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Hitachi NE-S1 Series Variable Frequency Drives – Comprehensive Technical Overview

Hitachi NE-S1 series VFDs are ultra-compact, economical drives designed for simple motor control applications. They feature a one-button built-in operator for Run/Stop/Reset and support optional remote keypads for added functionality.

Introduction

Hitachi's NE-S1 series **Variable Frequency Drives (VFDs)** are an economical, easy-to-use solution for controlling the speed of AC motors in the fractional to 5 horsepower range. Designed with OEMs and system integrators in mind, the NE-S1 drives prioritize simplicity and compact size – they are **among the smallest form-factors in their class**, allowing dense side-by-side mounting in control panels [1]. The series comes **pre-configured with default parameters** for out-of-the-box operation, minimizing setup time for common applications [2]. This makes the NE-S1 ideal for basic variable-speed needs where advanced high-end drives might be overkill. Despite its entry-level positioning, the NE-S1 incorporates many features typically found in larger drives, including integrated control functions and comprehensive motor protection. In this overview, we will delve into the technical specifications, built-in features, and real-world applications of the Hitachi NE-S1 VFD series, highlighting how these drives can solve common industrial challenges such as energy efficiency, motor wear, and process control.

Power Range and Specifications

The **Hitachi NE-S1 series** spans a broad range of low-voltage ratings to cover many small motor applications. At 230 VAC class (200–240 V supply), models support motors from **0.2 kW up to 2.2 kW** (approximately 1/4 to 3 HP). For 400 VAC class (380–480 V) three-phase supply, the series extends up to **4.0 kW** (about 5 HP) capacity [3]. These drives are available in both **single-phase input** (200–240 V) versions – which are valuable for installations lacking three-phase utility power – and **three-phase input** versions. All models output three-phase AC to the motor, with an adjustable **output frequency from 0.5 Hz to 400 Hz** for applications ranging from standard 50/60 Hz motors to high-frequency spindles [4]. The NE-S1 drives use straightforward **voltage/frequency (V/Hz) control** (with selectable constant-torque or variable-torque V/Hz profiles) to regulate motor speed. They are rated for **150% overload for 60 seconds** as standard, providing sufficient torque headroom for starting and transient loads [5] [6]. Starting torque is specified at **100% of rated torque at 6 Hz** output, indicating the drive can maintain full motor torque even at about 10% of base speed – suitable for many low-speed scenarios without requiring closed-loop vector control [7].

In terms of **electrical design**, the NE-S1 is a traditional PWM inverter with a diode front-end rectifier and IGBT output stage. The **input voltage tolerance** is ±10% (to handle typical line fluctuations) and it accommodates both 50 Hz and 60 Hz supply frequencies [8]. The drive's **carrier frequency is adjustable between 2 kHz and 15 kHz**, allowing trade-offs between quieter motor operation (higher kHz reduces audible noise) and drive thermal performance [9]. All standard protective functions are built-in, including

over-current, over-voltage, under-voltage, motor overload (thermal), inverter over-temperature, ground fault, input phase loss, and output short-circuit protection [10] [11]. The NE-S1 is an **IP20/NEMA 1 enclosed drive**, meaning it is intended for installation in a dry, clean location (often inside a control cabinet). The physical size of these drives is extremely compact – for example, a 1.5 kW (2 HP) unit measures only around 108 × 128 × 107 mm (W×H×D), and even the largest 4 kW model is roughly 125 mm deep [12] [13]. Thanks to this small footprint, **zero-clearance side-by-side mounting** is supported to save panel space (with modest derating for cooling as noted by Hitachi) [1]. The ambient operating range is typically **-10°C to +50°C** (14°F to 122°F) at full rating, with derating or forced cooling needed beyond 40°C [14].

Key Features and Built-In Functions

Despite its budget-friendly and compact design, the Hitachi NE-S1 comes equipped with a rich set of features to enhance usability and eliminate external components:

- **Integrated Operator and Optional Keypad** – Each NE-S1 drive includes a simple built-in operator interface: a single combined **Run/Stop/Reset button** on the front panel for basic control, along with LED status indicators [15]. This allows manual operation and quick resets without any external devices. For more advanced monitoring and programming, an **optional keypad/display (NES1-OP)** can be attached or door-mounted, providing a multi-digit display, parameter navigation keys, and a built-in speed potentiometer for easy frequency adjustment [15]. The drive supports "**keypad/terminal switching**," meaning the user can select whether the motor's start/stop and speed reference come from the local keypad or from remote control terminals on the drive [16]. This is useful for commissioning and debugging (you might run the motor from the keypad initially, then switch to external control signals in operation).

