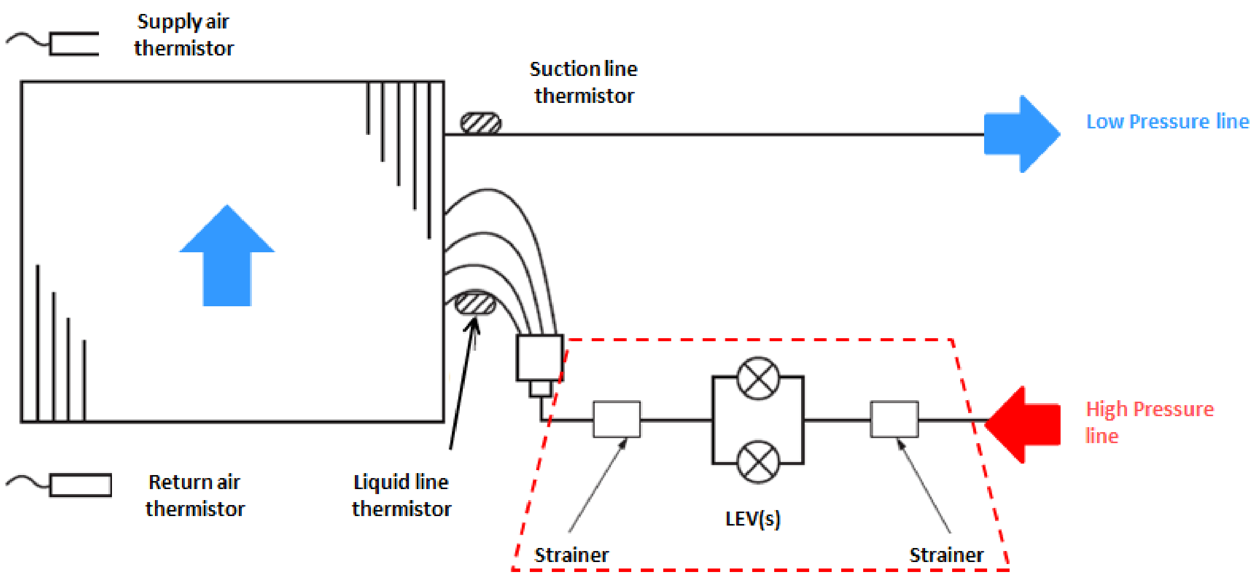
PAC-LEV48AC-1, PAC-LEV60AC-1



PAC-LEV96AC-1, PAC-LEV120AC-1

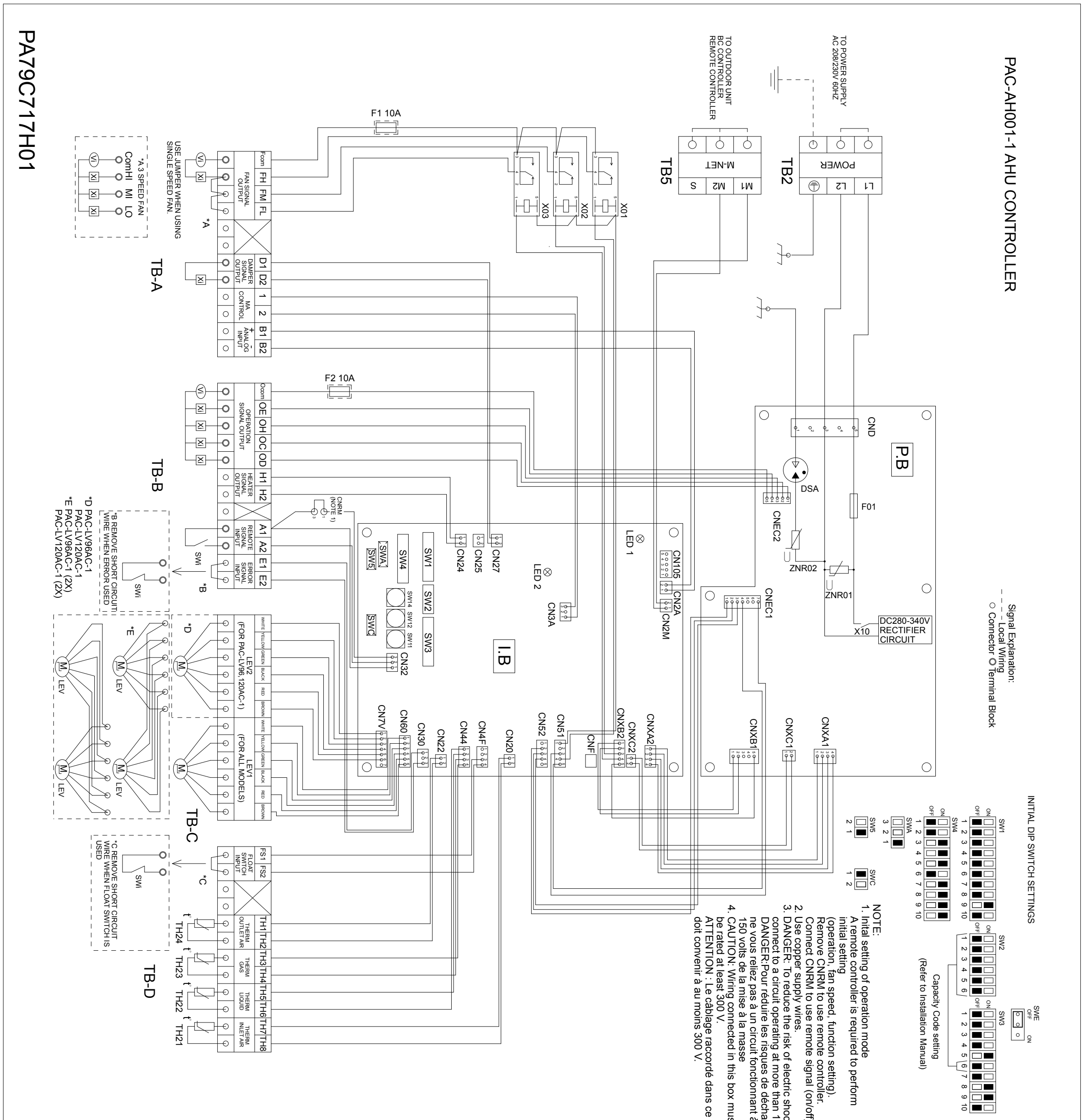


4. Refrigeration Circuit Diagram



NOTE
This diagram is for cooling mode only.

5. Wiring



NOTE:
1. Inital setting of operation mode
   A remote controller is required to perform initial setting
   (operation, fan speed, function setting).
   Remove CNRM to use remote controller.
   Connect CNRM to use remote signal (on/off) Input.
2. Use copper supply wires.
3. DANGER: To reduce the risk of electric shock-Do not connect to a circuit operating at more than 150V to ground.
   DANGER:Pour réduire les risques de décharges électriques, ne vous reliez pas à un circuit fonctionnant à plus de 150 volts de la mise à la masse
4. CAUTION: Wiring connected in this box must be rated at least 300 V.
   ATTENTION : Le câblage raccordé dans ce boîtier doit convenir à au moins 300 V.

SYMBOL EXPLANATION

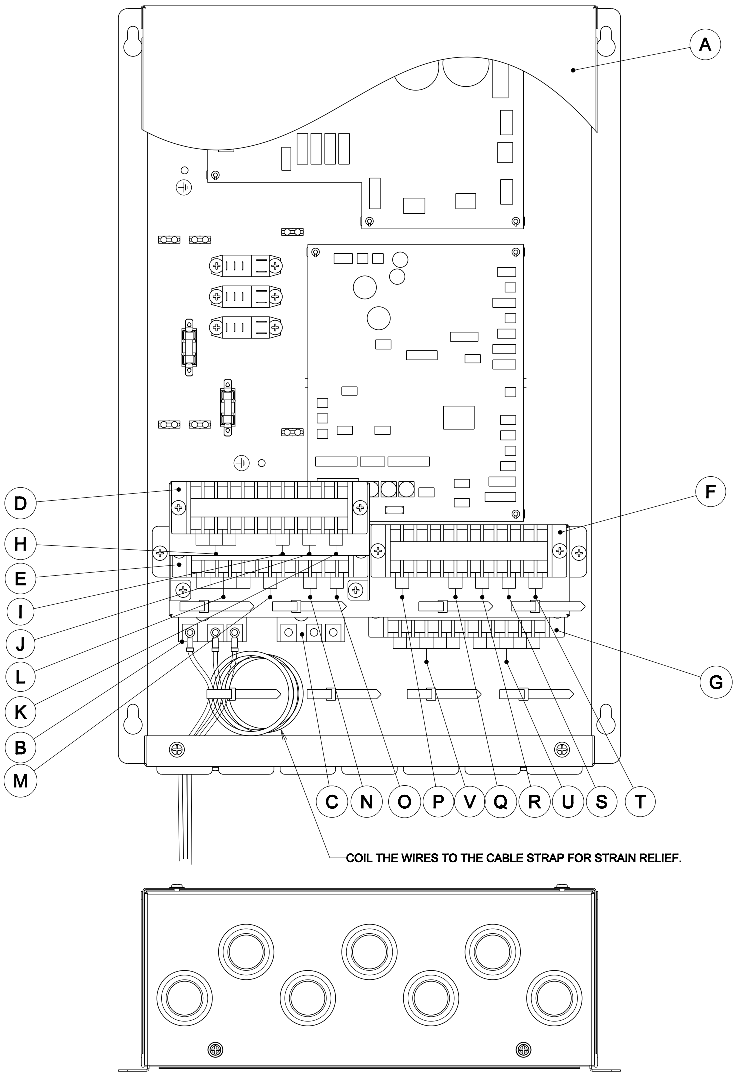
Symbol	Name
I.B	Indoor control board
LED 1	LED (Power supply)
LED 2	LED (remote controller supply)
SW1	Switch (for mode selection)
SW2	Switch (for capacity code)
SW3	Switch (for mode selection)
SW4	Switch (for mode selection)
SWA	Switch (for mode selection)
SW5	Switch (No function)
SWC	Switch (No function)
SWE	Switch (Fan Forced ON)
SW11	Switch (1st digit address set)
SW12	Switch (10ths digit address set)
SW14	Switch (Branch No.)
CN105	Connector (IT terminal)
CNF	Humidifier Input
CN25	Humidifier Outout
P.B	Power supply board
TB2	Power supply terminal block
TB5	M-NET terminal block
TB-A	Terminal block A
TB-B	Terminal block B
TB-C	Terminal block C
TB-D	Terminal block D
TH21	Thermistor (inlet air)
TH22	Thermistor (liquid pipe)
TH23	Thermistor (gas pipe)
TH24	Thermistor (outlet air)
F1, F2	Fuse AC250V 10A
X01, X02, X03	Relay (Fan output signal)
CNRM	Connector (Remote ON/OFF)
Vi	Power supply (Field supplied, external) [Max DC30V 1 A, Max AC250V 1A]
Xi	Relay (Field supplied, external)
SWi	Switch (Field supplied, external)
F01	Fuse AC250V 6.3A
ZNR01,02	Varistor
DSA	Arrester
X10	Aux. relay

