Introduction

ADVANCED Motion Controls® DigiFlex® Performance™ drives allow the configuration of up to 16 separate Sequences. A Sequence is a set of steps that are Motion Tasks and Control Functions linked together and executed in a sequential order. With the exception of Jogs, any Motion Task can be used in a Sequence. Control Functions are all the non-motion steps that impact the flow of the sequence.
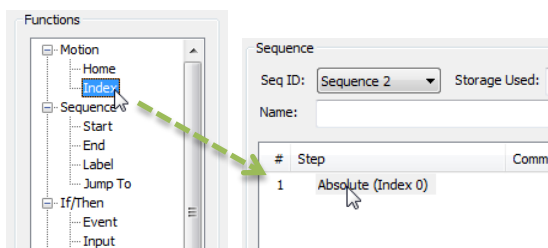
Configuration

DriveWare® 7 allows the different Sequences to be saved and stored to the project file and drive non-volatile memory. The *Storage Used* field in the *Sequencing* window will automatically update with the amount of memory used by the configured Sequences.

Each Sequence can be given a unique name or number as an identifier and selected by using the *Seq ID* drop-down menu or by choosing the desired Sequence from the System Browser tree view.

Each step in a Sequence is a distinct state of the Sequence. Steps are organized into one of the following groups:

- **Motion**
- **Sequence**
- **If/Then**
- **Wait For**
- **Set/Clear**

Drag-and-drop step items from the *Functions* pane over to the Sequence list area in the *Sequence* pane to create a Sequence.

Figure 1 Sequence drag-and-drop

Once a step item has been added to a Sequence, step behavior can be viewed and/or configured on the right side of the *Sequences* window. The options for step behavior will vary depending on the type of motion task or control function.

The order of steps within a Sequence can be changed by using the ⬆️, ⬇️, or ❌ buttons in the *Sequences* window.

Tasks and Functions

The Motion Tasks and Control Functions available for use in Sequencing are outlined here.

Motion	Description
Home	Runs the currently configured Homing routine
Index	Runs an Index task. Indexes may be pre-configured or configured directly in the Sequences window
Sequence	**Description**
Start	Used to start a new Sequence
End	Used to end a Sequence
Label	Assigns a label to a point in a Sequence. Labeled steps can be called out in other Sequence Control Functions within the same Sequence.
Jump To	Commands the Sequence to jump to a pre-configured Label within the same Sequence.
If / Then	**Description**
Event / Input / Logic Bit	These items are tested as If/Then statements within a Sequence with a corresponding action to take depending on if the item is Set or Clear (Active or Inactive).
Wait For	**Description**
Event / Input / User Bit / Value	Wait For… commands will hold a Sequence from progressing to the next step until a certain event or action has occurred. An optional Time-out duration and subsequent action can be configured.
Time	Wait For Time commands will hold a Sequence from progressing to the next step until a defined time period has passed.
Set / Clear	**Description**
Output / Logic Bit	Commands a specified Digital Output or Logic Bit to either Set or Clear.

Break Points

Up to two Break Points can be added to an inactive or active Sequence to pause the Sequence at a desired location. The Sequence will remain paused until either the *Run* or *Single-Step* button is selected to restart the Sequence progression.

Break Points are added or removed by clicking on the white space between the Sequence # and the Sequence *Step* name in the Sequence list area.
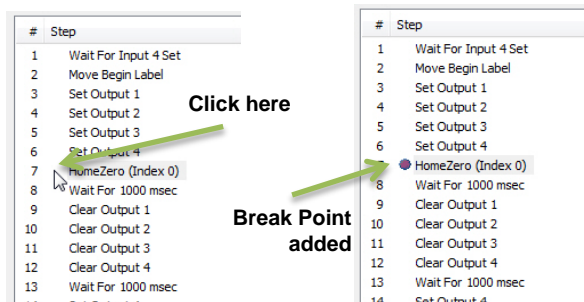

Figure 2 Sequence Break Point Addition

The use of Break Points and *Single-Step* progression through a Sequence is a useful troubleshooting method to help determine what may be causing unwanted machine behavior during a Sequence.

