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About This Manual

This manual describes the steps to install and commission the SmartCrane AntiswayComplete™ Controller and Sensor System.

SmartCrane™ Anti-sway is computer-controlled operation of the trolley speed for the purpose of reducing or eliminating sway caused by operator demand. The SmartCrane™ software runs on a supplied controller that accepts demand inputs from an operator interface device and sends real-time data to the customer’s crane drive(s). The patented SmartCrane™ Anti-sway Control uses an open-loop algorithm that eliminates load sway induced by trolley accelerations and decelerations. It operates in one of three modes: Manual Anti-sway, automatic Move to Destination, and Suspend. In Manual mode, the control responds to the operator's trolley stick demands and completely inhibits sway no matter what demands the operator gives. In Automatic Move mode, the software drives the horizontal speeds to move from the current position to a pre-stored position entered during commissioning. If automatic hoist control is enabled, the system will hoist to a hang length designated by the user as Travel Height before beginning trolley motion, and then lower to Destination Height upon arrival. Otherwise the system will wait for the operator to hoist manually. In Suspend mode, the control simply passes operator demands in appropriate signals to the drive(s), modulated as needed to conform to ramp time limitations.

In This Guide

This Installation and Maintenance manual includes the following information:

- Chapter 1, "How Anti-Sway Works" explains how the SmartCrane Anti-sway controls the motor speeds and explains why certain data are required from the PLC.

- Chapter 2, “Assembly and Internal Wiring” gives detailed instructions for assembling and wiring the SmartCrane system if ordered in kit form. Purchasers of factory-assembled versions may skip this chapter.

- Chapter 3, “Installation and External Wiring” explains the system components and explains how to connect external devices.

- Chapter 4, "Commissioning" explains how to use the Basic Display to accomplish the required steps for commissioning a new crane. Normally these steps are accomplished at initial installation and need not be repeated, except that users may wish to change the parameters of stored automatic move profiles.
• Chapter 5, "Operation" discusses the use of the SmartCrane Dashboard Display during operation.

• Chapter 6, "Operator Control of Anti-sway Functions" gives suggestions about implementing operator switch control of anti-sway.

• Chapter 7, “Parts List and Ordering Information” defines the options for configuring the product for a particular application and gives the list of equipment supplied for each configuration. Refer to this chapter for ordering an initial system or for adding options for upgrading.
1 How Anti-Sway Works

Read this chapter to understand how the SmartCrane Anti-sway controls the motor speeds and what is required from the PLC.

When an operator moves the control stick or button demand to a certain speed, the SmartCrane™ Anti-sway Control accelerates initially according to the input demand, inducing an initial load sway. When about half the reference velocity has been reached, the anti-sway "coasts," i.e., maintains constant velocity, for a short time. Then the trolley is accelerated again, this time to the full operator demand velocity during an operator action. This second acceleration kills the sway induced by the first acceleration, so the trolley is now traveling at the operator reference velocity with the load hanging directly below the trolley. When the demand goes to zero velocity, the same process is repeated in reverse to bring the load to a stop without sway. If the speed demand is activated only for a short time, the anti-sway will bring the motion to a stop and then perform a second movement to catch the sway.

This simple strategy, given the laws of physics and the limits of crane machinery, accomplishes a move in the absolute minimum time. No other strategy, including operator “tricks” or other imaginary processes, can ever achieve a faster move.

All this requires precise timing, which in turn depends on the natural frequency of the pendulum motion. The SmartCrane Anti-sway carefully accounts for changes in hoist cable length (signaled from the supplied encoder), changes in velocity demand, etc., in real time. The key feature is that the SmartCrane™ Anti-sway Control uses precise timing of accelerations to control the sway, rather than real-time sway measurement and control feedback. It does not require a camera or other sway-sensing device to control sway induced by moving the crane, and the AntiswayComplete™ product does not support “closed loop” sway correction.

What the Anti-sway needs from the crane

For manual anti-sway operation, the SmartCrane™ system requires only the following measured data from the PLC, as an absolute minimum.
• **Hang Length.** Hang length provides a first estimate for swing period, which is a critical component of sway control. The AntiswayComplete™ product includes a multi-turn, absolute encoder especially designed and automatically interfaced with the SmartCrane controller.

• **Lift Load.** Anti-sway uses load measurement in real time to adjust swing period, which depends on the location of the center of gravity of the load, as well as other peculiarities of the support cables and pulleys. The commissioning process includes calibration of swing periods under controlled conditions, using different load situations and different hang lengths. Minimum load levels are: no load, light load, and heavy load. the AntiswayComplete™ product controller uses speeds measured by the hoist encoder to estimate load conditions.

• **Operator Demands.** The AntiswayComplete™ product accepts either analog demand (0-10VDC) or digital increments (three selectable percentage levels, and fixed 100%), plus a separated digital signal to indicate a reverse (negative) motion. If configured for Automatic Move and if destination positions have been initialized, up to four separate signals can be used to designate a stored destination.

**Other Useful Data**

Although the above data are sufficient for normal operation, there are backup data elements that allow the SmartCrane™ system to double check data received from the PLC. The SmartCrane™ system has a complete failsafe process that constantly compares separate but related data to ensure that some communications or hardware fault has not corrupted critical data. For instance, should the hoist length data become corrupted, the resulting error in swing period could cause the anti-sway algorithm to *increase* sway rather than decrease it.