SIGNAL EXPLANATION

Fan Signal Output	Pilot Duty: Max DC30V/1A, Max AC250V/1 A
Damper Signal Output	DV12V, Max 1W (Note 3)
Analog Signal Input	DC 0-10 V. Input impedence 100 kΩ (Note 3)
Operation Signal Output	Pilot Duty: Max DC30V/1A, Max AC250V/1 A
Heater Signal Output	DV12V, Max 1W (Note 3)
Remote Signal Input	Contact Input. Fixed DC5V 1mA (Note 3)
Error Signal Input	Contact Input. Fixed DC5V 1mA (Note 3)
Float Switch Input	Contact Input. Fixed DC5V 1mA (Note 3)
LEV Output	DV12V, (Note 3) Max operating pressure: 3.8 Mpa Max fluid temperature : 70°C

5.1. PC Board Wiring Diagram

5.2. PC Board Component Diagram



Ⓐ Cover
Ⓑ Power Supply Terminal Block (208, 230 VAC)
Ⓒ M-Net Terminal Block
Ⓓ Terminal Block TB-A
Ⓔ Terminal Block TB-B
Ⓕ Terminal Block TB-C
Ⓖ Terminal Block TB-D
Ⓘ Damper Signal Output (D1, D2)
Ⓙ MA Controller (1, 2)
Ⓚ Analog Input (B1, B2)
Ⓛ Operation Signal Output (Ocom, OE, OH, OC, OD)
Ⓜ Heater Signal Output (H1, H2)
Ⓝ Remote Signal Input (A1, A2)
Ⓞ Error Signal Input (E1, E2)
Ⓟ Float Switch Input (FS1, FS2)
Ⓠ Thermistor, Outlet Air (TH1, TH2)
Ⓡ Thermistor, Gas Pipe (TH3, TH4)
Ⓢ Thermistor, Liquid Pipe (TH5, TH6)
Ⓣ Thermistor, Inlet Air (TH7, TH8)
Ⓤ LEV 1
Ⓥ LEV 2

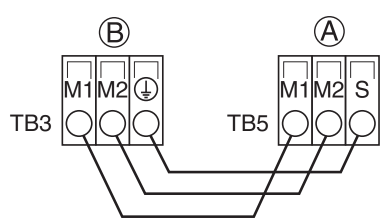
5.3. Transmission Cable Specifications

	Transmission cables	ME Remote controller cables	MA Remote controller cables
Type of cable	Shielding wire (2-core)	Sheathed 2-core cable (unshielded) CVV	
	CVVS, CPEVS or MVVS		
Cable diameter	AWG16 [1.25 mm^2] shielding wire (2-core) CVVS, CPEVS or MVVS	AWG 20 -16 (0.5 - 1.25 mm^2)[a]	AWG 22-16 (0.3 - 1.25 mm^2)[a]
Remarks	Max length: 656 ft [200 m]	When 33 ft [10 m] is exceeded, use cables with the same specification as transmission cables.	Max length: 656 ft [200 m]
	Maximum length of transmission lines for centralized control and indoor/ outdoor transmission lines (Maximum length via indoor units): 1640 ft [500 m] MAX		
	The maximum length of the wiring between power supply unit for transmission lines (on the transmission lines for centralized control) and each outdoor unit and system controller is 656 ft [200 m].		

[a]Connected with simple remote controller.CVVS, MVVS : PVC insulated PVC jacketed shielded control cable; CPEVS : PE insulated PVC jacketed shielded communication cable; CVV : PVC insulated PVC sheathed control cable

5.4. Connection to Outdoor Unit

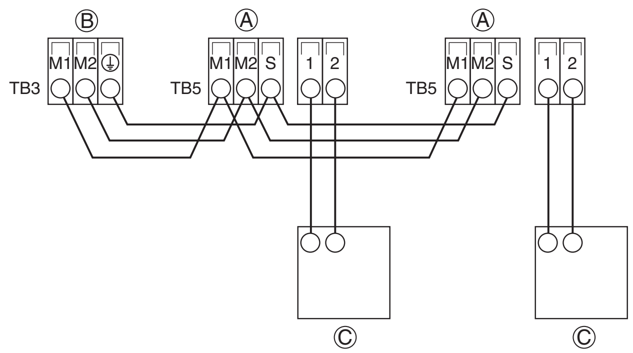
- Connect the “M1”, “M2” and “S” on AHU controller terminal block to the TB3 on the outdoor unit as shown below (Non-polarized 2-wire)   The “S” on AHU controller TB5 is a shielding wire connection. For specifications about the connecting cables, refer to the outdoor unit installation manual.



Ⓐ Terminal block for AHU controller/ indoor transmission cable
Ⓑ Terminal block for outdoor transmission cable

5.5. Connection for Operation with Mitsubishi Electric Controllers

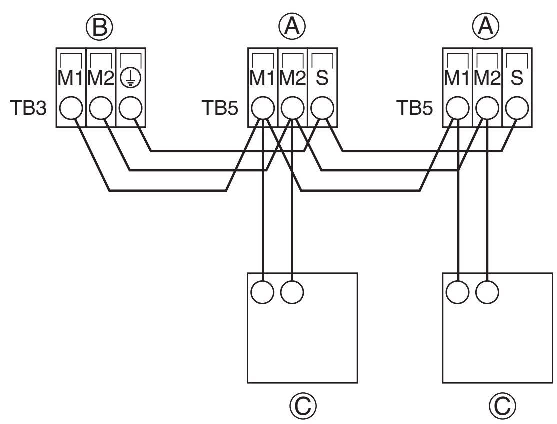
- Connect a Mitsubishi MA controller:
  To connect an MA controller, connect the 2 wires of the MA controller to positions “1” and “2” of the terminal labeled “MA Control.” on the AHU controller terminal block (Non-polarized 2-wire). Figure 5.5.0 shows an AHU controller system controlled with MA controllers.



Ⓐ Terminal block for AHU controller/ indoor transmission cable
Ⓑ Terminal block for outdoor transmission cable
Ⓒ Remote controller

Fig 5.5.0

- Connect a Mitsubishi ME controller (or system controller):
  To connect an ME controller (or system controller), connect the 2 wires of the controller to the positions labeled “M1” and “M2” of the terminal labeled “M-NET” on the AHU controller terminal block (Non-polarized 2-wire). Figure 5.5.1 shows an AHU controller system controlled with ME controllers.



Ⓐ Terminal block for AHU controller/ indoor transmission cable
Ⓑ Terminal block for outdoor transmission cable
Ⓒ Remote controller

Fig 5.5.1

- Install a remote controller following the manual supplied with the remote controller.
- Connect the remote controller’s transmission cable within 33 ft [10 m] using a 18 AWG [0.75 mm^2] core cable. If the distance is more than 33 ft [10 m], use a 16 AWG [1.25 mm^2] junction cable.
- To operate the system using a Mitsubishi controller, disconnect the jumper connector “CNRM” located inside the AHU controller as shown in Figure 5.5.3. Disconnecting “CNRM” activates the Mitsubishi controller.

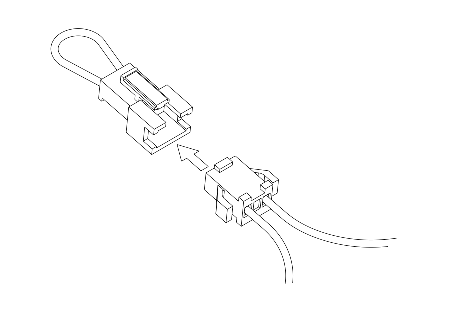


Fig 5.5.3

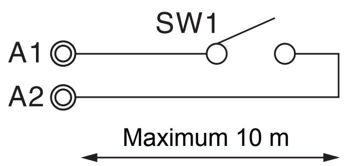
- The MA remote controller and the M-NET remote controller cannot be used at the same time or interchangeably.
- DC 9 to 13 V between 1 and 2 (MA remote controller)
- DC 24 to 30 V between M1 and M2 (M-NET remote controller)

5.6. Connection for Operation with Third Party Controller

- A 3rd party controller can be installed to control the following functions of the AHU controller:
  - ON/OFF (Operation) function
  - Temperature set point (Analog Input) function
- The AHU controller can either be controlled by a Mitsubishi controller or a 3rd party controller; it cannot be installed to be controlled by both.
- Wiring for ON/OFF (Operation) function

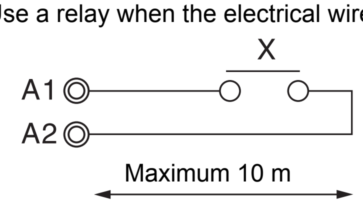
Connection circuit

■Operation contact specifications

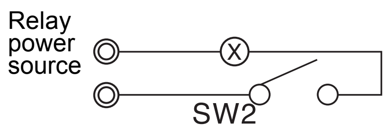


SW1: Operation command (field supply)
Minimum applicable load
DC5 V, 1 mA

■Use a relay when the electrical wire exceeds 10 m.



X: Relay (field supply)
Minimum applicable load
DC5 V, 1 mA



SW1: Operation command (field supply)

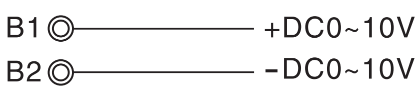
- Wiring for temperature set point (Analog Input)

Connection circuit

■Analog input

TBY

Wiring: AWG22~26



- To operate the system using a 3rd party controller, connect the jumper connector “CNRM” located inside the AHU controller as shown below. Connecting “CNRM” activates the control of the 3rd party controller.

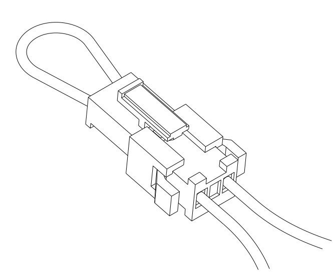


Fig 5.6

NOTE

When using a 3rd party controller, a Mitsubishi remote controller is still required to set the operation mode, fan speed, and function settings. A Mitsubishi remote controller is not required after the initial setting of the unit. Initial setting can be performed using the M-NET remote controllers connected to other indoor units. CNMR must be unplugged to operate the Mitsubishi controller.

