FRENIC-HVAC

Engineered
for
Fans & Pumps

Innovating Energy Technology

FRENIC- HVAC

- In the manufacturing sector, fans use about 78.7 billion kilowatt-hours of energy each year. This represents 15 % of the electrical energy consumed in Industry. In the commercial sector, similar usage of electrical energy is needed to operate fan motors for space conditioning.

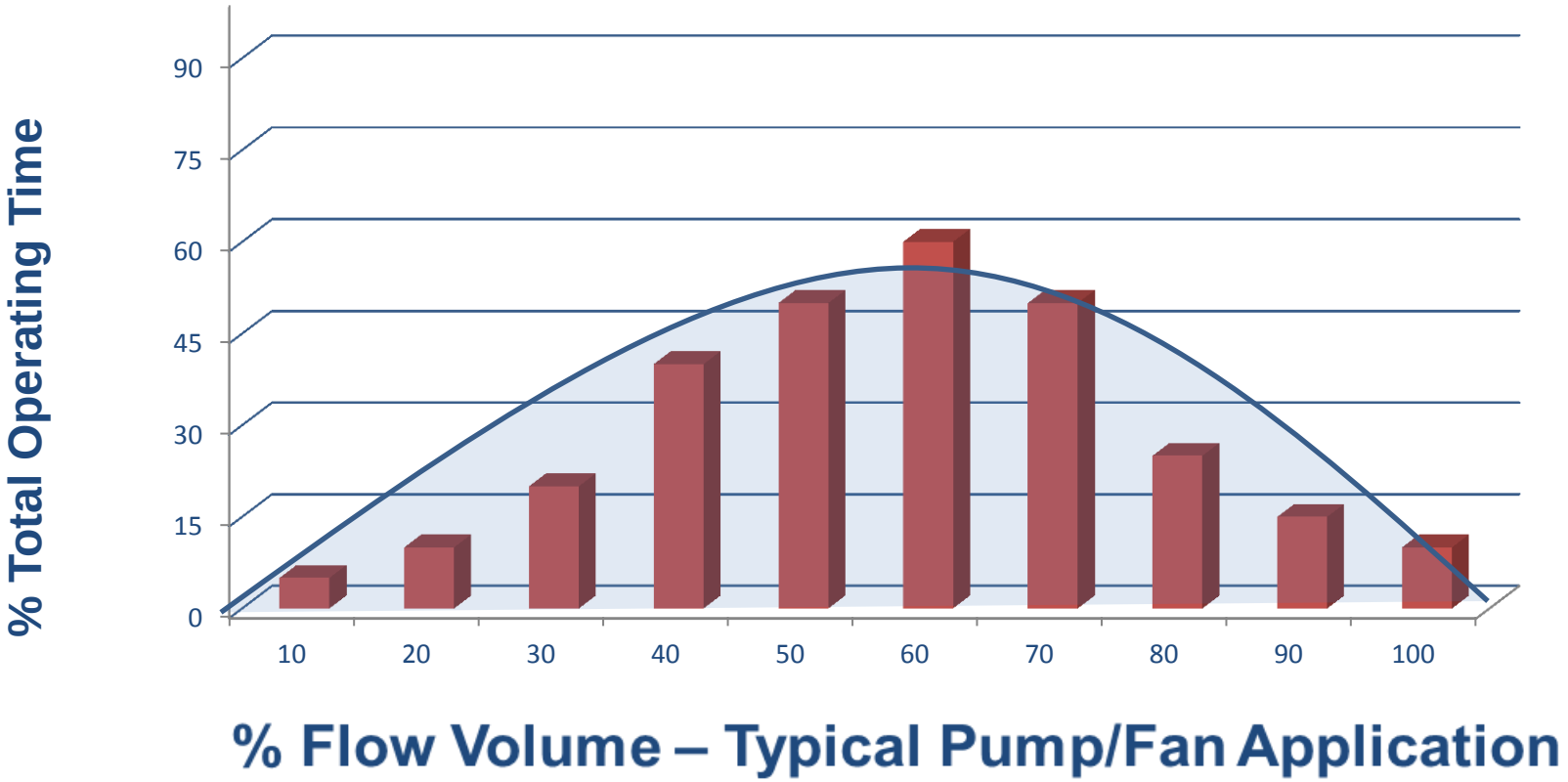
- Motor loads often vary according to cyclical production demands, environmental conditions, changes in customer requirements, seasonal changes

- It makes sense to adjust motor operating speed to demands of the load. Would you regulate your car's speed with just the brakes?

- Varying load applications like centrifugal pumps and fans in particular benefit from ASDs. For example, when pump speed can be cut in half, resulting power consumption is reduced by a factor of eight!

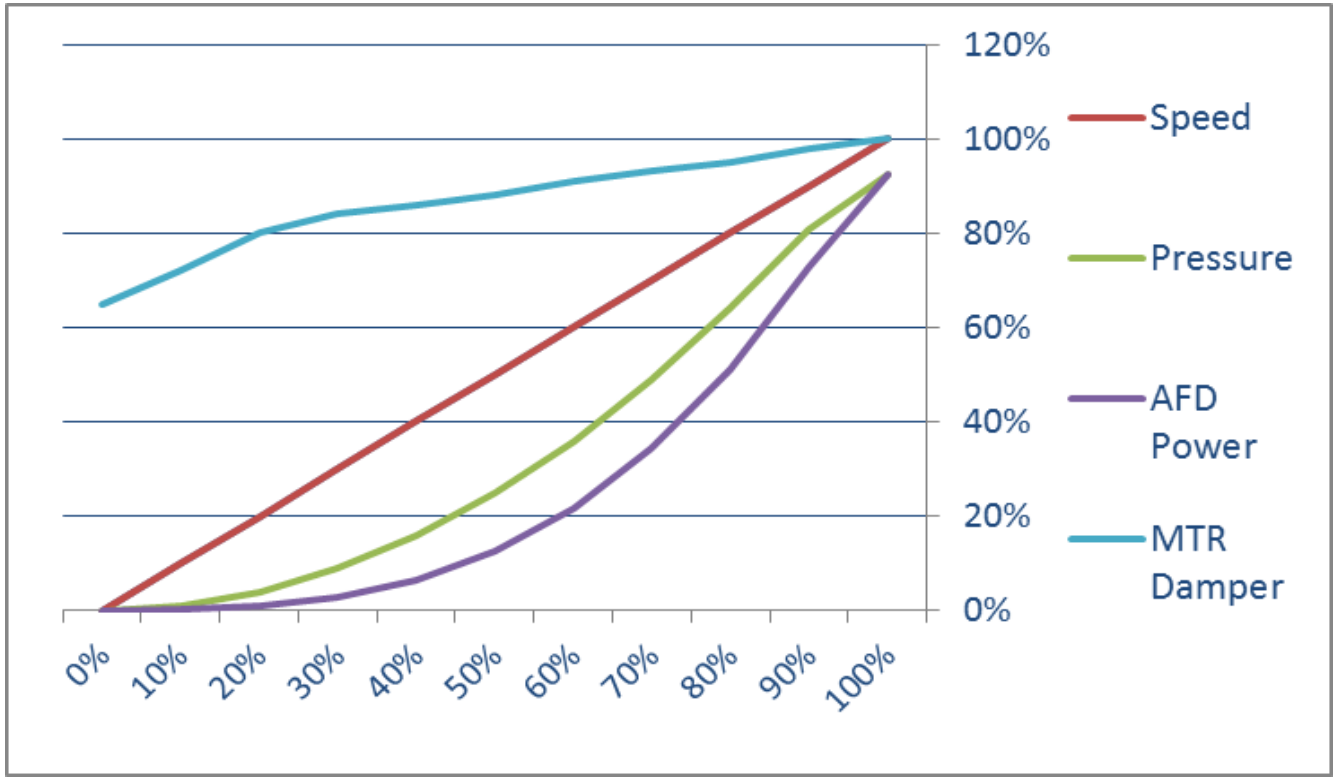
FRENIC- HVAC

HVAC systems are designed for “worst case” situations. Most of the time they have excess capacity.



