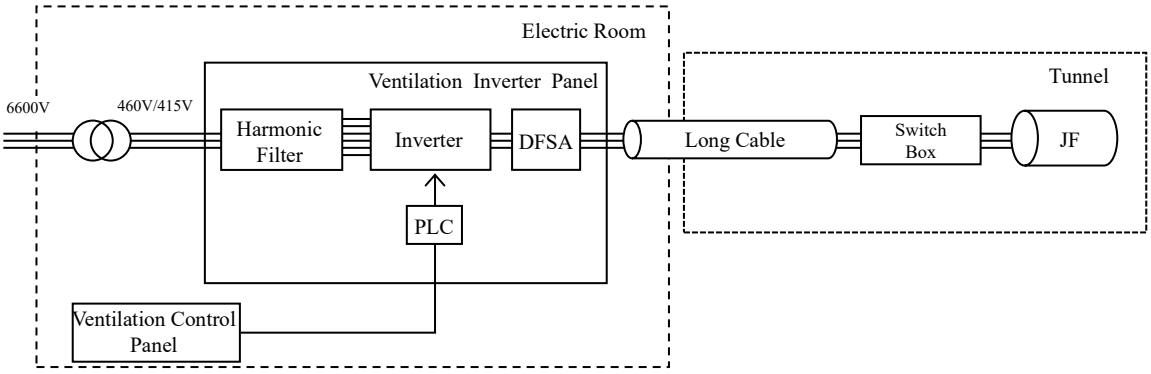
SO HATSU

VENTILATION INVERTER PANEL

Sohatsu Systems Laboratory Inc.

Contents

■System Configuration



■Specifications

Item \ Model		Jet Fan (1 unit)	Jet Fan (2 unit)
Panel Specification	Type	Indoor independent enclosed type	
	Electric supply system	Main circuit : 3-phase 3 wire 460V 60Hz／415V 50Hz Control circuit : 1-phase 100V 50/60Hz	
	Panel dimension (Reference)	W1000×H2300×D1000mm	W1200×H2300×D1000mm
Inverter Specification	Inverter capacity	37kW、55kW	
	Input voltage	3-phase 380～480V ±10%	
	Output voltage	3-phase 380～480V（Input voltage compatible）	
	Output frequency	0～50/60Hz	
	Control method	Two-level PWM control	
Surge voltage, noise and bearing current countermeasures		DFSA（Feedback type sine wave filter）	
Harmonic countermeasures		Three-phase diode bridge (capacitor smoothing) with ACL+DCL Conversion factor k=1.4	
		12-pulse converter Conversion factor k=0.7 (optional)	
		Self-excited three-phase bridge (PWM converter) Conversion factor k=0.0 (optional)	
Input and output signals		Voltage-free contacts, Ethernet communication, PLC general-purpose network	
Power cable		Length up to 2000m, Shielded and non-shielded cable compatible	
Applicable Jet fan		30,33kW×1, 50kW×1	30,33kW×2, 50kW×2
Applicable Jet fan motor		General purpose motor can be used.	

■Overview

- This is a ventilation inverter panel for jet fans that includes noise countermeasures in an industrial inverter.
- By controlling the rotation speed of the jet fan, it can create any desired tunnel air velocity.
- It uses a uniquely developed filter to suppress the negative impact of noise on the jet fan and other equipment.
- Smooth rotational speed control can save energy and improve safety.

■Features

The ventilation inverter panel is a power panel that uses an industrial inverter to control the rotation speed of jet fans (hereinafter referred to as JF) in road tunnels to create any desired tunnel air velocity.

＜About Inverter Drive＞

In the field of pumps and compressors, products that use inverter drives have long been popular due to their good controllability and energy-saving effects. However, JF has not been put into practical use for a long time because, under the environmental conditions of long power cables, 'noise' is generated by inverter drive, which has a negative effect on the JF motor and surrounding equipment.