• **Limit Switches.** The AntiswayComplete™ product can use slow limit switch data to bring the trolley to a safe stop near the ends of the boom. The customer may wire an existing sensor contact to the SmartCrane system or use a network sensor (available as an option) at each end indicating a “slow zone.” The slow zone is sufficient to alert the controller to bring the trolley or crane to a safe stop, without the need for a stop zone (the customer may have a separate system to interrupt power at a stop zone position). The distance at which the slow zone sensors should be placed to achieve safe stopping is calculated automatically during the commissioning.

• **Anti-Sway Mode Suspense.** Operators may be given the facility to select the mode of operation, either manual assist or suspend. The controller can accept a signal that indicates antisway is enabled, and when interrupted means to suspend antisway.
• **Emergency Stop.** The controller can accept a signal to enable all motion. When interrupted, the controller may either slow to a stop using a simple ramp or the antisway profile. The user makes this selection during commissioning.

• **Slow-Speed Suspend.** To allow operators to make small adjustments without antisway response and without any other operator action, the AntiswayComplete™ controller can be set to automatically interpret slow-speed motion (the slowest fraction) as motion without anti-sway.
2 Assembly and Internal Wiring

Read this chapter to learn how to wire and assemble SmartCrane™ AntiswayComplete™ — Skip this if you’ve ordered pre-assembly

There are five components for the AntiswayComplete™ product: (1) a Controller (ifm Efector CR2530 Mobile Controller), (2) one or two Encoders (ifm Efector RM9000, a multi-turn absolute encoder), (3) a connector plug (AMP-9797672), (4) a CR0451 Basic Display, (5) optional proximity sensors for slow zone detection, and (6) optional buttons, switch, and lights. The SmartCrane kit contains all the pieces needed to complete the installation, including nuts and bolts for mounting the controller, DIN rails, grounding bolt, and the display.

Wiring and assembly consists of a few simple steps:

- Measuring and drilling holes in enclosure backplate if needed;
- Cutting DIN Rail into segments to fit;
- Mounting DIN rails as needed;
- Mounting connectors, power supply, and Cube relays on DIN rails;
- Mounting Mobile Controller;
- Stripping heavy insulation from wired connector;
- Cutting and stripping wires to be used;
- Connecting controller wires to connector strip and Cube relays;
- Mounting display and connecting display and encoder cables to connector strip;
- Powering up unit and testing inputs and outputs using display screen;
- Mounting the subpanel and the display in the enclosure, drilling and mounting cable glands, and connecting optional beacons and pushbuttons;
- Connecting external devices, and drive inputs and outputs; and
SmartCrane Antisway Complete Installation and Commissioning

- Trimming unused wires.

## Mounting Parts to Subpanel

The SmartCrane standard template for enclosure backplane is 16 x 16 inches; using a larger enclosure will permit greater flexibility in placement of items inside the enclosure. With a large enough enclosure the drive(s) may be mounted in there also, as long as the distance from drive(s) to motor(s) does not exceed manufacturer recommendations.

Figure 1 shows the holes required for mounting parts.

![Figure 1. Template for Drilling Subpanel](image)

Mount controller using three 10-24 nuts and 1/2" bolts. Mount DIN rails using 8-32 nuts and 1/2" bolts. Mount power supply, 44 connector blocks, and end caps to the lower DIN rail. Mount relays to the upper rail. The overall arrangement with representative wiring runs, is shown in Figure 4.
Controller Wiring

The pre-wired controller connector has a full set of 55 numbered wires 1.5 meters long. Figures 3, 4, and 5 show those connections for some of the wire numbers in the pre-wired connector. There are two configurations: (1) Manual-Assist Anti-sway for trolley and gantry and (2) Manual and automatic anti-sway for trolley and hoist. Properly scaled, adhesive-backed versions of the strip connector labels are included in the SmartCrane kit. Cut out the correct versions for your configuration. Snap the ZB Marking Strips into place along the top and bottom of the connection strip. Peel the backs off the two labels and apply carefully.

Begin wiring by cutting the heavy insulation back carefully using shop scissors until wires can be shaped to run where needed, with about 1 inch of heavy insulation remaining. Install the controller and plug the pre-wired connector into the controller, hooking the wire end (bottom) to the controller until it is seated. Use the metal clamp attached to the controller to clamp the other end top firmly in place.

The connector wires are grouped by tens. Separate the first set of ten and move the others out of the way. Clip the black wire wrap to loosen the wires, then select one wire at a time, identifying it by its printed number. Lead the wire to its destination as given in Table 1, then cut, strip, and install where required. The pre-wired controller connector has a full set of 55 wires and some will be unused. Do not cut any wires until all connections are complete and tested.
Table 1. Wiring Connections