Affinity Laws

Change in power consumption is proportional to the cube of the change in speed, where change in flow is proportional to the change in speed, and change in head or pressure is proportional to the square of the change in speed.



FRENIC- HVAC

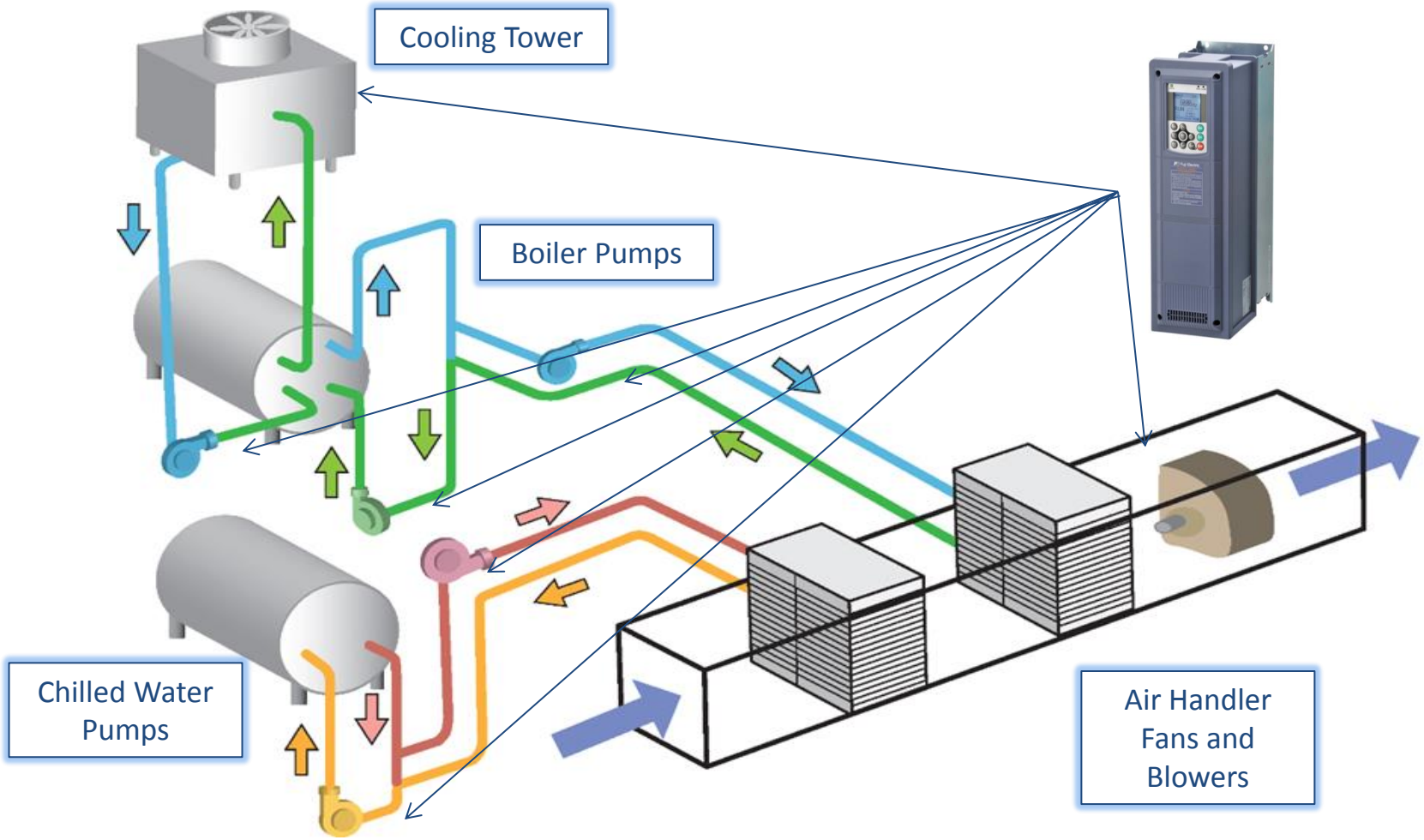
Fans & Blowers

- Cooling Towers
- Exhaust Fans
- Forced Draft Blower
- Fume Hoods
- Furnace Temperature Control
- Induced Draft Blowers
- Make-up Air Fans
- Supply and Return Fans
- Variable Air Volume for HVAC Systems

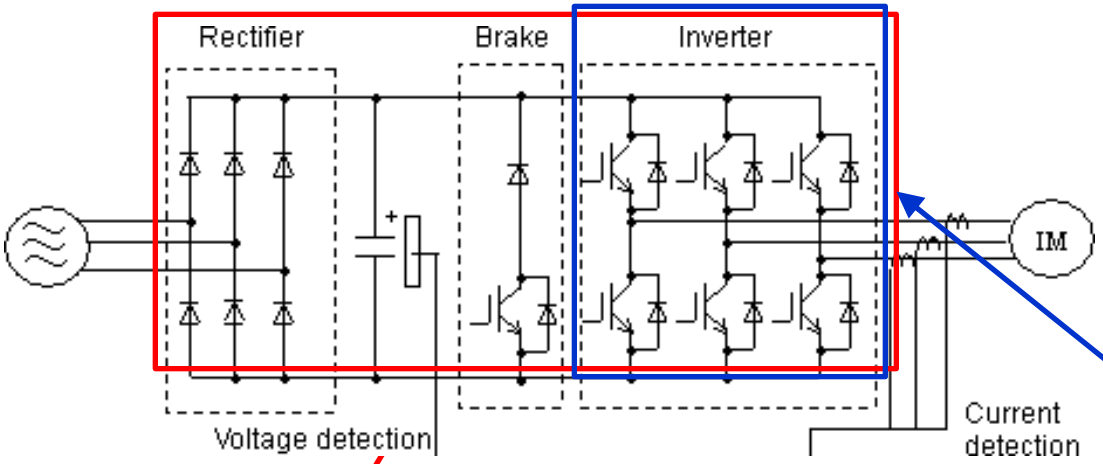
Pumps

- Boiler Feed Pumps
- Booster Pumps
- Chilled Water Pumps
- Geothermal Heat Pumps
- Hydronic Heating Pumps
- Industrial Cooling Pumps
- Inline Pumps
- Platform Pumps
- Water Treatment Pumps

