A WORLD LEADING MANUFACTURER OF HVAC PRODUCTS

FOUNDED IN 1924

OVER 60,000 DAIKIN VRV SYSTEMS OPERATING THROUGHOUT NORTH AMERICA

RESEARCH & DEVELOPMENT OVER $300 MILLION

Optimizing Design & System Efficiency with Smart Technology
### HVAC Typical Design Approach

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Scale</th>
<th>Conventional Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESIDENTIAL</strong></td>
<td>Small Size</td>
<td>Splits, Multi Splits, Packaged Units</td>
</tr>
<tr>
<td></td>
<td>Low Rise</td>
<td></td>
</tr>
<tr>
<td><strong>COMMERCIAL &amp; OFFICE</strong></td>
<td>Large Size</td>
<td>CHILLERS</td>
</tr>
<tr>
<td></td>
<td>Mid/High Rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small Size</td>
<td>Splits, Multi Splits, Packaged Units</td>
</tr>
<tr>
<td></td>
<td>Low Rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large Size</td>
<td>CHILLERS, District Cooling</td>
</tr>
<tr>
<td></td>
<td>Mid/High Rise</td>
<td></td>
</tr>
</tbody>
</table>
### Typical use of HVAC systems

<table>
<thead>
<tr>
<th>Unit</th>
<th>DX</th>
<th>Packaged</th>
<th>VRV</th>
<th>Air cooled Chiller</th>
<th>Water cooled Chiller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost (AED / TR)</td>
<td>4000</td>
<td>5500</td>
<td>8500</td>
<td>9000</td>
<td>11500</td>
</tr>
<tr>
<td>Energy efficiency (kW / TR)</td>
<td>2.1</td>
<td>1.8</td>
<td>0.9</td>
<td>1.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Life span (Years)</td>
<td>12.0</td>
<td>12-15</td>
<td>20Plus</td>
<td>20Plus</td>
<td>25 Plus</td>
</tr>
<tr>
<td>Suitable Installation range (Tons)</td>
<td>0 - 50</td>
<td>5 - 100</td>
<td>30 - 800</td>
<td>200 - 1000</td>
<td>1000 - no limit</td>
</tr>
</tbody>
</table>
| Pros                  | * Low First Cost  
* Low Comfort requirements  
* No emphasis or Energy use | * Low First Cost  
* High Comfort requirements  
* High Volume areas | * medium First Cost  
* High Comfort requirements  
* Excellent Energy savings  
* Service techs available | * medium First Cost  
* High Comfort requirements  
* huge loads satisfied  
* Specialised service | * Low running costs per TR  
* huge loads satisfied  
* Specialised service |
| Cons                  | * Small life cycle  
* More maintenance/repairs  
* can not be used for big applications | * Large space for Ducts  
* Roof openings  
* No individual area controls | * High Capital cost  
* Technician training  
* Freah air solution is limited | * High First Cost  
* No small load use  
* Long project time | * High First Cost  
* Cooling towers & make up water  
* Not suitable for low loads |
| Use                   | Villas, single office block, stand alone areas | Private areas - Masterbedrooms, Big halls, Multipurpose halls, Warehouses, | Small Offices, Schools, Medium rise, High rise, | Schools, Offices, Medium to High rise | District cooling, Big Shopping malls, Hotels, High rise buildings, Industrial use |
Design Limitations of Traditional DX Systems

- Higher Power Consumption
- Shorter productive life (10 years)
- No provision for standby
- No or limited Centralized Controls option
- Non Modulating Capacity Control (mostly on/off cycle only)
- Pipe Lengths limitations (up to 50m only)
- No Diversification of Loads possible (100% ratio)
- Low Comfort Levels (+/- 3 Deg C)
- Multiple Units - High Space Requirements—Higher Heat Generation
- High Sound Levels
- Limited Distance between indoor and outdoor
Limitations of Existing Solutions

➢ Larger System Sizes
➢ Low Part Load Efficiencies (minimum 25% compressor unloading)
➢ Standby capacity creation is expensive
➢ No redundancy during break down
➢ Shared Electricity – No direct billing.
➢ Higher infrastructure costs – Transformer (85% loading only)/foundations/ cables/ electrical panels/pump room
➢ Third party supplied central controls
➢ Specialized Maintenance Team – Higher cost
➢ Multiple Suppliers / Points of Contact
➢ Longer Installation Time
➢ Phase Commissioning Not Possible
➢ Non Scalable – Adding Capacity is Difficult
➢ Limited Range of Indoor Units
### GCC Energy Efficiency Requirements