<table>
<thead>
<tr>
<th>Wire Number</th>
<th>Connector Number or Other Destination</th>
<th>Wire Number</th>
<th>Connector Number or Other Destination</th>
<th>Wire Number</th>
<th>Connector Number or Other Destination</th>
<th>Wire Number or Other Source</th>
<th>Connector Number or Other Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>17</td>
<td>Relay 6 #14 OR 23</td>
<td>35</td>
<td>43</td>
<td>51</td>
<td>UNUSED</td>
</tr>
<tr>
<td>2</td>
<td>PWM Only</td>
<td>18</td>
<td>Relay 3 #14</td>
<td>36</td>
<td>35</td>
<td>52</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>PWM Only</td>
<td>19</td>
<td>4</td>
<td>37</td>
<td>11</td>
<td>53</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>Auto Start Light</td>
<td>20</td>
<td>10</td>
<td>38</td>
<td>30</td>
<td>54</td>
<td>42</td>
</tr>
<tr>
<td>5</td>
<td>Destination #5 light</td>
<td>21</td>
<td>29</td>
<td>39</td>
<td>31</td>
<td>55</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>Destination #4 light</td>
<td>22</td>
<td>36</td>
<td>40</td>
<td>34</td>
<td>PWR SUP -V</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Destination #3 light</td>
<td>23</td>
<td>33</td>
<td>41</td>
<td>32</td>
<td>PWR SUP +V</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Destination #2 light</td>
<td>24</td>
<td>41</td>
<td>42</td>
<td>12</td>
<td>Relay 1 #12</td>
<td>27</td>
</tr>
<tr>
<td>9</td>
<td>Destination #1 light</td>
<td>25</td>
<td>28</td>
<td>43</td>
<td>24</td>
<td>Relay 1,2,3 #5</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>28</td>
<td>17, 18</td>
<td>44</td>
<td>UNUSED</td>
<td>Relay 2 #12</td>
<td>26</td>
</tr>
<tr>
<td>11</td>
<td>20</td>
<td>29</td>
<td>14</td>
<td>45</td>
<td>UNUSED</td>
<td>Relay 3 #9</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>19</td>
<td>30</td>
<td>UNUSED</td>
<td>46</td>
<td>15 &amp; 16</td>
<td>Relay 4 #12</td>
<td>23</td>
</tr>
<tr>
<td>13</td>
<td>Relay 5 #14 OR 22</td>
<td>31</td>
<td>UNUSED</td>
<td>47</td>
<td>13</td>
<td>Relay 4,5,6 #5</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Relay 4 #14 OR 21</td>
<td>32</td>
<td>UNUSED</td>
<td>48</td>
<td>UNUSED</td>
<td>Relay 5 #12</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>Relay 1 #14</td>
<td>33</td>
<td>39</td>
<td>49</td>
<td>UNUSED</td>
<td>Relay 6 #9</td>
<td>21</td>
</tr>
<tr>
<td>16</td>
<td>Relay 2 #14</td>
<td>34</td>
<td>40</td>
<td>50</td>
<td>UNUSED</td>
<td>Relays GND #13</td>
<td>9</td>
</tr>
</tbody>
</table>

Wires 13, 14, and 17 are output signals for gantry/crane motion and activate internal relays or for automatic hoist and are direct outputs (to external relays) on connectors 21, 22, and 23. Power connector positions 1-5 and 8-13 require 5-bridge jumpers but it is easier to install those after all the wiring connections have been made. Conversely, 13-14 and 15-16 require 2-bridge jumpers that can be installed at the same time as the wires. Terminate the two CAN networks using the 120Ω resistors across 13 and 14 and across 16 and 18.

Figure 3. Wiring Diagram for Common Power, Network, and Output Connections.
Note that connections 6 and 7 supply power to relay set(s) independent of the installed power supply. If the brake relays (3 and 6) require a different, independent power source, then one or two connectors will need to be added to supply that power. Numbered connectors identify the pre-labeled wire numbers.

Figure 4. Outputs and Inputs for Two Dimensional Manual Antisway

In this version all six brake and drive outputs come from the six relays, pins 9 and 12 as shown.

Figure 5. Outputs and Inputs for Two Dimensional (Trolley and Hoist) Manual and Automatic Antisway

Note that in this version controller wires 17, 14, and 13 (hoist control) are delivered directly to external control relays on connections 21, 22, and 23 without using internal relays. If the hoist uses drive control (requiring signaling contacts and independent signal power), then internal relays will be required and should be wired identical to gantry/crane relays. Hoist brakes must be controlled externally; there is a hoist enable signal but for safety reasons hoist brake operation should not depend on this signal.

Wiring Forward and Reverse Relays

The signals from the controller use internal power 24VDC. These signals activate forward and reverse relays to make connections from the drive-controlled power source, whatever that might be. Route each signal wire to pin 13 on the appropriate relay.

Using spare wire, connect all grounds (pin 14) on all relays together and ground to connector number 9. Next connect together Pin 5 on both relays for one drive to the top of strip connector 6 (trolley) or 7 (gantry/crane). This is the common power source for all digital (binary) signals to the drive, supplied by the drive and independent of the SmartCrane enclosure power. Then run a new wire (cut from the same-numbered signal wire, for clarity) from relay pin 9 (the real output signal) to the proper connector on the strip.
It is important to protect the drive from conflicting signals (i.e., FWD and REV at the same time). Use spare wire to add safety jumpers connecting pin 9 on each relay to pin 4 on the other. This requires that one relay be energized and the other not energized before any signal is transmitted to the drive. IMPORTANT: This scheme requires the signals from the controller to pass through both relays, such that the input (FWD or REV) goes to one relay and the corresponding output (FWD or REV) appears at pin 12 of the other relay, as shown in Figure 6.

**Wiring Relays for FWD/REV Digital Signals**

To avoid sending both directions at the same time, each connection utilizes a normally open circuit on one relay and a normally closed on its companion. This way, if both relays happen to get energized at the same time, no connection will be made.

![Figure 6. Wiring Relays for FWD and REV Signals](image)

**Basic Display**

Connect the wires from the basic display using the supplied cable (shipped connected to the display). Black and Grey wires connect to “Display & Prog” strip connectors 15 and 17, respectively. Connect both blue and brown wires to one of the ground connectors and the white wire to one of the power +24VDC connectors 1-5.

**Wiring Check Software Feature**

After all internal wiring has been completed and the display is connected, connect the power supply and supply external 120VAC power. Connect a probe to one of the +24VDC connectors, with enough wire to reach all the pin connections.
The display should go through an initiation cycle and end on the “COMMISSIONING” page. Press CANCEL/ESC (f4) repeatedly until MAIN MENU appears. Select Wiring Checks.

The Wiring Checks display screen shows the connections by connector number, grouped by Inputs and Outputs.

