Technical Note

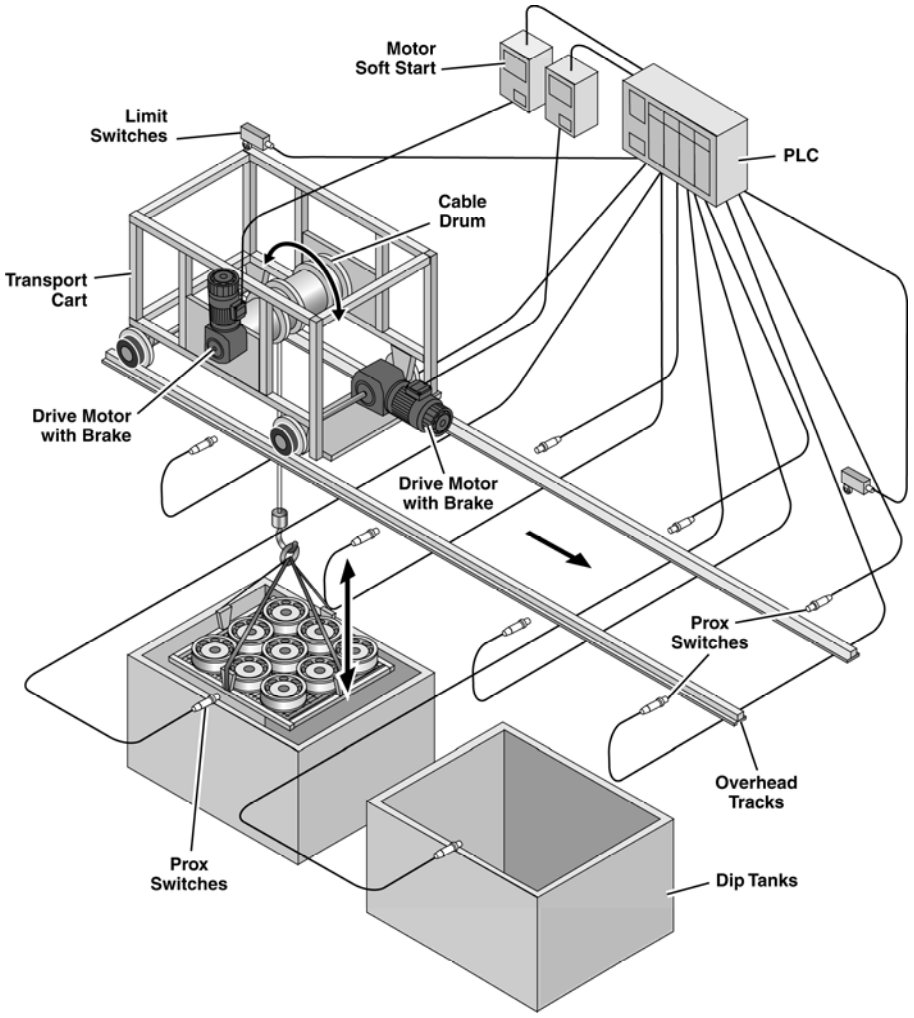
Application: Crane and Hoist – Plating Line System

Application

Description:

This plating line system is essentially a crane and hoist application. Racks of parts are raised and lowered into three dip tanks containing plating solutions (third tank is not shown). For proper quality, timing is critical between lifting the parts from one tank and submersing them into the next.

This application contains two 2-speed gearmotors with brakes, and numerous limit switches. A PLC controls the timing while the soft start controls acceleration. One motor (traverse) moves the cart along an overhead track. The other motor (hoist) raises and lowers a rack of parts. The traverse motor does not operate until the hoist motor has stopped. To minimize brake wear and to maximize stopping accuracy, the slower motor speed activates during braking. The faster motor speed provides fast travel.



