

# HIVECTOL-HVI



**Medium Voltage Multi-level IGBT Drives**

# Over 80 Years of Experience in Variable Speed Drives

Based on lengthy experience in drive systems for steel rolling mills, Hitachi supplies AC drive systems to various industry applications including mixers and extruders for the plastics and rubber industry, induced and forced draft fans for thermal power plants, pumps for water purification plants and water and waste water treatment facilities, and fans and blowers for general applications.

Mega power AC drives also have applied to wind mill power converters, dump truck drives for mining industry, compressor drives for oil & gas industry and propulsion drives for ice breaker ships.

## DC Motor to AC Motor Drives

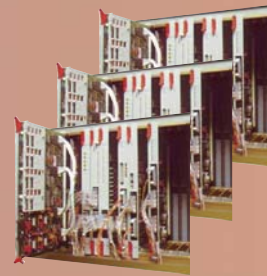
### HIGHLIGHTS

**1933**  
Ward Leonard Drives  
for steel rolling mills

**1958**  
Mercury-arc Rectifier  
applied Ward Leonard  
Drives for steel rolling  
mills



**1973**  
DC drive controls,  
HILECTOL



**1982**  
The world's first Digital  
Thyristor Leonard Drives

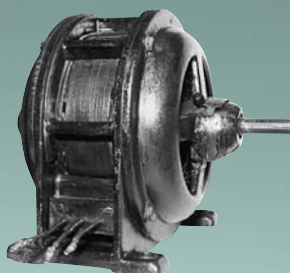


**1986**  
Medium Voltage AC Drives  
for steel rolling mills

**1930-1960**

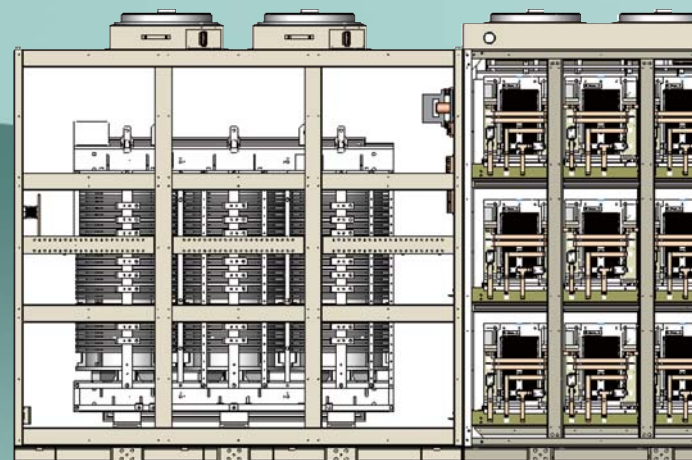
**1970**

**1980**



**1910**  
**The first products of Hitachi**

Hitachi was founded in 1910 as an electrical repair shop for a mining company and succeeded in the first domestic manufacture of three 5 HP motors as the company's first products.



Multi-winding isolation transformer

Inverter Section  
& Inverter Cells

#### NOTICE:

- All photos and illustrations in the catalog may be different from the actual product due to product improvement.
- The pictures in this catalog are inland composite images.



# Direct Inverter Controls



1995

20MVA GTO Drives for steel rolling mills



1999

Medium Voltage Multi-level IGBT Drives, HIVECTOL-HVI



2001

8MVA HIVECTOL-HVI for utility thermal power plants



2007

30MVA IGBT Drives for steel rolling mills

2004

Multi-level IGBT drive production started in China

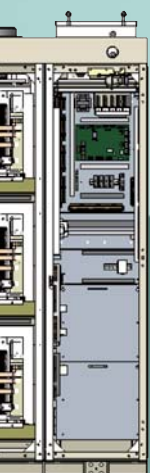
2009

30MVA 5-Level water cooled IGBT Drives

1990

2000

2010



Control Section

## HIVECTOL

### Features



#### Power Source and Machine Friendly

- Current harmonic at the power source conforms the IEEE 519-1992 guidelines without line side harmonic filters.
- Multi-level PWM approximates output waveforms to sine curves and reduces motor insulation stress.
- Multi-winding isolation transformer and diode converter help achieve a power factor of 0.95 or better.



#### State-of-the-art Technology and High Performance

- Stable operation is assured for applications needing high starting torque and high intermittent torque.
- Patented "external pre-charging method" helps reduce the parts count and down time.
- Automatic restarting function helps continuous operation in cases of instant power failure.
- Motor Speed accuracy is  $\pm 0.5\%$  at the rated 100% speed without a speed sensor device. ( $\pm 0.1\%$  with speed sensor device)



#### High Reliability

- IGBT, the most reliable, available and widely installed power semiconductors in industry are used.
- Quality production in manufacturing eliminates human error during manufacturing.
- "Realtime simulator" helps prevent axial vibration and minimize the commissioning period.



#### Operator Friendly

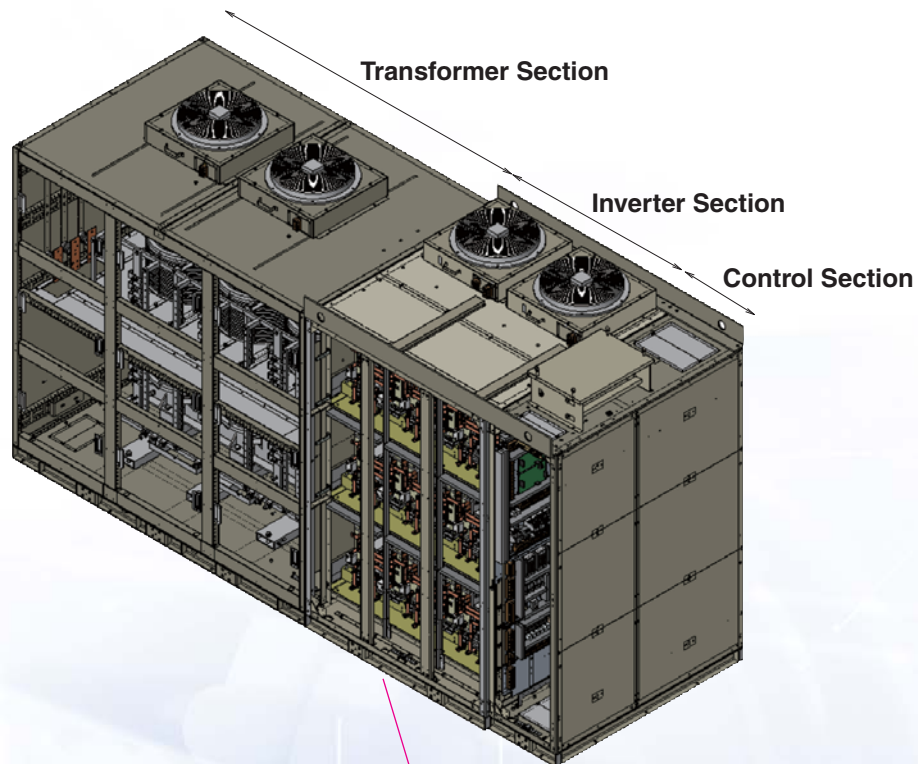
- Large touch-screen panel shows easy-to-understand information and assures user friendly operation.
- Windows® PC based maintenance software is supplied by Hitachi for user friendly operation.