5.7. Connecting LEV Assembly and Thermistors

5.7.1. Connecting LEV Assembly Cables

Route the LEV lead wire through the bottom of the control panel and through the cable strap.

Loop the lead wire once through the cable strap to prevent slipping of LEV wire.Attach the lead wires of the LEV to the terminal on the terminal strip with the same color.

If the LEV lead wire is too long, cut it to the appropriate length.

Do not bind it in the box.Follow the information in the table below to attach multiple LEV.

LEV Qty	Attachment Terminal
1	LEV 1: Attach 1LEV LEV 2: Attach 0 LEV
2	LEV 1: Attach 1 LEV LEV 2: Attach 1 LEV
3	LEV 1: Attach 2 LEV LEV 2: Attach 1 LEV
4	LEV 1: Attach 2 LEV LEV 2: Attach 2 LEV

5.7.2. Connecting Thermistor Cables

Route the thermistor lead wires through the bottom of the control panel and through the cable strap. Loop the lead wires once through the cable strap to prevent slipping of lead wire.

Connect the thermistors to the terminal block as follows:

- Outlet air thermistor: TH1 and TH2 on the terminal block
- Gas pipe thermistor: TH3 and TH4 on the terminal block
- Liquid pipe thermistor: TH5 and TH6 on the terminal block
- Inlet air thermistor: TH7 and TH8 on the terminal block

If the lead wire is too long, cut it to the appropriate length. Do not bind it in the box.

Take proper measures not to miswire. E.g. Attach a label before cutting the wire so that it is obvious whether the wire is for inlet air, for gas side or for liquid side.

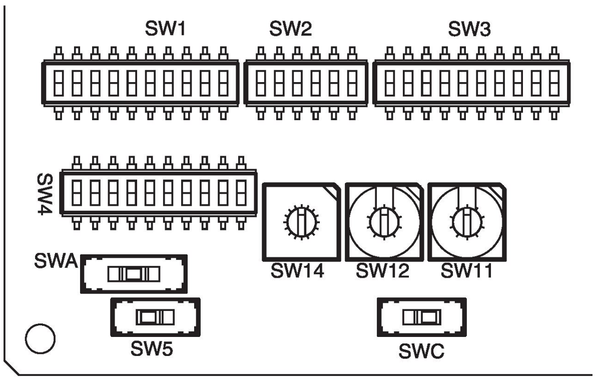
⚠ **CAUTION**

Do not route the thermistor cables together with power cables.

6. Setting Addresses

6.1. General

(Be sure to operate with the main power turned OFF.)

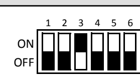
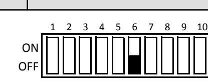
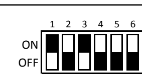
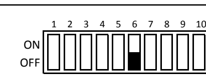


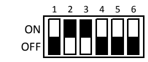
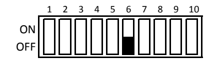
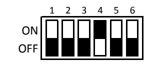
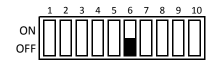
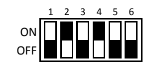
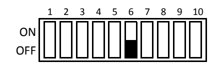
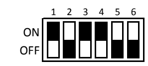
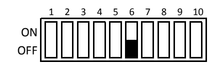
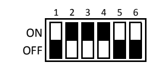
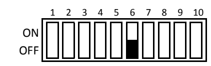
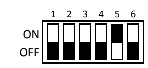
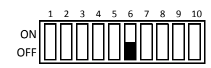
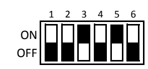
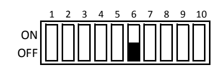
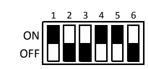
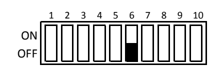
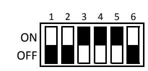
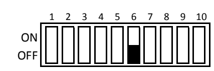
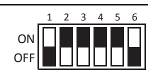
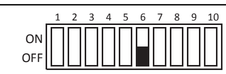
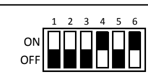
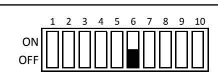
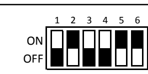
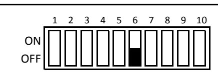
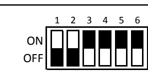
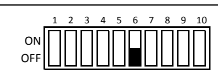
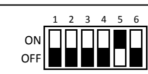
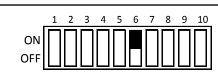
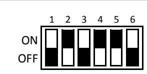
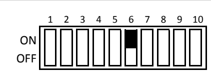
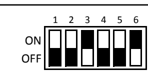
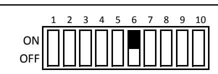
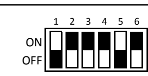
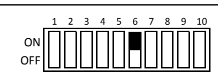
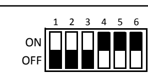
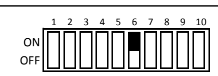
- There are two types of rotary switch settings available: setting address digits 1 to 9 and address digits 10, 20, 30, etc., and setting branch numbers
  1. How to set addresses
     Example: If Address is "3" set SW12 (used for address digits 10, 20, 30, etc) to "0", and set SW11 (used for address digits 1 to 9) to "3".
  2. How to set branch numbers SW14 (Series R2 only)
     The branch number assigned to each indoor unit is the port number of the BC controller to which the indoor unit is connected.
     Leave it to “0” on the non-R2 series of units.
- The rotary switches are all set to “0” when shipped from the factory. These switches can be used to set unit addresses and branch numbers at will.
- The determination of indoor unit addresses varies with the system at site. Set them referring to technical data.

6.2. Setting Unit Capacity

Set the unit capacity according to the heat exchanger type (field supply).

Set the dip switch (SW2 and SW3-6) on the control board in accordance with the chart below.

LEV Assembly Model	Capacity Code Setting	Design Capacity Range Cooling	Setting switches	
	[Ton]	[Btu/h]	SW2	SW3-6
PAC-LV24AC-1	0.5	4,800-6,000		
	0.7	6,000-8,000		

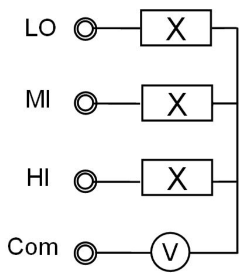
LEV Assembly Model	Capacity Code Setting	Design Capacity Range Cooling	Setting switches	
	[Ton]	[Btu/h]	SW2	SW3-6
	1.0	9,600-12,000		
	1.25	12,000-15,000		
	1.5	15,000-18,000		
	2.0	18,000-24,000		
PAC-LV48AC-1	2.25	24,000-27,000		
	2.5	27,000-30,000		
	3.0	30,000-36,000		
	4.0	36,000-48,000		
PAC-LV60AC-1	4.5	48,000-54,000		
	5.0	54,000-60,000		
PAC-LV96AC-1	6.0	60,000-72,000		
	8.0	72,000-96,000		
PAC-LV120AC-1	10.0	96,000-120,000		
PAC-LV96AC-1 (x2)	12.0	120,000-144,000		
	14.0	144,000-168,000		
	16.0	168,000-192,000		
PAC-LV120AC-1(x2)	18.0	192,000-216,000		
	20.0	216,000-240,000		

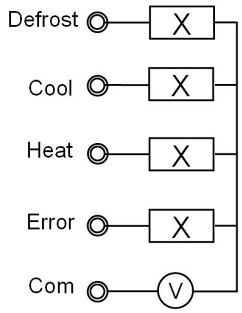
7. Connecting External Input/Output Signals

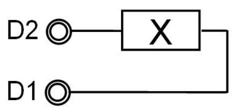
The AHU controller is equipped with multiple signal inputs and outputs that can interface with 3rd party peripherals and controls.

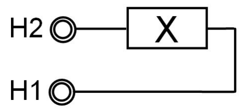
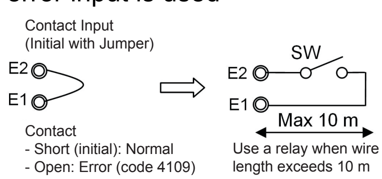
Connect the external inputs and outputs according to the table below.Route all wire through the holes in the bottom of the AHU controller.

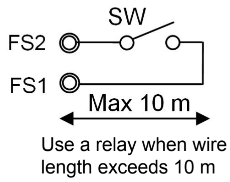
Loop the lead wires once through the cable strap to prevent slipping of lead wire.

Signal	Connection Circuit	Signal Details
Fan Speed Signal Output	 X: Relay (field supply) V: Power source (field supply) Max DC 30V/1A Max AC 250V/1A (within relay rating)	• AHU controller will output a fan level signal corresponding to the fan level set by the Mitsubishi controller.(fan speed can only be set with the Mitsubishi controller) **CAUTION** · Fan speed output should only be used as a signal to interface with 3rd party controls. · Fan speed outlet should not be used to provide power to a fan motor.

Signal	Connection Circuit	Signal Details
Operation Signal Output	 X: Relay (field supply) V: Power source (field supply) Max DC 30V/1A Max AC 250V/1A (within relay rating)	• AHU controller will output an operation signal corresponding to the operation mode (cool, heat) set by the Mitsubishi controller. • AHU controller will also output a defrost signal when the unit is in defrost mode. • AHU controller will also output an error signal when the unit is in error mode. **CAUTION** · Operation output signals should only be used as a signal to interface with 3rd party controls. · Operation output signals should not be used to provide power air handler peripherals.

Signal	Connection Circuit	Signal Details
Damper Signal Output	 X: Relay (field supply) Voltage: 12 VDC Max Power: 1 W	• AHU controller will output an damper signal corresponding to damper operation set by function setting 78. See Mitsubishi controller manual for more details. • Damper control will only operate when DIP SW are set for AHU controller to operate in Discharge Air Control. • If DIP SW are set for AHU to operate in Return Air Control, Damper Signal Output can be used to control 2nd stage electric heater. **CAUTION** · Damper output should only be used as a signal to interface with 3rd party controls. · Damper output signal should not be used to provide power to air handler peripherals.

Signal	Connection Circuit	Signal Details
Electric Heater Signal Output	 X: Relay (field supply) Voltage: 12 VDC Max Power: 1 W	• AHU controller will output an electric heater operation signal corresponding to electric heater logic. See service manual for more details. • Electric heat will only operate when DIP SW are set for AHU Controller to operate in Return Air Control. **CAUTION** · Heater output should only be used as a signal to interface with 3rd party controls. · Heater output signal should not be used to provide power to air handler peripherals.
Error Signal Input	Remove the short circuit when the error input is used 	• Normally closed input. • When open circuit, error code 4109 occurs.