Problems:

- Frequent brake wear and maintenance
- Frequent maintenance of proximity switches

Requirements:

- Parts must not spill when hoist motor stops (Soft Stop)
- Racks must not swing when traverse motor starts (Soft Start)
- Variable speed must be used to increase throughput

Discussion:

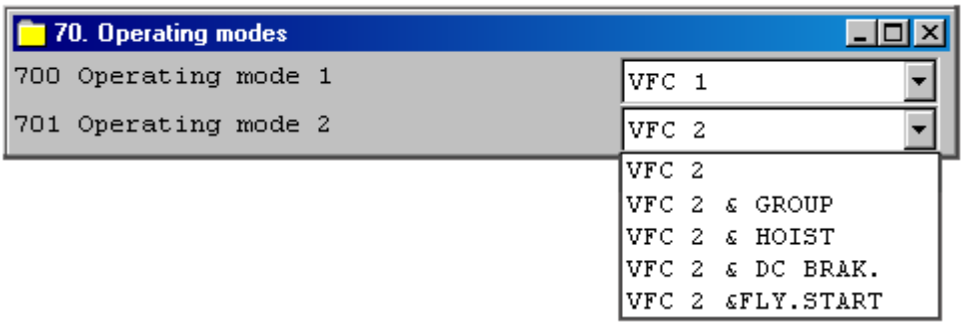
1. The requirements for this application necessitate the use of soft start and soft stop. These tasks are easily accomplished by increasing the acceleration and deceleration times on both motors. In addition, a hoist function is available on the Movidrive® and Movidrive® *Compact* to eliminate jerky movements through its pre-magnetization and post-magnetization features.

   Premagnetization – supplies a magnetic field to the motor for at least 100ms after the brake is released. This field holds the motor and prevents it from rotating (free-falling) when the brake is released before the motor receives power.

   Postmagnetization – maintains a magnetic field on the motor for at least 100ms after the motor stops so that the motor does not move (freefall) before the brake is applied.

2. The traverse motor is connected to an axle with two wheels. The potential for wheel slippage exists, even though the starting and stopping torques are adjustable through the acceleration and deceleration times. Nevertheless, position feedback from the motor should be avoided, if possible.

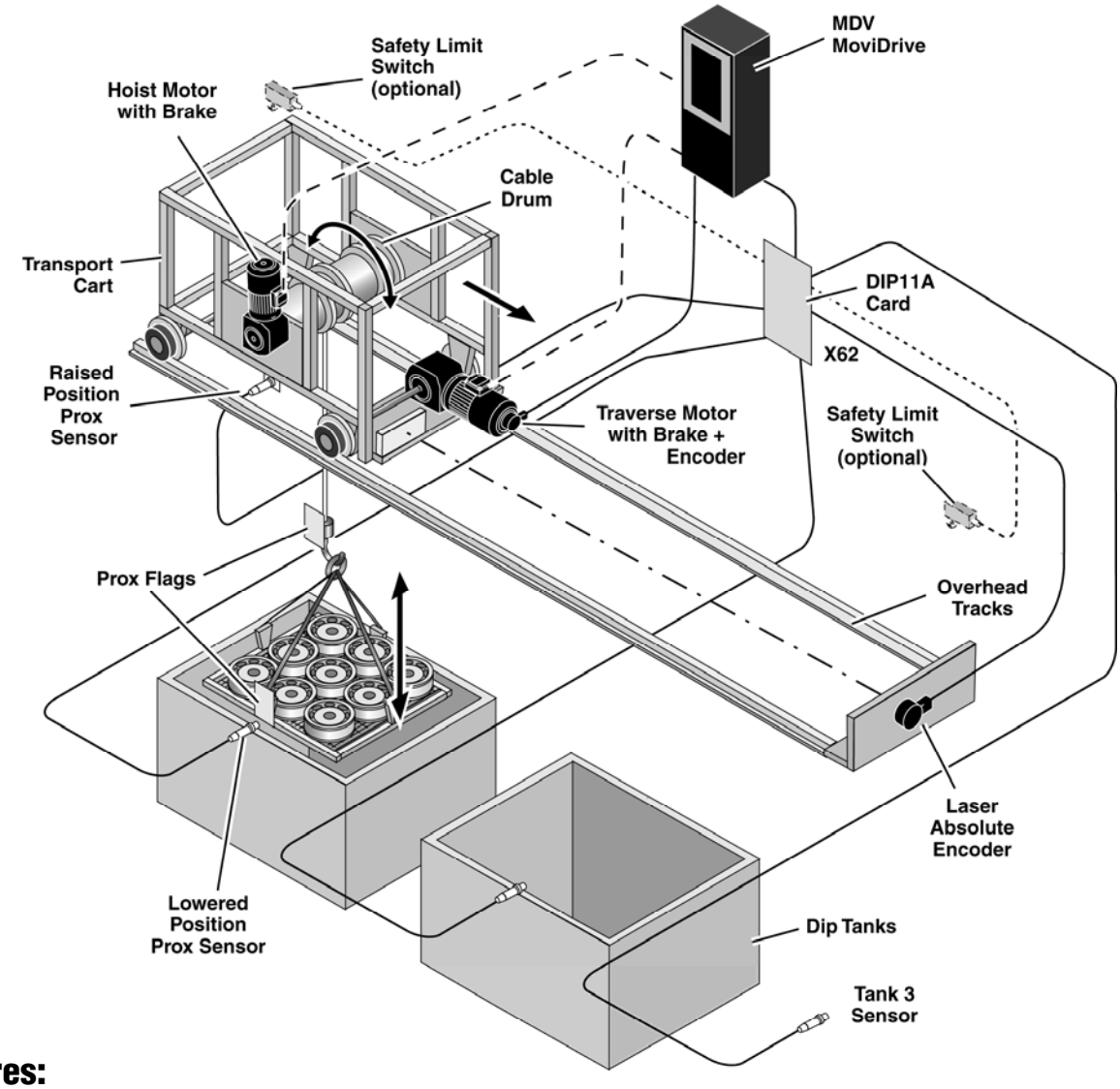
3. Since the motors never operate at the same time, the 2nd motor parameter function is applicable. This feature allows one inverter to control both motors, saving the cost of a second inverter. However, one stipulation is that the inverter cannot receive a feedback signal from Motor 2. Therefore the only commissioning modes available for the Motor 2 (P701) are VFC modes that do not require an encoder, as shown below.