To check one of the inputs, use the up/down and left/right arrows to highlight the pin you want to check. The wire number for that pin will appear at the bottom of the screen. Now apply 24VDC using your probe to that pin. The controller will detect the signal and set a green box next to that number. Continue through all 16 inputs until you verify that they are all wired correctly.

To check the outputs, use a multimeter and connect the common (negative) probe to one of the ground connections in the strip. With the correct output highlighted, check the voltage at that pin. If the voltage is correct, press and hold the OK button until the green box appears. Continue through all outputs until each of them produces a correct response voltage.

Do not cut wires 5, 6, 7, 8, 9 but save for extra outputs within the enclosure: (OUT10 through OUT15); and also save wire numbers 2 and 3 as a possible PWM outputs for trolley and gantry/crane drives (replacing 25 and/or 43, analog).

After all wiring is complete and tested, tighten all connections once more and cut the following wires as unneeded: 26, 27, 30, 31, 32, 44, 45, 48, 49, 50, and 51.

Installing in Enclosure

Cut holes in your enclosure to mount the various parts, including the display and cable glands. Also measure and cut holes for optional buttons and beacons.

Temporarily mount the subpanel in the enclosure and measure and cut the wires needed to connect optional beacons (for Antisway and Error Alerts), buttons, and button lights. Figure 7 gives sample wiring strategies.
Remove the subpanel before mounting the enclosure and installing external wiring.

Figure 7. Wiring Relays for Contactors, Lamps, and Beacons
3

Installation and External Wiring

Read this chapter to learn how to install and wire the SmartCrane™ AntiswayComplete™ product and to operate the basic display.

This section presumes all internal wiring is complete and tested in accordance with Chapter 2. Begin by mounting the enclosure securely in position and then install the backplane using the four mounting studs and nuts. Then route each external cable through its own cable gland. Leave plenty of extra cable inside the enclosure. Make any connections needed to internal buttons and/or beacons and use zip ties to bundle all internal wires as appropriate.

Controller Wiring

The 44 external connections, either factory wired or wired from a kit as in the previous chapter, are accessed via industrial screw connectors labeled and mounted on one or more DIN Rail segments. SmartCrane LLC supplies external cabling only for encoders and network slow-zone sensors. Other cables must be customer supplied. Figures 8, 9, and 10 show the wiring arrangement for external connections and are supplied as labels for permanent mounting on the connections strip. These figures correspond to the internal wiring connections in figures 3, 4, and 5.

```
+24VDC Power  Ext PWR  Common Ground  Encoders  Display + Prog  Alerts
PWR  PWR  PWR  PWR  D1  D2  GND  GND  GND  GND  C H  C L  C H  C H  C L  C L  A S  E R

Figure 8. External Connections 1-20 for Common Power, Network, and Alert Outputs
```

Devices needing direct 24VDC power should connect to positions 1-5 (PWR) and grounding should be applied to 8-12 (GND). External signal references for trolley and gantry relays attach to 6 (D1) and 7 (D2). The encoders and supplied slow-zone sensors are on a single network to be attached to 13 (CH) and 14 (CL). The display wires connect at 15 (CH) and 17 (CL) and, if supplied temporarily, a programming cable at 16 and 18. The green antisway and red error beacons attach at 19 (AS) and 20 (ER), grounded at 8-12.
For the motion outputs, BR signifies brake open demand, FW and RV enable the drive motion, and SPD supplies 0.5-100VDC reference, indicating 5%-100% maximum speed. The Gantry and Trolley inputs may have two configurations: (1) ZF and ZR for Slow Zone positive and Slow Zone negative (if not using the SmartCrane network sensors), RV indicating reverse demand, and four speed inputs or (2) three speed inputs forward and three reverse. The two or three percent inputs (less then full speed) can be set to 5%-85% in steps of 5% during the commissioning.

The AS signal can be configured during commissioning to supply an antisway ENABLED signal that when momentarily interrupted becomes a SUSPEND command. The ES Emergency Stop signal if configured assumes a positive signal which, when interrupted will stop the motor(s) either with a simple (non-antisway) ramp or using a sway control profile for a smooth safe stop. The commissioning process will advise the correct distance at which to install the slow zone sensors.

This version replaces the seven gantry/crane inputs with automatic move start button (ST), automatic move deadman (DM) and up to five separate trolley destination buttons. The ST and DM inputs can be configured during commissioning. Trolley Destination 1 may be used as a destination cycle function for a one-button “next” selector; however if this option is used, it requires the use of the automatic start (ST) button.
### RM9000 Encoder

The RM9000 is a multi-turn absolute encoder useful for measuring hang length from rotation of the hoist drum. An interface cable is supplied with the kit, and the pin assignments are shown in the table below.

<table>
<thead>
<tr>
<th>Signal</th>
<th>5-Pole M12 connector</th>
<th>Wire Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN GND</td>
<td>pin 1</td>
<td>Blue</td>
</tr>
<tr>
<td>24V Supply</td>
<td>pin 2</td>
<td>White</td>
</tr>
<tr>
<td>GND (PE)</td>
<td>pin 3</td>
<td>Brown</td>
</tr>
<tr>
<td>CAN High</td>
<td>pin 4</td>
<td>Black</td>
</tr>
<tr>
<td>CAN Low</td>
<td>pin 5</td>
<td>Grey</td>
</tr>
</tbody>
</table>

Connect both blue and brown wires to the common ground (GND) connector(s).

The hoist encoder should be fitted to the axle of the hoist drum or hoist motor with a flexible coupler. It is permissible to use a contact roller on the rim of the drum instead, but it is important that the contact roller is always connected and does not slip. In such a case a daily check of displayed his length and actual hoist length is advised, to prevent accidentally offsetting the encoder leading to false hoist readings. Regular hoist homing is recommended for any installation.

