Technical Overview

Rexroth HNC100 Controls Key Features for Servo-Hydraulics

Complex motion profiles can be difficult to set up when using motion controllers that utilize time-based ramps and velocities. Changes in velocity will vary the acceleration, and therefore the position at which the next velocity phase is reached. The HNC100 pre-calculates the motion based on the accelerations, velocities, and target positions defined in the move command. Velocity changes will not vary the accelerations.

A complex motion profile can be defined as a move with multiple phases. For example: Phase 1 – “Approach,” Phase 2 – “Part-Pickup,” and Phase 3 – “Part Transfer.” Normally, it is desirable to decelerate before reaching the part pickup or contact phase. This ensures that a desired velocity has been reached at the target position (i.e.: Pickup velocity at the part pickup point). Motion controllers utilizing time ramps and velocity commands typically define a target position (or condition to start Phase 2) in the second phase, thus starting deceleration at the target position rather than before reaching the target position. Consequentially, it is only after the target position has been reached that a deceleration and velocity change is started. To avoid the crashing at high speed into the part, careful adjustment of the motion parameters is required. One difficulty, other than to pick the right target position, is that the time based ramps and velocities interact and affect the acceleration/deceleration of the move.

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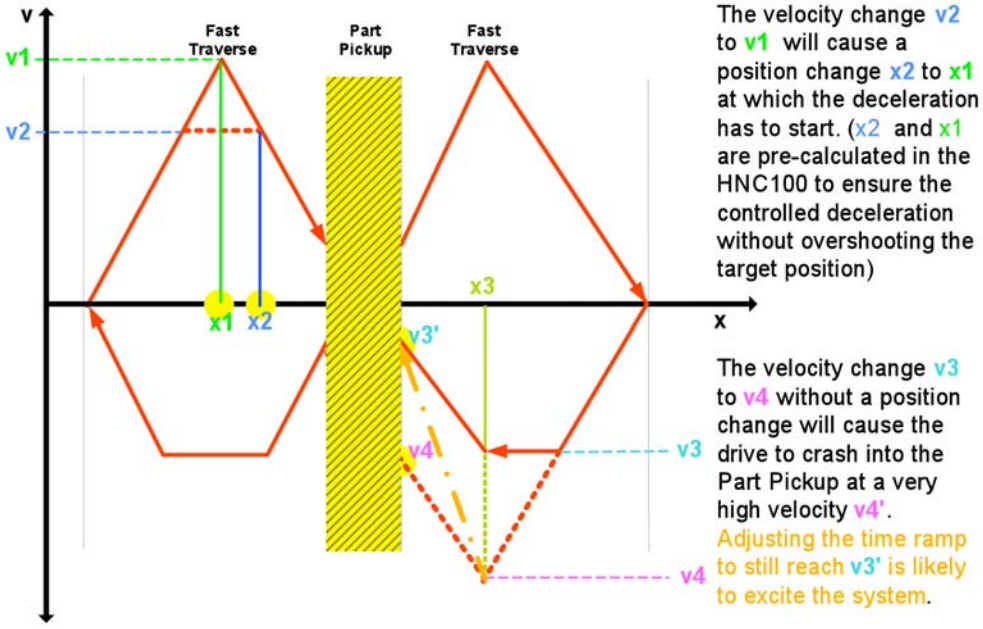
Utilizing a time-based ramp, changes in velocity will vary the position at which the next velocity phase is reached. To prevent the machine from crashing into the part at that point, the time ramp has to be adjusted to reach the target velocity at the target position, thereby increasing the deceleration.



Three phase motion profile

In many systems, and in particular with hydraulically stiff systems, this may not be a significant problem. However, as the system's hydraulic stiffness decreases, a point is reached where the system will be excited by an increase in velocity, which in fact has also increased the system's deceleration. An engineer may

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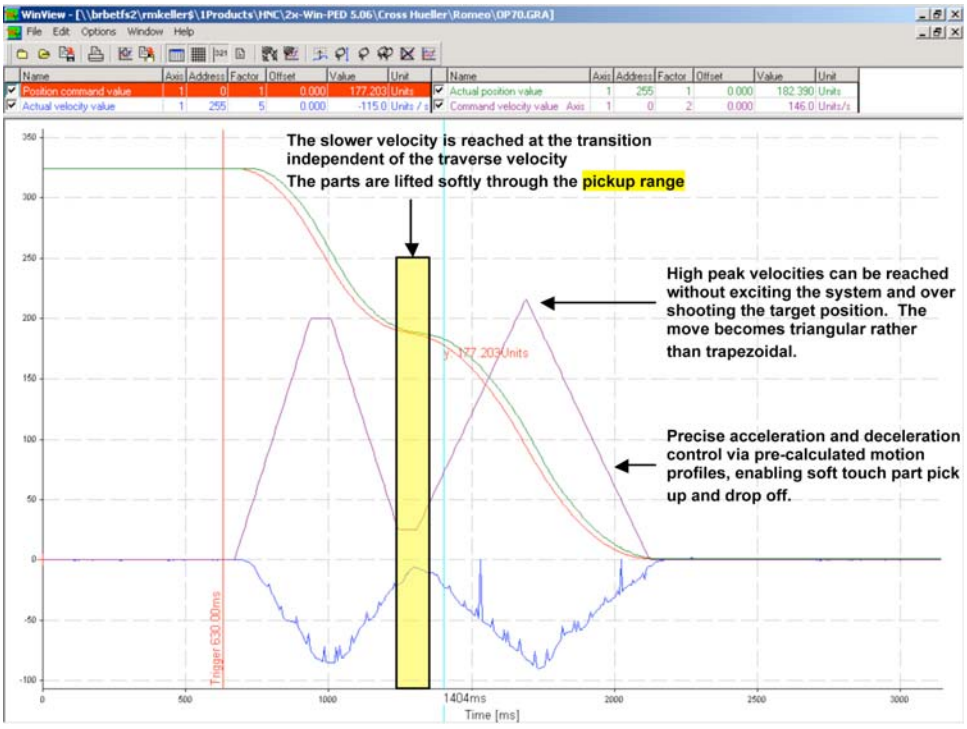
assume that increasing velocity is the limiting factor. However, it is the increase in acceleration, which is a result of increased velocity that causes the instability. With the ability to set the acceleration (deceleration) and the velocity independently, an operator can configure an axis for various velocities. And, while maintaining a constant acceleration that is set below the point of exciting the system to the point of instability; maximum usable accelerations are defined by a system's natural frequency. High-speed traverse moves utilizing triangular motion profiles can be easily achieved.