4. Three solutions are shown, depending upon which motor is selected as Motor 1.

   Solution 1 – features the Traverse motor as Motor #1 (P700).
   Solution 2 – features the Hoist motor as Motor #1 (P700).
   Solution 3 – features both motors as Motor #1 – uses two inverters

Solution 1: Traverse = Motor 1



Features:

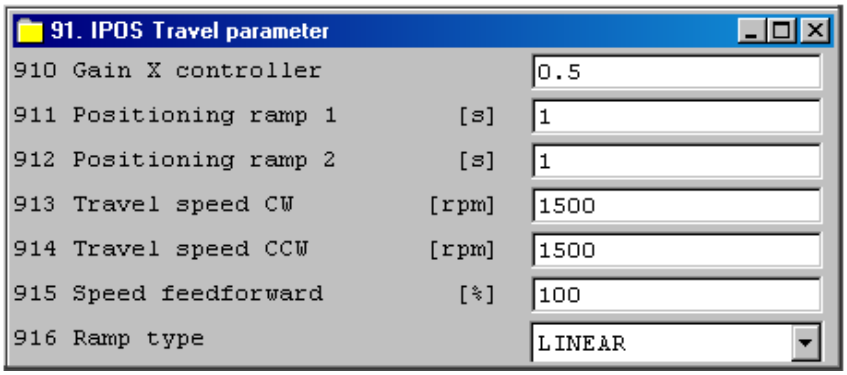
- (1) Movidrive® MDV sized for the largest motor
- (1) Gearmotor + Brake (traverse motor)
- (1) Gearmotor + Brake (hoist motor)
- (1) Absolute Encoder (laser)
- (1) DIP11A – Absolute Encoder Interface + Additional I/O
- IPOS^{Plus} – Traverse Motor
- (1) Brake Resistor

Details – Solution 1:

Traverse = Motor 1:

During commissioning with Movitools®, the traverse motor is selected as ***Motor 1***. Since encoder feedback is available for Motor 1, an IPOS*plus* program is able to position the motor. Therefore, ***CFC & IPOS*** is the correct operating mode.

After commissioning, P700 displays *CFC & IPOS.* The user should adjust the acceleration and deceleration times to provide soft start and soft stop. Parameters P911-P916 perform these functions, not P130-P135, since IPOS*plus* controls the movements.



The potential for wheel slippage exists; therefore, the end of the overhead track contains a laser absolute encoder. The laser beam determines the precise distance between the encoder and the cart. This laser information does not change if the wheels slip or if power is lost to the encoder.

Since the corrosive plating environment may require a motor without an encoder, an IPOS*plus* program may be written using just the absolute encoder. The SEW Absolute Positioning Module contains a prewritten IPOS*plus* program that does not require a motor encoder. However, it cannot be used since it requires two inverters and fieldbus (See Solution #3).