The cable will be pre-wired when shipped, terminated at both ends using supplied resistors across CAN High and CAN Low wires.

A second encoder, for measuring travel in one dimension, may be ordered to enable automatic move to destination. This encoder’s cable is to be plugged into the first encoder’s T-connection.

The travel encoder should be mounted securely to the travel motor rather than to a roller on a horizontal surface, which may slip and cause the encoder to lose calibration.

### CR0451 Display

The CR0451 display is a high resolution color display that can be mounted anywhere within reach of the controller. This device will also be pre-wired and tested, and mounted in the cover of the enclosure as appropriate. The cable is long enough to permit moving the display to a position where movement of the hook can be observed, for commissioning purposes. If the main enclosure is to be mounted in an inconvenient location the display may be mounted remotely, with an extension cable.

### Other Wiring

Other inputs and outputs will need to be connected to the supplied connectors on DIN rails, as numbered in the previous table. Ground cables may be connected to the indicated connectors or to the master ground bolt.
supplied. If automatic move to destination is required, the system will include a second absolute encoder, which is wired to the same CAN network as the hoist encoder. Operating the system in automatic move may require a signal to start the move and a constant high signal to continue, as a deadman switch. The system is delivered with connection strip labels. Select and install the correct set depending on the application.

**Hoist Relays for DC Motors**

If the hoist motor is a simple DC motor without a drive, hoisting is single speed and direction is controlled by the polarity of the DC voltage supply. DO NOT route DC motor voltage into the SmartCrane enclosure because of the problem of electromagnetic interference (EMI). Connect wires 17, 14, and 13 directly to strip connectors 21, 22, and 23. Route these to existing external relays in accordance with your crane’s wiring diagrams. If there are no relays or if the relay setup does not support separate signals for hoist UP and hoist DOWN, then you must procure new DP/DT relays with adequate capacity to handle the hoist current load. Two relays are connected as shown in the diagram below, to reverse polarity of a DC voltage supply. A third, optional relay (labeled Relay 1, below) uses the ON/OFF signal (wire 13, strip connector 23) to switch the supply. Without this relay, just connect the power source directly to pins 9 and 12 of Relay 2 (shown). Pins 9 and 12 of Relay 3 will now supply DC power of the desired polarity.

**Wiring Relays for Reversible DC Power**

The rotation direction of a DC motor is reversed by changing the polarity of the DC voltage applied. This diagram shows how to utilize two separate signals (e.g., UP and DOWN) to cause two relays to perform the polarity change. Relay 1 is optional and serves only to enable all.

![Figure 6. External Relays for Reversing DC Power](image)
4 Commissioning

Read this chapter to learn how to commission SmartCrane™ AntiswayComplete™

The AntiswayComplete™ system uses the system display to guide the installer through the important steps of commissioning. The steps are:

• Indicating what optional switch inputs are expected;

• Setting antisway capability in each crane direction;

• Calibrating the hang length encoder to actual crane hoist measurements;

• Setting the type of speed demand inputs;

• Setting ramp and response delay times; and

• Conducting swing timing tests and recording swing adjustment parameters.

• Creating saved destination positions and heights (if automatic move enabled);

• Recording trolley travel limits (if trolley encoder enabled);

• The SmartCrane display is used to perform all these tasks. Use the up and down directions of the rocker button to scroll through menus. Use the ok button to confirm or save (or just continue). Use the Cancel button (F4) to quit a menu and go back.

Use the Wiring Checks function if you are wiring up the kit version of SmartCrane AntiswayComplete, as discussed in the previous section.

Commissioning Detail

To use the commissioning tools in this project, first start the system and press ok. If the dashboard display is running, select the Cancel key (F4).
Accessing the Commissioning Tools

The first menu includes the option to enter commissioning. The first screen is an advice that only authorized personnel should be accessing these functions. If the system has been restarted, you may need activate encoder communications by operating the hoist as prompted. Then you may begin the commissioning process.

You will then be prompted to enter the passcode. Step through the code digits using the left and right rocker arrows and use up and down arrows to change digits. SmartCrane will supply the passcode separately to an authorized person.

The next screen offers the eight major steps as listed above.

Set the Optional Digital Signals

If digital speed increments are to be used, you can set the lowest level increment to automatically carry no antisway response; this may be useful to avoid having an operator use the special suspend switch when making small adjustments.

If digital slow limit signals (different from SmartCrane sensors on CAN network) are to be installed, set this option to ON.

Speeds can be signaled in two ways: (1) four speed levels (defined later) plus a single REV signal OR (2) six separate signals, three forward and three reverse speed levels.

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Speed demand option (2) and digital slow limit signals are mutually exclusive because of hardware limitations; you will only be able to select one or the other (or neither).

If a trolley travel encoder is installed and automatic moves are required, set travel encoder ON. Using an Antisway/Suspend signal allows the installation of one or more buttons or foot switches to turn antisway on or off, or interrupt it momentarily (suspend).

If trolley travel encoder is ON but slow zone signals are not installed, you may opt to apply automatic slow zones. This feature will apply slowing to operator demands within dynamic slow zones calculated from the encoder readings. Dynamic slow zones are smaller than fixed zones because antisway can slow the trolley in a shorter time at shorter hang lengths.

**Travel Directions**

All trolley speeds and directions must carry consistent signs, positive or negative. When the trolley is moved in a forward direction, the encoder should register a positive change. If this is backwards, you can switch the wiring or use the REV DIRECTION option here.