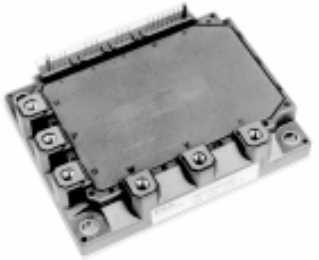
Traditional HVAC Configuration



World Leader in Power Semiconductors

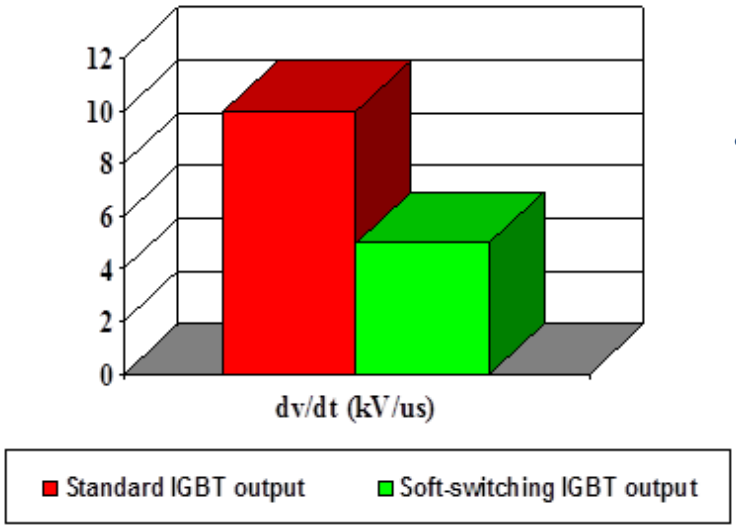


5th Generation IGBT Modules



Fuji Electric IPM Modules

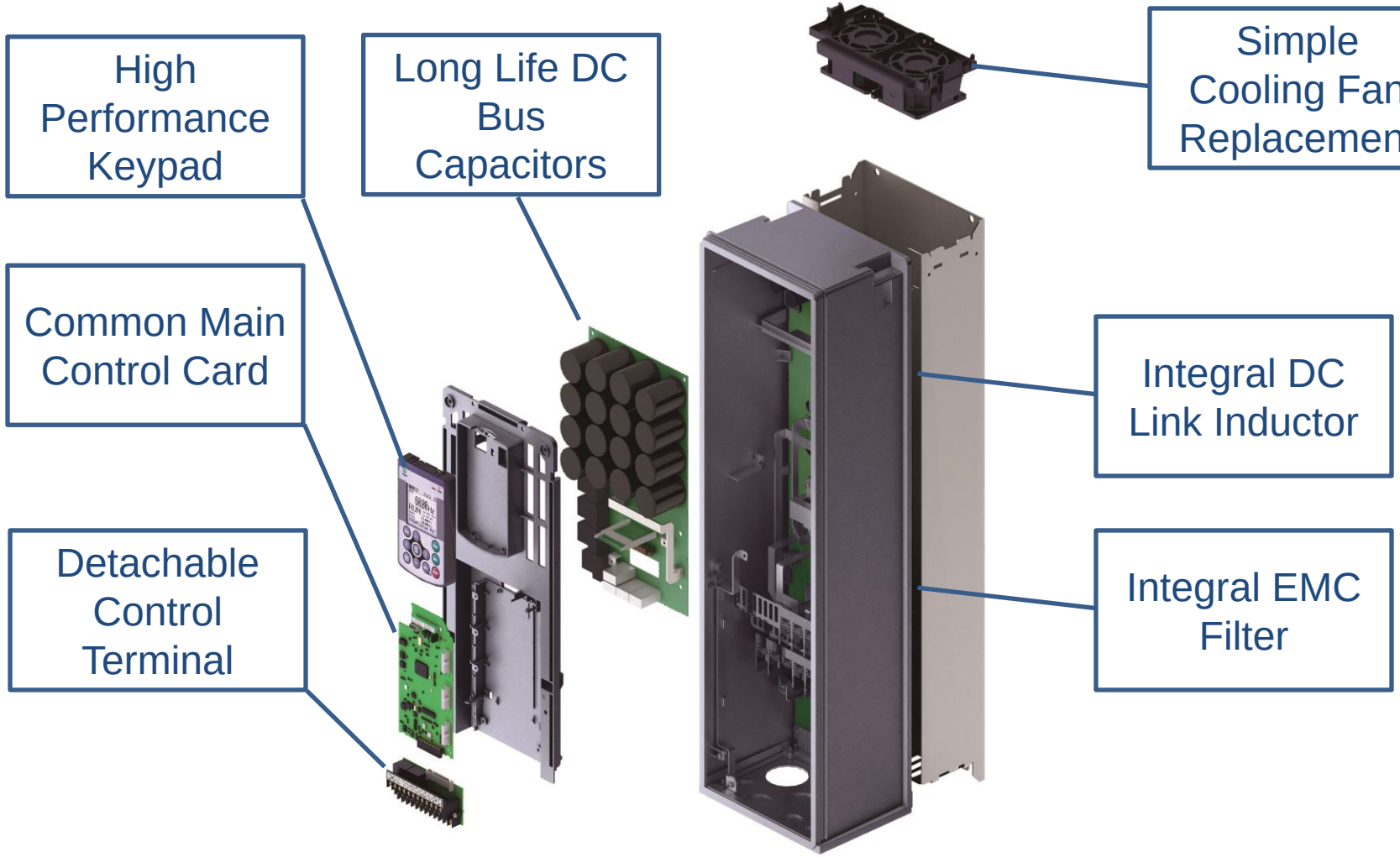
- Used in Lower Hp Drives for Compact Design



Fuji Electric IGBT Modules

- Improved IGBT Technology + Gate Turn-On Circuitry = Motor Friendly Output @ High Drive Efficiency Levels

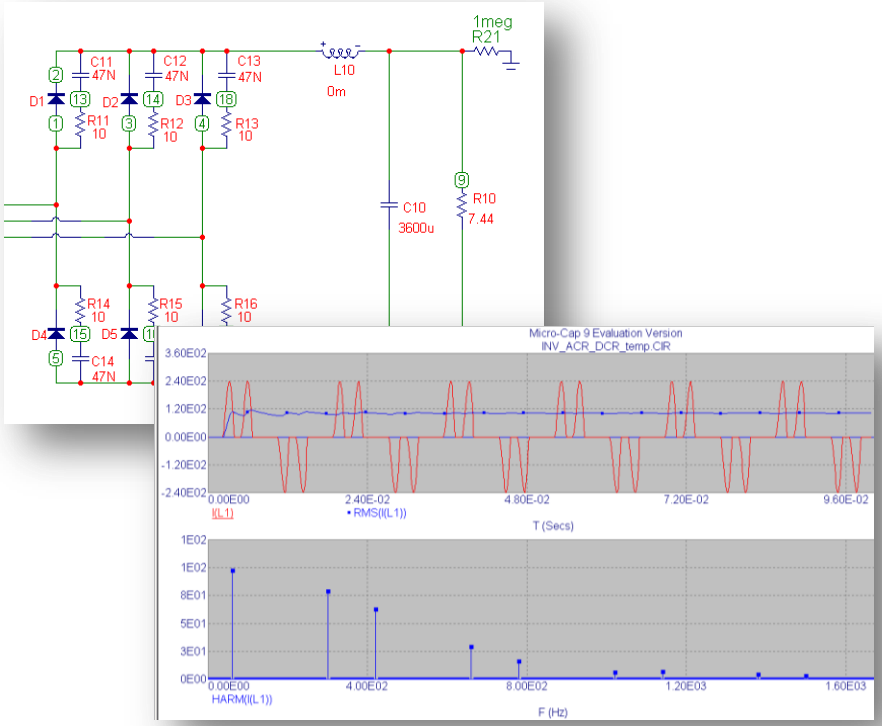
Modular construction - Easy Maintenance



Product Development

Fuji Electric takes pride on ensuring our drive products are accepted by customers as one of the highest quality and most reliable drive products available on the market today. In doing so, product reliability and quality is designed in, tested for, and verified with customers throughout a product's life cycle.