## HIVECTOL HVI Hardware Overview

Main components of HIVECTOL-HVI are the “Transformer Section”, “Inverter Section” and “Control Section”. Inverter Section is composed of a series-connected “Inverter Cell”.

Isolation Transformer is a phase shifted multi-winding type.

Control Unit has functions such as IGBT inverter switching, an interface to external equipment, etc.



Inverter Cell



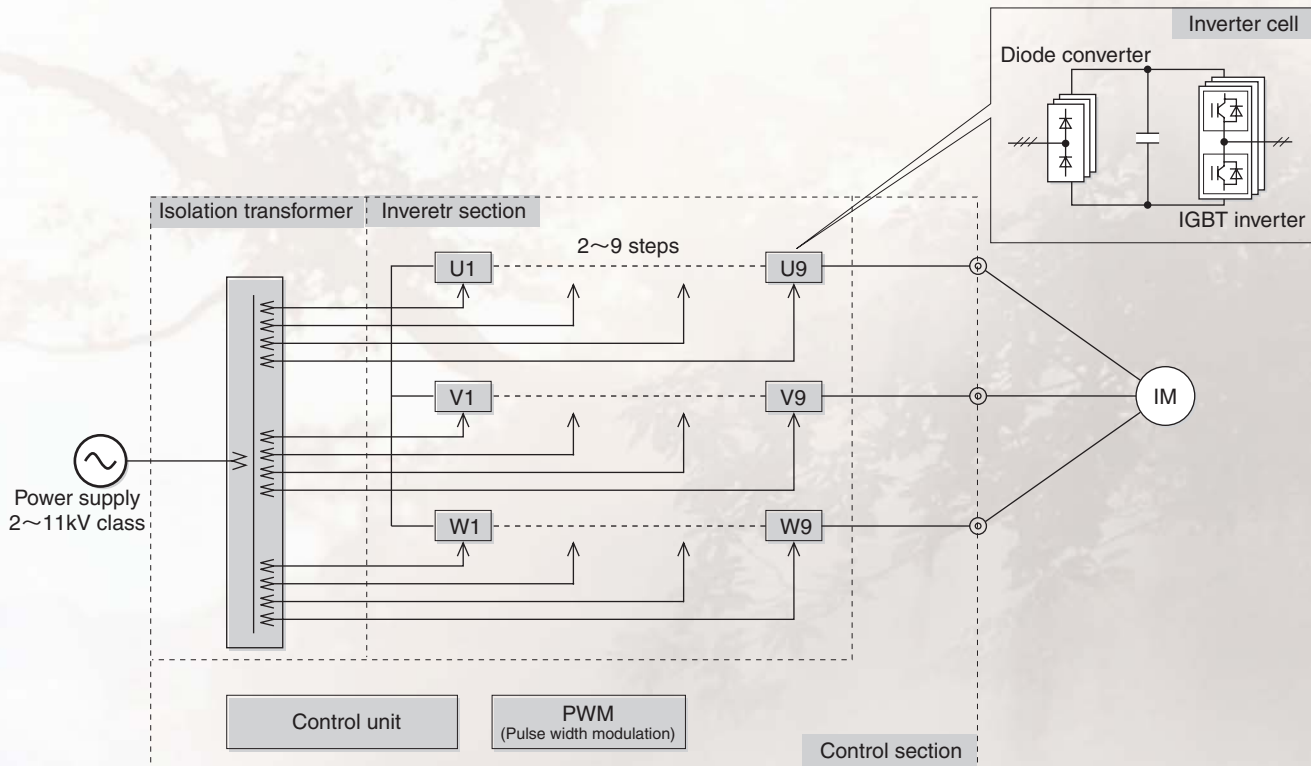
## Power Source and Machine Friendly

Inverter Cell is composed of a diode converter and IGBT inverter.

Each Inverter Cell is fed from a separate secondary winding of the isolation transformer.

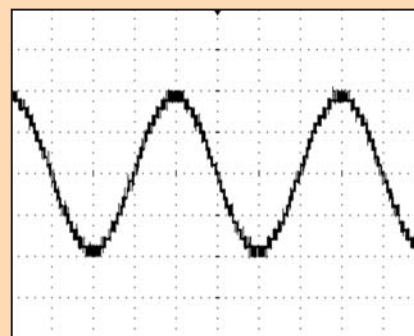
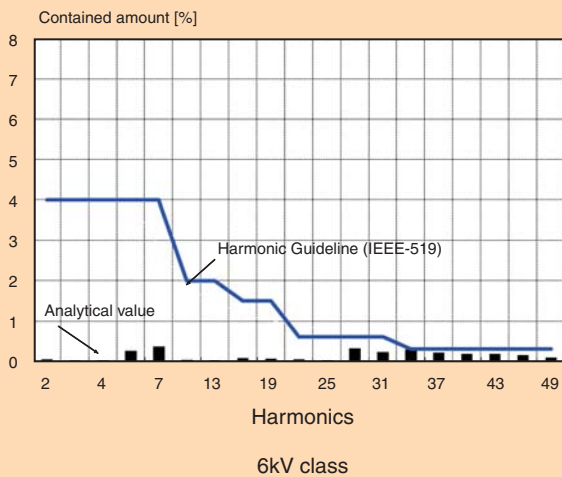
These Inverter Cells are connected in series and are operated in multiplexed mode. This mode of operation generates a stepped voltage output which approximates sine waveforms. This allows the direct inverter to be used not only with new inverter motors, but with existing standard motors as well.