<table>
<thead>
<tr>
<th>Country</th>
<th>T1 EER</th>
<th>T3 EER</th>
<th>T1 Estidama</th>
<th>T3 Duct</th>
<th>T1 Wall</th>
<th>T3 Duct</th>
<th>T1 Wall</th>
<th>T1 Wall</th>
<th>T1 Wall</th>
<th>T1 Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi</td>
<td>11.5</td>
<td>8.28</td>
<td>11.6</td>
<td>8.1</td>
<td>6.8</td>
<td>6.8</td>
<td>9.5</td>
<td>6.84</td>
<td>11.5</td>
<td>6.84</td>
</tr>
<tr>
<td>UAE</td>
<td>11.8</td>
<td>8.3</td>
<td>11.6</td>
<td>8.1</td>
<td>6.8</td>
<td>6.8</td>
<td>9.5</td>
<td>6.84</td>
<td>11.5</td>
<td>6.84</td>
</tr>
<tr>
<td>Qatar</td>
<td>9.5</td>
<td>6.84</td>
<td>11.5</td>
<td>6.84</td>
<td>9.5</td>
<td>6.84</td>
<td>11.5</td>
<td>6.84</td>
<td>11.5</td>
<td>6.84</td>
</tr>
<tr>
<td>Bahrein</td>
<td>8.0</td>
<td>6.84</td>
<td>8.57</td>
<td>6.84</td>
<td>8.0</td>
<td>6.84</td>
<td>8.57</td>
<td>6.84</td>
<td>8.57</td>
<td>6.84</td>
</tr>
<tr>
<td>Kuwait</td>
<td>11.5</td>
<td>8.0</td>
<td>11.5</td>
<td>8.0</td>
<td>11.5</td>
<td>8.0</td>
<td>11.5</td>
<td>8.0</td>
<td>11.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Oman</td>
<td>9.5</td>
<td>6.84</td>
<td>6.84</td>
<td>6.84</td>
<td>9.5</td>
<td>6.84</td>
<td>9.5</td>
<td>6.84</td>
<td>9.5</td>
<td>6.84</td>
</tr>
</tbody>
</table>

- **35°C**
- **46°C**

Minimum EER ≠ Testing points ≠ Energy Labels

- **52°C**
- **2 Hours**

T1 = 35°C, T3 = 46°C
HVAC SHARE IN ENERGY USE – Qatar

Distribution electricity consumption – 2013

- Residential: 48%
- Commercial: 36%
- Industry: 15%

Distribution electricity consumption for a typical villa

- Cooling: 71%
- Light: 12%
- Equipment: 11%
- Fan: 4%

How to reduce the energy use?

✓ Act on building performance (e.g.: insulation...)
✓ Act on air conditioning efficiency

(Source: July 2017 / KS-2017-DP16)
ENERGY CONSUMPTION SIMULATION

EER Or Seasonal EER

ELECTRICITY CONSUMPTION

OPERATION LOAD:
DEPENDS ON OUTDOOR TEMPERATURE

EFFICIENCY
CALCULATION METHOD

EER
ESEER
SEER

EQUIPMENT EFFICIENCY:
DEPENDS ON TECHNOLOGY
WHAT IS EFFICIENCY – WHY IS IMPORTANT?

- Energy Efficiency gives you an indication on how your system is performing.
- The more efficient, the less energy use.
- It is crucial to have a correct representation of efficiency to enable selection of system that will save energy.
- Several ways to represent efficiency:
## CONDITIONS

<table>
<thead>
<tr>
<th>NUMBER POINTS:</th>
<th>EER</th>
<th>ESEER</th>
<th>SEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>4</td>
<td>FULL CURVE</td>
</tr>
</tbody>
</table>

### TEMPERATURE:

- **EER** indicates the efficiency of AC 1 defined point (e.g., 46 or 35°CDB).
- **ESEER** indicates the efficiency of AC based on 4 points.
- **SEER** indicates the efficiency of AC over the full temperature distribution curve.

### LOAD:

- **100%**
- **75%**
- **50%**
- **25%**

---

EER indicates the efficiency of AC 1 defined point (e.g., 46 or 35°CDB).

ESEER indicates the efficiency of AC based on 4 points.

SEER indicates the efficiency of AC over the full temperature distribution curve.
TEMPERATURE DISTRIBUTION CURVE

HOT CLIMATE ... BUT NOT ALL YEAR LONG!

Source: airport weather data

Part Load Efficiency

OCCURRENCE (COOLING) ~ 75%
ZONE TO ACT ON TO REDUCE
ACTUAL ENERGY CONSUMPTION

设计点: 46CDB
EFFICIENT COOLING – ALL THE YEAR ROUND!

