



# Highly Efficient and Compact Side-Air-Flow Type Multi-Air Conditioner

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Mitsubishi Heavy Industries, Ltd. (MHI) has developed a new side-air-flow type multi-air conditioner for the Chinese market. It is most suitable for high quality apartments and small offices. The volume of the outdoor unit has been reduced by 22% and its COP (Coefficient Of Performance) has been increased by 40% compared to conventional KX2 series air conditioners, thus realizing a remarkable reduction in both size and energy consumption. A fully chargeless system that completely eliminates the need to charge refrigerant during installation has also been adopted in order to improve workability and reliability. In addition, the indoor unit (FDT: Ceiling cassette 4-way blowout model) and the wired remote controller have been completely redesigned.

## 1. Introduction

China is currently enjoying a construction boom as the 2008 Beijing Olympics and 2010 Shanghai Expo approach, with high quality apartments being constructed one after another for foreigners and Chinese high-income earners. Many of these apartments have a floor space ranging from 100 to 150 m<sup>2</sup> in which an air conditioner with a capacity of approximately 5 HP is required.

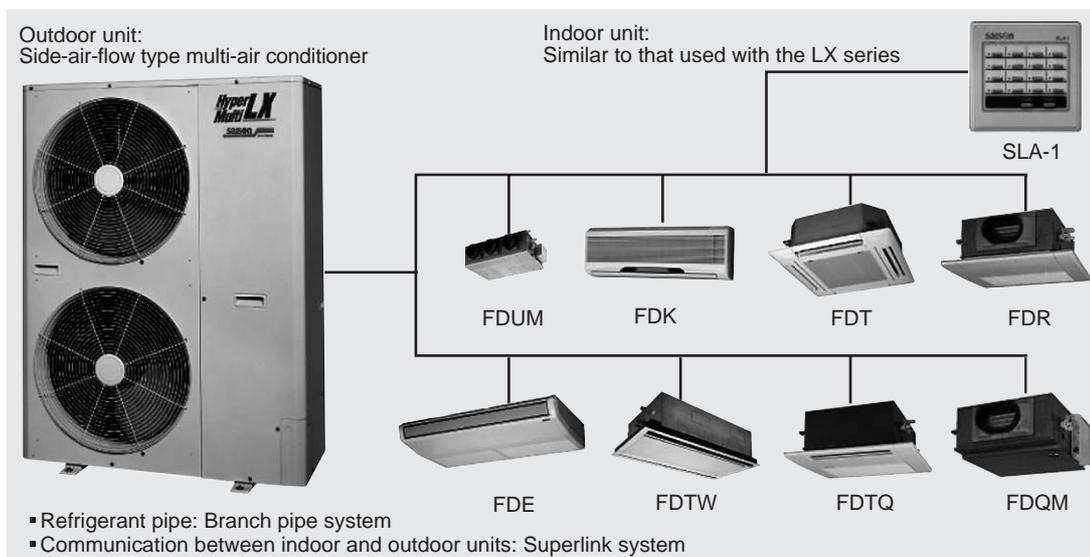
In response to this demand, MHI has put the KX2 series on the Chinese market with the aim of expanding the range of MHI products in the market. Since more growth in the market is expected in the future, MHI has developed and introduced a new side-air-flow 5 HP multi-air conditioner for use in homes such as apartments. It has marked energy-saving features, is remarkably reduced in

size compared with the conventional KX2 series, and has improved workability and serviceability.

An overview of the main features of the side-air-flow type multi-air conditioner is presented here.

## 2. Features

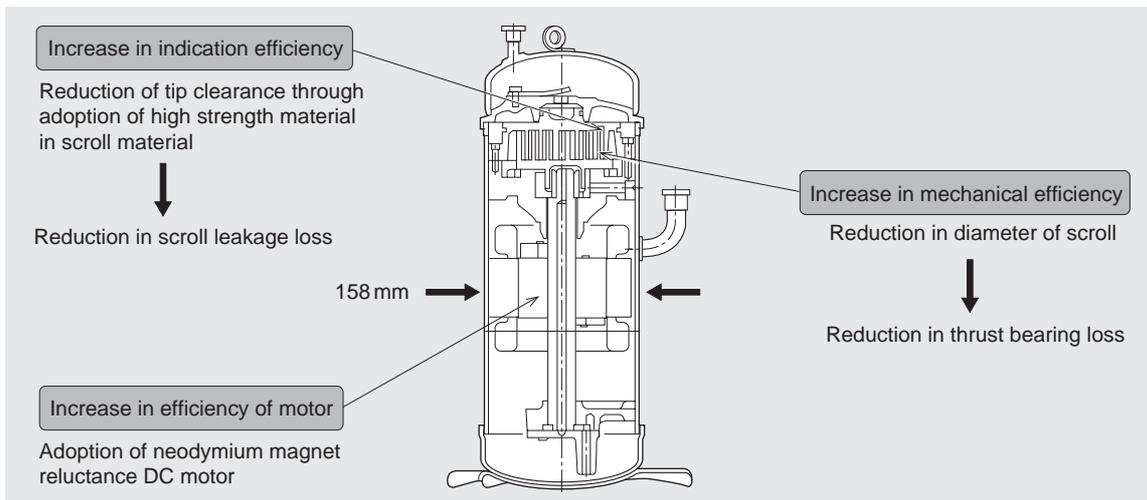
The side-air-flow type multi-air conditioner and its indoor units are shown in **Fig.1**. The accompanying indoor unit is standardized with that used in the LX series, and can be directly connected, together with the pipes and cables, to the outdoor unit without any special interface. Since the indoor unit is not designed for specific use, MHI can always put the latest model on the market. The communication system succeeds conventional "Superlink" so that multiple integrated control units such as SL-1 can be connected and used easily.