- Selection of devices based on 10 Year Design Life
- Device coordination that delivers optimum performance
- Predicted reliability via system modeling, simulation, & calculation
- Review of historical failure data – Continuous improvement



Prototyping & Product Testing

Operating & Storage Temperature Ranges	Product tested over range of –25°C to 80°C and certified for full performance over range of –10°C to 50°C.
Humidity Ranges	Product tested and certified for full operation over the range of 20-90% non-condensing
Electrical Susceptibility	Product tested to internal specifications as well as compliance with various international standards.
Vibration	Product tested to IEC618000-2 standard.
Mechanical Shock	Product tested with impact loads of 20g, 50g, and 100g for 50 impacts at each level.
	Multiple drop tests to a concrete surface are also performed on the product.
Static Discharge	Product tested extensively to ensure full and proper operation under a variety of electrical disturbances.
Lighting Surge	Lighting surge test conducted with surges applied between the connected power input terminals and ground, applied between connected power input terminals and ground with power lines attached, and
Conducted and Radiated Emissions	Product tested to internal specifications as well as compliance with various international standards.
Electrical Noise	Product tested extensively for full and proper operation in electrically noisy environments.
Short Circuit	Product tested at 100,000 amperes, certified by UL. Exceeds UL requirements for the drive ratings involved.
Accelerated Life Testing	Product stress tested to failure in order to predict failure under normal operating conditions. Note: accelerated life testing performed when required from engineering evaluation and/or historical data analysis.

Ratings Range ・NEMA/UL Type Enclosure

Capacity range	NEMA/UL Rating
1-125 Hp at 208 Vac 1-1000 Hp at 460 Vac 1-300 Hp at 575 Vac	NEMA/UL Type 1 & 12 230 Vac 60 Hp & below, 460 Vac & 575 Vac125 Hp & below Open Chassis 230 Vac 75 Hp & above 460 Vac & 575 Vac150 Hp & above NEMA/UL Type 1 option available

DC reactor (DCR)/EMC filter

	230 Vac 60Hp & below 460 Vac & 575 Vac 125Hp & below	230 Vac 75Hp & above 460 Vac & 575 Vac – 150Hp & above
DCR	Built-in	External
EMC filter	Built-in EN61800-3 Immunity/2nd env. Emission/Category C2	Built-in EN61800-3 Immunity/2nd env. Emission/Category C3

Slim Line Form Factor

UL Plenum Rated

FRENIC- HVAC

Available Ratings - Enclosures

NEMA/UL Type 1 enclosure

HP	208V, 3-Phase	460V, 3Phase	575V, 3Phase
1	FRN001AR1M-2U	FRN001AR1M-4U	FRN001AR1M-5U
2	FRN002AR1M-2U	FRN002AR1M-4U	FRN002AR1M-5U
3	FRN003AR1M-2U	FRN003AR1M-4U	FRN003AR1M-5U
5	FRN005AR1M-2U	FRN005AR1M-4U	FRN005AR1M-5U
7.5	FRN007AR1M-2U	FRN007AR1M-4U	FRN007AR1M-5U
10	FRN010AR1M-2U	FRN010AR1M-4U	FRN010AR1M-5U
15	FRN015AR1M-2U	FRN015AR1M-4U	FRN015AR1M-5U
20	FRN020AR1M-2U	FRN020AR1M-4U	FRN020AR1M-5U
25	FRN025AR1M-2U	FRN025AR1M-4U	FRN025AR1M-5U
30	FRN030AR1M-2U	FRN030AR1M-4U	FRN030AR1M-5U
40	FRN040AR1M-2U	FRN040AR1M-4U	FRN040AR1M-5U
50	FRN050AR1M-2U	FRN050AR1M-4U	FRN050AR1M-5U
60	FRN060AR1M-2U	FRN060AR1M-4U	FRN060AR1M-5U
75	N/A	FRN075AR1M-4U	FRN075AR1M-5U
100	N/A	FRN100AR1M-4U	FRN100AR1M-5U
125	N/A	FRN125AR1M-4U	FRN125AR1M-5U

NEMA/UL Type 12 enclosure

HP	208V, 3-Phase	460V, 3Phase	575V, 3Phase
1	FRN001AR1L-2U	FRN001AR1L-4U	FRN001AR1L-5U
2	FRN002AR1L-2U	FRN002AR1L-4U	FRN002AR1L-5U
3	FRN003AR1L-2U	FRN003AR1L-4U	FRN003AR1L-5U
5	FRN005AR1L-2U	FRN005AR1L-4U	FRN005AR1L-5U
7.5	FRN007AR1L-2U	FRN007AR1L-4U	FRN007AR1L-5U
10	FRN010AR1L-2U	FRN010AR1L-4U	FRN010AR1L-5U
15	FRN015AR1L-2U	FRN015AR1L-4U	FRN015AR1L-5U
20	FRN020AR1L-2U	FRN020AR1L-4U	FRN020AR1L-5U
25	FRN025AR1L-2U	FRN025AR1L-4U	FRN025AR1L-5U
30	FRN030AR1L-2U	FRN030AR1L-4U	FRN030AR1L-5U
40	FRN040AR1L-2U	FRN040AR1L-4U	FRN040AR1L-5U
50	FRN050AR1L-2U	FRN050AR1L-4U	FRN050AR1L-5U
60	FRN060AR1L-2U	FRN060AR1L-4U	FRN060AR1L-5U
75	N/A	FRN075AR1L-4U	FRN075AR1L-5U
100	N/A	FRN100AR1L-4U	FRN100AR1L-5U
125	N/A	FRN125AR1L-4U	FRN125AR1L-5U

Available Ratings - Enclosures

Open Enclosure

HP	208V, 3 Phase	460V, 3 Phase	575V, 3 Phase	HP	208V, 3 Phase	460V, 3 Phase	575V, 3 Phase
1	N/A	N/A	N/A	75	FRN075AR1S-2U*	N/A	N/A
2	N/A	N/A	N/A	100	FRN100AR1S-2U*	N/A	N/A
3	N/A	N/A	N/A	125	FRN125AR1S-2U*	N/A	N/A
5	N/A	N/A	N/A	150	N/A	FRN150AR1S-4U*	FRN150AR1S-5U*
7.5	N/A	N/A	N/A	200	N/A	FRN200AR1S-4U*	FRN200AR1S-5U*
10	N/A	N/A	N/A	250	N/A	FRN250AR1S-4U*	FRN250AR1S-5U*
15	N/A	N/A	N/A	300	N/A	FRN300AR1S-4U*	FRN300AR1S-5U*
20	N/A	N/A	N/A	350	N/A	FRN350AR1S-4U*	N/A
25	N/A	N/A	N/A	450	N/A	FRN450AR1S-4U*	N/A
30	N/A	N/A	N/A	500	N/A	FRN500AR1S-4U*	N/A
40	N/A	N/A	N/A	600	N/A	FRN600AR1S-4U*	N/A
50	N/A	N/A	N/A	800	N/A	FRN800AR1S-4U*	N/A
60	N/A	N/A	N/A	900	N/A	FRN900AR1S-4U*	N/A
				1000	N/A	FRN1000AR1S-4U*	N/A

Note:* NEMA/UL Type 1 Enclosure modifications available for these ratings

HVAC application functions provided as standard

- PID Control（4 individual PID regulators）
- Fire Mode (disregards protective alarms, continues operation)
- Filter Clogging Prevention
- Catch a Spinning Motor（Bi-Directional speed search)
- Customized Logic (14 rungs)
- Regenerative Avoidance Control
- Real-time Clock (optional Battery Back up)
- Wet-bulb Temperature Presumption Control
- Linearization Function
- Automatic Energy Optimization
- Reverse Lockout
- Low Torque (Broken Belt)
- PID Sleep Mode

Fire Mode

Forced Operation at a specified speed is enabled with Fire Mode. Even when a Drive Protective Alarm occurs, operation of the drive continues. The continued operation of the drive through an alarm may lead to a drive failure (which would not be covered by the drive warranty) and possibly additional damage.