Signal	Connection Circuit	Signal Details
Float Switch Input	Contact Input  SW: Operation command (field supply) Minimum applicable load (switch) DC 5 V, 1mA	• The switch should be a normally closed low voltage rated switch. • The switch should be installed in a location that it can sense a drain blockage causing a rise in water level. This resulting rise in level will cause it to open. • The switch location is to be determined by the installing contractor. • When the switch opens, it will cause the LEV to close, stopping the cooling operation. The fan will continue to run and a fault code will be shown at the controller. Correcting the problem and closing the switch will be required before normal operation can resume.

8. Temperature Control Options

8.1. Setting Remote Controller Type

- As described in section Electrical Wiring. The AHU controller can be installed to operate using either a Mitsubishi remote controller or a 3rd party controller. SWA must be set as shown below if a 3rd party thermostat is used.

SWA	Function	Note
1	Mitsubishi Controller (Analog input is disabled)	Factory Setting
2	3rd Party Controller (Analog input is enabled as Type1)	-
3	3rd Party Controller (Analog input is enabled as Type2)	-

- The analog input for the 3rd party controller can be set to either Type 1 (for temperature control) or Type 2 (for capacity control).
- The 0-10 VDC analog input from the 3rd party controller is converted to a temperature set point by the AHU controller.
  – In Type 1 Control (temperature control), the 0-10 VDC analog input corresponds to a temperature scale that is the same for cooling mode and heating mode.
  – In Type 2 Control (capacity control), the 0-10 VDC analog input corresponds to a temperature scale that is different for cooling mode and heating mode. The temperature scale corresponds to unit capacity demand.
  Type 2 Example: A low capacity for cooling mode corresponds to a high temperature set point. A low capacity for heating mode corresponds to a low temperature set point.

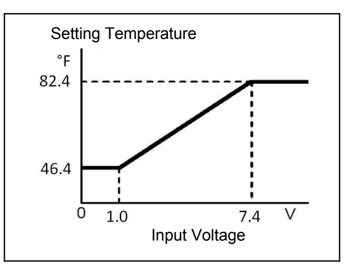
NOTE
0-10VDC Analog Input control is only available while operating in Discharge Air Control.

8.1.1. Type 1 (For Temperature Control)

Cooling/Heating

– Set point temperature = 5.625 X Ain + 40.775 [°F] [Ain = Input Voltage] [Ain = Input Voltage]

– Figure 8.1.1 below shows the relationship between the input voltage from the 3rd party controller and the set point temperature for Type 1 Control.

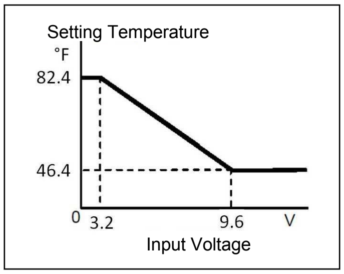


8.1.2. Type 2 (For Capacity Control)

Cooling

— Set point temperature = -5.625 X Ain + 100.4 [°F] [Ain = Input Voltage]

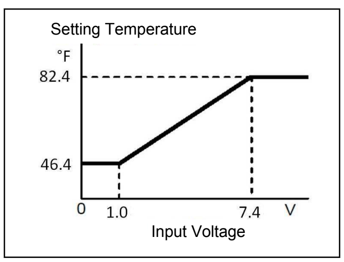
— Figure 8.1.2.1 below shows the relationship between the input voltage from the 3rd party controller and the set point temperature for Type 2 Control in cooling mode.



Heating

— Set point temperature = 5.625 X Ain + 40.775 [°F] [Ain = Input Voltage]

— Figure 8.1.2.2 below shows the relationship between the input voltage from the 3rd party controller and the set point temperature for Type 2 Control in heating mode.



8.2. Setting Temperature Control

- The AHU controller can be set to control capacity based on a discharge air set temperature point or a return air temperature set point. Choose the capacity control method with SW4 as shown below.

DIP SW			**Capacity Control Method**	**Note**
SW4-1	**SW4-7**	**SW4-8**		
OFF	ON	ON	Discharge Air Control	Factory Setting
ON	OFF	OFF	Return Air Control	—

- The return air temperature can be set to sense at the remote controller or with the return thermistor (TH21) as shown below.

DIP SW	**Return Air Temperature Sensing Location**	**Note**
SW1-1		
OFF	Return Air Thermistor (TH21)	Factory Setting
ON	Remote Controller	—

8.2.1. Settings For Discharge Air Control

Settings for Discharge Air Control with Mitsubishi Controller or 3rd Party Controller

- Thermo-ON/OFF conditions
  TH24: Discharge air temperature
  TH21: Return air temperature (Thermistor or remote controller)
  To: The set point temperature on the remote controller

	Cooling	Heating
The range of “To”	Mitsubishi Controller (SWA-1) 46 ~ 86 °F [8 ~ 30 °C] 3rd Party Controller (SWA-2,3) 46 ~ 83 °F [8 ~ 28 °C]	Mitsubishi Controller (SWA-1) 63 ~ 83 °F [17 ~ 28 °C] 3rd Party Controller (SWA-2,3) 46 ~ 83 °F [8 ~ 28 °C]
Thermo-OFF a) or b) or c)	a) TH21 < To b) TH21 < 57.2 °F [14 °C] TH24 < To – 3.6 °F [2 °C] continues over 10 minutes	a) TH21 > To b) TH21 > **59 °F [15 °C]** *1 c) TH24 > To + 9 °F [5 °C] continues for 10 minutes
Thermo-ON a) & b) & c) & d)	a) TH24 > To +1.8 °F [1 °C] b) TH21 > 59 °F] [15 °C] c) TH21 > To +1.8 °F [1 °C] d) Thermo-OFF continues over 3 minutes	a) TH21 < To –1.8 °F [1 °C] b) b) TH21 < **57.2 °F [14 °C]** *1 c) TH24 < To –1.8 °F [1 °C] d) Thermo-OFF continues over 3 minutes

*1 The value indicated in bold can be changed by dip-switch SW3-8 and SW3-9.

Dip switch		Heating mode changing suction air ON/OFF Points		Remarks
SW3-8	SW3-9	Thermo-OFF	Thermo-ON	
OFF	OFF	69.8 °F [21 °C]	68 °F [20 °C]	—
OFF	ON	50 °F [10 °C]	48.2 °F [9 °C]	—
ON	OFF	50 °F [10 °C]	48.2 °F [9 °C]	—
ON	ON	59 °F [15 °C]	57.2 °F [14 °C]	Factory setting

- When operating in discharge air control, an offset can be applied to the discharge air thermistor (TH24) with SW1-2 and SW1-3 to help compensate for un-ideal thermistor placement.

Dip switch		TH24 Detection temperature		Remarks
SW1-2	SW1-3	Cooling	Heating	
OFF	OFF	TH24	TH24	Factory setting
ON	OFF	TH24 - 1.8 °F [1 °C]	TH24 + 1.8 °F [1 °C]	—
OFF	ON	TH24 - 3.6 °F [2 °C]	TH24 + 3.6 °F [2 °C]	—
ON	ON	TH24 - 5.4 °F [3 °C]	TH24 + 5.4 °F [3 °C]	—

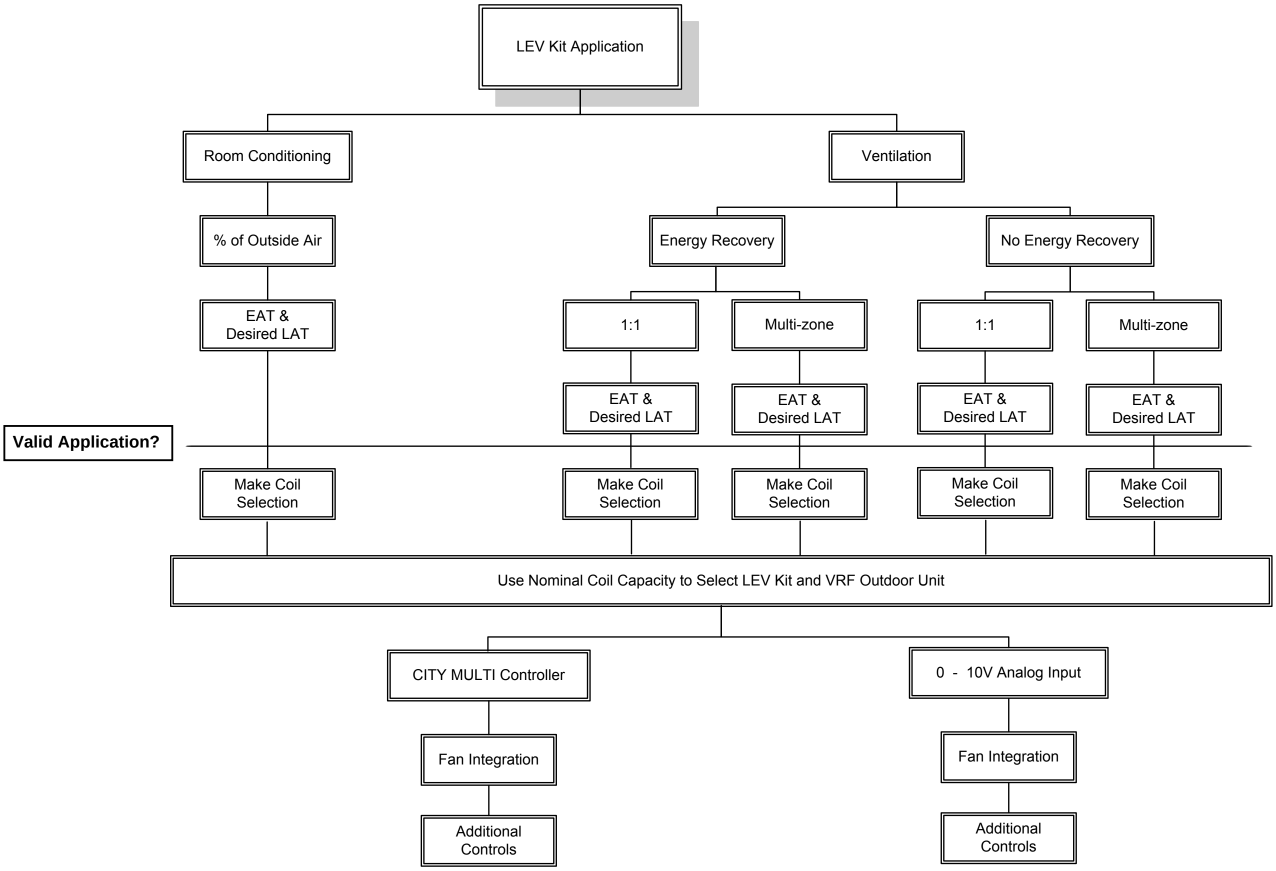
9. Model Selection Process

Step 1: Qualify the Application

Step 2: Select Evaporator Coil

Step 3: Controls Integration

Step 4: Fan Interlock & Additional Controls Design



10. Coil Selection

Coil Design for Comfort Conditioning Applications

For Comfort Conditioning applications the coil capacity requirement and LEV kit size are usually know and the coil needs to be sized to meet that capacity