In addition, the phase shifted multi-winding transformer effects reduction of current harmonics to the power supply well below the levels admitted under the IEEE 519-1992 guidelines.



### Line-side current distortion content

### AC voltage output wave form



Output wave forms are very smooth resulting in reduction of electrical and mechanical stress of the motor.

6kV class

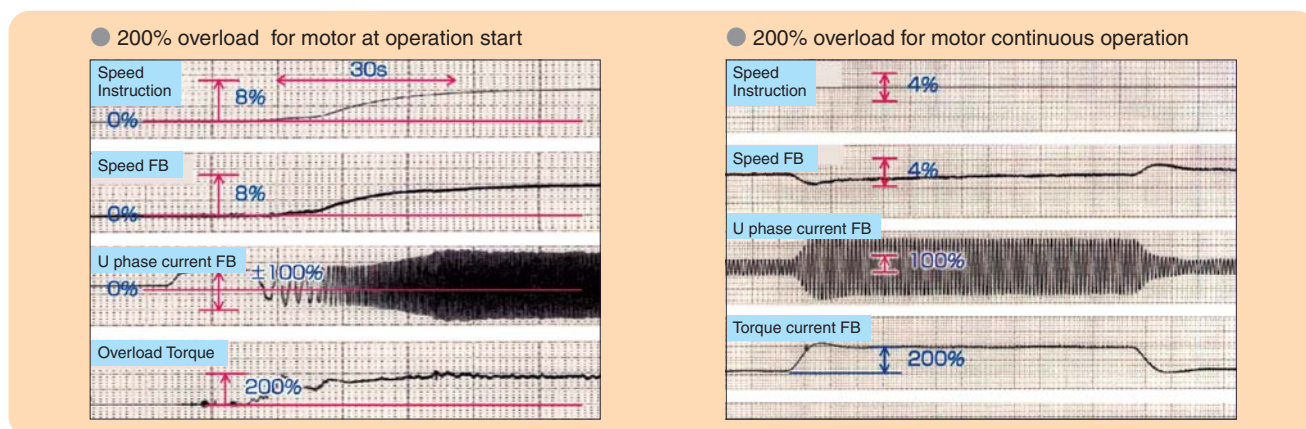


## State-of-the-art Technology and High Performance

### Best Fits for High Torque Application

Robust speed sensor-less vector control technology prevents over current conditions and operates machines in a safe and continuous mode when the impact load reaches 200%.

HIVECTOL-HVI is capable of driving a heavy starting load (200% torque) and can not only match but excel in performance compared to a DC motor. HIVECTOL-HVI best fits mixers and extruders for rubber and plastic industries.



For high torque applications such as rubber mixers, extruders, and agitators, Hitachi uses a method that controls the output voltage by adjusting current flux component using measurement of overload current. Smooth torque control in the operating speed range and high torque at the startup is achieved by sensor-less vector control by using calculated required current for torque and excitation for the given load.

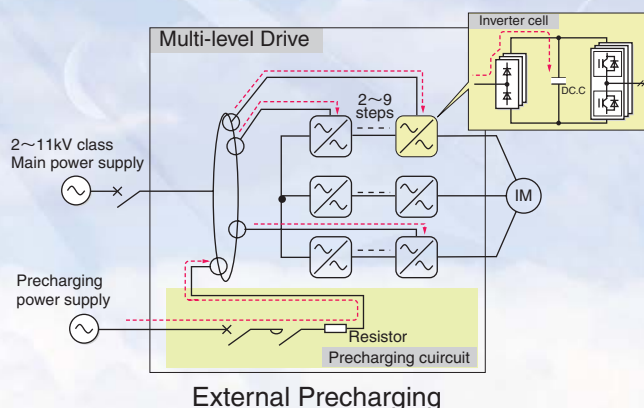
A sensor-less vector control scheme needs no speed feedback device (speed sensor) and it improves system reliability and maintainability.

### Lower Parts Count Enhances Reliability

In order to reduce inrush current when the main power is turned on, a pre-charging circuit is required to charge DC capacitors. Hitachi uses its patented external pre-charging circuit and pre-charging is done by a separate power supply.

The other method is to use a pre-charging circuit with each Cell Inverter.

Comparing between the two pre-charging methods, the external pre-charging method is very simple and reduces the parts count.



### Patented Pre-Charging method

Pre-charging circuit charges the DC capacitor before the input medium voltage breaker is turned on. This is done in order to prevent the inrush current when the medium voltage main power supply turns on.

HIVECTOL-HVI uses a separate LV power source for pre-charging. This power supply is switched on for about 20 seconds, during which capacitors in the inverter cells charge. Once capacitor charging is completed, the LV supply is disconnected and the medium voltage breaker for main supply is turned on. Compared to a pre-charging circuit that uses a thyristor switch and a resistor in each cell unit, the arrangement of separated pre-charging circuit is simple and easy to maintain. This design leads to high reliability in inverter operation.

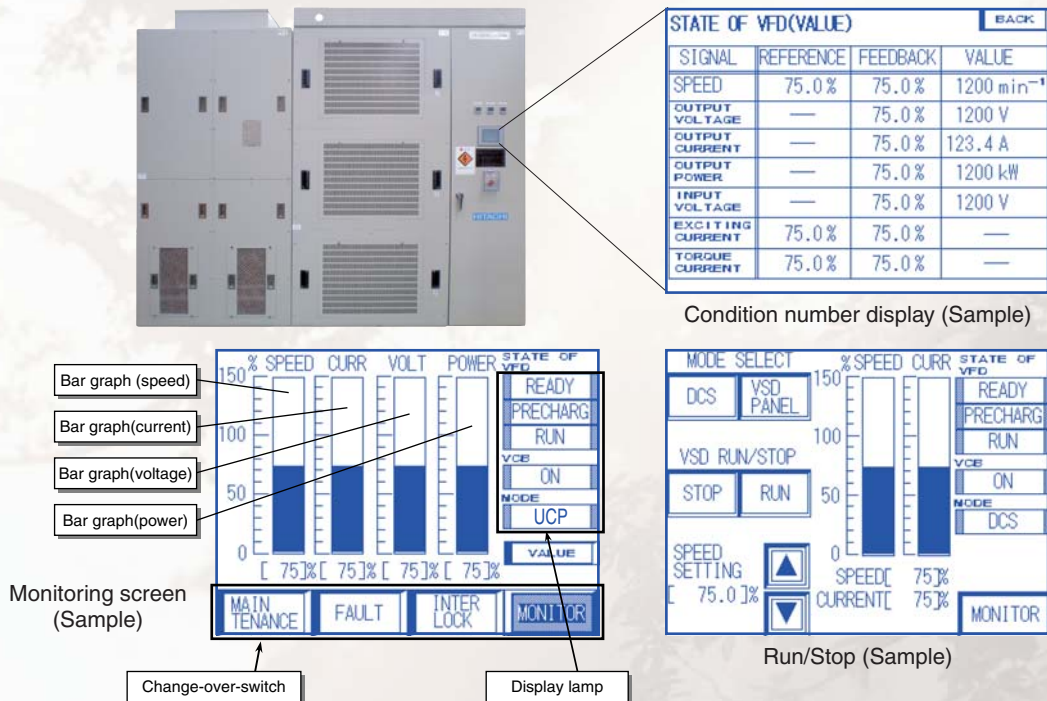
Separated pre-charging circuit method has been patented by Hitachi Ltd (Patent No.3,535,477).