Use the left and right direction of the rocker button to make changes.

**Select Antisway Modes**

Use the arrow keys to enable antisway in either trolley or crane direction, or both. In addition, if a travel encoder has been enabled, and you have not selected Gantry/Crane Manual, then you may select “TROLLEY Automatic.” Note that the use of TROLLEY and CRANE directions are not necessarily associated with the defined crane directions. Wiring crane travel signals to the trolley connections will work as expected, regardless. When the settings are correct, press the OK button.

**Setting Up Automatic Moves**

If you want the system to control the hoist during automatic moves,
set HOIST Automatic to ON. If a deadman switch is installed that must be closed during all automatic moves then set automatic move deadman to ON.

If you want an input signal to activate the selected move, set Automatic Move Start Signal to ON.

The system can accept a number of separate signals to activate different destinations, one signal per destination. Alternatively you can use Destination 1 signal as a cyclic or “next destination” button. To select this option you must first turn on the Automatic Move Start Signal option.

**Calibrate the Hang Length Encoder**

To calibrate the encoder, select the Measured Hang at Top menu then hoist without a load to the highest point possible. Now measure the approximate distance from the center of the hoist drum or other suspension point to the bottom of the hook and use the right/left arrows set that value in the first box. When that is done, hoist down all the way, select the Measured Hang at Bottom menu item, and again enter a measured distance in that box. The system will use the measurements from the hoist encoder to make the calibrations. If the encoder does not change, the system will indicate **Hoist Encoder Not Responding**. Check the cabling if this alert appears. If you forget to enter a value for Measured Hang at Bottom, the system will not accept the OK button.

**Travel Limits**

If a trolley encoder is installed, then the Travel Limits screen will allow you to calibrate the positions at the beginning and end of the travel. This process will require you to physically measure the distance between the beginning and end of permitted travel. Enter this at the first menu item. Then select the MIN Encoder Reading option and move the trolley to the beginning (lowest value of the encoder). Next, with the Max Encoder Reading menu item highlighted begin moving, at the slowest speed, all the way to the end of the travel.

The system will move the trolley a very short distance at the beginning, to measure the smallest trolley motion possible with the crane and its motor(s) and to measure the minimum speed demand (tickle) that the system will accept. It will use that slow speed for the remainder of the travel.
When the trolley has reached the end of the travel, press OK. The system will record the minimum and maximum trolley speeds and calibrate the encoder to measure trolley distances, for use in automatic moves.

Set Automatic Move Destinations

If automatic trolley move to destination is enabled, the Destinations screen allows you to set up to five (5) destinations in memory. For each destination do the following:

- Move the trolley to the position desired. The system will automatically show that position in feet, using the calibration values already calculated.

- Select the next menu item and set the size (maximum error plus or minus) of the destination window, in inches. The system will not accept any window smaller than half of the minimum trolley motion measured above.

- Select the next menu and hoist up or down to a hang length needed for the travel portion of the automatic move. The trolley motion will not begin until that height is reached. If automatic hoist control is enabled, the system will send the appropriate signals to the hoist motor; if not, it will wait for the operator to make the hoist changes.

- Select the final menu item and hoist down to the final destination hang length.

- DO NOT press the OK button; press the ADD button to accept each destination data in turn. The system will display the number of destinations that have been entered (“—Have 1”).

- When all the destinations have been entered, then and only then press the OK button. Nothing will be saved until you press the OK Button.

You may use the DEL button to delete one of the destinations or DEL ALL to remove all the destinations. Pressing Cancel will forget any and all changes made since this panel appeared.

Set the Speed Inputs

Two options are available for speed: three or four digital signals representing increasing fractions of max speed, always ending with 100%; and use of analog 0-10VDC input at the 100% input channel. First use the
rocker to elect one of these options. If the Analog Speed Demand is not ON, then scroll to the first, second, and third steps and use the left/right arrows to adjust the fractions as desired. Default is 10%, 20%, and 30%. Available fractions are 10% to 85%, in 5% increments. If there are separate speed signals, three forward and three reverse, then the third step will not be available.

You can change the maximum and minimum trolley (and gantry) speeds in this screen. Be careful because the minimum and maximum trolley speeds may have been calculated already when calibrating an installed encoder.

Set the Ramp and Delay times

For each of the directions that have Antisway Enabled (Step 1), you must set in a standard ramp time, in seconds. Antisway will always keep its output profile within that acceleration envelop when applying antisway corrections, even in SUSPEND mode.

Make sure you enter values that the drives and motors can and will respond to, otherwise Anti-sway will not be effect (and may be dangerous).

NOTE: Motor drives have options to set ramp times also, but these should be set at the smaller possible values. The SmartCrane system will always obey the correct ramps, even if antisway is in SUSPEND.

Use the left/right arrows to adjust the ramp times.

Some cranes exhibit small delays in beginning to move from zero, caused both by brake release or flux times in the motors. It is useful to measure these times in each direction and set the times in milliseconds in the third and fourth menu items. Doing this correctly will improve the antisway performance.

Set Slow Zone Distances

If the slow zones are to be used, it is important that they be set at the correct distance from the end of travel, or mechanical stops. If these are installed at the correct positions, then the trolley or crane can be moving at
full speed when passing the mark and the antisway will bring the crane to a safe stop just before the end. If needed, the operator can creep the drive to the physical stops after antisway has finished.

In this screen you may change the maximum speed used for this calculation and see what buffer size would result. The screen will automatically display the correct distance in feet for setting the sensors.

Please be careful: if you change the values of Max Speeds or Ramp Times and then press OK, those values will now replace the previous values and will be used in future operations. Press SKIP if you don’t want the values saved.