HNC100 integrated oscilloscope function showing a Triangular traverse profile

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What benefit is obtained by pre-calculating the move?

Using a “simple” profile of a lift move, as an example, the critical aspect is that the part be soft touched when the lift mechanism makes contact with the part. When part of a transfer machine, there may be multiple positions and lifts for a number of parts. As a result, multiple lift positions are needed rather than one position, as well as pick up ranges rather than pick up positions. These multiple lift moves and ranges create a more complex motion profile.

It now becomes a challenge to be able to control the multiple pickup positions or ranges, along with the associated velocities and accelerations. Using pre-calculated moves, the exact pickup positions and velocities can be defined for the entire motion profile. The HNC100 controller calculates the move(s) based on the desired acceleration / deceleration, velocity, and target position. These calculations determine the position at which the deceleration has to start. Increasing the velocity at a given acceleration / deceleration will eventually lead to a triangular traverse, making a further increase of velocity ineffective.

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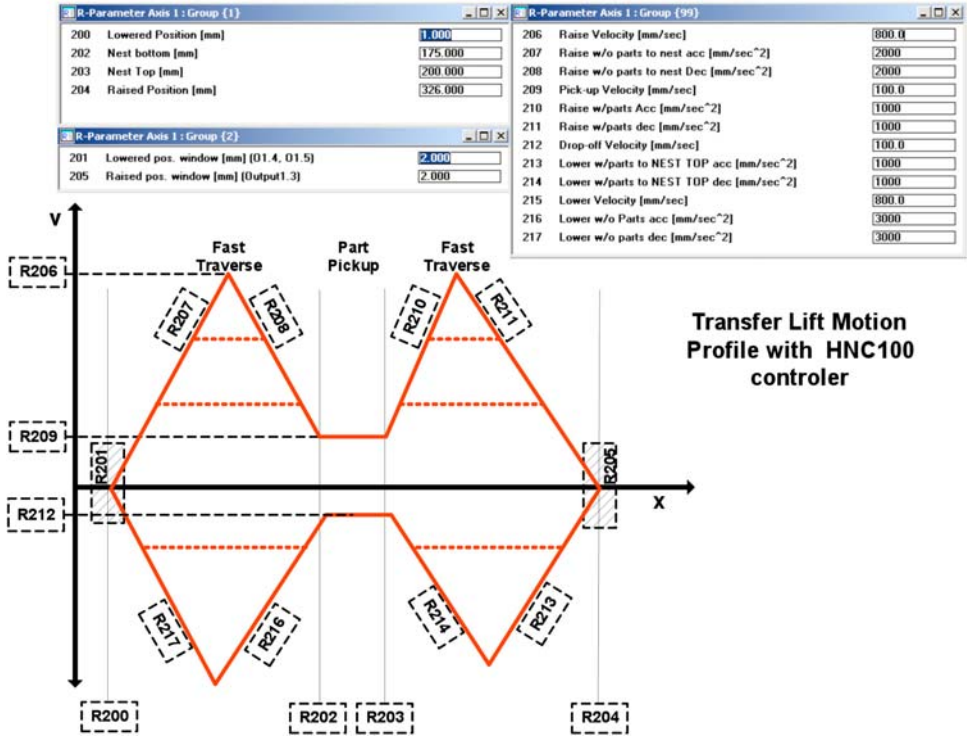

HNC100 uses R-Parameters to configure a Triangular Transfer Lift motion profile

The pre-calculation of the move enables the axis to decelerate to the target position. During the pre-calculated sequential move, the lift will traverse with the pickup velocity until the part is clear of its nest, allowing the velocity to be increased. These values are independent of the preceding fast traverse velocity, which is normally high, to maximize productivity. Lower traverse velocities may be used during machine set up and jog motions. Changing the velocities is easy since there is no interaction with other parameters.

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When configuring a motion controller, which does not pre-calculate the move, the position to start deceleration must be defined first. Since it is desirable to have a defined velocity at part pickup, the position at which the axis starts deceleration must be changed when the transit velocity is changed in order to maintain a consistent pickup velocity. Configuring a motion controller without pre-calculation becomes a tedious task of trial and error. Setting up a Triangular rather than a trapezoidal move becomes almost impossible.

It can be concluded that with complex motions, a benefit is realized when using an HNC100 as the motion controller. If two or more move positions and pickup velocities are required, it makes using an HNC100 controller, with its pre-calculated moves, a natural choice for easy machine setup and simple motion parameter changes.

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