## User Friendly

### Easy Analysis and Diagnostics

The operator touch-screen panel with a large LCD is easy to see and easy to operate.

Operator can see various kinds of helpful information such as the operation status and alarm information.

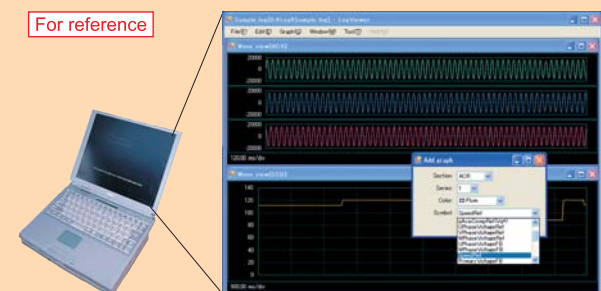


### Easy Maintenance

Hitachi provides a maintenance software tool which helps maintain the drive system easier. The software is designed for Windows® PC. The major functions of the maintenance tool are as follows:

- Memory Read/Write Function
- Display Diagnostic Message and Trend Data
- Selection of Analog Output Signal
- File Read/Write Function
- Bar Graph Display Function

### ● Maintenance Software



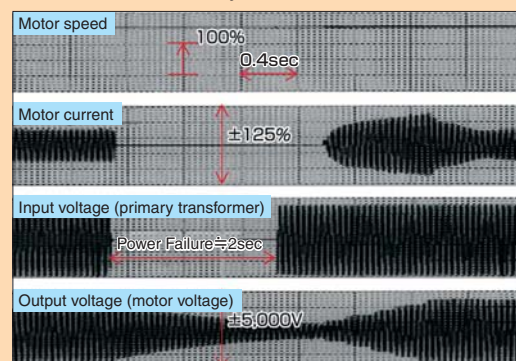
## Instantaneous Voltage Drop Measure

### Automatic Restart upon Instantaneous Power Failure

After input power recovery, the automatic restart function maintains continuous operation in the case of instantaneous power failure.

The coasting motor can be reaccelerated to the reference speed automatically.

### ● Restart automatically





## Quality

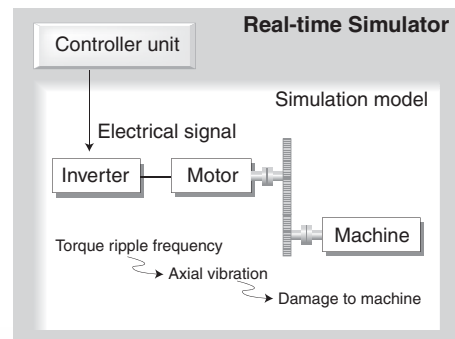
### Axial Vibration Prevention

Hitachi has developed a real-time simulator, which simulates the physical control system in real time.

The simulation models cover the main circuits of the drive motor and driven mechanical load.

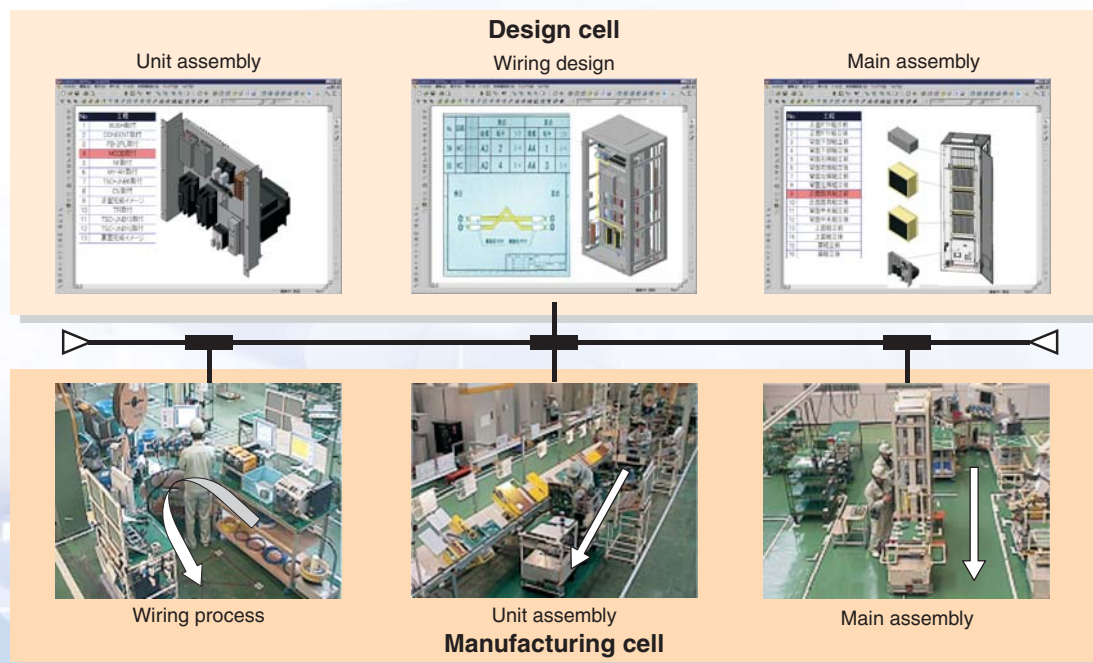
For example, axial vibration happens to be generated by resonant frequency from the load. Prior to shipment of the drives for such applications, Hitachi evaluates the resonance effects to prevent axial vibration.