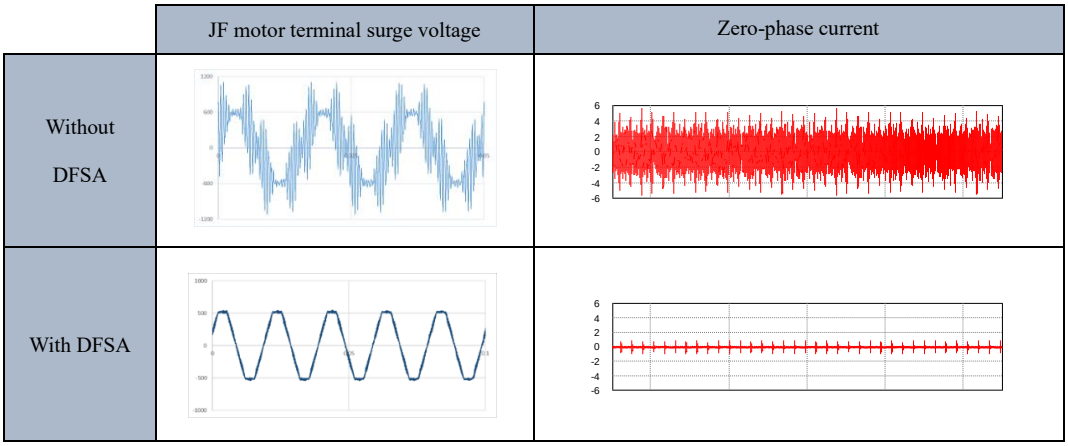
In response to this problem, we have developed our own filter, DFSA, to address the issue of noise generation. We have successfully applied our design optimization to each installation location.

＜Noise Countermeasures＞

The noise generated by the inverter drive can be classified into two categories: 'input side noise' and 'output side noise' of the panel.

To suppress noise (harmonic current) on the input side, a polyphase transformer or PWM converter is used. If regulations require conduction noise countermeasures, an EMC filter will be installed.

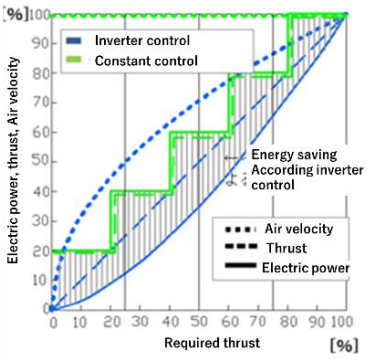
On the output side, DFSA is used for noise suppression. This reduces the zero-phase current in the cable inlet, which causes radiated and induced noise, as well as excessive surge voltage to the JF motor.



【Image of noise suppression effect by DFSA】

＜Energy Saving Effect＞

Previously, the standard method for controlling JF units was to start or stop each unit and adjust the number of units in operation to achieve the required air volume (thrust) for ventilation. However, this 'constant-speed control' method makes it challenging to make precise adjustments to air velocity, which can lead to excessive operation. In contrast, the inverter drive system allows for more efficient operation by controlling the rotation speed of the JF units. Even with the same thrust, operating multiple JFs at low speed consumes less power than operating a small number of JFs at 100% rotation speed.



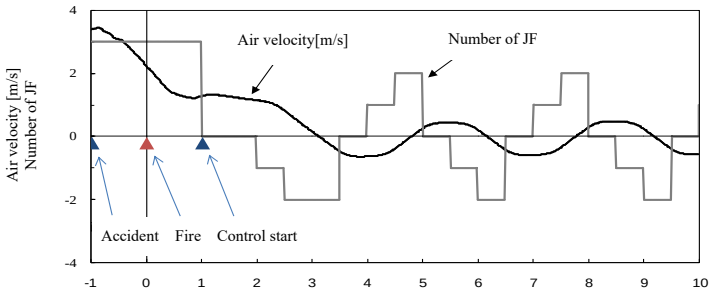
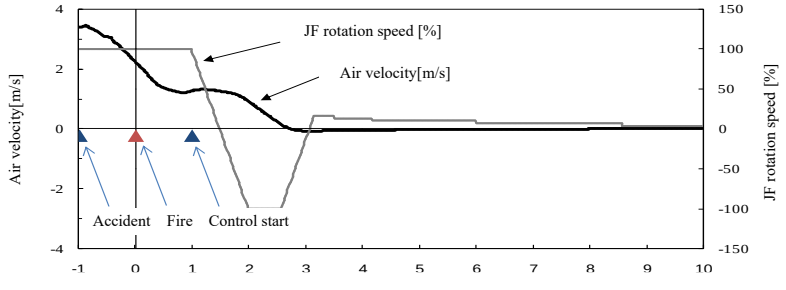
【Energy saving effect due to control method】

