

Final Measurement and Verification Report for I&T Trial Project

Permanent Magnet Synchronous Motor Fan Coil Unit

I&T Project No. : P-0009
I&T Wish No. : W-0126
I&T Solution No. : S-0035

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Purpose of the Project and Target Deliverables

This project aims at verifying the energy efficiency and reliability performances of the permanent magnet synchronous motor (PMSM) fan coil unit (FCU).

Project Description

This project undertakes a 1-year trial on the PMSM as compared with the traditional single-phase induction motors (SPIM) for FCU.

Trial Site

The trial is being carried out at an office of EMSD Headquarters.

Type of Equipment/ Installation/ Technology Adopted

1. One PMSM

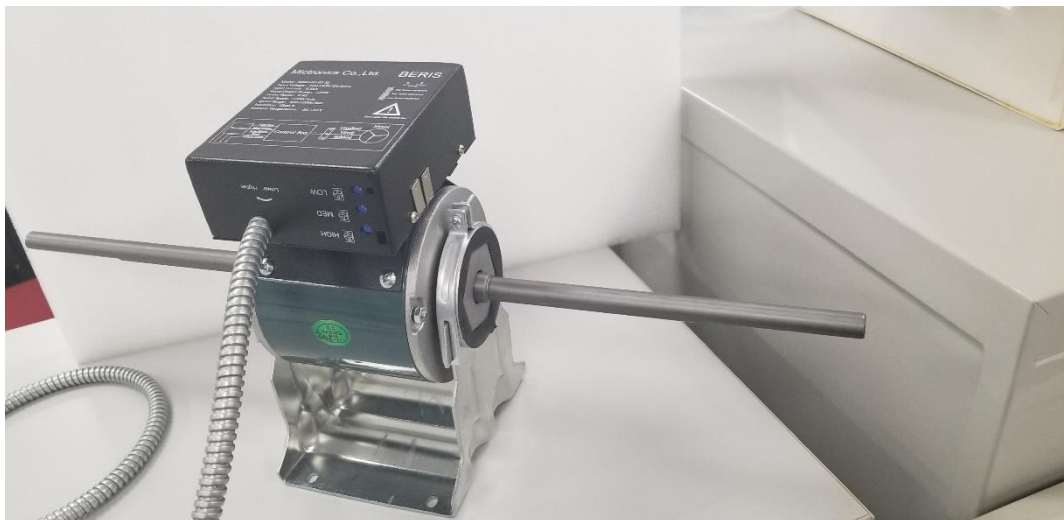


Photo 1 – Permanent Magnet Synchronous Motor for Fan Coil Unit

2. One SPIM
3. Two FCUs
4. Associated control and electrical wiring

Trial Timeframe

The trial period is from November 2018 to November 2019.

Name and Background of I&T Solution Provider

Micronics Co.Ltd is a newly established company based in the Hong Kong Science Park that produces and markets electronic/power electronic products and systems which contribute towards a sustainable world. Its core technologies include high efficiency PMSM, driver, intelligent thermostat and internet of things (IoT) control system.

Details of Implemented Trials

I. Methodology and Applicable Standards

SPIM FCUs

Traditionally, SPIMs are the predominant type of motors used for FCUs. Typical FCUs are designed for operation in multiple speeds (high-med-low). These FCUs usually achieve their peak efficiencies at the highest speeds, and their efficiencies decrease considerably at lower speeds.

PMSM FCUs

PMSMs used for FCUs is a new design, and it is claimed that a saving of about 50% and 70% in the electricity consumption of FCU motors can be achieved at high speed and low speed respectively when compared with the use of SPIMs. Besides, the operating temperatures of the bearings in the PMSMs are lower, thus resulting in a long bearing lifespan of about 8 years, whilst the bearings for the SPIMs can only last for about 3 years.

With the aim to verify the energy efficiency and reliability performances of a typical PMSM FCU as compared with a typical SPIM FCU, a trial project is being undertaken at an office of EMSD Headquarters. There are four 1000-CFM FCUs inside the office. We have replaced two of them with new ones, one was fitted with a PMSM and the other is fitted with a traditional SPIM. Both FCUs are designed to operate concurrently at the same speed by a 3-speed thermostat controller. This arrangement facilitates fair comparison between the two types of FCUs. Individual energy meters are installed for both types of FCUs for energy efficiency performance analysis. The trial installations were completed in August 2018, and site measurements for power consumptions have been taken continuously as recorded by the energy meters. Please refer to Photos 2 to

7 for some details of the project.