- **Communications and I/O** – An **RS-485 serial port with Modbus RTU** protocol support is included as standard on the NE-S1 [17]. This enables integration into supervisory systems or PLC networks for remote monitoring and control. In addition, the drive has multiple configurable digital and analog I/O points. There are typically 5 multi-function digital inputs (sink or source selectable logic) and one analog input (0–10 V or 4–20 mA) for speed reference, plus one open-collector digital output and one form-C relay output for status indications [18] [19]. Notably, the NE-S1's control terminals can be configured for either **sink or source** wiring logic via a parameter setting, so it can accommodate both NPN- and PNP-style input schemes without additional relays [20]. This flexibility simplifies retrofits and OEM integration, as it will work with a variety of sensor and PLC output types.

- **Programmable Multi-Speed, Logic & Timing** – The NE-S1 includes several features that allow it to perform basic logic and sequencing tasks that might otherwise require an external PLC or relay timer. Users can program up to **8 preset speeds** (multi-step speeds) and switch among them via digital inputs (useful for applications that require set speed steps). A built-in **PID controller** is available for closed-loop process control – for example, the drive can directly regulate a pressure or flow by adjusting motor speed in response to a feedback signal, eliminating the need for a separate PID loop controller [21] [22]. In fact, using the internal PID, a pump equipped with the NE-S1 can maintain a constant discharge pressure by automatically modulating speed, instead of relying on a throttling valve (improving efficiency and control accuracy) [22]. The NE-S1 also provides **basic PLC-like functions** such as simple logic operations and time delays. These are referred to as "arithmetic and delay functions" in Hitachi's literature, allowing the drive's I/O to implement small automation tasks (for example, one could configure a timer to automatically stop a motor after a certain run

duration, or to sequence two motors with a delay) [16]. There is even a *2nd motor control* function: the drive can store two separate sets of motor parameters (for two different motors) and switch between them via a digital input [23]. This is useful in scenarios like a single spare drive that can run either of two motors (one at a time) with different ratings, or machinery that switches between two motors and needs the drive to adjust its settings accordingly.

- **Pre-Configured and 3-Wire Control** – To simplify installation, the NE-S1 comes **pre-configured with default parameter settings** that work for most standard motors and basic V/Hz operation [24]. This means out of the box, a user can connect the drive to a motor and immediately have functional speed control via the front panel or a simple potentiometer, without needing extensive programming. Of course, parameters can be adjusted as needed for the application (acceleration time, min/max speed, etc.), but the default profile minimizes the setup required for a typical use case. The drive also natively supports **3-wire control circuits for Start/Stop** [25], which is the common momentary pushbutton control scheme in industrial panels (separate Start and Stop push-buttons, where Stop is normally closed). Many micro-drives require workarounds or latching circuits for 3-wire control, but the NE-S1 has a dedicated 3-wire mode making it straightforward to wire into traditional control stations for operators.

- **Energy-Saving Mode** – An **automatic energy-saving function** is built into the NE-S1, which can optimize the voltage/frequency output to the motor under light loads [26]. In practice, this means the drive will reduce the motor voltage when the motor is running at less than full load, thereby improving the motor's efficiency and reducing energy consumption (especially useful for centrifugal fan and pump applications where the torque demand drops at lower speeds). This feature is standard and does not require any special hardware – it can be enabled via a parameter and helps ensure the motor only uses the minimum energy required for the workload. Many leading manufacturers include similar functions in VFDs to maximize efficiency; for example, ABB's drives use an "energy optimizer" mode. Hitachi's inclusion of this in the NE-S1 means even a cost-conscious installation can achieve energy savings without extra complexity.