Sequence Initiation

Sequences can be started directly within the *Sequences* window by clicking on the *Run* button, or configured to initiate on power-up or via a digital input.

- **Power-Up** – In order for a configured Sequence to run on power-up, the following settings in the *Power-Up* and *Motion Engine Settings* windows must be applied.
  - ○ **Power-Up**
    - ▪ **Bridge Status** – Software Enable
    - ▪ **Configuration Select** – Appropriate drive Configuration selected
    - ▪ **Phase Detect** – If necessary, On First Enable Following Power-up
    - ▪ **Set Position** – Checked (or unchecked if a Home step is part of the desired Sequence)
    - ▪ **Motion Engine** – Enable
  - ○ **Motion Engine Settings**
    - ▪ **Default Mode** – Sequencer; Execute Sequence on First Enable

- **Digital Input** – Configuring a Sequence to run via a digital input involves utilizing the I/O functions within the Motion Engine grouping in the Digital Inputs window.
  - ○ **Motion Enable** – Enables the Motion Engine. The Motion Engine must be ON for Sequencing to run.
  - ○ **Motion Mode** – Toggles the drive between Indexer mode and Sequencer mode. The drive must be in Sequencer mode for Sequencing to run.
  - ○ **Motion Select 0/1/2/3** – Defines the selected Sequence as a binary number.
  - ○ **Motion Execute** – When triggered, the selected Sequence will initiate.

Use Cases

The flexibility offered by the Sequencing capabilities of DriveWare results in many possible methods and strategies for achieving the desired machine behavior. The following Use Case Examples are meant only to show the general theory and basic concepts of Sequencing – real-world application scenarios would typically require additional steps to test and validate safe and proper operation.

Use Case 1 – Container Fill

This example describes how a conveyor moves a procession of containers into position to be filled via a dispenser.

Requirements
- Conveyor belt must have Absolute Position defined
- Procession of containers – 6.5 revolutions between container
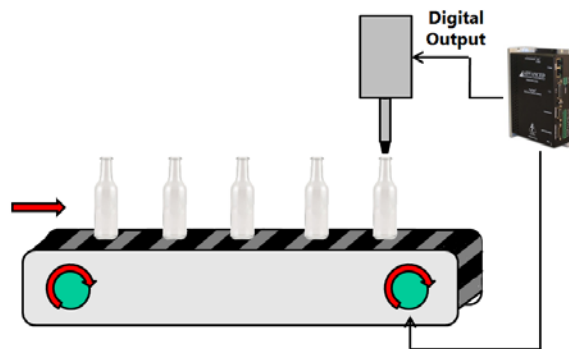- Digital Output control of dispenser – 472ms to fill a container

Figure 3 Container Fill Use Case

Steps

1. **Home** – The configured Homing routine will occur to establish Absolute Position.
2. **Wait For Zero Velocity** – Configure the Wait For Event command to establish that the conveyor belt is at rest after the Home routine.
3. **Label** – Set this label as the beginning of the actual machine movement.
4. **Index** – Configure an index to move the required 6.5 revolutions with the desired velocity, acceleration, and deceleration characteristics.
5. **Set Output** – Trigger the digital output to begin dispensing.
6. **Wait For Time** – Hold the Sequence from progressing for 472 msec while the dispensing occurs.
7. **Clear Output** – Deactivate the digital output to cease dispensing.
8. **Jump to** – Configure the Jump To command to return to the label preceding machine movement.
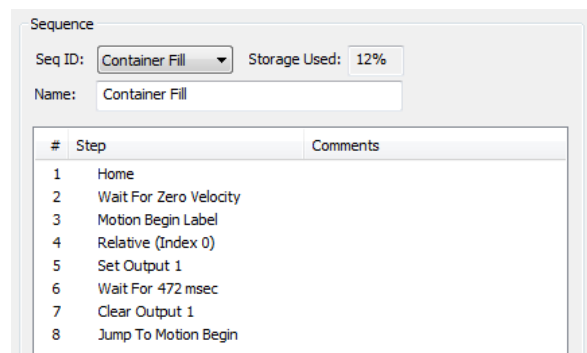

Figure 4 Container Fill Sequence Steps

Use Case 2 – Screen Printing

This example describes how a tri-color multi-position rotary screen printing machine rotates shirts to each printing station.