Photo 2 – Trial project on PMSM FCU at an office at 5/F, EMSD HQs

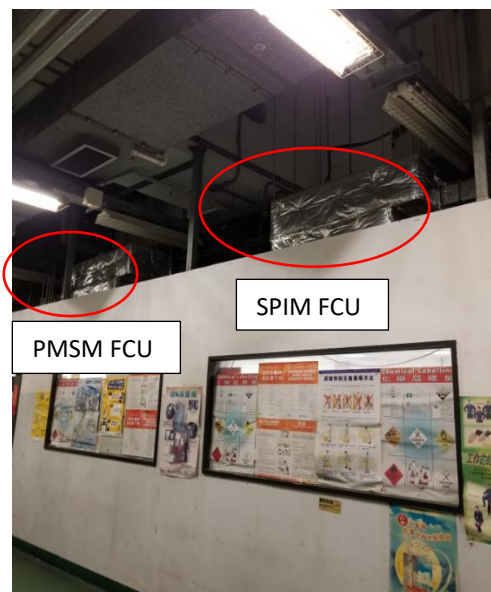


Photo 3 – Two replaced FCUs under testing



Photo 4 – Installed SPIM



Photo 5 – Installed PMSM



Photo 6 – 3-speed thermostat controller for the two FCUs



Photo 7 – Energy meters for the two FCUs

II. Measurement and Verification Activity Details

In order to verify the energy efficiency performance of the PMSM FCU in comparison with the SPIM FCU, on-site measurements on power consumption have been continuously recorded. A summary of the electricity consumptions is shown in Table 1, whereas the instantaneous power consumptions of the FCUs at different operating speeds are shown in Table 2.

Period*	% of Electricity Saving of PMSM FCU when compared with SPIM FCU
Nov-2018	50.5%
Dec-2018	48.4%
Feb-2019	51.4%
Mar-2019	44.3%
May-2019	41.7%
Jun-2019	50.4%
Jul-2019	51.6%
Aug-2019	54.4%
Sep-2019	46.8%
Oct-2019	55.8%
Nov-2019	53.2%
Dec-2019	55.5%
Overall (12 months)	50.3%

Table 1 – Comparison of monthly electricity consumptions of PMSM FCU and SPIM FCU

*Test results for January and April 2019 are not available due to failure of measuring system

Date	Instantaneous Power (W)						% Difference		
	PMSM FCU			SPIM FCU					
	High	Med	Low	High	Med	Low	High	Med	Low
31.7.2018	102.1	58.1	36.6	196.3	160.1	141.6	48%	64%	74%
31.12.2018	118.4	62.9	38.9	194.2	161.7	142.7	39%	61%	73%

Table 2 – Comparison of instantaneous powers of PMSM FCU and SPIM FCU at different operating speeds

Summary Results and Analysis

I. Analysis of M&V Results to Address the Target Deliverables

Energy Efficiency

With reference to the electricity consumption data as shown in Table 1, the overall energy saving of the PMSM FCU for 13 months (November 2018 to December 2019) was about 51% when compared with SPIM FCU. It can be seen from Table 2 that the energy saving of the PMSM FCU depended on its operating speed, and more saving could be achieved at low speeds.

Power Factor

It was measured that the power factor of the SPIM FCU was very close to unity (1.0) for all speeds, whereas that of the PMSM FCU varied between about 0.9 (low speed) and 0.99 (high speed).

Reliability and Lifespan

Both types of FCUs have been operating normally so far, and no fault has been reported since the completion of the trial installation. Reliability monitoring is still underway.

Bearing Temperature

For both types of FCUs, the surface temperatures of the motor shafts near the bearings were measured and the results were given in Table 3.

[Room temperature: 25.6 °C]

FCU	Motor shaft No. 1 Surface Temperature (°C)	Motor shaft No. 2 Surface Temperature (°C)
PMSM FCU	21	22.2
SPIM FCU	27	28.8

Table 3 – Comparison of surface temperatures of motor shaft near bearings

It is evident that the bearing temperatures of the PMSM FCU were lower.

Conclusion and Way Forward

It was measured that the energy saving of the PMSM FCU was about 50% when compared with the SPIM FCU, and more energy saving at lower speeds was observed. To date, no fault has been reported for both types of FCUs.

- END OF REPORT -

Energy Efficiency Office

Electrical and Mechanical Services Department

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