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Hitachi WJ200 Variable Frequency Drives: Comprehensive Technical Overview

Introduction

The **Hitachi WJ200** series is a family of compact yet high-performance Variable Frequency Drives (VFDs) designed for precise speed control of AC motors. These drives combine advanced motor control technology with user-friendly features to meet a wide range of industrial needs. The WJ200 inverters support input voltages from 100 V up to 480 V, covering power ratings roughly from 0.1 kW (1/8 HP) up to 15 kW (20 HP) 【7†】. They are built to deliver excellent torque and speed regulation, achieving **high starting torque (around 200% or more at low speeds)** thanks to integrated auto-tuning sensorless vector control【7†】【2†】. This makes the WJ200 suitable for demanding applications that require strong low-speed performance, such as cranes, hoists, lifts and other heavy-duty lifting or positioning systems【2†】. In this overview, we will delve into the technical specifications, key features, and real-world benefits of the Hitachi WJ200 VFD series, highlighting how these drives stand out and help solve common motor control challenges.

Power Range and Technical Specifications

The WJ200 series is available in multiple voltage classes and input phase configurations to accommodate various installations:

- **Single-Phase 100–120 V Input:** Models in this class (suffix **MF**) output three-phase power for motors, with available sizes of approximately **0.4 kW and 0.75 kW** (roughly 1/2 HP and 1 HP) [1]. These allow small motors to be driven from standard 115 V mains supply.
- **Single-Phase 200–240 V Input:** Models (suffix **SF**) cover **0.1 kW up to 2.2 kW** (about 1/8 to 3 HP) ratings [1]. This enables using single-phase source power to run three-phase motors in the fractional to small horsepower range – a cost-effective phase-conversion solution for workshops or rural sites with only single-phase service.
- **Three-Phase 200–240 V Input:** Models (suffix **LF**) span approximately **0.1 kW through 15 kW** (1/8 to 20 HP) for standard 208–240 V industrial power systems [2]. This broad coverage makes the WJ200 suitable for many light-industrial and commercial motor applications in this voltage class.
- **Three-Phase 380–480 V Input:** Models (suffix **HF**) range from around **0.4 kW up to 15 kW** (1/2 to 20 HP) for higher-voltage 400 V and 480 V grids [1]. These can handle larger motors used in factory automation, pumps, fans, and other medium-sized equipment.

Each drive in the series outputs a **three-phase, variable-frequency AC** to the motor. The output frequency range is wide – from **0.1 Hz up to 400 Hz** – allowing for significant speed turndown or overspeed if the motor and application permit [3]. The WJ200 drives use **Sinusoidal Pulse-Width Modulation (PWM)** control with carrier frequency adjustable between 2 kHz and 15 kHz [3]. This means the switching waveform can be tuned for lower noise or higher motor performance as needed (with automatic derating at higher carrier frequencies to protect the drive's power stage). The speed control accuracy is excellent; with a

digital frequency command, the output is stable within **±0.01%** of the set value [3], ensuring precise and consistent motor speed for sensitive processes.

In terms of construction, the standard WJ200 units are housed in **IP20-rated enclosures** [4] suitable for panel mounting in clean, dry locations. For harsher environments, optional enclosure kits (e.g. NEMA 1 conduit boxes or NEMA 4X housings) are available to protect the drive. The drives are relatively compact for their power – Hitachi employed an "ultra-compact" design so that even the 20 HP model has a small footprint. In fact, multiple WJ200 inverters can be mounted **side-by-side with zero clearance** between them to save cabinet space (up to 40 °C ambient with adequate airflow) [5]. This space-saving design is valuable in dense control panels.

Electrical characteristics: All models include robust built-in input surge protection and meet global safety and EMC standards (bearing **UL, c-UL, CE, and C-Tick** approvals) [6]. The drives accept either **source or sink logic** for control inputs (configurable) to simplify integration with different PLC or control system I/O arrangements [6]. Typical overload capacity for the WJ200 is **150% of rated current for 60 seconds** (heavy duty, CT rating) and around 120% for 60 seconds in light-duty (variable torque) mode, which is standard for industrial drives. Notably, the WJ200 series is **dual-rated for constant torque (CT) and variable torque (VT)** applications [7] [8]. This means a single drive model can serve a higher HP motor in variable torque applications (like fans or pumps) than it could in constant torque use. For example, the 200 V model **WJ200-075LF** is rated for **10 HP (33 A) in CT service and up to 15 HP (40 A) in VT service** [9]. Users can thus size the drive appropriately based on the load type, potentially using a smaller, more cost-effective unit for centrifugal fans and pumps where torque demand reduces with speed.