EXCELLENT SEASONAL EFFICIENCY, IN LINE WITH REAL LIFE OPERATING CONDITIONS

Average EER 20+ BTU/BTU (< 0.6 KW/Ton)
How to increase Part Load Efficiency

Variable Refrigerant Temperature

VRV IV operation

Lower capacity needed during mid season

Adapting to required heat load by Variable Refrigerant Volume

Automatic adjustment of refrigerant temperature depending on load and weather

+28% ESEER
**VRT Concept**

**VRF**

- **Temp outside**
  - 0°C
  - 21°C
  - 28°C
  - 46°C

- **Refrigerant Temp**
  - 6°C

**Fixed Refr Temp**

**VRV IV**

- **Refrigerant Temp**
  - 6°C
  - 13°C

**Automatic change depending on Temperature Outside**

**Result?**

- Higher efficiency - **28% SAVINGS OVER A FULL YEAR**
- Higher comfort
Efficiency = \frac{\text{Cooling Capacity}}{\text{Power Input}}
TECHNOLOGY
WHAT IS VRV®? – DEFINITION & How it works?

- **Variable:** The system responds depending on the required capacity.
- **Refrigerant:** Direct expansion system.
- **Volume:** The refrigerant volume is regulated by an electronic expansion valve in each indoor unit...
What is VRV? → VRV

VRV IV is Weather Compensating Air Conditioning System

- Central DX system
- Possible to take diversity
- Excellent Part load Efficiency or IPLV
- Long pipe run up to 190 meters
- Wide variety of indoor units
- Tenant Billing
- Multi phase - Scalable

3 – 100 T.R. Cooling Capacity

VRV IV is Weather Compensating Air Conditioning System
VRV – No Central Ducting
Smart Zoning and Diversification

- ZONE 1: 22°C
- ZONE 2: 20°C
- ZONE 3: 24°C
- ZONE 4: OFF
T1 = Inlet refrigerant temperature sensor (liquid)
T2 = Outlet refrigerant temperature sensor (gas)
T3 = Suction air temperature sensor
T4 = Set temperature from Remote controller air temperature

Modulating cooling capacity gives optimum comfort
VRV offer the best comfort via precise temperature and humidity control.
Extra protection for High Ambient Areas

Air cooled

Radiator fins

Refrigerant cooled

Reliable cooling without any influence from ambient air temperature!
Corrosion and Capacity

Acid salt spray test for heat exchanger

<table>
<thead>
<tr>
<th>Higher Grade PE Fin</th>
<th>Conventional Blue Fin</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 hours</td>
<td>300 hours</td>
</tr>
<tr>
<td>500 hours</td>
<td>500 hours</td>
</tr>
<tr>
<td>1,000 hours</td>
<td>1,000 hours</td>
</tr>
</tbody>
</table>

No corrosion!

After 1,000 hours of acid salt spray, definite corrosion found on the surface

Up to 50% Capacity Loss
VRV Outdoor Single - Multi

<table>
<thead>
<tr>
<th>(HP)</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
<th>26</th>
<th>28</th>
<th>30</th>
<th>32</th>
<th>34</th>
<th>36</th>
<th>38</th>
<th>40</th>
<th>42</th>
<th>44</th>
<th>46</th>
<th>48</th>
<th>......</th>
<th>96</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRV</td>
<td>![Single]</td>
<td>![Combination (Multi)]</td>
<td>![Single]</td>
<td>![Combination (Multi)]</td>
<td>![Single]</td>
<td>![Combination (Multi)]</td>
<td>![Single]</td>
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<td>![Single]</td>
<td>![Combination (Multi)]</td>
<td>![Single]</td>
</tr>
</tbody>
</table>

Depending on Design priorities:

- **Efficiency**
- **Footprint**

### 20HP:
- 20HP
- 8HP + 12HP
- 10HP + 10HP

### 24HP:
- 8HP + 16HP
- 10HP + 14HP
- 12HP + 12HP
- 8HP + 8HP + 8HP

-26-
High ambient model – Low Capacity Drop

Capacity derating at 46°C compared to 35°C

VRV

- 100% - 95% - 90% - 85% - 80% - 75% - 70%

8HP 10HP 12HP

Cooling

Tamb (° CDB) outdoor unit

pull down area

Tamb (° CWB) indoor unit

14 25 28

-5
➢ Max. height difference o.u. – i.u.: 90m
➢ Max. branch length: 90m
➢ Max. actual piping length: 165m
➢ Max. equiv. piping length: 190m
➢ Max. total piping length 1000m
➢ Max. I.U – I.U height: 30m

Note: There are limitations depending on connectable type of indoors, piping diameters etc. Always consult technical literature.
DESIGN TOOLS
Software Tools

Webxpress

VRV CAD

VRV PRO
Golden Pyramids (Cairo)

Solutions seasonal simulator
Roof Design

Space Planning:
1 m² = 10 TR foot print
1 m² = for service
Total = 2 m² per 10 TR
Dangers of Oversizing

Oversized for cooling

Despite advanced control methods, oversizing of equipment, even with Variable Refrigerant Volume technology, can lead to indoor units overcooling the space and cycling on and off. This results in poor temperature control.