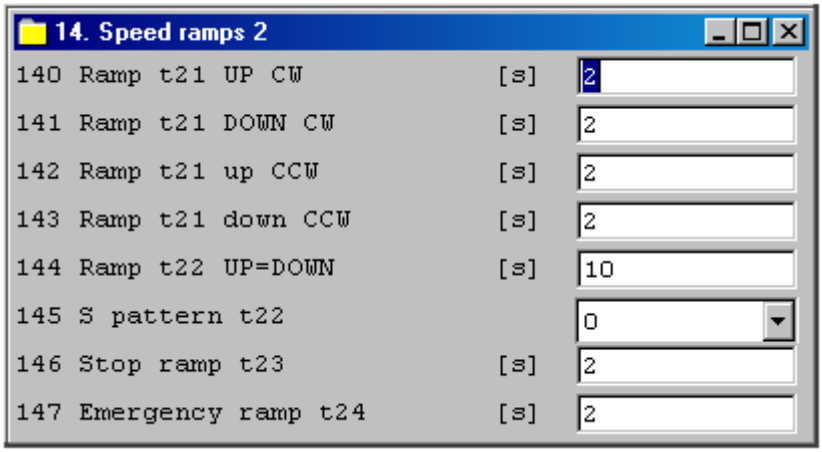
To allow a simpler IPOS*plus* program and to provide better speed regulation, an incremental encoder is installed on the motor. The drive obtains feedback from the motor, but references the absolute encoder in order to allow for wheel slippage.

The standard Movidrive® does not provide an absolute encoder port, so the optional DIP11A interface card is required. A proximity switch used during a reference travel is unnecessary since an absolute encoder retains position information. However, SEW always recommends the installation of safety limit switches at each end of the track to stop the motor if it happens to travel beyond its software limits.

Hoist = Motor 2:

During commissioning with Movitools®, the hoist motor is selected as ***Motor 2***.

Since the motor is performing a lifting operation, the premagnetization and post magnetization features are desirable to prevent the rack from jerking when the brake is applied or released. Both of these features are available with the hoist function. Therefore, ***VFC 2 & Hoist*** is the correct Operating Mode.



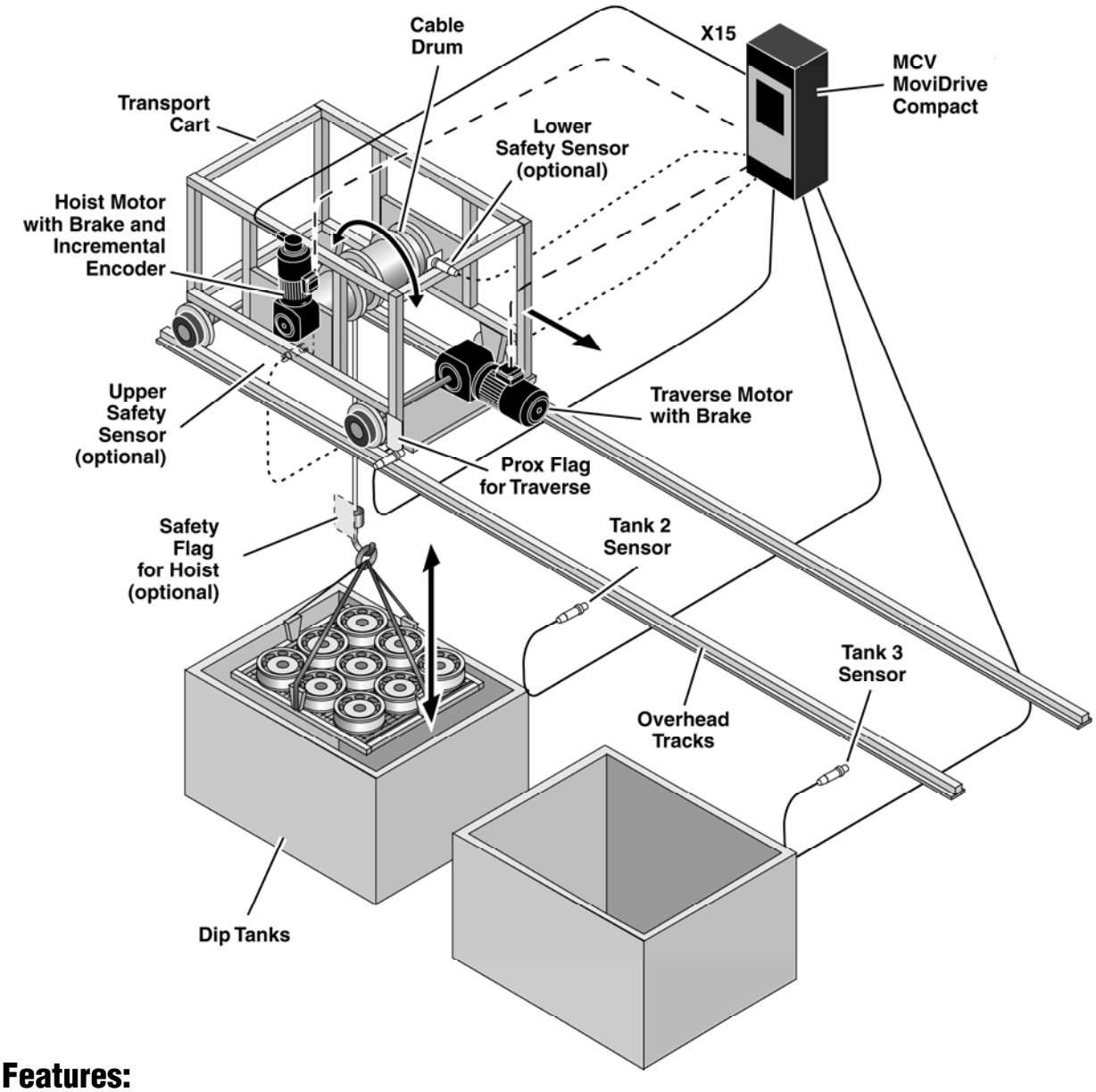
After commissioning, P701 displays *VFC 2 & Hoist.* The user should adjust the acceleration and deceleration times (P140-P145) to provide soft start and soft stop.