- **Protection and Reliability** – The NE-S1 series is designed to protect both itself and the connected motor from common fault conditions. The drive's internal **electronic overload protection** can be configured with the motor's rated current to mimic a thermal overload relay, automatically tripping to prevent motor overheating. In fact, Hitachi notes that for standard 3-phase motors, an external thermal overload relay is generally **not needed** in series with the motor when using the NE-S1, because the drive itself will provide the necessary motor over-current protection [27]. (Exceptions would be if you operate multiple motors on one drive or run outside certain frequency ranges, in which cases external protection is advised [28].) The drive also has **loss-of-signal protection** – if the analog speed reference is lost (e.g. broken wire or failed sensor), the NE-S1 can detect this and take a safe action, such as dropping to a preset speed or stopping the motor [29]. This prevents runaway conditions or unintended zero-speed situations in closed-loop control. **Phase-loss and under-voltage protection** ensure that if the input power is abnormal (e.g., one phase of a 3φ supply goes down, or significant voltage dip occurs) the drive will shut down gracefully rather than power through in a potentially damaging way. Additionally, the NE-S1 carries **global compliance certifications** – it is UL and cUL listed (meeting UL508C for industrial control equipment), CE marked for Europe, and C-Tick certified for Australia/New Zealand, among others [30]. These approvals indicate the drive meets relevant safety and electromagnetic compatibility standards, so users can deploy it with confidence in regulated environments and alongside other equipment.

Finally, Hitachi provides a range of **accessories and add-ons** for the NE-S1 to support various application needs. Options include external **EMI/RFI filters** to meet EMC requirements, **AC line reactors** and **DC link chokes** for input harmonic reduction, **output reactors or filters** to protect motors on long cable runs, and the above-mentioned **remote operator panels** (keypad displays with copy functionality for cloning settings) [31]. These accessories allow an NE-S1 installation to be tailored to more demanding scenarios – for instance, adding a line reactor can improve the drive's input power factor and reduce harmonic distortion, which might be required to meet IEEE-519 guidelines on a facility's power system. The drive's design is modular enough that users can start with a basic setup and later integrate such peripherals if needed.

Performance in Real-World Applications

The NE-S1 series VFDs are well-suited for a variety of **light-duty and general-purpose motor control applications**. Common uses include **HVAC fans and pumps, conveyors, mixers, machine tool spindles, feeders, and other machinery** in which adjusting motor speed can improve process control or efficiency. By installing an NE-S1 drive, operators gain fine-grained speed control and soft-start capability for their motors, which can yield several tangible benefits:

- **Energy Savings:** One of the primary advantages of adding a VFD like the NE-S1 to a system is the potential for significant energy reduction. Many motor systems run at full speed or use mechanical throttling when full speed isn't needed, which wastes energy. With a VFD, the motor can be slowed down to exactly the speed required by the load. For **centrifugal loads (fans, pumps)**, even a modest speed reduction can cut power usage dramatically (per the affinity laws, power scales roughly with the cube of speed). In practical terms, running a fan at 80% speed might use only ~50% of the energy compared to full speed [32]. Real-world case studies underscore these savings: for example, ABB reported that adding an ACS580 drive to a water pump system reduced annual energy costs by about **48%**, and also extended the pump's seal life by two years due to gentler operation [33]. In a municipal water treatment retrofit, replacing constant-speed pump motors with VFDs led to a **30% drop in energy consumption** per million gallons pumped [33]. Likewise, an office HVAC upgrade that implemented VFD control saw over \$150,000 in yearly energy savings [33]. While those examples involved larger drives, the same principles apply to the smaller 1–5 HP motors targeted by the NE-S1 – users can expect substantial efficiency gains and electricity cost savings, especially in variable-torque applications. Hitachi's built-in energy optimization function further enhances these gains by trimming excess voltage when possible, as mentioned earlier.

- **Soft Starting & Reduced Wear:** The NE-S1 drive provides **smooth acceleration and deceleration ramps** for the motor, which can be tuned (0 to 3000 seconds ramp time range) to the needs of the equipment [34] [35]. This soft-start capability eliminates the **high inrush current and mechanical shock** associated with direct across-the-line motor starts. A typical AC motor starting across the line draws 6–8 times its rated current and can produce a large torque spike, causing stress on couplings, belts, gears, and the motor itself [36]. By contrast, starting with a VFD, the current stays near the motor's rated level and the torque is controlled gradually. This **greatly reduces mechanical wear** and prevents electrical issues like voltage dips in the supply. For example, using VFDs on pump systems avoids water hammer by ramping the pump speed up and down gently, and on conveyor belts it prevents jerking that can damage products or the belt. The NE-S1 also supports configurable **DC injection braking** and coast-to-stop or fast-stop options, which help decelerate loads in a controlled manner. All of these features contribute to longer equipment life and lower maintenance costs. Motors run cooler with reduced voltage at startup and when slowed, which protects

insulation. In fact, plants that have retrofitted machinery with modern VFDs often report significant drops in maintenance issues – one study found that upgrading to new drives cut unplanned motor drive failures by 76%, improving uptime [37]. While that statistic isn't specific to the NE-S1, it highlights the general reliability benefits of using quality VFDs for motor control.