**Perform Load and Swing Tests**

Antisway calculations depend critically on pendulum period, which is always a function of “effective” hang length.

Effective hang length takes into account the center of gravity of the suspended object, which of course changes with different loads.

**Set Load Condition**

Every crane load configuration is different, so it’s necessary to take a number of trials from which the system can collect data and produce parameters to correct measured hang length to effective hang length.

Load tests must be conducted with added light and heavy loads and swing tests under three load conditions: no load (0.0 tons), light load, and heavy load. You must enter the actual load (in tons, not including no-load block, hook, or spreader weight) for the light and heavy conditions. It’s best to use weights close to what will be experienced in routine crane operation. For each test, select the load condition. The screen shows the loads in tons and a tally of which tests have been done already.
Perform Hoist Test

Once a light or heavy load is selected, you will need to hoist all the way down and then up at full speed, one time as in the Hoist Test screen. The hoist symbol on the screen will turn green when it has collected enough data for the test. This test calibrates the speed of the hoist with this load condition, assuming constant motor torque. Then during operation, the system will observe the hoist during every new hoist and determine the load condition for adjusting effective hang length.

Hoist Down for Swing Test

The next screen will prompt you to hoist down to the lowest position to begin the swing timing.

When the hoist is in the correct position, the screen will switch to a prompt to start a moderate load swing in the correct direction. Make sure you induce enough swing so that the swing will be still observable after 5 cycles.

The Start screen shows a picture of the swing collection process.

Always press the OK button at EVERY swing bottom but in the SAME motion direction (forward or backward, left or right), so as to indicate the timing of a complete back and forth cycle (not half cycle).
During the data capture process a data screen will show the current hang length being measured, the next hang length, the mean swing period observed so far, the time since the last mark, and the total number of observations so far.

If you miss a swing bottom or press the button during the wrong part of the swing, the software will detect a bad time interval and will prompt you to start over, in which case you will need to induce a bit more swing: you will be required to record exactly five swing intervals, requiring six presses of the OK button.

When you have done the required five swings, the system will show the results. Press OK to continue to the next step.

The next screen will prompt you to switch directions (if both dimensions have antisway enabled) and repeat the test in that direction.

When tests at one hang length are complete, the system will prompt...
you to hoist up to the next level if needed.

Once the hook is at the right height, the screen will switch back to the data collection display.

When you have completed swing timings at the highest position, the system will prompt you to hoist down and select a new load condition. When you have added the required load and hosted it clear of the floor or ground, select that load condition and a swing direction. Now simply repeat the process for the light load and heavy load conditions.

When you have completed all the required swing timings, the next screen will appear. Press the OK button and the system will analyze the swing parameters and record them for future use. You will see the progress of the analysis. Do not press any buttons or turn off the controller during this process.

**Complete Commissioning**

When the analysis is complete, a screen will appear for each antisway dimension, giving five swing adjustment parameters calculated from your swing timing tests. You may record these values, or later access them from the main commissioning screen.

**Editing Swing Parameters**

You can edit these parameters with a selection from the Choose Commissioning Step screen, so that if you have a second, identical crane you may transfer these parameters from one to the next. Scroll to select each parameter and use the left/right arrows to edit the values. When the Swing Timing tests and data analysis are complete, you may return to the dashboard screen and the system is ready to go. Even before conducting swing timing tests, the system uses a default set for each direction with the Length Factor and Empty Length Factor to 1.0 and all other values to 0.0.
5 Operation

Read this chapter to learn how to use the AntiswayComplete™ system

There are five components for the AntiswayComplete™ product: (1) a Controller (ifm Efector CR2530 Mobile Controller), (2) one or two Encoders (ifm Efector RM9000, a multi-turn absolute encoder), (3) a connector plug (AMP-9797672), (4) a CR0451 Basic Display, (5) optional proximity sensors for slow zone detection, and (6) optional buttons, switch, and lights.

Display Operation

When the system powers up, the logo screen is displayed and details the initialization process. When initialization is complete, the display switches to the correct dashboard, either representing motion in trolley and gantry or trolley motion and position. Press OK to access the main menu. Select Dashboard to view the real time operation.

In the dashboard, the white and green bars on each side represent the trolley or crane speed demand and the anti-sway shaped response, respectively. The swing symbols indicate whether antisway is active. The brake symbols at the bottom indicate whether anti-sway is requesting brake open or closed. The white bar in the center indicates the current hang length.

When the trolley encoder is active and automatic move is enabled (in trolley direction only) the dashboard contains a vertical depiction of the trolley position shown as a yellow arrow and the numeric value (in feet) between the motion limits. (The arrow may not appear until the first crane motion after powering up the system.)
When an automatic move is in progress, the position of the current destination is displayed numerically and as a single horizontal bar along the trolley position line. The stored travel and final heights are shown as green and red lines along the hoist column. Trolley speed and hoist position are displayed numerically at the bottom.

**Automatic Tuning**

When commissioning a crane with the automatic move feature, the SmartCrane system will analyze each automatic move and will “learn” about the crane’s performance by estimating key tuning parameters. In the beginning, the trolley may stop short or go past the destination, exhibiting last minute slow seeking of the destination.

For this reason, you should run the system through automatic moves to a number of different destinations repeatedly, using typical operational loads. You can observe the performance using the “dashboard” shown here, by comparing the yellow arrow indicating the trolley position to the line representing the destination position on the distance scale. The accuracy of the stopping should improve after each move.

Once the automatic moves begin to stop accurately at all destinations, without undershoot or overshoot, the system is ready for operational use.