Requirements

- Absolute feedback device with a 20:1 gear box
- Control panel with "Ready", "Start Position", and "Fault Reset" signals
- Machine must receive a "Ready" signal after power-on to begin operation
- After receiving "Start Position" signal, machine moves to start position of 15.35 revs
- Test that spray applicators are homed via a digital input – if applicators are not homed, machine enters an error state with an alert via a digital output. Fault Reset signal must be received to restart program
- Machine moves to 1st position
- Applicators are activated/deactivated via a digital output – application requires 3.4 seconds
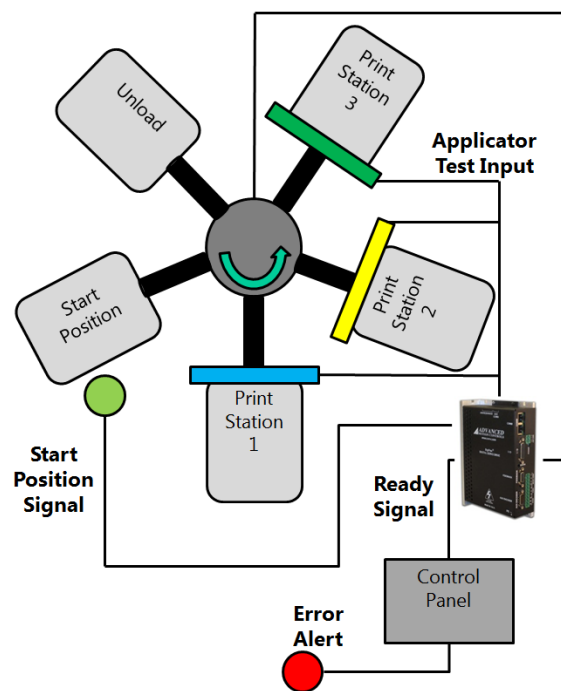- Repeat applicator test, move, and print

Figure 5 Screen Printing Use Case

Steps

1. **Label** – Set this label as the beginning of the machine process.
2. **Wait for Input** – Wait to receive the Ready Signal from the control panel.
3. **Wait for Input** – Wait to receive the Start Position Signal from the control panel.

4. **Index** – Configure an index to move the required 15.35 revolutions with the desired velocity, acceleration, and deceleration characteristics.
5. **Label** – Set this label as a "repeat" point in the Sequence.
6. **If/Then** – Configure an If/Then step to test if the applicator input is homed (input is set/active). If the input is clear/inactive, then the Sequence should jump to the Error State Label.
7. **Index** – Configure an index to move the required 15.35 revolutions with the desired velocity, acceleration, and deceleration characteristics.
8. **Set Output** – Trigger the digital output to begin spray application.
9. **Wait For Time** – Hold the Sequence from progressing for 4 seconds while the spray application occurs.
10. **Clear Output** – Deactivate the digital output to cease spray application.
11. **Jump to** – Configure the Jump To command to return to the Applicator Check Label (step 5) to repeat the machine process.
12. **Label** – Set this label as the beginning of the Error State portion of the sequence.
13. **Set Output** – Trigger the digital output that controls the Error Signal.

14. **Wait For Input** – Hold the Sequence from progressing until the Fault Reset Signal is received.
15. **Clear Output** – Deactivate the Error Signal.
16. **Jump to** – Configure the Jump To command to return to the beginning of the machine process to start over.

Figure 6 Screen Printing Sequence Steps