Thrust	Constant Speed Control			Inverter Control			Energy Saving Effect (Reduction rate)
	No.of operating units	Air Velocity	Power	No.of operating units	Air Velocity	Power	
20%	1 unit	100%	20%	5 units	45%	9%	55%
40%	2 units	100%	40%	5 units	63%	25%	37%
60%	3 units	100%	60%	5 units	77%	46%	23%
80%	4 units	100%	80%	5 units	89%	72%	11%
100%	5 units	100%	100%	5 units	100%	100%	0%

＜Improved Safety＞

In the event of a fire in a tunnel, one method to ensure the safety of evacuees is 'zero air velocity control'. This method, which suppresses air flow and keeps heat and smoke from flames in the ceiling, uses an inverter drive system to quickly and stably create a target air velocity.

【Comparison of quick response in emergencies: Constant Speed Control/Variable speed control】

Control Method	Features	Tunnel air velocity, JF Operation example
Constant-speed control (on/off control)	A small number of JF will lead to the unstable air flow. There are startup restrictions such as motor overheat protection, and it takes time to control the air velocity.	
Variable-speed control (Inverter Control)	Stable air velocity with optimal rotational speed output. No start-up restrictions, quick control of air velocity.	

■Comparison

With constant-speed control, 3 to 5 times of the rated current flows at start. In contrast, the inverter drive can gradually increase the speed of the JF from the start to the target value, thus preventing an excessive starting current.

A comparison of constant-speed control and variable-speed control is shown below.

【Characteristic comparison between constant-speed control and Variable-speed control】

Comparison Items		Constant-speed control	Variable-speed control
Starting Characteristics	Starting current	Starting current is 3~5 times of rated current.	Starts at the rated current.
	Simultaneous operation of multiple units	Due to starting current, there is a limit to simultaneous start.	No restriction
Operating Characteristics	Responsiveness (Emergency operation)	Limited startup and lack of responsiveness	Highly responsive with no startup restrictions
	Energy saving (Normal operation)	Always operate at rated power	Energy saving effect can be achieved by operating multiple units below the rated capacity.
	Sound noise （JF）	Sound noise level is always high due to operation at maximum rotation speed	It is possible to operate multiple units at low rotation speeds to reduce sound noise levels.
Facilities	Power Transformer	In addition to the rated current, a capacity matching the starting current is required.	Capacity matching rated current is required.
	Harmonic Countermeasures	Not required	Required depending upon the supply capacity.
	Ventilation power panel	Control center or ventilation power panel	Ventilation inverter panel
	Noise filter	Not required	Noise suppression is necessary to prevent adverse effects on communication equipment and radios.
	Cable	Voltage drop of the starting current and rated current should be considered.	Only the voltage drop for the rated current should be considered.
		Unshielded	Shielded or Unshielded

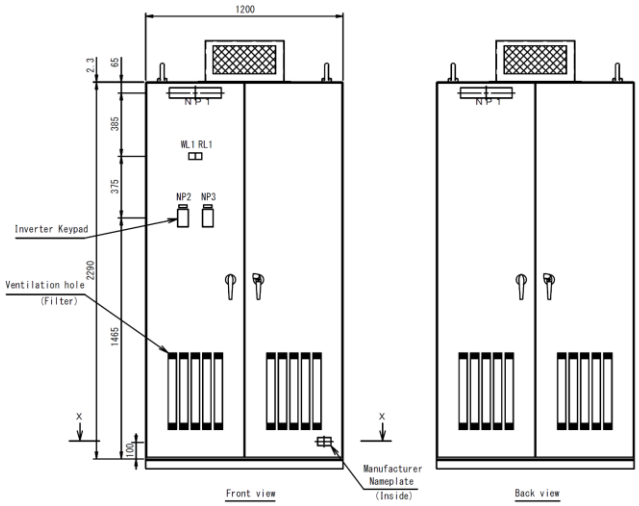
■Installation Track Records

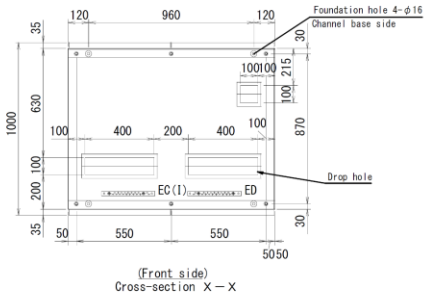
Installation track records of the ventilation inverter panel are as follows.