Every WJ200 unit also comes equipped with a **built-in dynamic braking transistor** across the DC bus [10]. This means an external braking resistor can be added to absorb regenerative energy during quick decelerations or when driving overhauling loads. Having this transistor standard on all models (even the smallest) is an advantage – **rapid stops and deceleration without tripping** are achievable simply by wiring an appropriate resistor, with no need for external braking modules [10]. This feature is useful in applications like elevators or machines that must stop quickly and smoothly.

Advanced Motor Control and Performance

One of the standout features of the Hitachi WJ200 series is its **advanced sensorless vector control** capability. Sensorless vector control allows the drive to achieve excellent torque and speed regulation without needing a physical encoder on the motor shaft. Upon installation, the WJ200 can perform an **automatic motor autotune** routine to identify the motor's characteristics. With the parameters from autotuning, the drive's vector control algorithm can precisely modulate the motor flux and torque-producing currents. The result is **high starting torque – approximately 200% or more of rated torque at low speeds (around 0.5–1 Hz)** [11]. In practical terms, even at crawl speeds, a motor powered by a WJ200 can produce near its full rated torque. This is critical for applications like hoists and cranes that need to lift heavy loads from standstill, or conveyance systems that must start under load. For example, Hitachi notes that the WJ200's low-speed torque performance makes it ideal for **cranes, hoists, lifts, and elevators**, where reliable heavy lifting and smooth low-speed operation are required [12].

Beyond brute force, the vector control also gives **improved speed stability** under changing loads. The WJ200 can dynamically adjust voltage and frequency to maintain set speed within tight limits, which is beneficial for processes that demand consistent speed (such as mixers, grinders, or extruders). The drive

offers both **constant torque** and **variable torque** modes, and even supports **permanent magnet synchronous motors (PMAC)** in open-loop mode [10]. This means the WJ200 isn't limited to standard induction motors – users can employ high-efficiency PM motors (sometimes called brushless AC or EC motors) for better energy savings while still using the same drive. Running a PM motor typically requires advanced control, which the WJ200's algorithms can handle. This flexibility allows one inverter model to handle two motor types, enabling energy conservation and system optimization when upgrading to new motor technology [13].

Another noteworthy capability is the WJ200's **simple positioning control function**. The drive has an integrated position control mode that can perform basic motion tasks without a separate motion controller. It provides parameters for setting target positions (via pulses or encoder counts) and can execute homing routines and incremental moves [14] [15]. There is an onboard high-speed pulse input that can serve as an **incremental encoder feedback interface**, enabling closed-loop positioning or enhanced speed accuracy if needed [16] [17]. For example, a WJ200 could be used to index a table or perform a simple pick-and-place motion by configuring the built-in position controller – useful in small assembly machines or material feeders. While not as sophisticated as a dedicated servo drive, this feature is a bonus for applications that require a touch of positioning without the cost of a full motion control system.

Trip-avoidance functions are built into the WJ200's control software to maximize uptime. These include features like over-current suppression, DC bus regulation, and auto-restart. The drive actively tries to **prevent nuisance trips** during transient conditions. For instance, if a rapid deceleration would cause an over-voltage on the DC bus, the WJ200 can automatically extend the decel time or activate dynamic braking to avoid tripping on an over-voltage fault. Similarly, on sudden load increases, it can momentarily limit current to avoid over-current faults (stall prevention) while still driving the motor as much as possible. The WJ200 also has an adjustable **"trip retry" or auto-restart** function: after a momentary power loss or fault, it can attempt to re-start the motor once conditions stabilize, which is useful for unmanned operation continuity. Hitachi improved these algorithms in the WJ200, describing them as "new and more effective trip avoidance functions" in this series [18]. In practice, users experience fewer unexpected shutdowns. For example, the drive can ride through brief power dips by using its capacitors to maintain control power, avoiding a complete stop of the motor. All these measures enhance reliability in real-world installations where power quality or load conditions aren't perfectly steady.