Filter Clogging Prevention

When a fan's filter is clogged with coarse-grained dust, the filter clogging prevention function expels the dust through reverse rotation operation, break it up, and then starts air flow through normal rotation operation.

Anti Jam Function

When substance such as sand jams in the impeller of a submersible pump, the anti jam function expels it through reverse rotation operation and then starts normal water supply through normal rotation operation.

Customized Logic

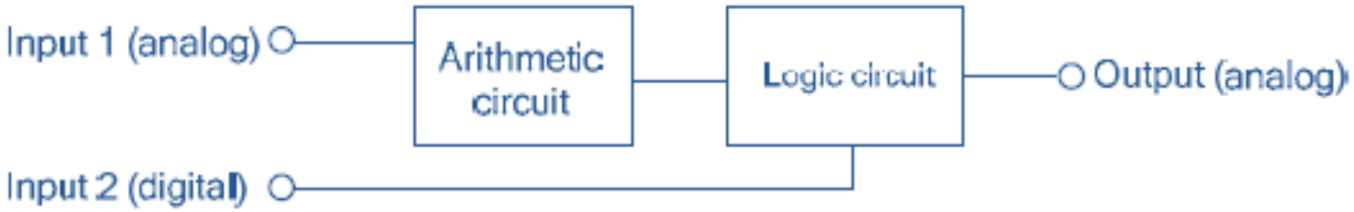
The customizable logic function allows the user to form logic circuits and calculation circuits with respect to digital and analog I/O signals, process signals, and establish simplified relay sequences in the inverter.

In the customizable logic, the following can be specified as one step or *macro* to establish sequences using 14 steps in total:

(1) Digital 2 inputs/digital 1 output + logic calculation (including timer)

(2) Analog 2 inputs/analog 1 output/digital 1 output + value calculation

(3) Analog 1 input/1 digital input/analog 1 output + value calculation/logic calculation



Real Time Clock

Alarm information with date/time

- The last 10 alarms can be “stamped” with date and time

Time Clock Reset function to daylight saving time（DST）

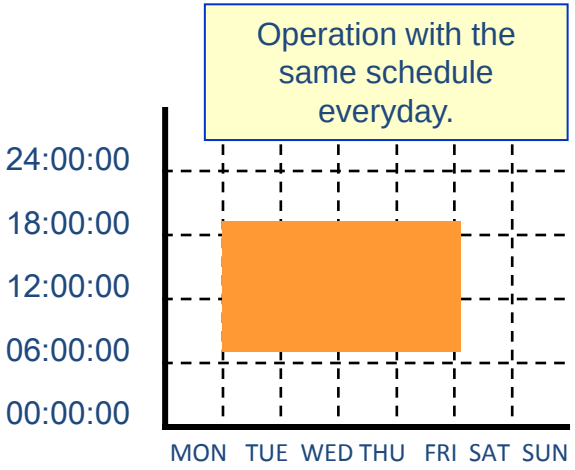
- Start date，End date，Setting correction time（+1hour，+30mintues）

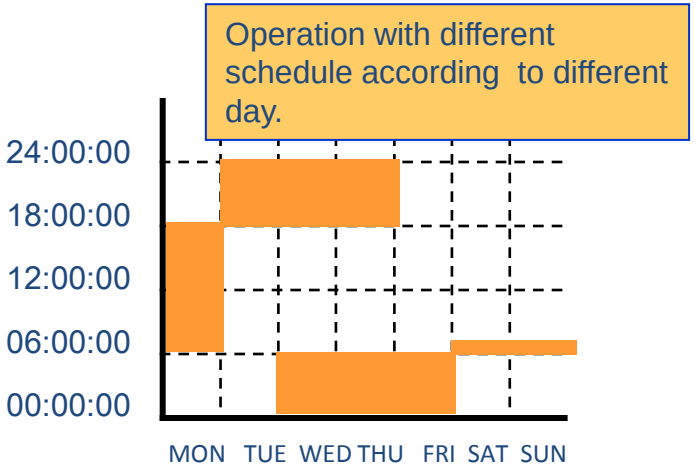
Timer operation

- Max.4 timers can be set per a week
- Holiday setting is available.(20days/year)

Battery Option Available

- Maintains clock operation when AC power main to the drive is shutoff.



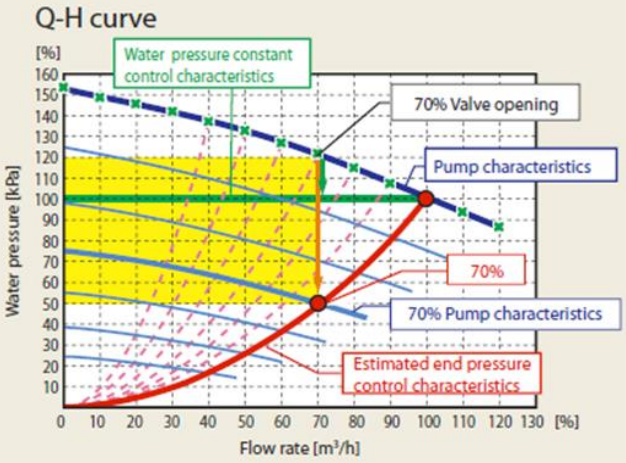


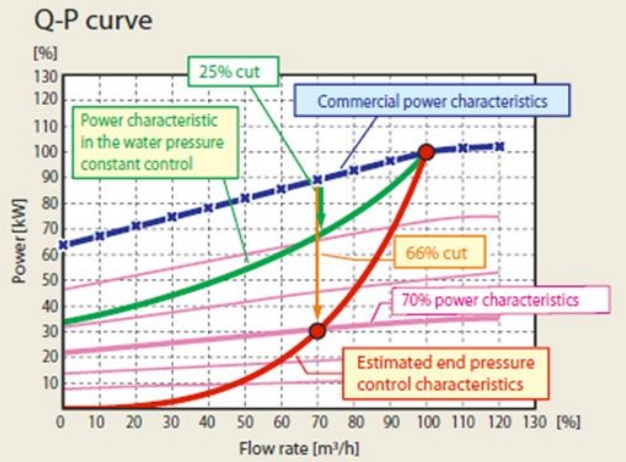
Linearization Function

The best location for a pressure sensor in a closed pump system is at the most distant, key load point. This allows the system to maintain constant system pressure at all loads and takes all system resistance into consideration.

It is not always possible to place the pressure sensor at this point in the system. Often the pressure sensor is located near the pump discharge. In these cases, the drive regulates the pump speed to produce a constant pressure at the outlet of the pump regardless of the actual load requirements of the system. At reduced demand, the energy that is required to produce pressure in excess of actual load requirements is wasted.

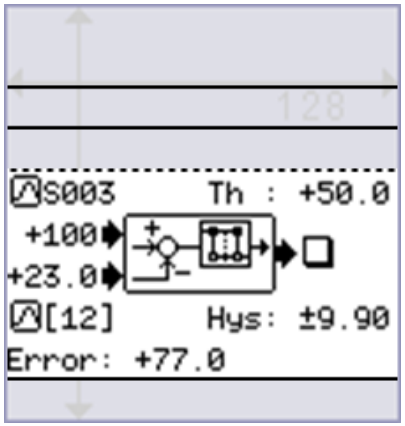
The Linearization Function of the FRENIC HVAC allows the user to adapt the control system to imperfect placement of the sensor. By calculating the pump control curve of the system the drive reduces the pump speed to meet actual load requirements. Significant Energy savings are possible with adaptive control macros.