Year	Clients	Highway	Tunnel	Tunnel Length (m)	Specifications		Summary
					Capacity	No.of units	
2008	Hanshin Expressway Company Ltd.	Kita-Kobe Line	Shinkarato Tunnel	1,711	37kW(1250φJF)	1	(For on-site testing)
2010	Kinki Regional Development Bureau Toyooka River and National Highway Office	National Highway 9	Minamitajima Tunnel	1,224	30kW(1000φJF)	1	(For on-site testing)
2010	Shutoko Metropolitan City Expressway Ltd.	Saitama Omiya Line	Shintoshin Tunnel	2,870	25kW(1000φJF)	1	(For on-site testing)
2010	Hanshin Expressway Company Ltd.	Kobe Yamate Line	Kobe Nagata Tunnel	3,364	50kW(1250φJF)	5	
2011	Civil Engineering Research Institute	National Highway 201	Chikuhokarasuo Tunnel	2,870	50kW(1250φJF)	1	(For on-site testing)
2012	Kinki Regional Development Bureau, Toyooka River and National Highway Office	Wadayama Yoka Road	Yoka Tunnel	2,990	50kW(1250φJF)	6	
2012	Hanshin Expressway Company Ltd.	Yodo River Left Bank Line Route 2	Shorenjigawa Tunnel	3,446	33kW(1000φJF)	34	
2014	Kinki Regional Development Bureau, Kinan River and National Highway Office	Kinki Expressway Kisei Line	Migusa Tunnel	2,380	50kW(1250φJF)	3	
					33kW(1000φJF)	1	
2014	Kinki Regional Development Bureau, Kinan River and National Highway Office	Kinki Expressway Kisei Line	Atagi Tunnel	2,730	50kW(1250φJF)	3	
					33kW(1000φJF)	2	
2014	Kinki Regional Development Bureau, Kinan River and National Highway Office	Kinki Expressway Kisei Line	Susami 2 Tunnel	2,648	50kW(1250φJF)	3	
					33kW(1000φJF)	2	
2014	Kinki Regional Development Bureau, Kinan River and National Highway Office	Kinki Expressway Kisei Line	Kurosaki Tunnel	2,841	50kW(1250φJF)	4	
					33kW(1000φJF)	1	
2014	Chubu regional Development Bureau Iida National Highway	National Highway 19	Torii Tunnel	1,738	50kW(1250φJF)	4	
2014	Kyushu Regional Development Bureau, Yatsuhiro River and National Office	Kumamoto Route 3	Tsunagi Tunnel	1,848	33kW(1000φJF)	4	
2015	Hanshin Expressway Company Ltd.	Kobe Yamate Line	Kobe Nagata Tunnel	3,364	50kW(1250φJF)	6	
2015	Tohoku Regional development Bureau, Noshiro River and National Highway Office	National Highway 7	Matoyama Tunnel	3,372	50kW(1250φJF)	7	
					33kW(1000φJF)	1	
2015	Kinki Regional Development Bureau, Toyooka River and National Highway Office	Yoka-Hidaka Road	Mitani Tunnel	2,810	50kW(1250φJF)	4	
2016	Hokuriku regional Development Bureau, Nagaoka National Highway	National Highway 253	Hakka-toge Tunnel	2,840	50kW(1250φJF)	4	
2017	Kagoshima Prefecture	Hokusatsu Crossing Road	Hokusatsu Tunnel	4,850	50kW(1250φJF)	4	
2017	Kobe City Road Public Corporation	Rokko Toll Road	Rokkosan Tunnel	2,843	15kW(630φJF)	14	
2018	Nagoya Expressway Public Corporation	Expressway 2 Higashiyama Line	Higashiyama Tunnel	3,560	50kW(1250φJF)	18	
2021	Hanshin Expressway Company Ltd.	Kobe Yamate Line	Kobe Nagata Tunnel	3,364	50kW(1250φJF)	1	Renewal with 2-level Inverter
2022	Hanshin Expressway Company Ltd.	Kobe Yamate Line	Kobe Nagata Tunnel	3,364	50kW(1250φJF)	4	Renewal with 2-level Inverter
2022	Japan-Nepal Relation	Tribhuvan Highway	Nagdhunga Tunnel	2,688	50kW(1250φJF)	8	2-level Inverter
2022	Japan-Philippines Relation	Davao City Bypass	Davao Tunnel	2,249	50kW(1250φJF)	6	2-level Inverter
2023	Ibaraki Prefecture	Regional road Ishioka-Chikusei Line and Sakuragawa City-road M2753	Uwaso Tunnel	3,538	50kW(1250φJF)	4	2-level Inverter
2023	East Nippon Expressway Company Ltd. (NEXCO)	Kan-etsu Expressway	Kan-etsu Tunnel	11,055	120kW(Axial Fan)	2	2-level Inverter