Safety and Protective Features

Modern industrial equipment often must meet stringent safety standards, and the Hitachi WJ200 addresses this through an integrated **Safe Stop** function. Each WJ200 drive is equipped with a hardware-based safe torque off mechanism that can be used to quickly disable the drive's output in emergency stop conditions. When the **Safe Stop input terminals (GS1, GS2)** are activated (for example, via an E-stop pushbutton or a safety relay), the inverter's output is shut down **via hardware, bypassing the CPU** and any software delays [19]. This provides a **Category 0 Stop (immediate coast)** in accordance with safety standards. The WJ200's safe stop function is designed to meet **ISO 13849-1, Category 3** performance and **IEC/EN 60204-1 Stop Category 0** requirements [19]. In practical terms, it means the drive can be integrated into a safety circuit to reliably remove power from the motor without the need for auxiliary contactors in the motor power circuit. This not only enhances safety (a fault in the drive's CPU or software cannot prevent the stop – it's a direct hardware cut-off of gating signals) but also can **save cost and panel space** by reducing external components [20] [21]. Many competitive drives in this class require an optional module or don't offer this

feature at all, so having it standard on the WJ200 is a significant advantage for machine builders concerned with functional safety.

Of course, the WJ200 also includes all the conventional electrical protection functions expected in a VFD. It continuously monitors for **over-current, over-voltage, under-voltage, motor overload (thermal protection), heatsink over-temperature, ground fault, and short-circuit** conditions. The drive's electronic overload protection can be configured with the motor's full-load current to protect both the motor and the drive from overheating [22] [23]. There is also a built-in **motor thermal model** and the ability to connect an external motor thermistor if needed for direct temperature feedback. An **output phase loss** detection can alert if a motor lead becomes disconnected. Additionally, the WJ200 provides an **over-torque detection** feature (with adjustable threshold) that can sense if the load has stalled or a mechanical problem has occurred (triggering an alarm or fault if torque exceeds defined limits). These protective features help prevent equipment damage and pinpoint problems quickly via fault codes on the drive's display.

From a design longevity perspective, Hitachi has engineered the WJ200 for a **10-year design life** on critical components like DC bus capacitors and cooling fans (assuming average 40 °C ambient) [24]. The cooling fan is intelligently controlled – it runs only as needed, which reduces noise and prolongs fan life by avoiding continuous operation [24]. In fact, the fan can be turned off when the drive is at idle or light load and will automatically start when temperatures rise. Moreover, the fan assembly is easy to replace without special tools, reflecting a maintenance-friendly design [25]. The drive performs **self-diagnosis on its capacitors and fan**, tracking their usage and runtime to notify the user of a potential wear-out before a failure occurs [26]. This predictive maintenance feature can be a big benefit in facilities where drives are running 24/7 – an alarm can prompt service staff to replace a fan or capacitor during scheduled downtime, rather than having the drive fail unexpectedly. Overall, the WJ200's safety and protective features aim to maximize both **personnel safety and equipment uptime**.

Integration and Control Features

The Hitachi WJ200 is packed with features that simplify integration into automated systems and give engineers flexibility in control. A key feature is the **built-in Easy Sequence (EzSQ) programming** capability [27] [28]. EzSQ is essentially a simple PLC-like logic controller embedded in the drive. Using Hitachi's programming software, users can create custom logic sequences, timers, counters, and conditional operations that the drive will execute internally – no external PLC required. This is extremely useful for small standalone systems. For example, one could program the WJ200 to execute a sequence of speed changes at certain intervals, respond to a sensor input to reverse direction, or coordinate multiple drives in a simple process. An **illustrative use-case** is energy management: the drive's EzSQ program could reduce a fan's speed during peak tariff hours and resume full speed off-peak, automatically optimizing energy usage [29]. Since the logic runs on the drive, it continues to function even if the central controller is down, and it simplifies wiring (the drive's I/O can directly interact based on the custom program). Essentially, the WJ200 can act as both a drive and a mini controller for modest control tasks – improving system compactness and cost efficiency.