Entering Air temperature range	Cooling	59 - 75°FWB
	Heating	59 - 81°FDB
Design Temperature	Cooling	80°FDB / 67°FWB

Nominal Capacity	(tons)	0.5	0.7	1	1.25	1.5	2	2.25	2.5	3	4
Cooling Capacity Design Range [1]	Max. (Btu/h)	6,000	8,000	12,000	15,000	18,000	24,000	27,000	30,000	36,000	48,000
	Min. (Btu/h)	4,800	6,000	8,000	12,000	15,000	18,000	24,000	27,000	30,000	36,000
Heating Capacity Design Range [1,2]	Max. (Btu/h)	6,700	9,000	13,000	17,000	20,000	27,000	30,000	34,000	40,000	54,000
	Min. (Btu/h)	5,400	6,700	9,000	13,000	17,000	20,000	27,000	30,000	34,000	40,000
Valve Assembly(s)		PAC-LV24AC-1						PAC-LV48AC-1			
Nominal Airflow [3]	CFM	200	280	400	500	600	800	900	1000	1200	1600
HEX Internal Volume	Min. cu/in.	15	21	31	37	46	58	67	73	88	116
	Max. cu/in.	27	34	52	67	82	107	122	134	165	217
HEX Tubing Size	in (mm)	5/16" or 3/8" (First choice should be 5/16")									
HEX No. of Refrig. Passes (For Reference) [4]	5/16" Tube	1 - 2	1 - 2	2 - 3	3 - 4	4 - 5	4 - 6	5 - 6	6 - 8	6 - 9	7 - 10
	3/8" Tube	1 - 2	1 - 2	1 - 2	2 - 3	2 - 3	3 - 4	3 - 4	3 - 4	4 - 5	4 - 5
HEX Refrigerant Pressure Drop	PSI	Maximum = 4.35 PSI									
HEX Refrigerant Velocity	FPM	Minimum = 1,000 FPM									
Liquid Refrigerant Temperature Entering LEV	°F (°C)	77 (25)									
HEX Evaporating Temperature in Cooling	°F (°C)	See Chart #1 Below									
HEX Superheat	°F (°C)	9 (5)									
HEX Entering Air Temperature	°F DB / °FWB (°CDB / °CWB)	80 / 67 (26.67 / 19.4)									

Nominal Capacity	(tons)	4.5	5	6	8	10	12	14	16	18	20
Cooling Capacity Design Range [1]	Max. (Btu/h)	54,000	60,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000
	Min. (Btu/h)	48,000	54,000	60,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000
Heating Capacity Design Range [1,2]	Max. (Btu/h)	61,000	67,000	81,000	108,000	135,000	161,000	188,000	215,000	242,000	269,000
	Min. (Btu/h)	54,000	61,000	67,000	81,000	108,000	135,000	161,000	188,000	215,000	242,000
Valve Assembly(s)		PAC-LV60AC-1		PAC-LV96AC-1		PAC-LV120AC-1	PAC-LV96AC-1 X (2)			PAC-LV120AC-1 X (2)	
Nominal Airflow [3]	CFM	1800	2000	2400	3200	4000	4800	5600	6400	7200	8000
HEX Internal Volume	Min. cu/in.	131	143	174	229	287	345	403	458	516	574
	Max. cu/in.	244	272	326	436	546	656	766	873	982	1095
HEX Tubing Size	in (mm)	5/16" or 3/8" (First choice should be 5/16")				3/8" or 1/2" (First choice should be 3/8")					
HEX No. of Refrig. Passes (For Reference) [4]	5/16" Tube	8 - 10	8 - 10	10 - 12	12 - 14	N/A					
	3/8" Tube	5 - 6	5 - 7	6 - 10	8 - 10	10 - 12	12 - 14	16 - 20	16 - 20	16 - 20	18 - 22
HEX Refrigerant Pressure Drop	PSI	Maximum = 4.35 PSI									
HEX Refrigerant Velocity	FPM	Minimum = 1,000 FPM									
Liquid Refrigerant Temperature Entering LEV	°F (°C)	77 (25)									
HEX Evaporating Temperature in Cooling	°F (°C)	See Chart #1 Below									
HEX Superheat	°F (°C)	9 (5)									
HEX Entering Air Temperature	°F DB / °FWB (°CDB / °CWB)	80 / 67 (26.67 / 19.4)									

Chart #1 HEX Evaporator Temperature in Cooling

If unsure of the distance between indoor and outdoor unit, use 47°F (8.3°C).

Distance from outdoor unit to indoor unit				
100'	165'	230'	295'	361'
44°F (6.7°C)	45°F (7.2°C)	46°F (7.8°C)	47°F (8.3°C)	47°F (8.3°C)

Notes:

1. These capacities ranges are for selecting the valve to apply to the application. The minimum is not the lowest modulating capacity of the valve. It's the lowest nominal capacity to apply that valve model. Also, when selecting a valve for an application, select the smallest valve that meets the requirement. For example: If the application requires a 60,000 Btu/h cooling capacity. Select the PAC-LV60AC-1 which has a maximum cooling capacity of 60,000 Btu/h. Do not use the PAC-LV96AC-1 which has a minimum cooling capacity of 60,000 Btu/h capacity.

2. When sizing a coil for cooling, the heating capacity will be cooling x 1.12 like standard Mitsubishi indoor units with 70°FDB (21.1°CDB) entering air temperature and 43°FWB/47°FDB (6.1°CWB/8.3°CDB) outdoor temperature

3. Nominal airflow is based on 400 CFM/ton, actual design airflow per ton may vary.

4. The number of refrigerant passes is for reference only. Coil maximum refrigerant pressure drop and minimum refrigerant velocity will be the overriding factor in numbers of circuits

All standard derates need to be included such as line lengths and defrost

IMPORTANT

Please contact a Mitsubishi representative for assistance with coil selections.

When connecting two or more outdoor units to one evaporator coil, use a face split coil design for best temperature control.

Coil Design for Outdoor Air Processing Applications

For Outdoor Air Processing applications the capacity requirement is not necessarily known. The coil needs to be sized based on the entering air, leaving air conditions and CFM requirements. Then the outdoor unit and LEV Kit can then be selected based on these capacity requirements. The coil can be sized based on the cooling or heating requirements which ever is more important or larger. Then the coil can be run in the other mode for verification of performance

Entering Air temperature range	Cooling	59 - 75°FWB
	Heating	0 - 59°FDB

Nominal Capacity	(tons)	3	4	4.5	5	6	8
Cooling Capacity Design Range 1	Max. (Btu/h)	36,000	48,000	54,000	60,000	72,000	96,000
	Min. (Btu/h)	30,000	36,000	48,000	54,000	60,000	72,000
Heating Capacity Design Range 1	Max. (Btu/h)	40,000	54,000	61,000	67,000	81,000	108,000
	Min. (Btu/h)	34,000	40,000	54,000	61,000	67,000	81,000
Valve Assembly(s)		PAC-LV48AC-1		PAC-LV60AC-1		PAC-LV96AC-1	
HEX Internal Volume	Min. cu/in.	88	116	131	143	174	229
	Max. cu/in.	165	217	244	272	326	436
HEX Tubing Size	inches	5/16" or 3/8" (First choice should be 5/16")					
HEX No. of Refrig. Passes (For Reference) 2	5/16" Tube	6 - 9	7 - 10	8 - 10	8 - 10	10 - 12	12 - 14
	3/8" Tube	4 - 5	4 - 5	5 - 6	5 - 7	6 - 10	8 - 10
HEX Refrigerant Pressure Drop	PSI	Maximum = 4.35 PSI					
HEX Refrigerant Velocity	FPM	Minimum = 1,000 FPM					

Nominal Capacity	(tons)	10	12	14	16	18	20
Cooling Capacity Design Range 1	Max. (Btu/h)	120,000	144,000	168,000	192,000	216,000	240,000
	Min. (Btu/h)	96,000	120,000	144,000	168,000	192,000	216,000
Heating Capacity Design Range 1	Max. (Btu/h)	135,000	161,000	188,000	215,000	242,000	269,000
	Min. (Btu/h)	108,000	135,000	161,000	188,000	215,000	242,000
Valve Assembly(s)		PAC-LV120AC-1	PAC-LV96AC-1 X (2)			PAC-LV120AC-1 X (2)	
HEX Internal Volume	Min. cu/in.	287	345	403	458	516	574
	Max. cu/in.	546	656	766	873	982	1095
HEX Tubing Size	inches	3/8" or 1/2" (First choice should be 3/8")					
HEX No. of Refrig. Passes (For Reference) 2	5/16" Tube	N/A					
	3/8" Tube	10 - 12	12 - 14	16 - 20	16 - 20	16 - 20	18 - 22
HEX Refrigerant Pressure Drop	PSI	Maximum = 4.35 PSI					
HEX Refrigerant Velocity	FPM	Minimum = 1,000 FPM					

Data required for HEATING calculation		
Superheated Refrigerant Entering HEX	°F (°C)	Depends on outdoor unit and design temperature. See Chart #2 Below
HEX Condensing Temperature in heating	°F (°C)	Depends on outdoor unit and design temperature. See Chart #2 Below
HEX Subcooling	°F (°C)	27 (-2.8)
HEX Entering Air Temperature	°F (°C)	0 - 59°FDB (-17.8 - 15°CDB)
HEX Leaving Air Temperature	°F (°C)	63 - 83°FDB (17 - 28°CDB)

Data required for COOLING calculation		
Liquid Refrigerant Temperature Entering LEV	°F (°C)	77
HEX Evaporating Temperature in Cooling	°F (°C)	See Chart #1 Below
HEX Superheat	°F (°C)	9
HEX Entering Air Temperature	°F (°C)	59 - 75°FWB (15 - 24ºCWB)
HEX Leaving Air Temperature	°F (°C)	46 - 80°FDB (7.8 - 27ºCDB)

Chart #1 HEX Evaporator Temperature in Cooling

If unsure of the distance between indoor and outdoor unit, use 47°F (8.3°C).