Since encoder feedback is unavailable on Motor 2, IPOS^{Plus} cannot position the hoist motor. However, IPOS^{Plus} can still start the motor and can still receive signals from a binary input to stop the motor. Therefore, a proximity sensor is placed on every dip tank. As the rack descends, the sensor tells the motor to stop when it detects the metal proximity flag on the cable.

The inverter uses one binary input for each proximity sensor. Since there are four proximity sensors plus two safety switches, six inputs are needed. Unfortunately, only five inputs are available on the standard Movidrive®. Additional inputs are normally available via an optional DIO11A board. However, the absolute encoder used for positioning Motor 1 requires the use of a DIP11A interface that also contains additional input. Therefore, the DIP11A serves two purposes in this solution: to accept feedback from an absolute encoder and to provide additional input. A Movidrive® Compact (MCV) cannot be used since it does not contain provisions for either additional input or for an absolute encoder.

On Motor 1 and Motor 2, the Movidrive® controls stopping by dissipating regenerative energy through a brake resistor. The motor completely stops before the mechanical brake is applied. Brake wear and frequent brake repairs are substantially reduced, since sliding friction does not occur on the brake pad.

Solution 2: Hoist = Motor 1



Features:

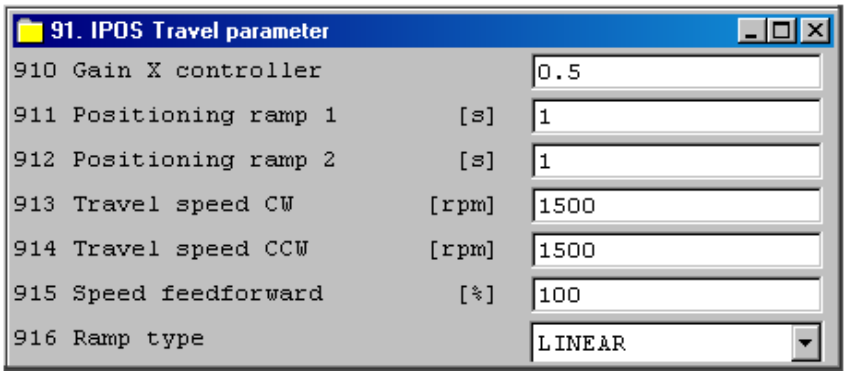
- (1) Movidrive® compact MCV – sized for the largest motor
- (1) Gearmotor + Brake + Encoder (hoist motor)
- (1) Gearmotor + Brake (traverse motor)
- (1) Brake Resistor
- IPOS^{Plus} – Hoist Motor