HVAC Maintenance Functions provided Standard

- Life Prediction Function
  - DC Link Capacitor
  - Printed Circuit Card Electrolytic Capacitors
  - Cooling Fans
- Motor Starts Counter
- Cumulative Motor Run Time
- Wire Break Detection
- Stores, in memory, the last 9 faults and records all operational data
- Date and Time Stamp
- Keypad Custom Logic Trace



Application functions provided as standard

- Data Protection
- Password Function
- Automatic Reset of Alarms
- Bypass Logic Control
- Current Limit
- Motor Preheat Circuit - Prevents Condensation Build up in the Motor Stator
- Overload Early Warning
- Data Initialization
- PTC Thermistor Input
- Low Limiter Mode Selection
- Clear Alarm Data
- Cascade Pump Control

Automatic Reset of Alarms

Drive can be programmed to automatically reset particular alarms to allow continued operation without someone having to reset the fault/alarm.

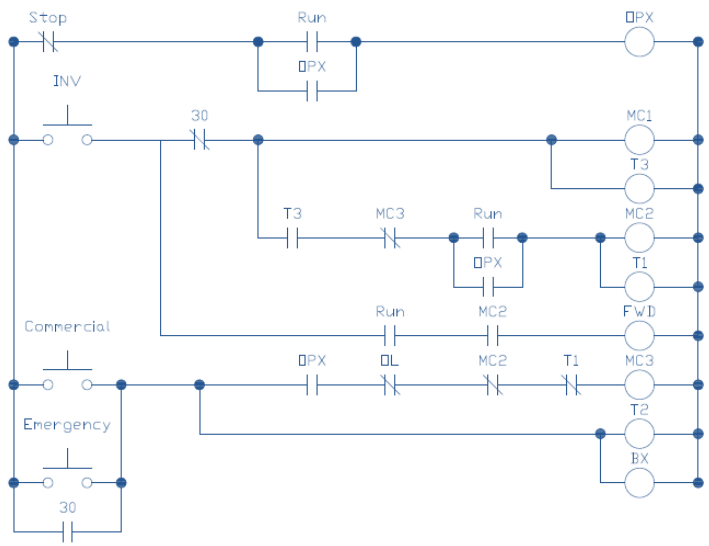
- Up to 10 reset attempts are possible
- With 0.5 – 20.0 second time interval between reset attempts

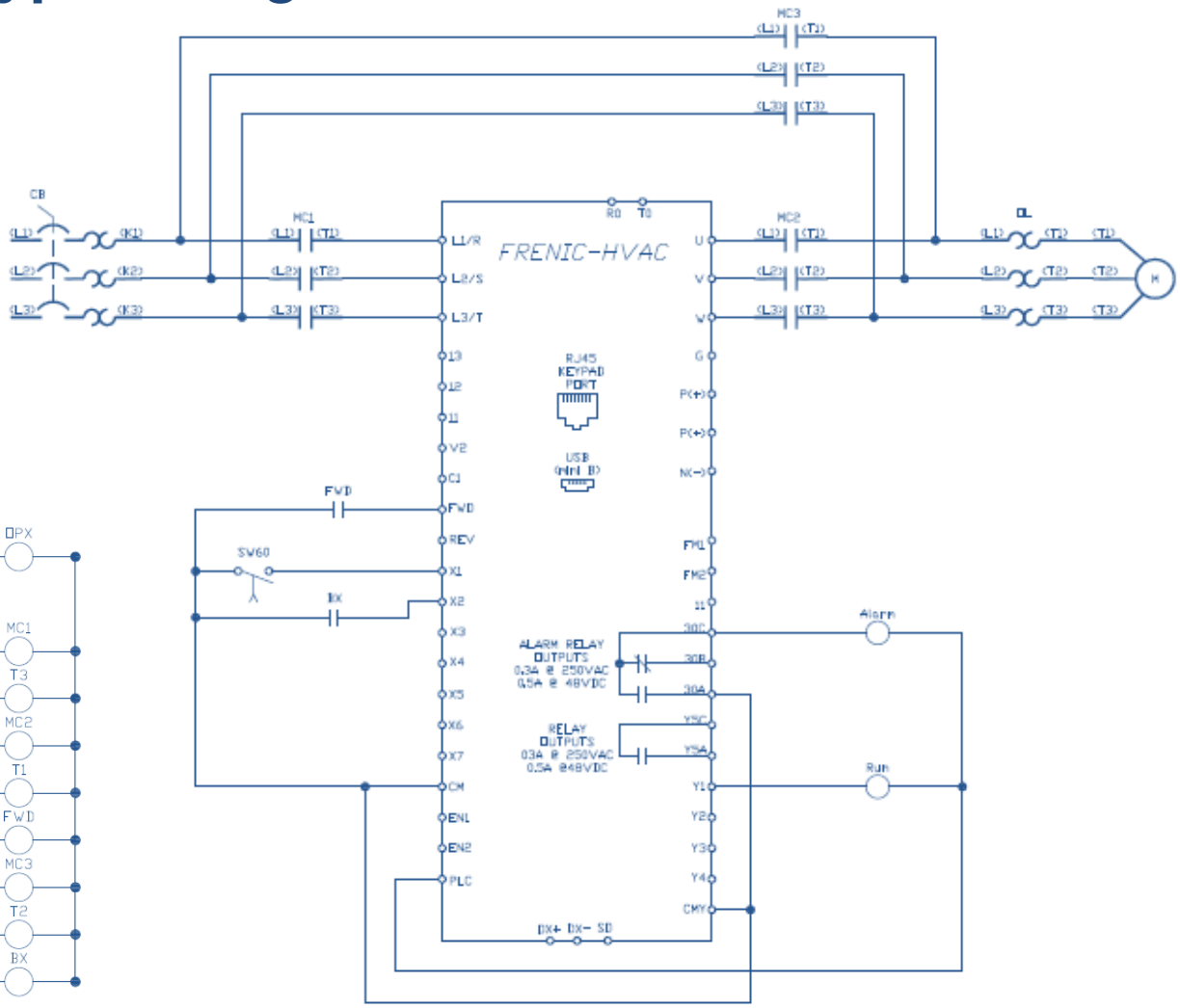
Alarms that may be automatically reset

Alarm status	LED monitor displays:	Alarm status	LED monitor displays:
Instantaneous overcurrent protection	0C1, 0C2 or 0C3	Motor overheated	0H4
Overvoltage protection	0U1, 0U2 or 0U3	Motor overloaded	0L1
Heat sink overheated	0H1	Inverter overloaded	0LU
Inverter overheated	0H3		

Bypass Logic Control

Processing logic for sequencing of Manual or Automatic Bypass function is built in