Distance from outdoor unit to indoor unit				
100'	165'	230'	295'	361'
44°F (6.7°C)	45°F (7.2°C)	46°F (7.8°C)	47°F (8.3°C)	47°F (8.3°C)

HEX Design Temperatures		Outdoor Ambient °FDB						
		-13	-3	7	17	27	37	47
Standard and High Efficiency Outdoor Units	Superheated Refrigerant Entering HEX Temp °F	182	182	178	176	176	176	170
	HEX Condensing Temperature °F	94	100	103	107	114	120	120

HEX Design Temperatures		Outdoor Ambient °FDB						
		-13	-3	7	17	27	37	47
Hyper Heat Outdoor Units	Superheated Refrigerant Entering HEX Temp °F	150	160	170	170	170	170	170
	HEX Condensing Temperature °F	107	114	120	120	120	120	120

HEX Design Temperatures		Entering Water Temperature °F									
		23#	33#	43#	53	63	73	83	93	103	113
Water Source Units	Superheated Refrigerant Entering HEX Temp °F	180	180	180	180	175	170	170	170	170	170
	HEX Condensing Temperature °F	103	108	113	118	120	120	120	120	120	120

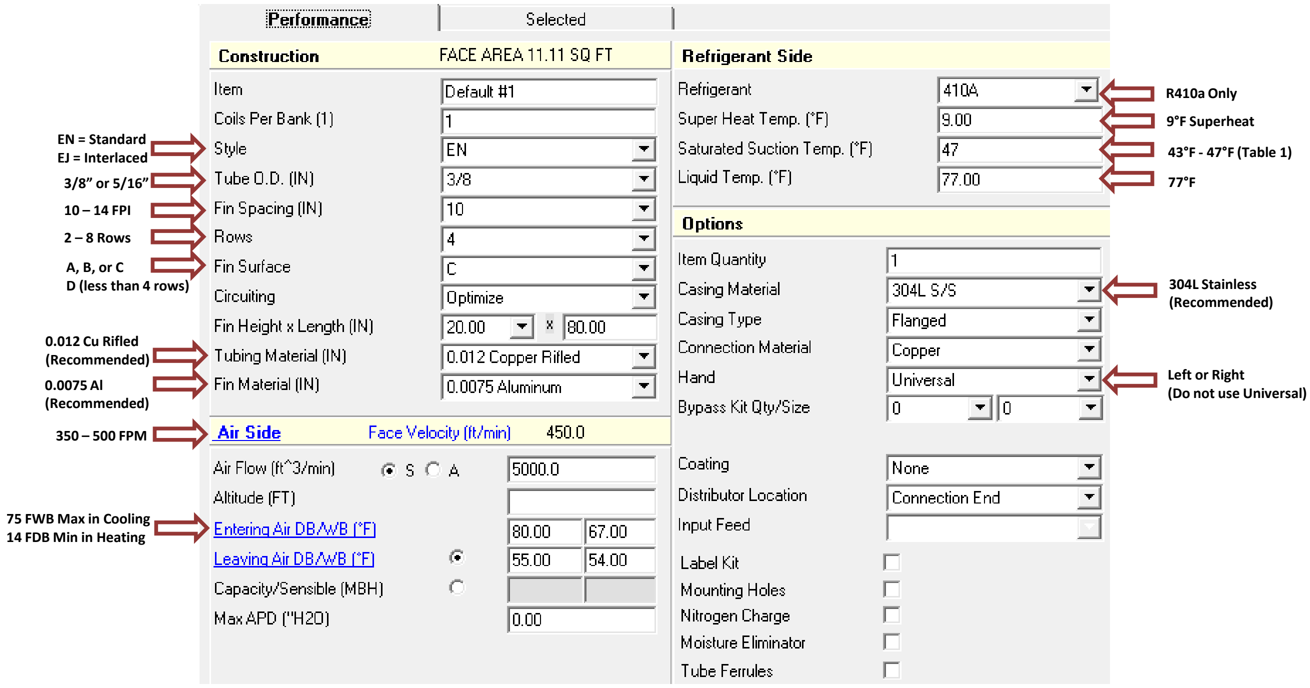
Function Code setting changed for low entering water temperature.

Notes:

1. These capacities ranges are for selecting the valve to apply to the application. The minimum is not the lowest modulating capacity of the valve. It's the lowest nominal capacity to apply that valve model. Also, when selecting a valve for an application, select the smallest valve that meets the requirement. For example: If the application requires a 60,000 Btu/h cooling capacity. Select the PAC-LV60AC-1 which has a maximum cooling capacity of 60,000 Btu/h. Do not use the PAC-LV96AC-1 which has a minimum cooling capacity of 60,000 Btu/h capacity.

2. The number of refrigerant passes is for reference only. Coil maximum refrigerant pressure drop and minimum refrigerant velocity will be the overriding factor in numbers of circuits.

All standard derates will need to be included such as line lengths and defrost.



Evaporator Temperature vs Piping Line Length

Table 1.

Pipe Length	100' (30 m)	165' (50 m)	230' (754.59m)	295' (89.9m)	361' (110m)
SST	43°F (6.1°C)	44°F (6.67°C)	45°F (7.2°C)	46°F (7.7°C)	47°F (8.3°C)

Heatcraft® heat transfer coils

MODINE

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Performance | **Selected**

Style	EN			S-Air Flow (ft^3/min)	5000.0
Tube O.D. (IN)	3/8	Fin Height x Length (IN)	20.00 x 80.00	Entering Air DB/WB (°F)	80.00/67.00
Fin Spacing (IN)	10	Tubing Material (IN)	0.012 Copper Rifled	Leaving Air DB/WB (°F)	55.00/54.00
Rows	4	Max APD ("H2O)	0.00		
Fin Surface	C	Fin Material (IN)	0.0075 Aluminum		
Casing Material	304L S/S				

MOST ECONOMICAL COIL | SPECIFIED COIL

	UOM	Coil 1	Coil 2	Coil 3	Coil 4	Coil 5	Coil 6	
Model Number		3EN2403C			3EN1004C			
Air Velocity	ft/min	450.0			450.0			
Total Capacity	MBH	201.4			182.1			**Determines LEV Kit Model & Condenser Size**
Sensible Capacity	MBH	139.6			125.3			
Leaving Air DB	°F	54.15			56.80			
Leaving Air WB	°F	54.05			55.48			
Standard APD	"H2O	1.23			0.49			
Code 18/19		6020/10			6020/8			**20 Paths**
Code 18/19_2		N/A			N/A			
Suction Connection	IN	(1) 1.375			(1) 1.375			
Distributor Connection #1	IN	(1) 0.875			(1) 0.875			
Distributor Connection #2	IN	N/A			N/A			
Refrigerant PD	lbf/in^2	2.13			2.40			**Refrigerant Pressure Drop 4.35 PSI Max**
Refrigerant Velocity	ft/min	1155.3			1044.5			**1,000 FPM Minimum**
Internal Volume	in^3	510.5			673.1			**Internal Volume Range: 457 – 866 Cubic Inches**
Weight	lbm	155.6			126.0			**(Varies by Kit Size, see Table 2)**
Notes		CDMW			CGM			

Heatcraft® heat transfer coils

MODINE®

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11. Connected Capacity

Unit	Application	VRF System Type		Connectable Capacity Range	Comments
Only LEV Kit(s)	Room Conditioning	Heat Pump	1:1	50% - 100%	-
			Multi-zone	50% - 130%	
		Heat Recovery	1:1	50% - 100%	
			Multi-zone	50% - 150%	
	Ventilation	Heat Pump	1:1	50% - 100%	
			Multi-zone		
		Heat Recovery	1:1		
			Multi-zone		
LEV Kit(s) + VRF Fan Coils	Room Conditioning	Heat Pump	Multi-zone	50% - 130%	
		Heat Recovery		50% - 150%	
	Ventilation	Heat Pump		50% - 110%[a]	The capacity of the LEV kit(s) should be less than 30% of the outdoor unit capacity
		Heat Recovery			

[a](100% if heating below 23°F)

12. Condenser Selection

Condenser size is chosen based upon the nominal cooling tonnage of the DX coil the LEV kit is being coupled with. Even in applications where heating is the primary concern and will force the condenser size, the starting point is to select an evaporator coil that is compatible with design parameters shown in the Section 11 of this guide. Even if the application is heating only, the starting point for the application is with a cooling coil selection, then rating that same coil in heating to yield performance.

NOTE
Please contact a Mitsubishi representative for assistance with coil selections.

13. Room Conditioning Applications

Both 1:1 and multi-zone configurations are allowed for room conditioning applications.

Room conditioning applications utilize room temperature control using either CITY MULTI® controllers or via analog input. When using CITY MULTI® controls, there is the option to use Mitsubishi's thermostat interface, part number PAC-US444CN-1, connected to CN105 on the LEV kit PC board, which allows the connection of a 3rd party thermostat and other miscellaneous controls functions.

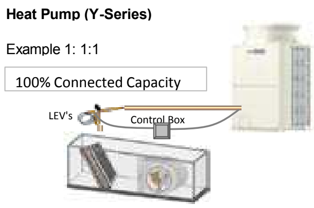
Outside air should be limited to 15 -20% of the nominal airflow for room conditioning applications since the return air control strategy will not provide humidity control. The fraction of acceptable outside air may be even less for humid climates.

14. Ventilation Applications

Both 1:1 and multi-zone configurations are allowed for ventilation applications.

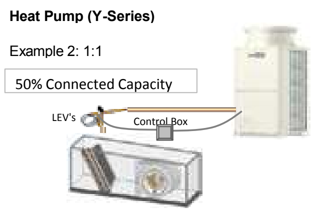
1:1 is the recommended configuration for all ventilation applications. Multi-zone configurations are acceptable, but the ventilation zone should constitute 30% or less of the nominal capacity of the CITY MULTI® outdoor unit it is connected to. For example, on a 10 ton heat recovery system such as a PURY-P120TLMU, where several fan coils are served by this single outdoor unit, an LEV kit used for ventilation is limited to 3 tons in size.

15. Applied System Examples



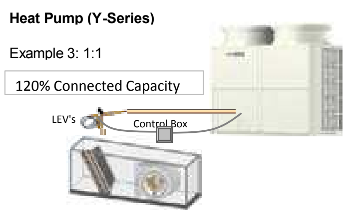
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P96TLMU-A	8 tons	50%	100%	OK
LEV Kit	PAC-LV96AC-1	8 tons	63%	100%	
AHU	-	8 tons	-	-	

In this example, an 8 ton VRF heat pump unit has been paired with an 8 ton air handling unit in a 1:1 configuration. Since this meets connected capacity and other applicable design guidelines, it is an approved combination.