In addition to large temperature swings, an indoor unit that cycles on and off does not provide continuous de-humidification.
Proper Sizing

Correct Sizing

Using traditional rules of thumb to size HVAC equipment can lead to oversizing of equipment as construction methods have changed from the days when the 500 ft² per ton or 400 cfm per ton was the standard one-size-fits-all solution for residential, light commercial, and commercial buildings. The latter is especially true with VRV indoor units typically operating at 320~350 cfm per ton.

The minimum information needed to produce accurate and optimized equipment selection on a project:

<table>
<thead>
<tr>
<th>Indoor Unit</th>
<th>Outdoor Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Cooling and Heating Load</strong></td>
<td><strong>Design Air Conditions</strong></td>
</tr>
<tr>
<td>» Engineers will provide total and sensible loads sizing is possible when either is provided.</td>
<td>The dry and wet bulb temperatures entering the coil.</td>
</tr>
<tr>
<td>» Required when either heating is the dominant operation or the heating design condition is below 32°F.</td>
<td>» Also known as “air-on” or “mixed air” conditions.</td>
</tr>
<tr>
<td><strong>Ambient Conditions</strong></td>
<td><strong>Pipe Length</strong></td>
</tr>
<tr>
<td></td>
<td>» Longest linear length, NOT the total amount of piping.</td>
</tr>
<tr>
<td>» Both engineers and D&amp;B contractors should have this information.</td>
<td>» Both engineers and D&amp;B contractors should be able to pinpoint the outdoor unit location.</td>
</tr>
<tr>
<td>» ASHRAE standard design conditions for the location are easily obtained.</td>
<td></td>
</tr>
</tbody>
</table>
Outdoor Unit Location

- Shading the outdoor unit from sun will improve unit performance in the summer. If necessary use overhang.
- In areas close to water, avoid exposure to sea breeze. Use heavy anti-corrosion.
- Avoid areas where sand can be blown in the unit use deflectors.
INSTALATION
Air short circuit

It refers to a phenomenon when discharged air (exhaust heat) from the outdoor unit is drawn back into the suction vent.

If an air short circuit occurs

1. Efficiency of cooling operations will decrease.
2. Shortage in capacity.
3. High pressure cut-off will occur (operation stops).
4. The lifespan of the outdoor unit will be shortened.
To prevent friction loss, we recommend not using louvres in front of discharge ducts.

Original Layout:
Outdoor units on the upper floors draw in the exhaust heat from the lower floors. (Suction vents of outdoor units and discharge ducts are facing the same direction.)

Close the front louvre (or use a solid wall) everywhere except in front of the discharge area to avoid recirculation of discharged air.
Air Conditioning

Technical Data

Outdoor unit layout guide

Energy Efficiency - Design

Fresh air

Original Layout
Discharged air is drawn into the front row suction vents.

Suction side should be facing outward
Energy Efficiency - Design

Air Conditioning

Technical Data

Outdoor unit layout guide

Turn one part of the wall into a louver and use discharge ducts.

Discharged air can escape from the top

Fresh air
When there is a wall to the side
Elevate the front row of units, so that both rows can draw in air from the front.

Suction side of both rows should be facing the front.

Elevate the front row of units.

Note: Do not merge ducts. Only one duct is to be installed on each fan in order to prevent air from being directly circulated into the neighbouring fan.
4. Design guidelines
(1) Remove outdoor unit discharge grill.
(2) Install air discharge ducts on all outdoor units. Fix the duct against the louvre if existing.
(3) Louvre angle: 20 degrees from horizontal
(4) Air velocity: Discharge air $V_D = 5 - 8 \text{ m/s}$ and Suction air $V_S \leq 1.6 \text{ m/s}$
(5) Total pressure loss (through the discharge duct and the louvre) should be less than 78.4 Pa for VRV IV (with high static pressure setting).
(6) Space should be left for suction air to circulate freely and for installation/service/maintenance to be done.