This real-time simulator works not only to improve reliability, but also to shorten the commissioning period on site.



### Quality Production

Hitachi has implemented a production data management system which displays on a video terminal the last updated or the new schematics and the Bills of Materials (BOM). Visual assistance helps the manufacturing work force to prevent human error and to improve quality. No paper schematics are used in the wiring and assembly process.



## Why does Hitachi choose IGBT ?

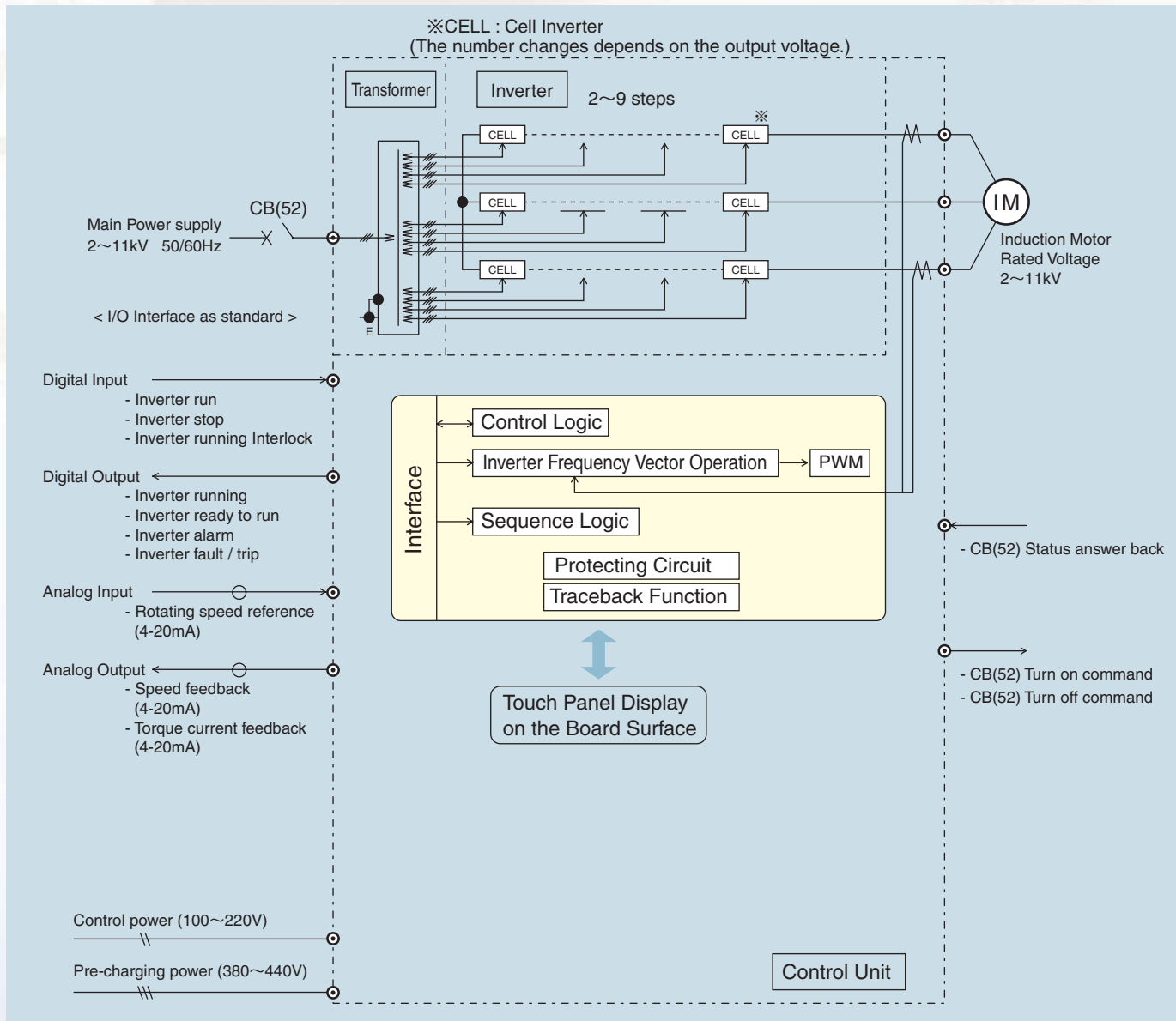
Hitachi applies IGBT power semiconductors for all product lines of variable frequency drives. The reliability of IGBT has been proven in a variety of application environments such as steel rolling mills, traction drives, generator converters, and general purpose drives. Compared to the other types of power semiconductors, IGBT is a more commonly used power device. From this viewpoint, IGBT parts are more availability.





## External Interfaces

External interfaces allow user specific or plant specific signals to be coordinated for operation of the inverter in the plant environment. These signals can be interlocking signals, monitoring signals or process control signals that are connected to the inverter so the it works in a synchronized fashion with the machine and the process.