Details – Solution 2:

Hoist = Motor 1:

During commissioning with Movitools®, the hoist motor is selected as ***Motor 1***. Since encoder feedback is available for Motor 1, an IPOS*plus* program is available to position the motor. Therefore, ***CFC & IPOS*** is selected as the operating mode. Even though this mode does not contain the word "Hoist", pre-magnetization and post magnetization are still available because they are standard features of any CFC mode. These features prevent the product from falling or jerking when the brake on the hoist motor is released or applied.

After commissioning, P700 contains *CFC & IPOS*. The user should adjust the acceleration and deceleration times to provide soft start and soft stop. Parameters P911-P916 perform these functions, not P130-P135, since IPOS*plus* controls the movements.



IPOS*Plus* positions the motor by allowing it to rotate in the CW or CCW direction for an exact amount of encoder increments to lift the parts in and out of the plating solution.

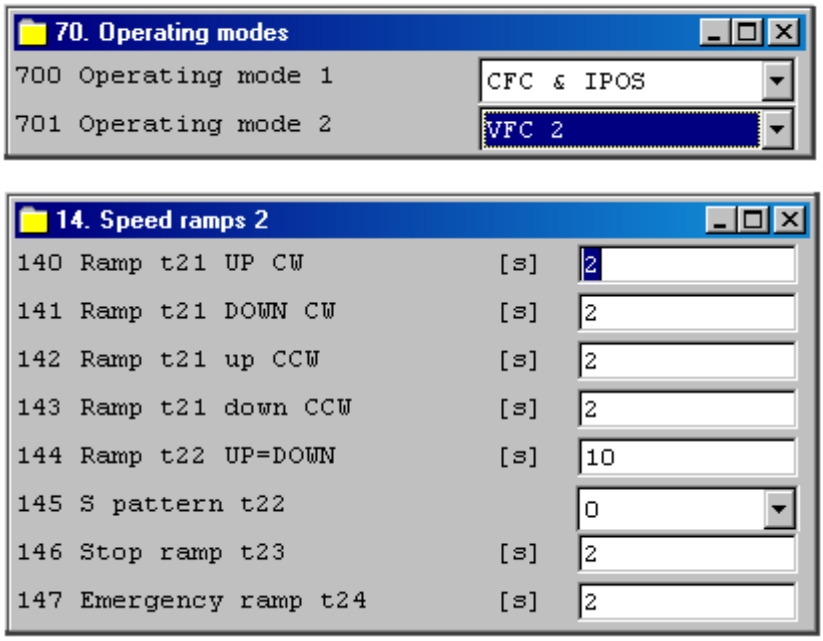
Since wheel slippage is not an issue (as it is in Solution 1), an incremental encoder on the end of the hoist motor is satisfactory. Its signal connects to the X15 input of the standard Movidrive® Compact.

An incremental encoder does not retain position information, so a reference travel is required when power is lost. Installation of reference limit switches may or may not be necessary – depending upon the type of IPOS reference travel used (travel types 0 and 5 require none). Nevertheless, SEW always recommends the installation of safety sensors to stop the motor if it travels beyond its software limits. The illustration shows a sensor that switches in the presence of metal from the drum cable. In the event that the motor travels beyond its software limit, the cable unwinds, removing metal from in front of the sensor and causing the sensor to stop the motor. The total number of inputs (including the safety limit switches) is five, which is the maximum number of binary inputs available on the standard Movidrive®. Therefore, the DIO11A option is not needed.

Traverse = Motor 2:

During commissioning, the traverse motor is selected as ***Motor 2***. Only five operating modes are available, as explained on page 2. Since the traverse motor is not performing a lifting operation, VFC 2 & Hoist is not correct. Of the five choices, the most applicable is ***VFC 2***.

After commissioning, P701 shows *VFC 2*. To prevent the parts from swaying when the cart is moved, the user should adjust the acceleration and deceleration times of the traverse motor using P140 – P145.



Even though IPOS^{plus} cannot position the second motor by counting encoder increments, it can still power the motor, and can still receive 24V from a proximity sensor to stop the motor. In addition, IPOS^{plus} can automatically control the switchover from parameter 1 to parameter 2 without using a binary input.