Speaking of I/O, the WJ200 provides a generous array of built-in **input/output terminals** for control and monitoring. Each drive includes multiple digital inputs (several of which are multi-function and **user-programmable** for different commands), digital outputs (transistor and relay outputs that can be assigned to numerous status indicators or fault alarms), as well as analog inputs/outputs. Typically, a WJ200 has **5 or more logic inputs**, 1 dedicated Safe Stop input (dual channel), **1 high-speed pulse input**, **1 analog voltage**

input (0–10 V), **1 analog current input (4–20 mA)**, **1 analog output (0–10 V or 4–20 mA)**, and at least **1 relay output** for fault or run indication. Both **sink and source logic** are supported on the control terminals (selectable by a jumper or parameter), so it can adapt to NPN or PNP wiring schemes easily [6]. The analog inputs can be used for speed reference (e.g. from a potentiometer or 4–20 mA transducer), and there's a built-in **PID control function** that allows the drive to perform closed-loop process control (such as maintaining pressure or flow by modulating motor speed). The PID controller uses one of the analog inputs as the feedback (e.g. from a pressure sensor) and automatically adjusts the output frequency to regulate the process variable. This is very handy for pump, fan, and HVAC applications – the drive can maintain a setpoint (like air pressure or liquid level) on its own, eliminating the need for an external PID controller.

For commissioning and connectivity, the WJ200 offers both local and remote options. On the front keypad, an LCD or LED display and a few buttons provide access to all parameters. The **standard keypad** includes a potentiometer knob for convenient speed adjustment and can display various monitoring values (current, frequency, voltage, etc.). Hitachi implemented multiple levels of menu display: a **Basic Display mode** shows only the most commonly used parameters for quick setup, while an **Advanced (or "All") mode** gives access to every setting. There's also a **"Quick Menu"** that can be customized – up to 32 user-selected parameters can be grouped for easy access [30] [31]. This makes it easier for maintenance personnel to tweak frequently adjusted settings without wading through hundreds of codes. The drive also features a **parameter copy function** when using the optional advanced keypad or PC software, so one drive's configuration can be duplicated to others (useful when deploying many drives with similar settings). A **Password protection** feature allows the user to lock access or hide certain parameters to prevent unauthorized changes or confusion [32] [33]. Additionally, the interface has a **data comparison** utility – it can list all parameters that have been changed from factory defaults, which greatly simplifies troubleshooting and auditing of settings [34] [35].

For **PC-based configuration and monitoring**, Hitachi provides the **ProDriveNext** software. Uniquely, the WJ200 includes both a **standard RS-422/485 serial port** (often via an RJ45 connector) and a **USB port (Mini-B)** built into the drive [36]. The USB interface allows direct connection to a laptop for programming or firmware updates without needing a USB/serial converter – a very convenient feature. Over the RS-485 port, the WJ200 supports **Modbus RTU protocol by default**, enabling basic networking and remote control/monitoring out of the box [37]. Up to 32 drives can be multi-dropped on an RS485 network, or the drive can interface with an HMI or PLC using Modbus commands for start/stop, speed reference, status feedback, etc. This is great for simple multi-drive systems or integration into building management systems.

When it comes to industrial network integration, the WJ200 is highly flexible via **optional communication expansion cards**. The drive has an internal option slot where one plug-in communication module can be installed. Hitachi (and third-party providers) offer modules for popular fieldbus protocols including **EtherNet/IP, PROFIBUS-DP, PROFINET, EtherCAT, DeviceNet, CompoNet, and CANopen** [38] [36]. By choosing the appropriate option, the WJ200 can seamlessly tie into a plant's existing network, whether it's an Ethernet-based PLC network or a legacy fieldbus. For example, using a PROFINET module, the drive can be a node on a Siemens PLC system with cyclic I/O data exchange; with an EtherCAT module, it can join a high-speed motion network, etc. These networking options allow the WJ200 to be deployed in **distributed control systems**, intelligent manufacturing lines, and IIoT (Industrial Internet of Things) environments where remote monitoring and control of drives is essential. The modular approach means you only add the cost and complexity of network capability if you need it – otherwise the standard Modbus and I/O might suffice for simpler installations.