## Specifications (For Reference)

No.	Item	Output Volt[V]	Specifications										
1	Line-up	Capacity[kVA]	2,400	—	—	360	530	800	1,060	1,600	2,130	2,900	3,630
2			3,000	—	330	450	660	1,000	1,330	2,000	2,670	3,650	4,550
3			3,300	—	360	500	730	1,100	1,460	2,200	2,930	4,000	5,000
4			4,160	310	460	630	920	1,380	1,850	2,770	3,700	5,040	6,300
5			6,000	450	660	900	1,330	2,000	2,670	4,000	5,340	7,300	9,100
6			6,600	500	730	1,000	1,460	2,200	2,930	4,400	5,870	8,000	10,000
7			10,000	750	1,110	1,510	2,220	3,330	4,450	6,670	8,900	12,100	15,200
8			11,000	830	1,220	1,660	2,440	3,670	4,890	7,340	9,790	13,300	16,700
9		Rated Output Current [A]	43.7	64.2	87.5	128.5	192.8	257.1	385.6	514.2	700	875	
10		Output Frequency [Hz]	50 / 60Hz (Max.75Hz)										
11	Power Supply	Input Voltage	AC2,400V / 3,000V / 3,300V / 4,160V / 6,000V / 6,600V / 10,000V / 11,000V										
12		Input Frequency	50 / 60[Hz]										
13		Power supply for control	AC100 / 110 / 200 / 220 / 230 / 240V 1 Phase (Standard) or DC100/110V (Option)										
14		Pre-charge power supply	AC400 / 415 / 440V (Standard) AC220 / 200V or other low voltage (option) 3 Phase										
15		Voltage fluctuation	within $\pm 10\%$ (Working without fault although the output power become lower)										
16			within $\pm 5\%$ (Guarantee output power)										
17		Frequency fluctuation	within $\pm 5\%$										
18	Structure	Cubicle	Forced air cooled self-standing cubicle type										
19		Transformer	In-built dry type (Oil-immersed Transformer as option)										
20		Protection	IP21 (Higher degrees of protection as option)										
21	Control	Type	Medium Voltage Multi-level IGBT Inverter										
22		Control Method	Sensor less Vector Control / Vector Control with Sensor (Option)										
23		Driving Method	2 quadrant Operation										
24		Deceleration	Natural Deceleration										
25		Speed Control Range	1%~100% speed										
26		Accuracy	$\pm 0.5\%$ at 100% speed without sensor / $\pm 0.05\%$ at 100% speed with sensor										
27		Overload	125% 60sec										
28		Efficiency	approximately 97% (including Transformer)										
29		Power factor	above 95%										
30		Interface	Analog / Field network (DeviceNet / Profibus / Modbus / CAN)										
31	Protection	Momentary Over Current	Detected output AC side										
32		Over voltage of DC circuit	Detected DC over voltage of each cell										
33		Power drop for Driver board	Detected power drop of each cell										
34		PT CT failure	Comparing drive frequency with voltage/current feed back										
35		Ground fault	Detected current flow into earthing resistor										
36		Power failure	Detected at quaternary voltage of multiplex winding transformer										
37		Abnormal Cooling Fan	Detected by thermal or MCCB trip										
38	Indication	Charging	Indicate until main DC voltage to 50V										
39		Speed / Current / etc.	Indication Bar chart on Graphic Panel										
40		Fault	Indication on Graphic Panel										
41		Trace Back Data	Read out to the Maintenance tool										
42	Others	Cable entrance	Bottom / Upper (Option)										
43		Restart after instantaneous power failure	Option (Need UPS power supply)										
44		Restart while the motor rotating	Option										
45	Standards		IEC / JIS / JEC/ JEM										

\* The output rated voltage shall be guaranteed within the above mentioned voltage fluctuation.

\* More options are available. Please inquire for more details.

\* All specifications are subject to change without notice.

\* DeviceNet is trademark of Open DeviceNet Vendor Association (ODVA), Inc.

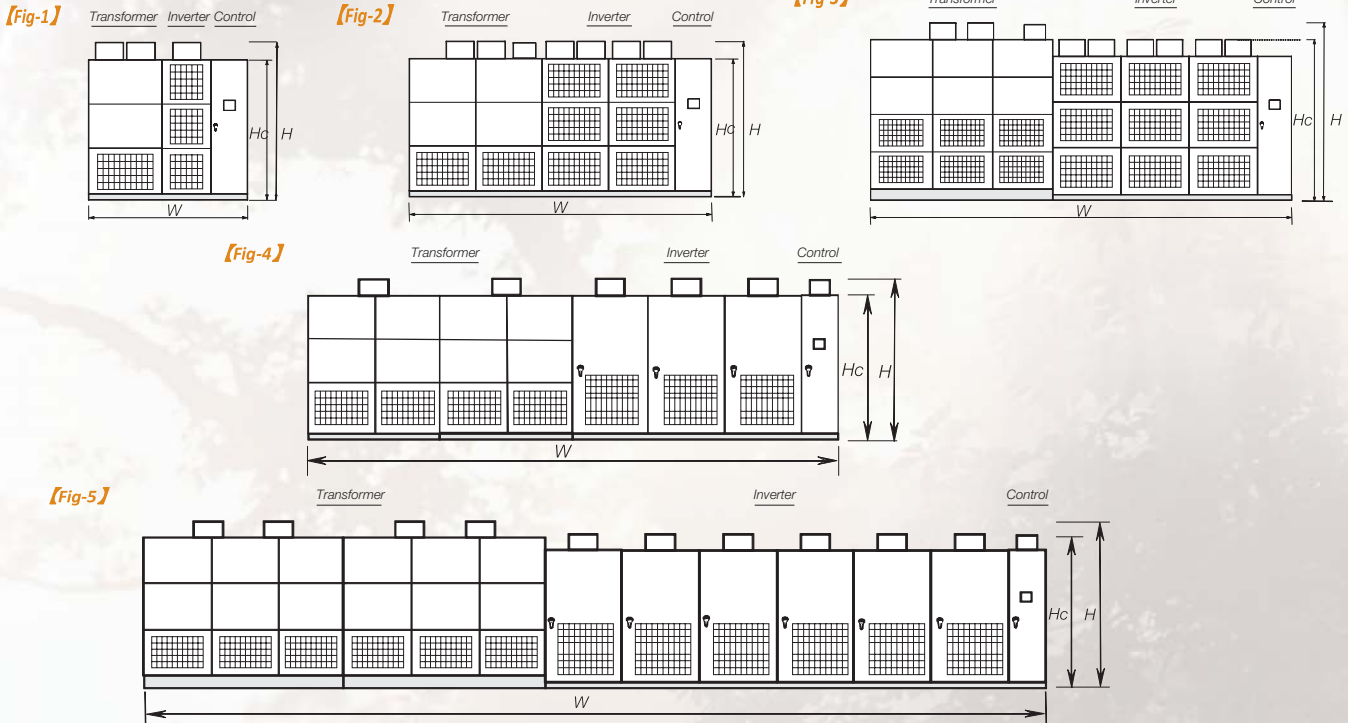
\* Profibus is a registered trademark of Profibus Nutzerorganisation e. V.

\* Modbus is a registered trademark of AEG Schneider Automation Inc.

\* HIVECTOL is a registered trademark of Hitachi, Ltd.