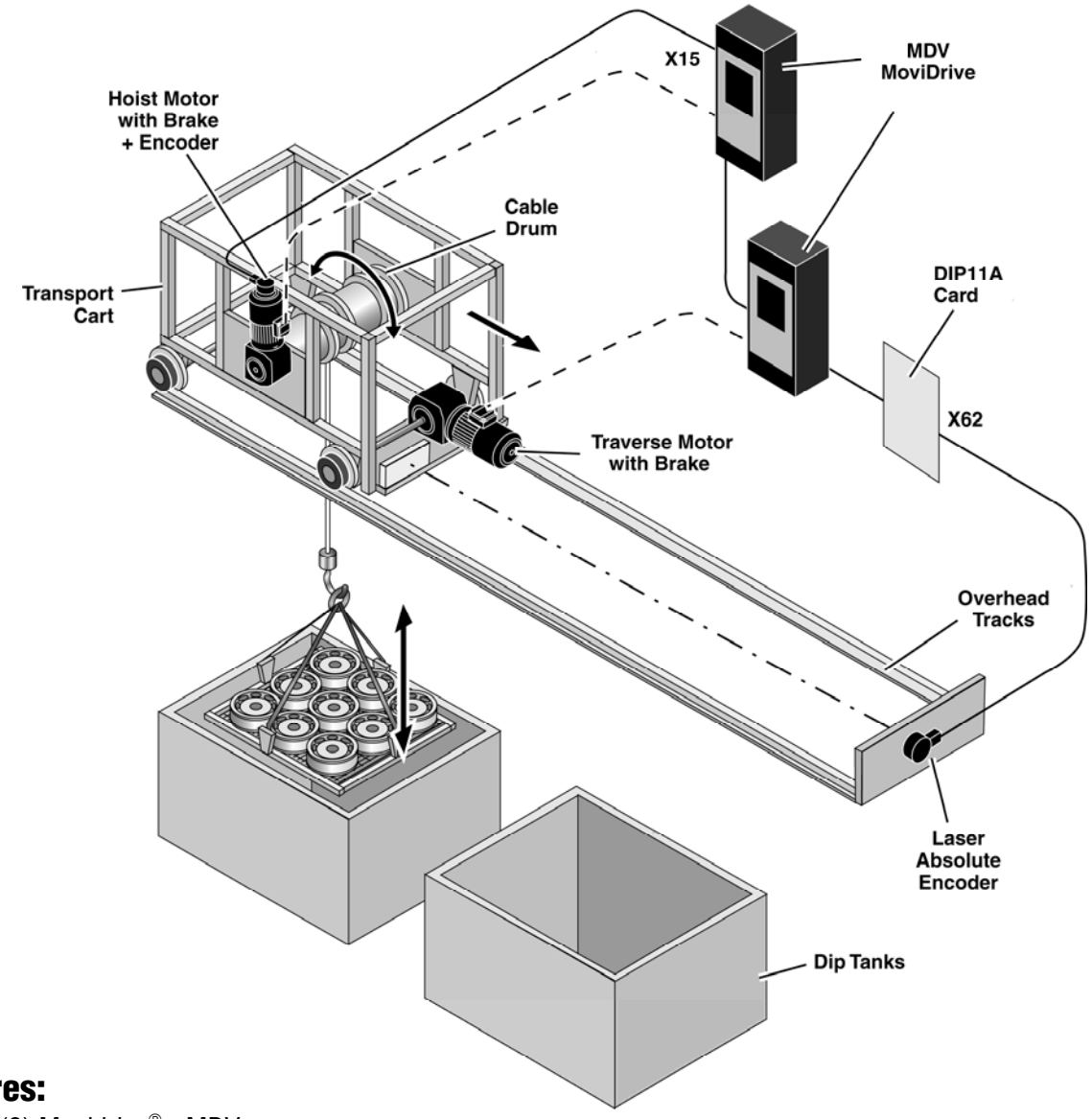
Each dip tank requires one proximity sensor for stopping. Since there are three tanks, three sensors and three binary inputs are required. In addition, two binary inputs are needed for the safety limit switches of the hoist motor. The total number of required inputs is five, which is equal to the maximum available inputs on the standard Movidrive® *Compact*. Therefore, the DIO11A option is not needed.

