

AC INVERTER

Application Note:

Applying Hitachi Inverters to Cranes & Hoists

Please refer also to the relevant
Inverter Instruction Manual

AN090310-1

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General

Hitachi AC variable frequency inverters may be applied on cranes and hoists for either hoisting or traverse (bridge and trolley) motion.

There are two basic types of hoist. The first is the load-brake hoist. This class incorporates a load brake (a self-locking mechanical device that resists downward motion of the load) which requires the motor to apply downward torque to move the load downward. The load will not accelerate downward by gravity alone.

The other class of hoist is called “non-load brake” and essentially encompasses all other hoist types. Non-load brake hoists require upward motor torque to suspend the load, and must resist gravity all the way down. This type of hoist will regenerate¹ energy into the inverter when moving the load downward, so an electrical means of removing this energy from the inverter must be provided – namely dynamic braking (DB).

All traverse applications are similar to non-load brake hoists, in that they do not incorporate a mechanical load brake. Although gravity does not play a role as it does in hoisting, traverse axes will exhibit a degree of regeneration during deceleration to a stop, so dynamic braking is needed.

Selection Criteria

The overall crane and hoist system must meet basic safety and operating criteria, such as those defined by CMAA and HMI. This means that the mechanical and electrical components must be appropriately sized to be able to raise, lower and stop (hold) the rated load safely. As far as the electrical components, this means the inverter and motor hp rating must be large enough to allow for adequate shaft torque to meet these requirements. This will depend on the mechanical design (gearing, etc.), and will depend on the CMAA/HMI class of service the system is designed for as well.

In general, industry standards require that the complete hoist electromechanical system must provide over-speed protection, over-travel protection, and at least two means of braking. Dynamic braking can be one of the braking means, and may be required to dissipate the regenerative energy developed when lowering the load.

For traverse axes, sizing again depends on the rating, design of the system and the CMAA class. Over-travel protection must also be provided. As previously stated, dynamic braking is required to dissipate the regenerative energy developed when decelerating and stopping.

¹ Regeneration occurs when the load overhauls the motor. This causes the motor to act like a generator, and it generates electrical energy that flows back to the inverter's DC bus, causing its voltage to rise. If this energy is not somehow removed, the inverter will trip on over voltage. DB is generally the solution used to solve this problem, converting this regenerated energy into waste heat.

Hitachi vector inverters are suitable for all crane and hoist applications, whether for load brake hoists, non-load brake hoists, or traverse axes. Hitachi vector inverters deliver optimal torque characteristics for crane & hoist applications, such as high torque at starting and low speeds. Once the required hp rating is established, you can select the appropriate Hitachi inverter and accessories for the application. Hitachi's selection charts simplify this process. The inverter may be either the SJ200 or SJ700 series. The SJ200 series generally is used for applications up to 10 hp, and the SJ700 series for applications 15 hp and higher. The specific model recommended depends on a number of considerations, such as hoist or traverse axis, class of service, etc.

Load Brake Hoists

In general, for load brake hoists Hitachi open-loop vector inverters may be used, meaning no motor encoders are needed (see below for more explanation). The inverter provides more than sufficient torque without an encoder. Dynamic braking is not required in the case of load brake hoists either, since the load brake itself restricts downward motion and absorbs the potential energy transferred from the descending load. In addition to an inverter, a pendant interface board (115VIF-3) is required to complete the inverter package.

Non-Load Brake Hoists

Non-load brake hoists can utilize either open-loop or closed-loop vector inverters, depending on the mechanical design of the hoist and class. The term "closed-loop" refers to the fact that the motor (or gearbox) is fitted with a rotary pulse encoder to provide speed feedback to the inverter. The preferred location for the encoder is the motor shaft. This provides the best resolution and best performance. In some cases, the encoder may be installed after gearing, but this introduces issues with backlash and result is poorer speed regulation performance.

As mentioned, CMAA/HMI stipulates the provision of at least two means of braking, as well as over-speed protection for non-load brake hoists. In the absence of a load brake, actual shaft speed feedback via encoder provides the over speed protection means. Hitachi closed-loop inverters would typically be utilized for non-load brake hoists. Only the SJ700 can be used for closed-loop applications because it has internal option board slots which can accept the separately purchased SJ-FB encoder feedback board. The encoder signal is wired into the SJ-FB board. However, depending on the mechanical design of the hoist, open-loop inverters may be used. In this case, over speed protection would need to be provided by mechanical means.

Dynamic braking is the customary means² of dealing with regenerative energy and is required for most non-load brake hoists. This is considered the second means of braking for this type of hoist, the first usually being some type of electromechanical brake. You can utilize Selection Charts developed by Hitachi to choose the appropriate dynamic braking solution, based on the hp, the axis (hoist or traverse) and CMAA/HMI class of service.

² As mentioned, DB resistors convert the regenerative energy from the inverter into waste heat which is dissipated to the air. Alternatively, a regenerative inverter unit can be used. This is a device that will convert that energy into 3-phase 60 Hz power that can be put back into the power supply, reducing total electric demand.

Finally, a pendant interface board (115VIF-3) is required to complete the inverter package for this hoist type as well. For SJ700, a 115VIF-KIT is also required to mount and connect the 115VIF-3 to the inverter.

Refer also to the separate Hitachi Application Note which covers the specific considerations for setting up and optimizing crane and hoist systems utilizing closed-loop vector inverter.

Traverse Axes (Bridge and Trolley)

All traverse applications are open-loop, so encoders and feedback boards are not required. The SJ200 may be used through 10 hp, and the SJ700 is used for 15 hp and above. Pendant interface cards are required for each inverter. DB units and/or DB resistors may be required. Refer to the selection charts.

The Hitachi Advantage

Hitachi inverters are reliable, powerful, high-performance general purpose drives. They include many diagnostic functions for safe operation. They are empowered for crane and hoist applications by means of an exclusive Hitachi pendant interface board. This economical board features optically-isolated inputs, converts the pendant signals and performs the necessary logic and safety functions for crane and hoist control. One board is required per inverter, whether SJ200 or SJ700.

Since the Hitachi crane & hoist system is based on a general purpose inverter, the cost is lower than an application-specific inverter, even with the pendant interface. Plus, Hitachi inverters are available from hundreds of distributors across North America.

Dynamic braking circuits are incorporated in all models up to 30 hp, and economical external brake units are available for larger capacities.

The SJ700 features a built-in logic controller called EZ Sequence (EzSQ), which provides on-board PLC-like functionality. With the special crane & hoist EzSQ program downloaded into it, the SJ700 delivers both torque proving and brake proving for maximum safety. Torque proving ensures the brake will not release unless there is adequate holding torque is being developed by the motor. Brake proving makes sure the electro-mechanical brake has sufficient holding strength, before every move.

Hitachi inverters feature powerful PC-based ProDrive configuration software, excellent US-based technical support, an unsurpassed distribution network and much more, making Hitachi is the best inverter partner you can choose for your crane and hoist equipment.