Finally, the WJ200 supports some unique functions that help with multi-drive coordination and application-specific needs. One such feature is **peer-to-peer communication** between drives [39]. In a multi-drive system, one WJ200 can act as a master and share a speed reference or other data directly with other WJ200 drives over a simple network link, without requiring a PLC to broadcast the command. This could be used, for instance, to electronically line-shaft two motors (one drive following the frequency of another), or to synchronize the acceleration/deceleration of a group of drives. Additionally, the WJ200's **output signals** (assignable digital outputs) include things like a **"frequency arrival" signal (speed reached), a pre-alarm for overload**, a **PID feedback deviation alarm**, and even a **resistive brake control signals (BRK/BER)** for coordinating external brake mechanisms [40]. This rich set of I/O signals allows the drive to **interact intelligently** with the machine – for example, it can directly release a motor's mechanical brake when a certain frequency is reached, or trigger a warning light if the motor is nearing an overload condition, all without separate sensors or controllers.

Real-World Benefits and Applications

With its array of features and capabilities, the Hitachi WJ200 series provides tangible benefits across many applications. One major advantage is **improved energy efficiency**. By enabling precise speed control instead of running motors at full speed constantly, VFDs can drastically cut energy usage, especially in variable torque applications. For instance, centrifugal fans and pumps follow the affinity laws where **power draw is roughly proportional to the cube of speed**. This means that even a modest speed reduction yields significant energy savings. *For example, running a fan at 80% of its full speed may only consume about 50% of the power compared to full speed* [41]. In other words, a 20% speed reduction can half the energy consumption, illustrating how VFDs allow huge efficiency gains by matching motor output to the actual demand. The WJ200, with its sensorless vector control and PID capabilities, is well-suited to such tasks: it can automatically slow down a pump when pressure setpoint is reached, or modulate a fan based on temperature, **only using the energy required by the process** [42]. In HVAC systems, this translates to lower utility bills and less wear on equipment. In fact, a case study in a large commercial building retrofit showed that adding VFDs to HVAC fans and pumps yielded about a **22% reduction in energy usage** – equating to **47.8 million kWh saved and \$5 million in cost savings** over the measurement period [43]. Such savings underscore the impact that drives like the WJ200 can have in high running-hour applications.

Another benefit is the **elimination of high startup currents and mechanical stresses**. Traditionally, AC motors started across-the-line experience an inrush current that can be **6 to 7 times the motor's full load current** (sometimes around 600%+ of normal current) [44]. This surge not only causes electrical stress and potential voltage sag in the power system, but also translates to mechanical shock (belts squeal, gears jerk, product can spill, etc.). By using the WJ200 drive's soft-start capability (ramping up frequency and voltage gradually), the inrush is virtually eliminated. Motors start smoothly with controlled acceleration, dramatically **reducing peak demand charges** on electrical systems and minimizing wear on couplings, bearings, and gearboxes [44] [42]. This soft-start also means less maintenance and longer lifespan for the motor and driven equipment. For example, a conveyor system using a WJ200 can accelerate without the jolt that often breaks product or stretches the belt. In pumping stations, water hammer is mitigated by gradual speed changes. These improvements in process **smoothness and equipment longevity** are difficult to quantify but very much valued by end-users.

The high torque performance of the WJ200 at low speeds also broadens its application envelope. It can handle **high starting torque loads like compressors, mixers, and crushers** that previously might have required an oversized drive or a closed-loop (encoder) system. With 200% torque available, many loads that

need a strong breakaway or high peak torque can be driven without issues. For example, a **crusher or mill** might need extra torque to start turning a heavy mass – the WJ200 can deliver this in sensorless mode. Similarly, **hoisting applications** benefit from the drive's torque and the ability to decelerate with dynamic braking. The built-in braking transistor means even a loaded hoist can be stopped quickly and safely by dissipating energy in a resistor, avoiding an uncontrolled descent. And with the **Safe-Off function**, the WJ200 ensures compliance with safety norms in crane or elevator controls, so that power to the motor can be cut in an emergency without adding large contactors. This combination of power and safety is crucial in industries like material handling and logistics (e.g. forklifts, automated storage and retrieval systems, overhead cranes).