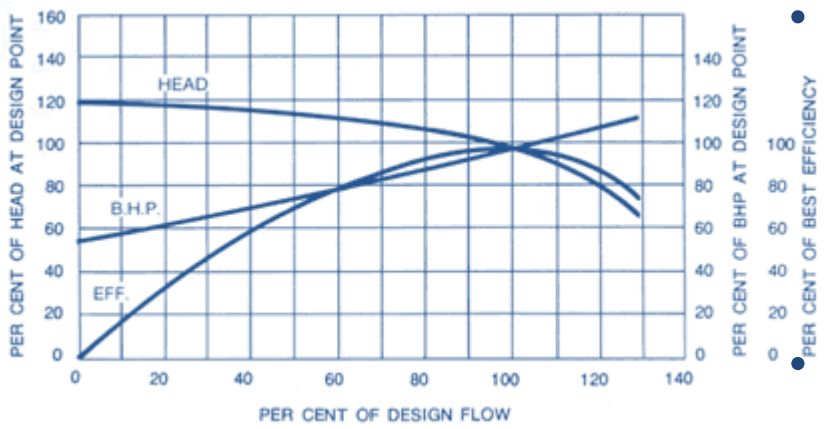




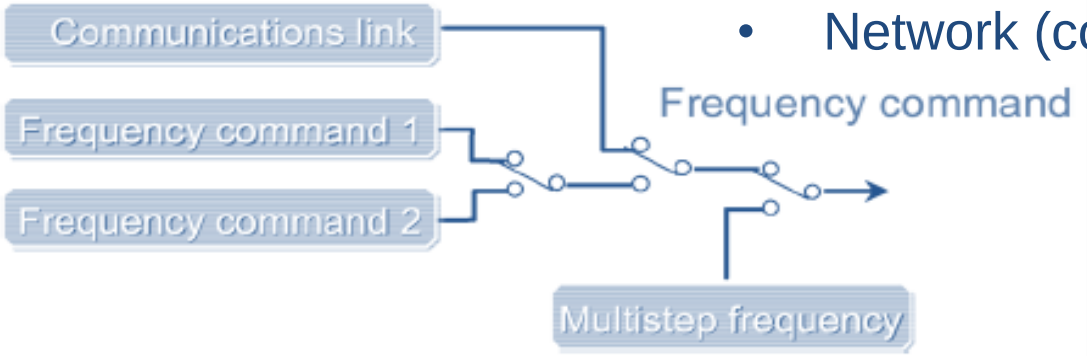
Control Inputs/Outputs

- Qty 9 Programmable Digital Inputs:
  - X1 – X7, FWD, & REV
  - 67 Selectable Functions
- Qty 3 Analog Inputs:
  - Qty 2 – 0-10Vdc
  - Qty 1 – 4-20mA
- Qty 6 Programmable Digital Outputs
  - Qty 2 – relay, 1 form C (N.O./N.C.)& 1 form A (N.O.) rated 0.3A @ 250VAC
  - Qty 4 – transistor
  - 77 Selectable Functions
- Qty 2 Analog Outputs
  - Qty 2 –selectable 0-10Vdc or 4-20mA
  - Configurable to provide 43 functions
- 24Vdc Output Terminal 50mA maximum supply
- Qty 2 Safety Input Terminals: EN1, EN2

Multiple Input Reference Configurations



- Keypad (Increment/Decrement Keys)
- Analog Input
  - 0 to +10VDC [term. 12]
  - 4 to 20mA [term. C1]
  - 0 to +10VDC [term. V2]
  - Normal or Inverse Operation
- Digital Inputs
  - Multistep Frequencies (up to 8)
  - UP/DOWN
- Selection between 2 settings
- Network (communications options)



Integral Keypad

LCD Monitor

Programming Keys

Programming Key

SET Key

UP/DOWN/LEFT/ RIGHT Arrow Key

RESET Key

LED Indicators

Run Key (Forward)

Run Key (Reverse)

STOP Key

HELP Key

Keypad Functionality

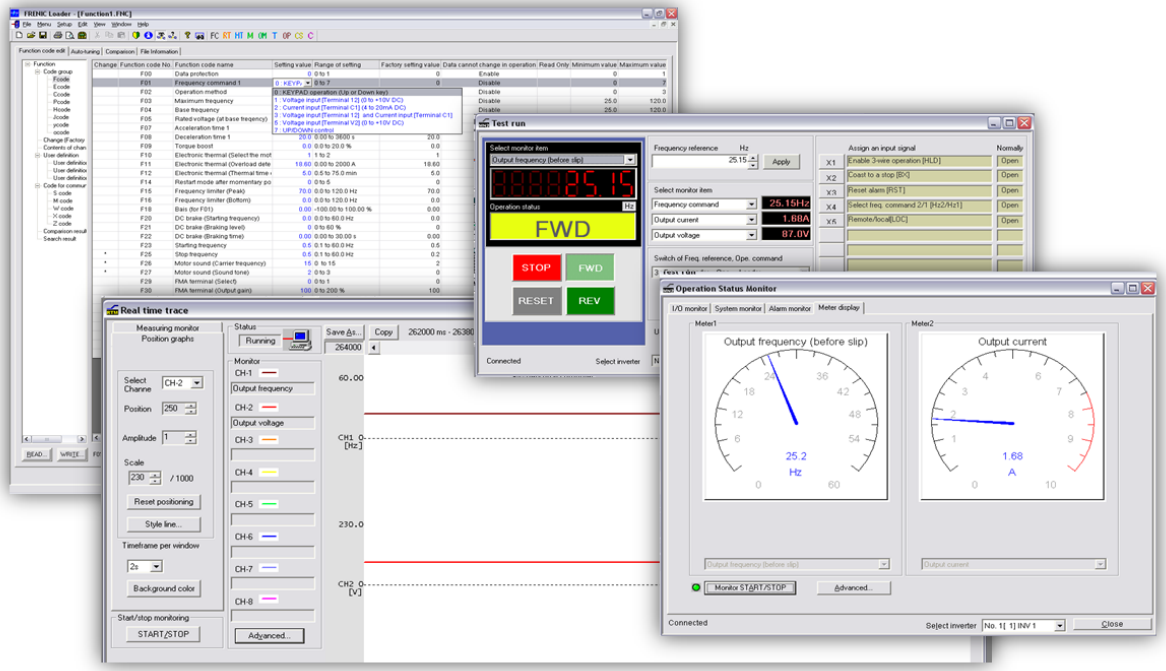
- Lockable, alphanumeric backlit display keypad & copy unit
- Text Displays in English, Spanish, French, Portuguese and additional 15 Languages
- Running Mode
  - Output Frequency
  - Rotation speed
  - Output Torque
  - Output Current
  - Output voltage
  - Present value (PID P V）
  - Set value (PID S V）
  - Manipulative value (PID M V）
  - Input power
  - Input Watt-power
- Programming Mode
  - Quick Setup
  - Start-up
  - Function Code
  - INV Info
  - Date & Time
  - User Configuration
- Alarm Mode
  - Overcurrent
  - Ground fault
  - Overvoltage
  - Phase Loss
  - Over temperature
  - Motor Protective
  - Blown Fuse
  - Communication Error
  - Reference Loss
  - Hardware Error

Remote Keypad and Communications

- Keypad may be mounted up to 20 Meters from drive using standard RJ-45 Port and 10BASE-T/100BASE-TX Lan Cable – Cat. 5 Compliant
- Standard communications protocols:
  - Modbus RTU
  - Johnson Controls Metasys N2
  - ASHRAE/ANSI/ ISO-compliant BACnet
- Option boards for the following communications protocols
  - LONWORKS
  - Ethernet
  - PROFIBUS
- Standard Communication ports :
  - Port 1 RJ-45 Connector
  - Port 2 RS-485 Terminals (SD, DX-, and DX+)
  - USB Port – miniB connector, Version 2.0 compliant

FRENIC Loader Software

- Computer (PC) to FRENIC–HVAC Drive Communications
- PC software is provided at no charge
- Downloaded from Fuji Electric's website @ www.americas.fujielectric.com
- Complete setup and access of the FRENIC-HVAC