5. Illustration
Diagram below indicates the minimum distance for the unit layout in case of a floor-by-floor installation

- Louvre angle: $\alpha \leq 20^\circ$ downwards
- Air velocity
  - $V_D$: Air discharge effective velocity
    \[ V_D = \frac{\text{Flow rate}}{\text{Discharge effective surface}} \]
  - $V_S$: Air suction effective velocity
    \[ V_S = \frac{\text{Flow rate}}{\text{Suction effective surface}} \]

  Discharge effective surface = Actual discharge surface $\times$ Louvre opening ratio
  Suction effective surface = Actual suction surface $\times$ Louvre opening ratio

- $5 \text{ m.s}^{-1} \leq V_D \leq 8 \text{ m.s}^{-1}$
- $V_S \leq 1.6 \text{ m.s}^{-1}$

- Total pressure loss: Less than 78.4 Pa for VRV IV
Air Conditioning

Technical Data

Outdoor unit layout guide

Discharge duct
930 mm width casing with 1 fan

Discharge duct
1240 mm width casing with 2 fans
Air temperature and airflow simulation results

**Original Layout**
- Discharged air is drawn back in.

**Improved Layout**
- Fresh air also supplied from centre.

*Use Simulation Tools*
Energy Efficiency - Design

Air Conditioning
Technical Data
Outdoor unit layout guide

Air temperature and airflow simulation results

Original Layout
Discharged air is drawn back in.

Improved Layout
Fresh air also supplied from underneath.
CONTROLS
Market requirements

My budget is limited so I am looking for basic control of my A/C.

I want to integrate the A/C into the existing BMS system.

I am looking for an advanced centralized control system.

I am looking for advanced energy management.

Basic control possibilities to advanced BMS systems,
**Controls choice**

- **Individual Controls**
  - Thermostats
  - Wired
  - Wireless

- **Centralized Controls**
  - iTouch Manager
  - iTouch Control
  - Central Controller

- **BMS / Network Management Controls**
  - Bacnet Interface
  - Modbus
  - KNX
  - LonWorks

- **Cloud Control**
Controls choice

- Advanced package
  - Includes all the packages
  - Automatic function for energy saving
  - Local functions in addition to performance & energy consumption visualization
  - Control of different sites from a single location
  - Multi-site Control
  - Remote monitoring & control
  - Energy saving
  - Web browser interface
  - Cloud
Centrulized Controls

iTouch Manager (iTM)

iTouch Control

Residential controller

Tablet Controller
Concept of Mini BMS
Intuitive user interface...

All Functions accessible via touch...

...with a virtual layout view...
Smart energy management

...and detect the origin of energy waste

Visual overview indicates indoor units where energy saving is possible.
Flexible

Modular concept for use in medium... 

...to large applications. 

2560 Groups
**Proportional Power Distribution**

- Power consumption of the outdoor units
- kWh meter
- Division Calculation Done by ITM

- Tenant A
- Tenant B
- Tenant C
- Tenant D
Control parameter:

**Basic Monitoring & control**
- On/Off
- Mode
- Setpoint
- Fanspeed & airflow direction
- Room temperature
- Error code
- Filter sign

**Advanced functions**
- R/C buttons prohibition
- Schedule (weekly)
- Emergency stop
- Simple interlock

**3rd pty product integration**
- Digital inputs

Examples:
- Emergency stop
- Window contact
INTELLIGENT TABLET CONTROLLER

Concept

- Dedicated Light Commercial segment solution
- Price competitive centralized controller
- User-friendly and intuitive user interface

Cloud connectivity

STEP 1

Remote cloud connection
Web Based Data Management

- Installation Site
- Network Center
- Airnet Control Center → Local Service Office

• Notification is sent to customer
• Technician dispatch arranged at minimum possible time

Continuous Monitoring
Continuous Data Transfer

Error detected

Monitored every minute – reported everyday in normal operation. In failure, immediately reported includes last 30 minutes data.

Summarized & Reported (stored server, can be referred via web)

130 data points
• All sensors, valves, actuators, and control points are monitored 24/7 in the outdoor and indoor units (aprx. 130 points)
• Over 80 different predictions for VRV can be generated. Examples:
  • Gas leak
  • Thermistor failure
  • Abnormal operation of expansion valve
  • High compressor consumption
  • Clogged filters
  • Irregular high / low pressures

Additional data and trends are also saved:
  • Running hours
  • Power input
  • Maximum and minimum consumption

Leak in refrigerant circuit

Avoiding compressor breakdown
Network Controls - Adapters

- Modbus
- KNX
- BACnet
- LonWORKS
VRV - Connections

VRV indoors
Ventilation
Controls
Thank you