**Fig. 1 The side-air-flow type multi-air conditioner and its indoor units**

The indoor units are similar to the units of LX series. All pipes and cables can be connected directly to the system as in the conventional system.

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**Fig. 2 Structure of reluctance DC compressor**

The scroll and motor have been modified, and the efficiency of the compressor unit could be increased by approximately 11%.

The side-air-flow type multi-air conditioner has the following five outstanding features that are not incorporated in conventional units.

### 2.1 Notable energy-savings

The side-air-flow type multi-air conditioner is remarkably improved in terms of energy savings compared with the 5 HP KX2 series. The COP for the outdoor unit of the system is increased by 40%, that is, from 2.57 to 3.61. This is due to the major impact of a newly developed high efficiency compressor fitted with a DC motor and a DC converter to drive the compressor.

**Fig. 2** shows the structure of the reluctance DC compressor. By optimizing the design of the scroll, leakage loss and thrust bearing loss are reduced, and both indication

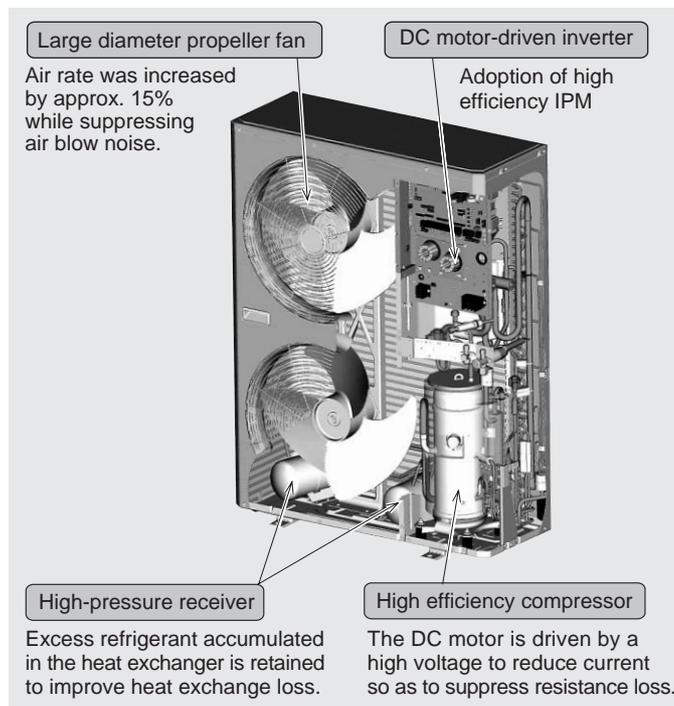
efficiency and mechanical efficiency are increased. In addition, neodymium magnets are buried in the core of the motor rotor in order to increase its efficiency up to the low speed rotation region through the combined effects of Fleming's force and reluctance torque. In addition, the compressor minimizes loss as an inverter through the adoption of a highly efficient Intelligent Power Module (IPM) and a high voltage drive motor.

In addition to the above, remarkable energy savings could be realized by the adoption of a large diameter propeller fan and a reduction in unit pressure loss by streamlining airflow, as can be seen in **Fig. 3**.

### 2.2 Reduction in size

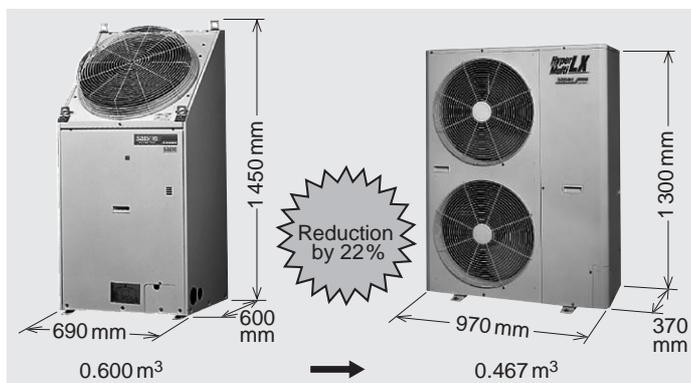
A comparison of the outer dimensions of the KX2 series and the side-air-flow type multi-air conditioner is shown in **Fig. 4**. The volume of the unit could be reduced by 22% by renovating the external design and changing the air blow direction of the fan from a diagonal to a side direction. In particular, since the depth dimension has been reduced from 600 to 370 mm, the unit can be easily installed in a restricted space such as the verandas of apartments.