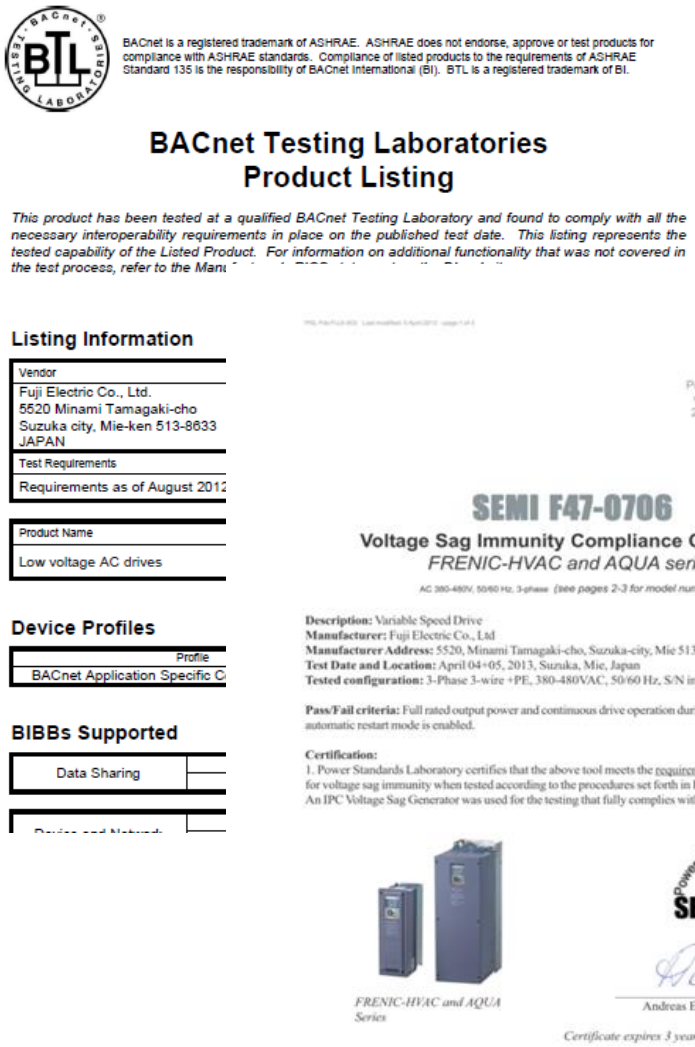


- Editing, comparing, and copying function code data
- Real-time Operation Monitor
- Alarm History (last 9 alarms)
- Maintenance Information
- Historical Trace

Option Cards

Option Type	Description	Model Name	Option Mounting Port			Remarks
			A-port	B-port	C-port	
Relay Output	Option converts Y1,Y2,Y3, and Y4 transistor outputs to relay outputs. Option has 2 outputs - two option modules may be mounted concurrently to deliver 4 relay outputs	OPC-RY	✓	✓		Two option cards connected at a time to A- and B- ports (4 outputs)
	Option adds seven independent transfer contacts - Only one of this option module may be connected	OPC-RY2		✓	✓	A single option card connected to B- and C- ports (both ports occupied)
I/O	Additional analog signal I/O include One Bipolar -10 to +10 Vdc Input, One 4-20mA Input, One Bipolar -10 to +10 Vdc Output, One 4-20mA Output	OPC-AIO	✓	✓	✓	A single option card connectable at a time to any one of A-, B-, or C- ports
	Additional analog output signals are two 4-20mA Output	OPC-AO	✓	✓	✓	A single option card connectable at a time to any one of A-, B-, or C- ports
	Input module allows a resistance temperature detector connection to drive. Supports 2 temperature sensor inputs for PID Tempearture difference control	OPC-PT	✓	✓	✓	A single option card connectable at a time to any one of A-, B-, or C- ports
Communications	DeviceNet	OPC-DEV	✓	✓	✓	Only one of these communication option cards is connectable to the drive at a given time.
	CANopen	OPC-COP	✓			
	PROFIBUS-DP	OPC-PDP2	✓			
	Control & Commuications Link	OPC-CCL	✓			
	LonWorks	OPC-LNW	✓			
	ProfiNet RT	OPC-PRT2	✓			
	Ethernet - Supports following Protocols - Modbus/TCP, BACnet/IP, Ethenet/IP, Allen Bradley CSP	OPC-ETH	✓			

Codes, Standards, Certifications



BACnet is a registered trademark of ASHRAE. ASHRAE does not endorse, approve or test products for compliance with ASHRAE standards. Compliance of listed products to the requirements of ASHRAE Standard 135 is the responsibility of BACnet International (BI). BTL is a registered trademark of BI.

BACnet Testing Laboratories
Product Listing

This product has been tested at a qualified BACnet Testing Laboratory and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manu

Listing Information

Vendor
Fuji Electric Co., Ltd. 5520 Minami Tamagaki-cho Suzuka city, Mie-ken 513-8633 JAPAN
Test Requirements
Requirements as of August 2012

Product Name
Low voltage AC drives

Device Profiles

Profile
BACnet Application Specific C

BIBBs Supported

Data Sharing	

PSL

Power Standards Laboratory
www.PowerStandards.com
2020 Challenger Drive #100
Alameda, CA 94501 USA
TEL ++1-510-522-4400
FAX ++1-510-522-4455

SEMI F47-0706

Voltage Sag Immunity Compliance Certificate
FRENIC-HVAC and AQUA series

AC 380-480V, 50/60 Hz, 3-phase *(see pages 2-3 for model numbers)*

Description: Variable Speed Drive
Manufacturer: Fuji Electric Co., Ltd
Manufacturer Address: 5520, Minami Tamagaki-cho, Suzuka-city, Mie 513-8633, Japan
Test Date and Location: April 04+05, 2013, Suzuka, Mie, Japan
Tested configuration: 3-Phase 3-wire +PE, 380-480VAC, 50/60 Hz, S/N in report

Pass/Fail criteria: Full rated output power and continuous drive operation during all voltage sags if automatic restart mode is enabled.

Certification:
1. Power Standards Laboratory certifies that the above tool meets the requirements of SEMI F47-0706 for voltage sag immunity when tested according to the procedures set forth in IEC 61000-4-34.
An IPC Voltage Sag Generator was used for the testing that fully complies with IEC 61000-4-34.

FRENIC-HVAC and AQUA Series

Power Standards Lab PSL SEMI F47

Andreas Eberhard 11 April 2013
Power Standards Lab
Certificate expires 3 years after of the issuance date

FRENIC-HVAC Drives comply with provisions of the following:

- **UL Labeled -** Standard UL508C
- **cUL Labeled** – CSA Standard C22.2 No. 14
- **UL Labeled** - Listed for a short circuit current rating of 100kA
- **SEMI F47-0706** Voltage Sag Immunity Compliance
- **UL Plenum Rated**
- **CE Labeled** - Compliance with European Standards – Low Voltage Directive IEC/EN 61800-5-1:2007
- **BACnet** Laboratories Certified

Quality Assurance Provisions & Warranty

FRENIC-HVAC Drive Quality

- ISO 9001:2008 Certified
- Re-certification granted March 3rd, 2010
- Comprehensive Production Testing
- Voltage Withstand Test
- Operation Test without Motor
- Aging Test
- Functional Test with Motor
- Final Inspection

International Organization for Standardization

FRENIC-HVAC Drive is warranted by Fuji Electric for a period of 36 months from date of shipment

Packaged Solutions for Variable Torque Fans

Building upon Fuji Electric's FRENIC-Packaged Drive experience, FRENIC-HVACPAK is a packaged solution designed for variable torque fan applications in commercial buildings, educational facilities, hospitals, and industrial facilities. Offering the most common specified features and options required by facility and consulting engineers, FRENIC-HVACPAK provides a compliant and competitive packaged drive solution for HVAC applications.

The Right Choice

- Time Savings = $$$ Savings
  - Quick installation
  - Quick start-up
  - Easy to use Keypad
  - Easy to maintain
  - Tripless operation

- 10 year Design Life
- Less Peripheral Equipment Required
- Energy $avings = Reduction in CO_2

Thank You
for
Your Time!