



Inverter Air Conditioners, 1980-1981

IEEE Milestone Celebration Ceremony

Date: Tuesday, March 16, 2021

Venue: Fuji Operations, Toshiba Carrier Corporation

Hosted by: IEEE Nagoya Section

I. IEEE Milestone Dedication Ceremony (8:30 – 9:10 a.m.)

Master of Ceremonies: Naoki Uchiyama, Secretary, IEEE Nagoya Section

Opening

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| 1. Greetings from the Organizer | Masaaki Katayama | Chair, IEEE Nagoya Section |
| 2. Greetings from IEEE HQ | Toshio Fukuda | Past President, IEEE |
| 3. Plaque Dedication | Toshio Fukuda | Past President, IEEE |
| | Toru Kubo | President & CEO, Toshiba Carrier Corp. |
| 4. Winner's Remarks | Toru Kubo | President & CEO, Toshiba Carrier Corp. |
| | Oon Wee Chin | Senior Executive Vice President,
Toshiba Carrier Corp. |
| 5. Introduction of Distinguished Guests | Naoki Uchiyama | Secretary, IEEE Nagoya Section |
| 6. Greetings from Distinguished Guests | Yoshimasa Konagai | Mayor, Fuji City |
| | Hideaki Ishii | Executive Officer & Corporate Vice President,
Toshiba Corporation |
| | Shiro Saito | President, IEEJ |

Closing

Break

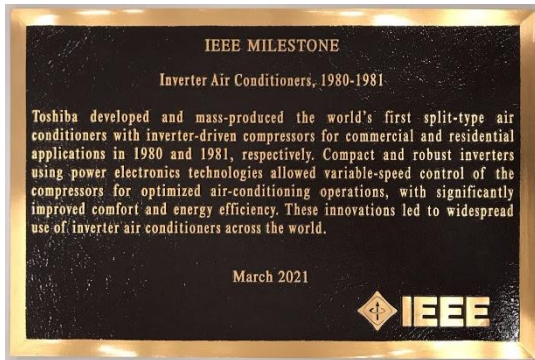
II. IEEE Milestone Commemorative Speeches (9:50 – 10:40 a.m.)

Moderator: Masayuki Nagao, History Committee Chair, IEEE Nagoya Section

1. Special Speech: "Outline of IEEE Milestone"
Isao Shirakawa, Japan Council History Committee Chair, IEEE / Specially Appointed Professor, University of Hyogo
2. Greetings from Reviewers
Hirofumi Akagi, Specially Appointed Professor and Distinguished Professor, Tokyo Institute of Technology
Mark Dehong Xu, Professor, Zhejiang University
3. Commemorative Speech: "Technological Advancements and Future Outlook of Inverter AC"
Takehiko Sato, Chief Technology Executive, Toshiba Carrier Corporation

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About the Recognized Achievement



IEEE Milestone Plaque

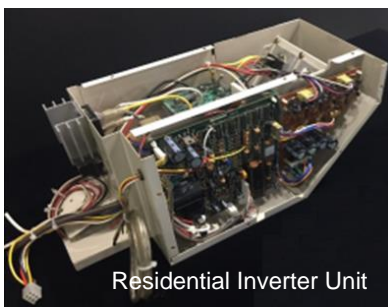
Plaque Citation:

Toshiba developed and mass-produced the world's first split-type air conditioners with inverter-driven compressors for commercial and residential applications in 1980 and 1981, respectively. Compact and robust inverters using power electronics technologies allowed variable-speed control of the compressors for optimized air-conditioning operations, with significantly improved comfort and energy efficiency. These innovations led to widespread use of inverter air conditioners across the world.

Historical Significance of the Achievement

In the early 70s, which is before the emergence of the inverter air conditioner, cooling/heating (i.e. heat pump) type air conditioners had a limited heating capacity and most of them needed auxiliary electric heaters in their indoor units to complement their heating capacity. As energy-saving awareness rose in the wake of the 1973 oil crisis, the emergence of new technology was long awaited for reducing energy loss by a continuous control of compressor capacity so that the conventional on-off control for temperature adjustment was to be replaced. Japanese HVAC manufacturers stood up to develop such new technology, as Japan, a nation scarce with key natural resources such as oil, was one of the countries hardest hit by the oil crisis and was desperate to address a nationwide call for energy conservation.

The HVAC industries inside and outside Japan in fact had already started earlier to study various options for such new technologies. Many had predicted that the use of an inverter, or frequency converter, would be an optimal choice to serve the purpose, but inverters in those days were too large and expensive to be built into air conditioners. Despite these challenges, Toshiba, with a state-of-the-art high-power transistor and microprocessor-controlled sinusoidal pulse width modulation, achieved a significant downsizing in its inverters. An inverter whose size and weight was only one-sixth that of a conventional inverter, was instrumental in Toshiba's mass-production of 100 units and launch of the world's first air conditioner for commercial use in October 1980.



Residential Inverter Unit

Toshiba's next quest was to apply this inverter technology to residential air conditioners in the hope that the technology would also allow flexible capacity changes for residential air conditioners. The development started in December 1980. The biggest challenge was the price and size of the inverter. Given the size of residential air conditioning units, which are far smaller than commercial units, considerable effort for additional downsizing of inverter was necessary with a minimized cost. Through numerous trials and errors especially with developing the compressor and inverter for nearly two years, however, the residential split air conditioners were finally complete in September 1981 for mass-production and product launch in Japan. The size of the inverter was reduced to one-third that of a commercial inverter, which was small enough to be mounted above the compressor inside the outdoor unit, and the cost was reduced to 40% of the commercial air conditioners. Toshiba mass-produced 10,997 units of the residential air conditioners in Year 1 after the product launch. The

energy efficiency of the inverter residential air conditioners saw approximately 40% improvement from that of the conventional fixed-speed models.

The product received a rave review after a press release on December 12, 1981. Other HVAC players, who were reluctant to the challenging development of downsized inverters and lower costs and initially skeptical on Toshiba's move, eventually followed suit of Toshiba after seeing Toshiba expanded its inverter lineup the following year. These circumstances have driven the ownership ratio of residential inverter air conditioners in Japan ahead of other countries by far and have also boosted Japanese HVAC manufacturers to a leading position in the world. In addition, the technologies used for the achievement, including drive control and downsizing, were also instrumental in promoting innovation of other various inverter-driven home appliances such as refrigerators and washing machines. The inverter air conditioner, whose origin is Japan, is nowadays widely used throughout the world and is considered to have become the global standard of air conditioners.



Commercial Inverter AC RAV-46HTY



Residential Inverter AC RAS-225PKHV

IEEE Milestone Plaque Site