The weight has also been reduced from 150 to 125 kg. The reduction in weight and size of the unit results in easy load handling and transportation to installation.



**Fig. 3 Improvements in unit**

Overall COP has been increased by 40%, from 2.57 to 3.61 compared with the existing 5 HP KX2 series.



**Fig. 4 Comparison in size between new and old models of outdoor unit**

The direction of air blowout was changed from the diagonal to the side direction in order to reduce the volume of the outdoor unit by 22%.

### 2.3 Fully chargeless system

A major feature of the side-air-flow type multi-air conditioner described here is the fully chargeless system, which completely eliminates the need to charge the refrigerant at the time of installation. It not only reduces the costs associated with both the refrigerant cost and construction, such as charging operation, but also serves to prevent any difficulties due to an excess or deficiency of refrigerant, thereby improving reliability. MHI believes that the system is indispensable to facilitate the penetration of its products into the Chinese market where the infrastructures for new refrigerant HFC410A are not so maintained.

In order to realize this goal, a method for processing excess refrigerant had to be established, since the side-air-flow type multi-air conditioner needs a large amount of refrigerant to operate properly.

The excess refrigerant produced by eliminating charge is stored in a high pressure area through the adoption of superheat control in the electronic expansion valve and an increase in the capacity of the high pressure receiver. This leads to a reduction in heat exchange loss by preventing the accumulation of refrigerant in the heat exchanger and a reduction in suction pressure loss by eliminating a low-pressure accumulator, thereby contributing to an increase in efficiency.

The high-pressure receiver is not installed in the machine chamber but rather is installed in the fan chamber in the double-split state. To cope with the increase in capacity, the compact machine space is effectively utilized. In addition, it has been confirmed that air flow noise is not affected.

### 2.4 Good workability and serviceability

#### (1) Adoption of new refrigerant HFC410A

HFC407C was used in conventional multi-air conditioners as a new refrigerant that does not destroy the ozone layer. In the side-air-flow type multi-air conditioner, a high-pressure and high-density refrigerant, HFC410A, has been newly adopted following on use in room air conditioners. This refrigerant is convenient for reducing pressure loss and increasing efficiency. Since HFC410A is a pseudo-azeotropic refrigerant, any gas leak that might occur can be remedied simply by adding additional charge. There is no need to replace the entire amount of HFC410A refrigerant, whereas HFC407C must be fully replaced.

#### (2) Adoption of single-phase power

A single-phase power supply has been adopted based on the assumption that the side-air-flow type multi-air conditioner will be used in homes such as apartments. In addition, a passive filter formed of a reactor and a capacitor was newly designed to suppress the occurrence of higher harmonics. Considering the situation regarding electric power in China, an optimum start pattern was determined from the power voltage and refrigerant equalizing level, and applied to the DC inverter com-

pressor to ensure that the system can be started at a wide range of voltage levels.

#### (3) Acquisition of operational data by personal computer

A function is added to acquire operation data from the outdoor circuit board using a general personal computer but not a special checker. Should the side-air-flow type multi-air conditioner stop abnormally, data on operation of the system for the thirty minutes prior to the occurrence of the abnormality can be stored automatically for use in quickly investigating the cause of the problem and taking appropriate countermeasures.

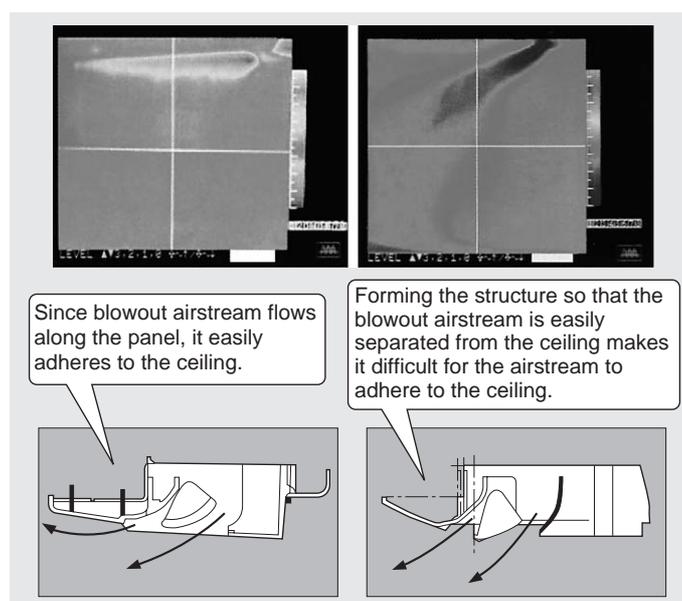
#### (4) Improvement of 7-segment display function