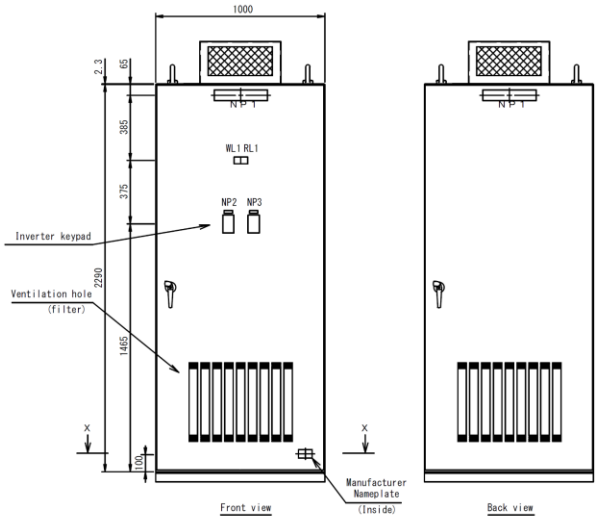
■Standard outline drawing

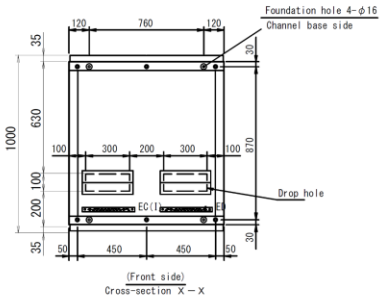
＜For JF 2 units＞【W1200×H2300×D1000mm】（37kW、50kW common）



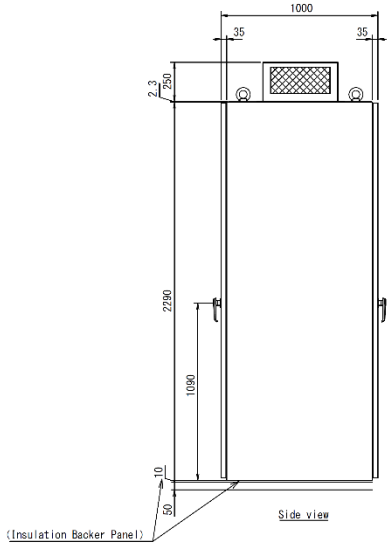


＜For JF 1 unit＞【W1000×H2300×D1000mm】（37kW、50kW common） ＊Reference for development model.

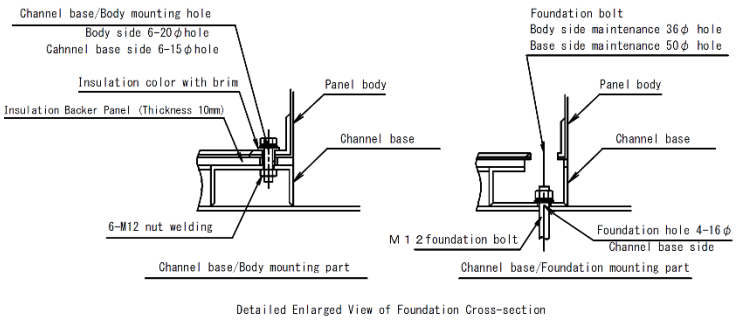




< Side view (common) >



< Foundation part (common) >



http://www.sohatsu.com