On Motor 1 and Motor 2, the Movidrive® *Compact* controls stopping by dissipating regenerative energy through a brake resistor. The motor completely stops before the mechanical brake is applied. Brake wear and frequent brake repairs are substantially reduced, since sliding friction does not occur on the brake pad.

Benefits – Solution 1 & 2:

- Only one inverter needed for two motors.
- Timers, relays, and many limit switches eliminated.
- PLC eliminated.
- Brake life substantially increased.
- Smooth starting and stopping
- Easy commissioning using Movitools® software

Solution 3: Two Inverters +
Absolute Positioning Application Module



Features:

- (2) Movidrive® - MDV
- (1) Gearmotor + Brake + Incremental Encoder (Hoist Motor)
- (1) Gearmotor + Brake (Traverse Motor)
- (1) Absolute Encoder (Laser)
- (1) DIP11A – Absolute Encoder Interface
- (2) Brake Resistors – one for each Movidrive®
- IPOS^{Plus} – Hoist Motor
- IPOS^{Plus} – Traverse Motor
- Absolute Positioning Application Module

Details – Solution 3:

This is the simplest solution, since there are no proximity sensors used for positioning. However, two inverters are needed.

Using the ***SEW Absolute Positioning Application Module***, the hoist drive tells the traverse drive the distance to each dip tank and also tells it when to operate the traverse motor. Since the traverse motor does not have an incremental encoder, it is commissioned as ***Motor 1*** in ***VFC*** mode, not CFC & IPOS. An incremental encoder installed on the back of the hoist motor provides position feedback for hoisting. Therefore, the hoist motor is commissioned ***Motor 1*** in ***CFC & IPOS*** mode. Brake resistors dissipate any regenerative energy from hoisting or positioning. Benefits of this solution are the same as solutions 1 and 2, and even less proximity sensors.

OPTIONS:

- Safety limit switches are not shown in Solution 3, but are always recommended as shown in solutions 1 and 2.

- To ensure that the position information of the hoist motor is never lost, an absolute encoder could be used instead of the incremental encoder on the hoist motor. However, this option also requires the use of a DIP11A absolute encoder interface, as shown in solution 1.

Questions:

1. In Solution 2, the hoist motor is performing a hoisting operation. So, why is CFC & IPOS selected for P700 instead of VFC-n-ctrl & Hoist?

   First, an SEW motor is being used with feedback, so CFC, not VFC, should always be selected. Secondly, IPOS^{Plus} is positioning the motor; therefore, IPOS must also be selected in the mode of operation. The customer still benefits from the pre-magnetization and post-magnetization features during hoisting because these features are automatically performed with CFC mode.

2. If a 4th tank were added to solution #2, what changes would be necessary?

   A fourth tank adds another proximity sensor to tell the traverse motor when to stop, which increases the total number of inputs to 6. Since the Movidrive® compact (MCV) has only 5 inputs and is non-expandable, a Movidrive® (MDV) with a DIO11A I/O Interface is required.

3. Can a Movidrive® Compact be used for Solution 1?

   NO. Solution 1 requires an input for an absolute encoder. The standard Movidrive® Compact does not have this feature nor does it have an option board with this feature.

4. Can a Movidrive® Compact be used for the hoist motor in Solution 3?

   YES - but, only if the hoist motor contains an incremental encoder. If the optional absolute encoder is used, then a DIP11A option card is required, which is not possible with the Movidrive® Compact.

5. In Solution 1, if the incremental encoder is removed from the traverse motor, what mode of operation (P700) is required?

   Since the motor does not provide performance feedback to the drive when the incremental encoder is removed, the drive cannot operate in CFC or IPOS mode. Therefore, VFC mode is appropriate, as in Solution #3.

   NOTE: Even though VFC mode is selected, IPOS^{plus} logic, including a GO command, is still used for the traverse motor. The absolute encoder is used as a reference to stop the motor.

Important Concepts:

- The motor commissioned as Motor 2 cannot have encoder feedback. Therefore, IPOS^{plus} cannot be used to position it.
- IPOS^{plus} can change I/O, which can start/stop a second motor even though positioning is unavailable.
- CFC mode performs pre-magnetization and post-magnetization automatically.
- Hardware limit switches are not needed with IPOS but are always recommended for safety.
- Brake wear is greatly reduced with an inverter, since the inverter stops the load and the brake holds the load.