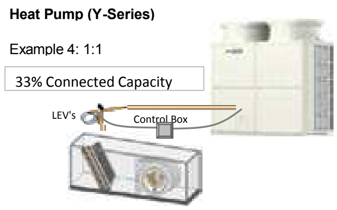
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P72TLMU-A	6 tons	50%	100%	OK
LEV Kit	PAC-LV48AC-1	4 tons	50%	100%	
AHU	-	3 tons	-	-	

In this example, an 8 ton VRF heat pump unit has been paired with a 4 ton air handling unit in a 1:1 combination, resulting in 50% connected capacity. While this combination represents an approved combination, there may be capacity turndown concerns if this is a ventilation application rather than a room conditioning application.



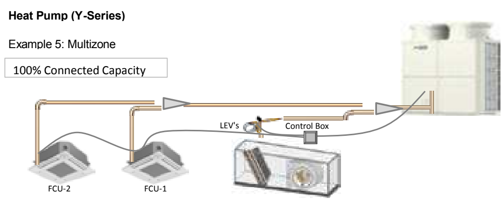
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P120TLMU-A	10 tons	50%	100%	~~NG~~
LEV Kit	PAC-LV96AC-1 (x2)	12 tons	63%	100%	
AHU	-	12 tons	-	-	

In this example, a 10 ton VRF heat pump unit has been paired with a 12 ton air handling unit. This is not an approved combination because it exceeds the connected capacity rules detailed in Section 11 of this guide. Note that regardless of line length or ambient temperature, the 10 ton heat pump is not going to produce 12 tons of capacity since the refrigerant mass flow rated is limited by the heat pump specified for the application. To correct this application, the design professional should size the heat pump to 12 tons to get the connected capacity down to 100%.



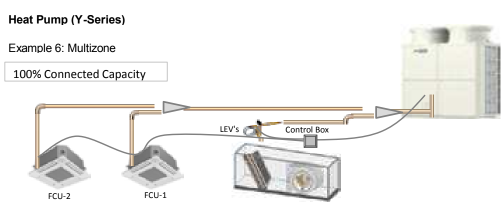
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P144TLMU-A	12 tons	50%	100%	NG
LEV Kit	PAC-LV48AC-1	4 tons	50%	100%	
AHU	-	4 tons	-	-	

In this example, a 12 ton VRF heat pump unit has been paired with a 4 ton air handling unit. This is not an approved combination because it violates the connected capacity rules detailed in Section 11 of this guide. Below 50% connected capacity, the system will have a capacity code error which prevents system operation. To correct this application, the design professional can either reduce the size of the heat pump or increase the size of the air handling unit in order to get within the applicable connected capacity constraints.



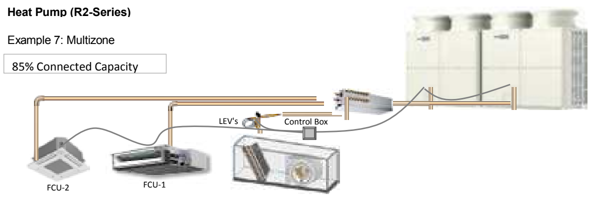
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P120TLMU-A	10 tons	50%	100%	OK
LEV Kit	PAC-LV48AC-1	3 tons	50%	100%	
AHU	-	3 tons	-	-	
FCU-1	PLFY-P48NEMU-E	4 tons	-	-	
FCU-2	PLFY-P36NEMU-E	3 tons	-	-	

In this example, a 10 ton VRF heat pump has been paired with a 4 ton VRF fan coil, a 3 ton VRF fan coil, and a 3 ton LEV kit. Since this meets connected capacity and other applicable design guidelines, it is an approved combination. If the LEV kit in this application is processing ventilation, it is currently the largest acceptable size given the heat pump it is connected to. If the LEV kit in this application is conditioning room air, the air handler could be upsized making the LEV kit constitute greater than 30% of the heat pump's nominal capacity, and the design professional could exceed 100% connected capacity provided building load calculations demonstrate sufficient diversity that the block load doesn't exceed 10 tons.



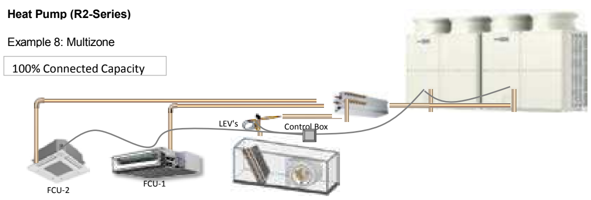
	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P168TLMU-A	14 tons	50%	100%	NG
LEV Kit	PAC-LV96AC-1	6 tons	63%	100%	
AHU	-	6 tons	-	-	
FCU-1	PLFY-P48NEMU-E	4 tons	-	-	
FCU-2	PLFY-P48NEMU-E	4 tons	-	-	

In this example, a 14-ton VRF heat pump has been paired with two 4-ton VRF fan coils as well as a 6-ton air handling unit. If the LEV kit in this application is processing ventilation air, this is not an approved combination since it would violate the 30% rule found in Section 11. Connected Capacity [37] connected capacity guidelines. To correct this application, the design professional can either increase the size of the heat pump or break off the ventilation LEV kit as a separate 1:1 system. If the LEV kit in this application is conditioning room air, then it is an approved combination since it meets connected capacity and other applicable design guidelines.



	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P240TLMU-A	20 tons	50%	100%	OK
LEV Kit	PAC-LV60AC-1	5 tons	80%	100%	
AHU	-	5 tons	-	-	
FCU-1	PEFY-P96NMHU-E	8 tons	-	-	
FCU-2	PLFY-P48NEMU-E	4 tons	-	-	

In this example, a 20-ton heat recovery VRF unit has been paired with an 8-ton VRF fan coil, a 4 ton VRF fan coil, and a 5-ton air handling unit. Since this meets connected capacity and other applicable design guidelines, it is an approved combination. This is an approved combination regardless of whether the LEV kit is processing ventilation or conditioning room air.



	Model	Cooling Capacity	Connected Capacity Range		Judgement
			Min	Max	
Outdoor Unit	PUHY-P240TLMU-A	20 tons	50%	100%	NG
LEV Kit	PAC-LV96AC-1	8 tons	63%	100%	
AHU	-	8 tons	-	-	
FCU-1	PEFY-P96NMHU-E	8 tons	-	-	
FCU-2	PLFY-P48NEMU-E	4 tons	-	-	

In this example, a 20-ton heat recovery VRF unit has been paired with an 8-ton VRF fan coil, a 4 ton VRF fan coil, and an 8-ton air handling unit. If the LEV kit in this application is processing ventilation air, this is not an approved combination since it would violate the 30% rule found in Section 11 connected capacity guidelines. To correct this application, the design professional can either increase the size of the heat pump or break off the ventilation LEV kit as a separate 1:1 system. If the LEV kit in this application is conditioning room air, then it is an approved combination since it meets connected capacity and other applicable design guidelines.

16. Ventilation Air Delivery

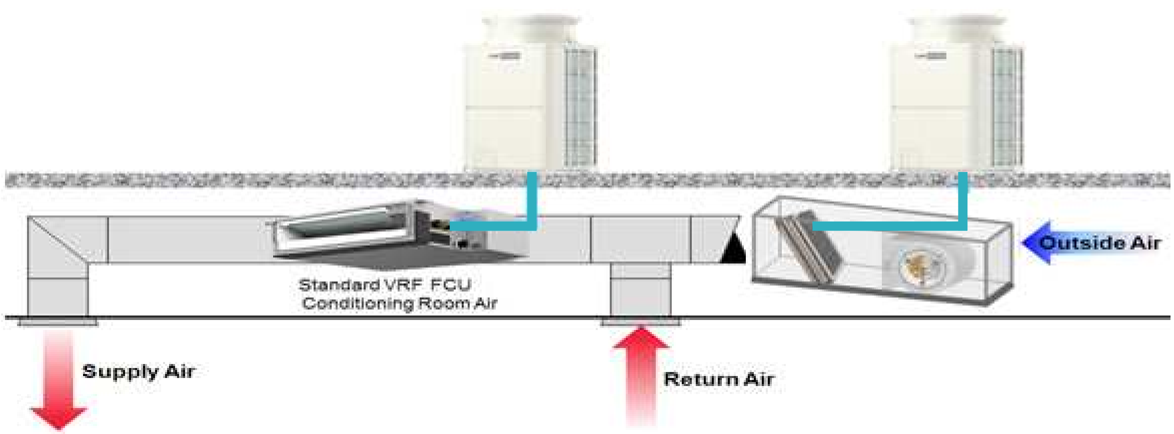
While standard VRF fan coils control to room temperature, the LEV kit has supply air temperature control capabilities. Consequently, it is important to note that for ventilation applications, the stability of supply air temperature may vary more significantly than it would from a hydronic system since the DX based VRF condensing unit is continually working to meet load while maximizing efficiency. The compressor is relatively slow to react so as to conserve energy, and while a quicker reaction would yield more stable supply air temperatures, the energy penalty to do so outweighs the occupant comfort benefit of more consistent supply air.

As a result, it is recommended that design professionals duct the conditioned ventilation air to the back of the other VRF fan coils on the project rather than introducing this air directly to the occupied space. If the air must be ducted directly to the occupied space due to architectural or other constraints, it would be best to introduce the air in a location where it isn't going to impact occupant comfort, such as hallways, corridors, or near the return of the other VRF fan coils.

Design Example

Figure 1 below shows one possible method to maximize the benefit of LEV kit based ventilation systems when designing them for use with VRF cooling/heating systems. This is not the only acceptable method of design, but rather a recommended method of mechanical design should architectural constraints allow for direct coupling of ventilation air with the cooling and heating system.

Figure 1:



17. Cycling Limits

17.1 Indoor Unit Cycling

What is cycling

LEV opening and closing during operation. Unit going into thermal OFF.