# Dimensions (For reference)



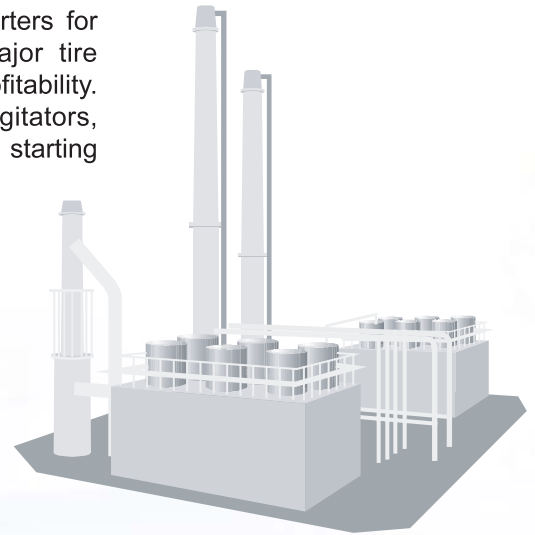
Voltage (kV)	kVA	Outline	Dimensions(mm)				Weight (kg)	(mm) (at least)		
			Width(W)	Depth(D)	Height(H)	Panel Height(Hc)		Front	Rear	Top
2.4	360	Fig-1	2,700	1,200	2,700	2,400	3,900	1,800	600	500
	530		3,300				4,400			
	800		3,500				5,100			
	1,060		3,700				5,700			
	1,600		3,800				6,300			
	2,130		4,100				6,900			
3.3	360	Fig-1	2,700	1,200	2,700	2,400	3,800	1,800	600	500
	500		3,300				4,900			
	730		3,300				5,100			
	1,100		3,700				5,800			
	1,460		3,800				6,300			
	2,200		4,100				7,800			
	2,940	Fig-4	5,800	1,500	2,700	2,400	11,300	1,800	600	500
	4,000		7,900				18,000			
	5,000		8,800				19,300			
4.16	310	Fig-1	3,100	1,200	2,700	2,400	4,200	1,800	600	500
	460		3,300				4,500			
	630		4,200				5,900			
	920		4,400				6,500			
	1,380		4,400				7,500			
	1,850		5,000				8,900			
	2,770	Fig-2	5,600	1,700	2,700	2,400	11,500	1,800	600	500
	3,700		7,500				16,300			
6.6	500	Fig-1	3,100	1,200	2,700	2,400	4,600	1,800	600	500
	730		3,100				5,300			
	1,000		4,200				6,900			
	1,460		4,200				7,900			
	2,200	Fig-2	5,200	1,200	2,700	2,400	10,900	1,800	600	500
	2,930		5,800				12,600			
	4,400		8,000				19,600			
	5,880		11,000				22,400			
	8,000	Fig-5	19,800	1,700	2,900	2,600	30,100	1,800	600	500
	10,000		19,800				30,100			
11.0	830	Fig-1	4,400	1,500	2,700	2,500	7,000	1,800	600	500
	1,220		4,400				7,000			
	1,660	Fig-3	5,300				10,000			
	2,440		5,900				13,000			
	3,670		8,900				16,300			
	4,890		9,900				16,500			
	7,340	Fig-3	14,500		3,000	2,700	24,900			
	9,790		14,500				25,200			

Note: 1) The dimensions and weight mentioned above are only for reference. Please ask to our sales network and confirm it by technical specifications.  
2) Differences may occur due to some factors like : options, components, modifications, installation condition. Please contact us for more details.  
3) Please inquire about weight and dimensions for transformer (dry type or oil-filled type) separation.  
4) Less clearance space in back can be available. Please inquire for more details.  
5) Dimensions are subject to change without notice.

## Trusted in various industrial fields

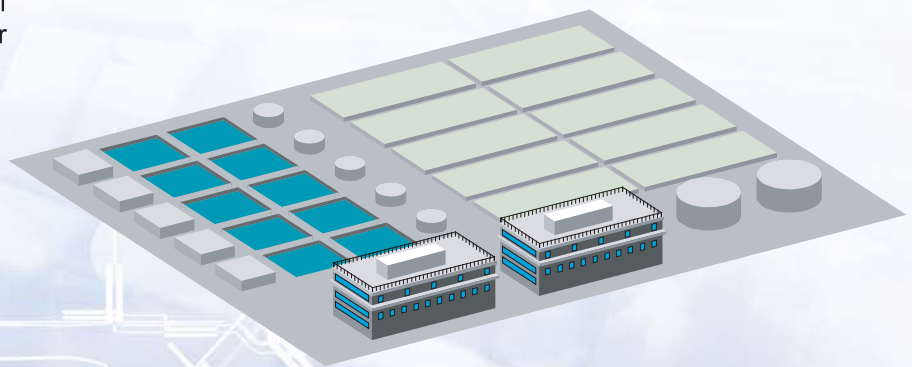
### Rubber and Plastic

Hitachi has delivered more than one hundred HIVECTOL inverters for rubber mixer drive systems to major tire manufacturers. Major tire manufacturers in the world enjoy higher productivity and profitability. Hitachi has also delivered more HIVECTOL inverters for agitators, pelletizers, extruders and more applications which require high starting torque and high intermittent torque in their operation.



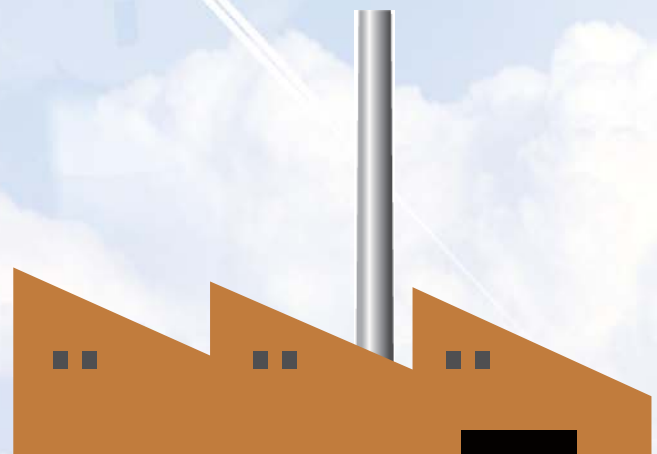
### Water and Waste Water

Hitachi has delivered hundreds of drives for variable speed control of pumps in water and waste water treatment facilities.



### Metals

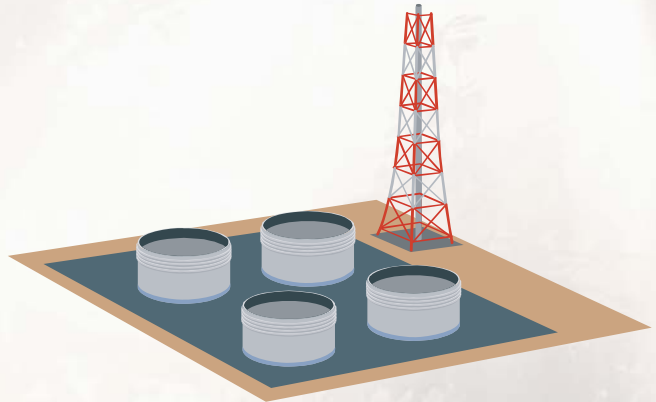
Hitachi has delivered hundreds of rolling mill drives all over the world. Their high reliability and performance are proven and well known in the metal industry. Hitachi has delivered a number of fan drives for energy saving in this industry.