- **Improved Process Control:** With the NE-S1's **infinitely variable speed control** and built-in PID regulator, processes can be finely tuned for better quality and consistency. Operators are not limited to on/off or one-speed-fits-all – they can dial in the exact speed that produces the best output. For instance, a **conveyor system** can be adjusted to match throughput with upstream/downstream processes, preventing bottlenecks. A **mixing tank's agitator** speed can be ramped up slowly to avoid splashing, then run at the precise speed to get the desired mix, and slowed before stopping to reduce sloshing – all via a programmed VFD profile rather than manual intervention. In **pump and fan systems**, the NE-S1's PID loop can maintain a target pressure, flow, or temperature by continuously adjusting motor speed, responding much faster and more accurately than a human operator or a simple thermostat could. The result is tighter control over industrial processes, which can improve product quality (e.g. uniform drying in an oven due to constant airflow) and reduce waste. Additionally, because the NE-S1 can accept remote analog signals and fieldbus commands, it can seamlessly integrate into an automated system architecture. Plant PLCs or distributed control systems can send speed setpoints or start/stop commands to the drive over Modbus, enabling centralized coordination of multiple drives. This is crucial in complex machines or facilities where many motors must work in unison. The NE-S1 provides the necessary interface and control fidelity for such tasks, despite being a cost-effective unit.

- **Application Examples:** To illustrate, consider a **small manufacturing cell** using three 1 HP motors for a drill press, a conveyor, and an exhaust fan. By installing NE-S1 drives on each: the drill's speed can be optimized for different materials (instead of running the motor at full speed constantly, improving tool life), the conveyor can adjust speed for varying product sizes or start/stop softly to position items, and the exhaust fan can modulate based on the work being done (saving energy during idle times). None of these motors individually draws much power, but collectively the energy savings and productivity gains add up. Another example is in **agriculture or farming**: a 2 HP irrigation pump on an NE-S1 drive can be ramped down during times of lower demand or when only a trickle is needed, preventing excessive pressure and conserving water and electricity. In workshops, hobbyists have even used the NE-S1 (with the optional keypad) to retrofit **milling machines or lathes** for variable-speed control, replacing mechanical pulley setups with electronic speed control for better surface finish and easier speed changes [38]. These scenarios show the versatility of a microdrive like the NE-S1 – it brings sophisticated motor control to applications that previously might have run motors at fixed speed or used inefficient methods to throttle output.

Conclusion

The Hitachi NE-S1 series VFDs combine **compact size, simplicity, and robust features** to address the essential needs of motor speed control in the sub-5HP range. By focusing on core functionalities – like easy setup, flexible I/O, built-in PID control, and effective motor protection – Hitachi has delivered a drive that can be dropped into countless situations to improve performance and efficiency without a steep learning curve. The NE-S1 helps customers solve problems such as excessive energy use, mechanical wear from hard starts, and lack of process flexibility, all in an affordable package. It carries the backing of Hitachi's engineering and global standards compliance, meaning users can trust its reliability in industrial

environments. While it may not have the full feature set of larger high-end drives (no vector control or extensive network protocols beyond Modbus, for example), the NE-S1 intentionally avoids those complexities to remain **user-friendly and economical**. For many applications, that trade-off is ideal – it delivers exactly what is needed to get the job done with minimal fuss.

In summary, the Hitachi NE-S1 VFD is a **space-saving workhorse for basic applications**, offering precise speed control and a suite of intelligent functions usually expected only in pricier units. Whether you're an OEM designing a compact machine, a plant engineer looking to retrofit a few small motors for better control, or an energy manager trying to cut utility costs on HVAC equipment, the NE-S1 provides a compelling solution. Its successful blend of technical capability and simplicity can empower users to modernize motor systems and gain the well-known benefits of VFD technology – from energy savings and extended equipment life to improved automation and process quality – all with a relatively small investment and footprint.

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