Normal cycle time is approximately	ON for 10 minutes OFF for 3 minutes

Fan does stay running during thermal OFF

Conditions that can affect cycling
room air temperature/intake air temperature

Setpoint

Airflow

Line lengths

Capacity demand (entering air conditions)

17.2 Outdoor Unit Cycling

Y-Series Indoor Units and Operating Range: K-Models

Model Size	Connectable Units	Min. Compressor Operating Range
P72	1 – 18	18%
P96	1 – 20	19%
P120	1 – 26	18%
P144 (Single)	1 – 31	14%
P144 (Dual)	1 – 36	8%
P168	1 – 36	8%
P192	1 – 41	6%
P216	2 – 46	9%
P240	2 – 50	8%
P264	2 – 50	7%
P288	2 – 50	7%
P312	2 – 50	4%
P336	2 – 50	7%
P360	2 – 50	6%

R2-Series Indoor Units and Operating Range: K-Models

Model Size	Connectable Units	Min. Compressor Operating Range
P72	1 – 18	16%
P96	1 – 24	17%
P120	1 – 30	15%
P144 (Single)	1 –36	13%
P144 (Dual)	1 – 36	8%
P168	1 – 42	7%
P192	1 – 48	9%
P216	2 – 50	8%
P240	2 – 50	8%
P264	2 – 50	7%
P288	2 – 50	7%

18. Variable Air Volume (VAV)

Variable air volume is permitted with the following supply airflow turndown range:

- Cooling: 80% - 100% of nominal design airflow
- Heating: 40% - 100% of nominal design airflow

The airflow turndown range can be extended for designs utilizing condensing unit systems consisting of multiple modules twinned together as this increases the system's capacity turndown since individual modules can turn completely off to reduce capacity.

When designing an LEV kit air handling unit with airflow ranges beyond the standard range, it is important to consider minimum to maximum capacity ranges for the system being designed. Once you have established the Btu/h range, this capacity can be applied to the ventilation airflow value in CFM that is being conditioned to see the point where the VRF outdoor unit needs to start to cycle in order to meet the cooling or heating load.

Example:

10 Ton Scenario:

- 1 compressor

- Btu Min: 18 MBH

- Btu Max: 120 MBH

- Design Airflow: 2,000 CFM

- EAT at Design: 15°F (-9.4 °C)

- LAT at Design: 70°F (21.1 °C)

<u>Calculating Minimum Airflow Before Capacity Cycling Occurs (Full Load, 55°F Delta T):</u>

18,000 Btu/h = 1.08 x CFM x 55

CFM = 303 (15% of design airflow)

<u>Calculating Minimum Airflow Before Capacity Cycling Occurs (Full Load, 30°F Delta T):</u>

18,000 Btu/h = 1.08 x CFM x 30

CFM = 556 (28% of design airflow)

<u>Calculating Minimum Airflow Before Capacity Cycling Occurs (Part Load, 20°F Delta T):</u>

18,000 Btu/h = 1.08 x CFM x 20

CFM = 833 (42% of design airflow)

<u>Calculating Minimum Airflow Before Capacity Cycling Occurs (Part Load, 10°F Delta T):</u>

18,000 Btu/h = 1.08 x CFM x 10

CFM = 1,667 (83% of design airflow)

20 Ton Scenario:

- 2 compressors
- Btu Min: 18 MBH
- Btu Max: 240 MBH
- Design Airflow: 4,000 CFM
- EAT at Design: 15°F (-9.4 °C)
- LAT at Design: 70°F (21.1 °C)

Heating Performance at Full Airflow:

Btu/h = 1.08 x CFM x Delta T

Btu/h = 1.08 x 4,000 x 55

Btu/h = 237,600

Calculating Minimum Airflow Before Capacity Cycling Occurs (Full Load, 55°F Delta T):

18,000 Btu/h = 1.08 x CFM x 55

CFM = 303 (7.5% of design airflow)

Calculating Minimum Airflow Before Capacity Cycling Occurs (Full Load, 30°F Delta T):

18,000 Btu/h = 1.08 x CFM x 30

CFM = 556 (14% of design airflow)

Calculating Minimum Airflow Before Capacity Cycling Occurs (Part Load, 20°F Delta T):

18,000 Btu/h = 1.08 x CFM x 20

CFM = 833 (21% of design airflow)

Calculating Minimum Airflow Before Capacity Cycling Occurs (Part Load, 10°F Delta T):

18,000 Btu/h = 1.08 x CFM x 10

CFM = 1,667 (42% of design airflow)

19. Multi-Zone Versus 1:1 Applications

19.1. Multi-Zone Applications

On a multi-zone Y-Series system where other VRF fan coils are used, LEV kits should not be used for ventilation because the mode changeover point for space cooling/heating and ventilation differs since ventilation air isn't subject to internal gains (people, lights, and equipment).

19.2. 1:1 Applications

Pairing a single outdoor unit system to a single LEV kit / air handler is always the preferred method for applying LEV kits, this eliminates variables and assures more reliable system operation across a wider range of operating conditions. The larger the tonnage of the LEV kit being applied, the more suitable it is for a 1:1 application rather than multi-zone. Additionally, with the 100% connected capacity limitation, multi-zone applications aren't as appealing from a design perspective as are standard VRF designs.

20. Mode Changeover

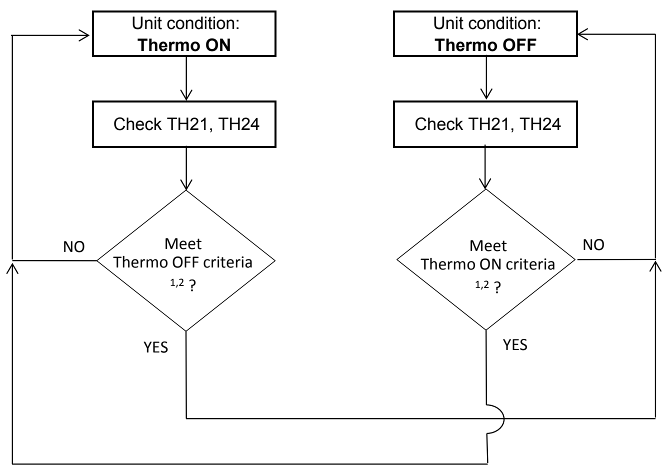
20.1. Mode Changeover for CITY MULTI® Controls

When using CITY MULTI® controls, mode changeover is handled the same way it would be for a standard VRF system, the controllers have the ability to command mode directly from a remote controller or central controller.

20.2. Mode Changeover for Analog Input

Changeover sequence for discharge air temperature control (US Model)

20.2.1. Transition Between Thermo ON and Thermo OFF

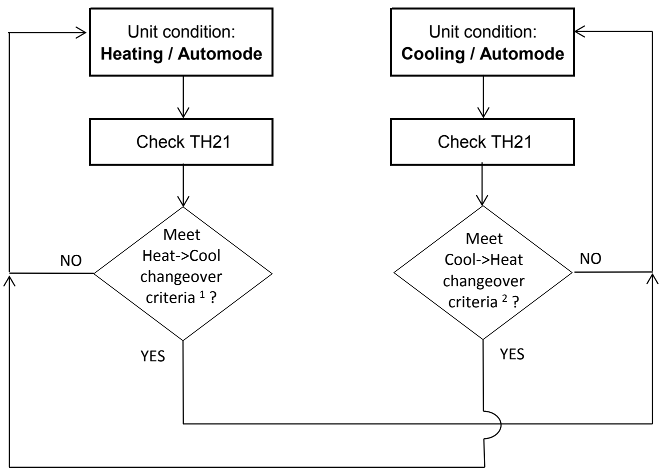


T_0 (Setpoint)
TH21 (Outside Air)
TH24 (Discharge Air)

[1]Cooling Mode	
Thermo ON Criteria	Thermo OFF Criteria
TH24 > T_0 + 1 °C [1.8 °F] AND **TH21** > T_0 + 1 °C [1.8 °F] AND TH21> 15 °C [59 °F] AND Thermo OFF continues for over 3 min	**TH24** < T_0 - 2 °C [3.6 °F] continues for over 10 min OR **TH21** < 14 °C [57.2°F] OR **TH21** < T_0

[2] Heating Mode	
Thermo ON Criteria	Thermo OFF Criteria
TH24 < T_0 - 1 °C [1.8 °F] AND **TH21** < T_0 - 1 °C [1.8 °F] AND **TH21** < 14 °C [57.2°F] AND Thermo OFF continues for over 3 min	**TH24** > T_0 + 5 °C [9 °F] continues for over 10 min OR **TH21** > 15 °C [59 °F] OR **TH21** > T_0

20.2.2. Changeover Between Cooling and Heating (AUTO Mode)



[1]Heating → Cooling
TH21 > T_0 + 1.5 °C [2.7 °F] continues for over 3 min
[2]Cooling → Heating
TH21 < T_0 - 1.5 °C [2.7 °F] continues for over 3 min

T_0 (Setpoint)
TH21 (Outside Air)

21. Diamond System Builder (DSB)

LEV Kit models will be added to DSB in the near future. In the meantime, designers must enter existing Mitsubishi fan coils (of equivalent tonnage) as a place holder for zones utilizing LEV kits as this will provide the appropriate cooling/heating capacity, piping diagram, wiring diagram, and refrigerant charge information from the software program’s outputs.

22. Piping

Unit Capacity (TON)	Liquid Line Diameter [inch (mm)]	Suction Line Diameter [inch (mm)]	LEV Valve
0.5	1/4 (6.35)	1/2 (12.7)	PAC-LV24AC-1
0.7	1/4 (6.35)	1/2 (12.7)	
1	1/4 (6.35)	1/2 (12.7)	
1.25	1/4 (6.35)	1/2 (12.7)	
1.5	1/4 (6.35)	1/2 (12.7)	
2	3/8 (9.52)	5/8 (15.88)	
2.25	3/8 (9.52)	5/8 (15.88)	PAC-LV48AC-1
2.5	3/8 (9.52)	5/8 (15.88)	
3	3/8 (9.52)	5/8 (15.88)	
4	3/8 (9.52)	5/8 (15.88)	
4.5	3/8 (9.52)	5/8 (15.88)	PAC-LV60AC-1
5	3/8 (9.52)	3/4 (19.05)	
6	3/8 (9.52)	3/4 (19.05)	PAC-LV96AC-1
8	3/8 (9.52) or >= 295 ft (89.9 m) 1/2 (12.7)	7/8 (22.2)	
10	3/8 (9.52) or >= 131 ft (39.9 m) 1/2 (12.7)	1-1/8 (28.58)	PAC-LV120AC-1
12	1/2 (12.7)	1-1/8 (28.58)	PAC-LV96AC-1 x (2)
14	5/8 (15.88)	1-1/8 (28.58)	
16	5/8 (15.88)	1-1/8 (28.58)	
18	5/8 (15.88)	1-1/8 (28.58)	PAC-LV120AC-1 x (2)
20	5/8 (15.88)	1-1/8 (28.58)	

Please be sure to put the contact address/telephone number on this manual before handing it to the customer.

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LEV Control Box and Valve Assemblies Application Guide
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