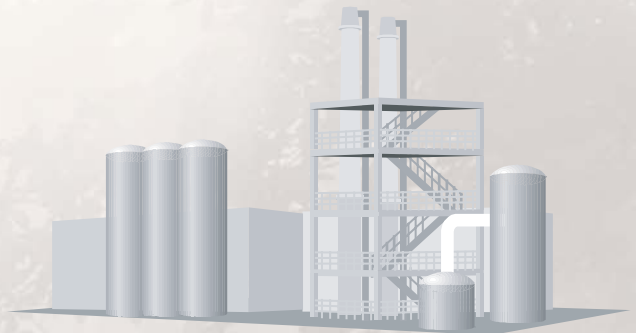
### Oil and Gas

Replacing a mechanical drive with an AC motor drive for compressors. A motor drive is well suited for energy and maintenance cost savings and delivers better performance with precise drive control.



### Cement

HIVECTOL inverters are used not only for various fan drives but also for rotary kiln drives in the cement industry. HIVECTOL inverters help slash energy and maintenance costs.



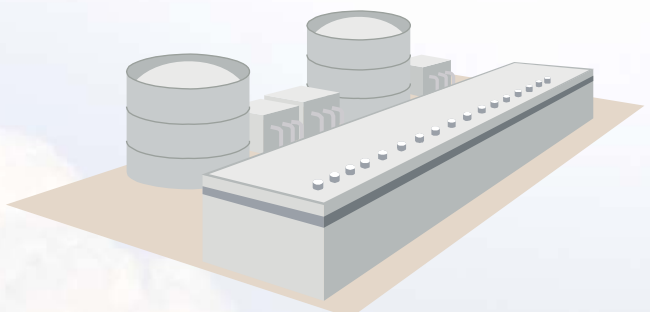
### Thermal Power Generation

Optimization of drive speeds of ID Fans and FD Fans for boiler combustion facilities significantly save energy consumption. Hitachi has delivered HIVECTOL inverters for such applications to large utilities for many years.



### Nuclear Power Generation

Hitachi has delivered reactor internal pump drives for years.



\*All illustrations in this paragraph are used only for commentary purposes

## Order sheet

No.	Item	Specification
1	Application (Facility Name)	
2	Load Machine Name	<input type="checkbox"/> Fan <input type="checkbox"/> Blower <input type="checkbox"/> Pump <input type="checkbox"/> Compressor <input type="checkbox"/> Extruder <input type="checkbox"/> Agitator <input type="checkbox"/> Others
3	Load Machine Character	<input type="checkbox"/> Square Reduction Torque <input type="checkbox"/> Constant Torque <input type="checkbox"/> Proportional Torque <input type="checkbox"/> Power Constant <input type="checkbox"/> Others Starting Torque: ____%      Overload: ____% ____s GD <sup>2</sup> (Motor Axis Conversion): ____kg-m <sup>2</sup> Natural Deceleration Time: ____s
4	Regenerative Operation	<input type="checkbox"/> No. <input type="checkbox"/> Yes.(Regenerative type Inverter required)
5	Motor Specification	<input type="checkbox"/> Existing <input type="checkbox"/> New-Built <input type="checkbox"/> Squirrel Cage Induction Motor <input type="checkbox"/> Winding Induction Motor <input type="checkbox"/> Non Explosion Protection <input type="checkbox"/> Explosion Protection(Safety Increase, Pressure Proof, Inner Pressure) Output: ____kW    Voltage: ____V    Current: ____A Frequency: ____Hz    Number of Poles: ____p    Rotational Speed: ____min <sup>-1</sup> Efficiency: ____%    Power Factor: ____%
6	Rotational Speed Range	____ min <sup>-1</sup> - ____ min <sup>-1</sup> Stall Torque: <input type="checkbox"/> Yes <input type="checkbox"/> No
7	Acceleration, Deceleration Time	<input type="checkbox"/> Set(Acceleration Time: ____s, Deceleration Time: ____s ) <input type="checkbox"/> Unset
8	Speed Sensor	<input type="checkbox"/> Sensorless Control <input type="checkbox"/> Sensor Control
9	Commercial Bypass Drive	<input type="checkbox"/> Necessary(Automatic Switch, Manual Switch) <input type="checkbox"/> Unnecessary
10	Signal Interface	<input type="checkbox"/> PIO Interface / <input type="checkbox"/> DeviceNet <input type="checkbox"/> Profibus <input type="checkbox"/> Modbus <input type="checkbox"/> CAN
11	Main Circuit Power Supply	Voltage: ____kV    Frequency: ____Hz    Short Circuit Current: ____kA
12	Main Power Supply Transformer	<input type="checkbox"/> Oil <input type="checkbox"/> Mold <input type="checkbox"/> H type Dry System <input type="checkbox"/> Any
13	Control Power Supply	Voltage: ____V    Frequency: ____Hz    Capacity: ____kVA
14	Installation Requirements	Address: _____ City/Country: _____ Ambient Temperature: ____ - ____°C Humidity: ____ - ____%RH Altitude: ____m Gas: ____ppm Dust: <input type="checkbox"/> No <input type="checkbox"/> Yes(Class: ____thousand)
15	Inverter Capacity	Inverter: ____kVA $\text{Inverter Capacity} = \frac{\text{Motor Capacity(kW)}}{\text{Motor Eff.(PU)} * \text{Motor PF(PU)}}$
* For other specifications, please describe here.		



# MEMO

[illegible]

# HIVECTOL HVI

## Medium Voltage Multi-level IGBT Drives

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### U.S.A.

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(New York Office)

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(Toronto Office)

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(Headquarters, S&IC)  
<1>(905)814-0848(Digital Media)

(Calgary Office)

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Phone:<1>(403)278-1881  
Fax: <1>(403)278-1810

### Mexico

#### Hitachi Mexico, S.A. de C.V.

(Mexico Office)

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### Brazil

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