High- and low-pressure sensors and an suction pipe temperature sensor have been newly added to the side-air-flow type multi-air conditioner. Consequently, the data on high-pressure, low-pressure and suction superheat, can also be displayed in 7-segments on the outdoor circuit board which was installed in conventional models. As a result, the operation points of the system can be detected without a gauge manifold.

### 2.5 New type of indoor unit and wired remote controller

Not only the outdoor unit but also the ceiling cassette 4-way blowout indoor unit (FDT) and wired remote controller were redesigned as well during the course of developing this system.

With regards to the FDT, contamination of the ceiling has been reduced by improving the panel blowout port (**Fig.5**), and efficiency increased by improving the inside air route and increasing the capacity of the heat exchanger. A louver peripheral structure has been adopted that allows blown-out airflow to be easily separated from the panel surface, and an air blowing method has also been adopted that makes it more difficult for mold and dust to be adhere to the ceiling. In addition, fan input has been reduced by 20% of that of conventional machines by modifying the structure



**Fig. 5 Reduction in contamination of ceiling**  
The structure of the panel blowout part of the system was improved so that the blowout airstream can be separated easily from that part.

**Table 1 Basic specifications of side-air-flow type multi-air conditioner for export**

Cooling capacity (kW)		14.6	Indoor unit	Quantity of connected units	2 to 8/2 to 6	
Heating capacity (kW)		16.6		Volume of connected units	80~130%/80~150%	
COP		Average of cooling and heating 3.61	Refrigerant pipe specifications	Max. length (m)	70	
Refrigerant		HFC410 A		Overall length (m)	100	
Power supply		220~240 V, 50 Hz		Head difference	Indoor-outdoor distance (m)	Outdoor unit (Up: 30/Down: 15)
Outdoor unit	Exterior dimensions	Height (mm)			1300	Indoor-indoor distance (m)
		Width (mm)	970	Atmospheric temperature lower limit value	In cooling time (°C)	-5
		Depth (mm)	370		In heating time (°C)	-15
	Volume (m <sup>3</sup> )	0.467				
	Noise value (dB(A))	53 dB(A)				

so that the blowout port flow passage is increased, and the heat exchange performance was increased by 30% through the adoption of a high performance heat exchanger tube.

As can be seen in **Fig. 6**, the operation data display of the wired remote controller was increased in size through the adoption of a dot liquid crystal to improve visibility. Further, the function of the timer was improved by installing a weekly schedule timer as a standard reference in addition to the conventional 24-hour timer. Accordingly, even at the end of the week when living patterns tend to differ from each other, individual timer operations can be set. In addition, models are available that use pictographic plus alphanumeric or Chinese character displays to provide product specifications best suited to a given market anywhere in the world.

### 3. Outline Summary

The basic specifications of the side-air-flow type multi-air conditioner for export are summarized in **Table 1**. The connectable capacity of the indoor unit is up to 150%. As a result, the initial investment cost per unit air conditioning area can be reduced in residential apartments, where the load factor and simultaneous operation ratio are rather small. In terms of refrigerant pipe specifications, a total length of up to 100 m of pipes can be installed without the need for charging, which is sufficient for homes and small offices.

### 4. Conclusion

Development of the side-air-flow type multi-air conditioner was mainly focused on use in residences such as apartments. As a result, product specifications were determined by placing emphasis on realizing energy savings, reduction in size, and improved reliability. All phases of



**Fig. 6 New type of wired remote controller**  
System visibility and operability were improved with the adoption of dot liquid crystals and the improvement of the timer function.

the side-air-flow type multi-air conditioner have been remarkably improved compared with the conventional KX2 series. MHI plans to expand the sale of the side-air-flow type multi-air conditioner primarily in the apartment market of China, where remarkable market growth of the system can be expected in the future.

At the same time, MHI believes that there is also a need for the side-air-flow type multi-air conditioner in European and Japanese markets as well as in the Chinese market, although the scales of such systems will differ from each other. The company is currently moving ahead with preparations to develop a three-phase powered version of the side-air-flow type multi-air conditioner system.

The global air condition market is expected to expand further largely in the future and, concurrently, a variety of needs will also be produced. In this regard, MHI has its antennae raised high to grasp these trends quickly and with keen insight, and develop successive new products that best meet these wide ranging needs.



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