In real-world case studies, VFDs like the Hitachi WJ200 have consistently demonstrated operational improvements. For instance, a **five-star hotel in Dubai** retrofitted VFDs to its large HVAC chillers and air handling units and achieved around **25% energy savings** on those systems, significantly reducing their electricity bills [45]. The VFDs allowed the air conditioning to precisely match cooling output to the hotel's varying demand, instead of running fans and pumps at full power all the time. In another industry example, installing VFDs on large air compressors and blowers at a manufacturing facility yielded not only energy savings but also improved **process stability and product quality** – the tighter speed control meant air pressure in the system stayed more constant, which was essential for the production process. Academic research and field data support these anecdotes: studies have found that adding VFDs can generally cut energy use by **5–15% in applicable systems** on average, and in systems with highly variable loads, energy savings of **20–50% or more** are common. This is why many plants consider VFD retrofits one of the top energy efficiency measures. The **return on investment** for a drive like the WJ200 is often very quick – energy cost reductions, utility rebates, and improved process output can pay back the drive cost in a matter of months to a couple of years for continuous processes.

Apart from energy and performance, the WJ200's **networking and control integration** features help solve automation problems in a streamlined way. For example, consider a small packaging machine that needs to coordinate a conveyor belt motor and a feeder motor. A WJ200 on each motor can communicate peer-to-peer or be controlled via a simple Modbus PLC. The built-in EzSQ logic might handle interlocks like "don't run feeder unless conveyor is running," eliminating extra PLC programming. If the machine needs to be part of a larger line, a plug-in Ethernet module lets the drives communicate status (like "Motor at speed" or "Motor tripped") to a central SCADA system. All this can be achieved without extensive wiring or additional control boxes, since the WJ200 is acting as a smart drive and controller in one. Maintenance is also simplified: technicians can connect a laptop via USB to any drive and **pull diagnostic information**, monitor real-time currents and speeds, or adjust parameters on the fly. The fact that the WJ200 logs the last trip events and has change history for parameters means troubleshooting is much quicker – one can see if a parameter was inadvertently changed or if the drive tripped due to overvoltage during a certain event.

In summary, the Hitachi WJ200 VFD delivers a blend of **power, precision, safety, and intelligence** that directly translates into operational benefits. Users gain **energy savings, lower peak power draw, reduced mechanical stress, improved safety compliance, and easier automation integration**. Whether it's a simple fan control or a complex multi-motor system, the WJ200 series provides a robust solution that stands out in its class. Its ability to drive both standard and permanent-magnet motors, perform PLC-like functions, and connect to modern networks gives it a flexibility usually seen in higher-end drives. For customers, this means one drive model can be employed across many applications – simplifying inventory and training – and they can trust that the WJ200 will not only run their motors, but also enhance the overall efficiency and reliability of their operations.

Conclusion

The Hitachi WJ200 series of variable frequency drives represents a **comprehensive, high-performance solution** for AC motor control in industrial and commercial settings. Through this overview, we've seen that the WJ200 packs an impressive set of features: from advanced sensorless vector control with high torque output, to integrated safety and programmability, to broad connectivity and easy-to-use interfaces. These drives are engineered to **optimize motor performance and energy usage**, while also simplifying installation and integration thanks to their compact size and flexible design. The technical capabilities – such as autotuning, dual CT/VT ratings, dynamic braking, and multi-motor/PMAC support – ensure that the WJ200 can tackle demanding applications that were once the realm of more expensive systems. At the same time, the user-friendly aspects like the EzSQ PLC functionality, configurable I/O, and modern communication options empower engineers to create smarter and more efficient control systems with minimal extra hardware.

In practice, adopting WJ200 VFDs can lead to **substantial improvements**: significant energy savings (often double-digit percentage reductions) through speed control, improved process precision and product quality due to stable motor speeds, enhanced safety for personnel and machinery via the Safe Stop feature, and reduced downtime owing to the drive's protective functions and trip-avoidance design. Furthermore, Hitachi's focus on reliability (long component life, self-diagnostics, conservative design) means these drives are built to last in the field, providing confidence to end-users and OEMs alike.

Overall, the **Hitachi WJ200** distinguishes itself as a well-rounded, **innovative VFD solution** that helps customers solve real-world problems – be it cutting energy costs, meeting safety codes, or boosting automation capabilities. Its combination of broad technical specs and deep application-focused features makes it a versatile choice for anyone looking to modernize their motor control systems. By choosing a WJ200 series drive, users are investing in proven Hitachi engineering that will enable their motors (and operations) to run **smarter, safer, and more efficiently**.

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