**Special Menu Items**

Under **Display Setup** menu, select **Software Version** to view information about contacting SmartCrane for questions and technical support.

Select **Display Settings** to change the brightness of the display.

Two other options, **Set Download ID** and **Set Baudrate** should never be accessed except under direct supervision of SmartCrane engineers.

**Alert Beacons**

Alert outputs at positions 36 and 37 indicate antisway operation and warning conditions. Normal use of these signals powers a green and red beacon, respectively. The following table shows the behavior of those signals and what conditions those behaviors indicate.
In case of errors, the red beacon will flash a number of times corresponding to the error code in Table 3 and then remain off for a time before starting the same sequence of flashes again.

### Button Lamps

There are five lamp control signals that may be connected to lighted pushbuttons for automatic move.

When individual buttons are connected for each destination and no automatic move is in progress, the button lamp for each individual destination is steady ON. When the destination cycle (one button selection) strategy is used, destination button #1 is used for cycling and it is steady ON if there is at least one stored destination. When an automatic move is in progress, the active destination or cycling (#1) button lamp flashes along with the Antisway (GREEN) beacon.

If a valid destination is selected and the trolley is not already at the stored position, the Start Auto Move button light will be steady ON, except when an automatic move is in progress.

---

Table 2. Alert Signals

<table>
<thead>
<tr>
<th>Condition</th>
<th>Antisway (GREEN)</th>
<th>Warning (RED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>During startup</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Commissioning Incomplete st startup (pending)</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>During commissioning</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Normal condition, antisway available, no errors</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Automatic move awaiting hoist or automatic hoist UP</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Automatic move in progress (trolley in motion)</td>
<td>Slow Flash</td>
<td>Opposite of Green</td>
</tr>
<tr>
<td>Automatic move awaiting hoist or automatic hoist DOWN</td>
<td>Slow Flash</td>
<td>Opposite of Green</td>
</tr>
<tr>
<td>Antisway ON/OFF (SUSPEND) Signal is installed and is OFF</td>
<td>Fast Blink</td>
<td>Fast Blink Opposite of GREEN</td>
</tr>
<tr>
<td>Antisway Error, Coded Flash in Groups (See Error Codes)</td>
<td>Group Flash</td>
<td>Opposite of Green</td>
</tr>
</tbody>
</table>
System Error Codes

Error codes are indicated by group flashes of red warning beacon. Some errors may appear briefly during a cold start—these can be ignored. Error codes are also displayed in red along the top of the Dashboard display screen.

Table 3. Error Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BAD CONTROL CODE IN</td>
<td>Contact SmartCrane</td>
</tr>
<tr>
<td>2</td>
<td>BAD VEL DEMAND IN</td>
<td>Contact SmartCrane</td>
</tr>
<tr>
<td>3</td>
<td>BAD HOIST RATE IN</td>
<td>Check hoist encoder, cable, and connections</td>
</tr>
<tr>
<td>4</td>
<td>BAD HANG LENGTH IN</td>
<td>Check hoist encoder, cable, and connections</td>
</tr>
<tr>
<td>5</td>
<td>BAD MAX SPEED IN</td>
<td>Review commissioning steps for Speeds</td>
</tr>
<tr>
<td>6</td>
<td>BAD VELOCITY RAMP IN</td>
<td>Review commissioning steps for Ramp Time</td>
</tr>
<tr>
<td>7</td>
<td>BAD ACCELERATION RAMP IN</td>
<td>Set Acceleration Ramp Time less than 10% of Velocity Ramp Time</td>
</tr>
<tr>
<td>8</td>
<td>CRANE NOT RESPONDING</td>
<td>Check travel encoder, cable, and connections</td>
</tr>
<tr>
<td>9</td>
<td>BRAKE NOT RESPONDING</td>
<td>Cannot happen—no brake response inputs</td>
</tr>
<tr>
<td>10</td>
<td>TIME INTERVAL TOO LONG</td>
<td>Contact SmartCrane if this happens after startup</td>
</tr>
<tr>
<td>11</td>
<td>AWAITING CRANE MOTION</td>
<td>Momentary alert</td>
</tr>
<tr>
<td>12</td>
<td>HOLD SUSPEND UNTIL STOPPED</td>
<td>Wait for crane motion to stop before turning on Antisway</td>
</tr>
<tr>
<td>13</td>
<td>CALLING INTERVAL TOO LONG</td>
<td>Contact SmartCrane if this happens after startup</td>
</tr>
<tr>
<td>14</td>
<td>CLOCK ROLLOVER IN</td>
<td>Momentary alert—may be ignored</td>
</tr>
<tr>
<td>15</td>
<td>DESTINATION CHANGED</td>
<td>Cannot change destination while automatic move is in progress. This should not be possible so contact SmartCrane if it happens.</td>
</tr>
</tbody>
</table>
Operator Control of Anti-sway Functions

Read this chapter for suggestions about implementing operator switch control of anti-sway.

The following are suggested guidelines for providing operator switches.

Anti-sway control switches

Most customers will wish to have an on/off switch for anti-sway. This switch should have a light or other indication that anti-sway is responding properly to the PLC.

When this switch is OFF, it should send ANTISWAY = suspend (no voltage) to the anti-sway controller.

In addition, operators should have a separate "suspend" function for several reasons. First, there may be some small residual sway that the operator wishes to remove: leaving anti-sway ON will defeat the operator’s commands, leaving the load with same residual sway. Touching SUSPEND (a normally closed switch) will prevent antisway from interfering.

In addition, an operator may stops the load a small distance away from the destination. In these cases, it may be quicker to swing the load that small distance with anti-sway in SUSPEND mode and then lower the load to contact while it is still swinging.

Anti-sway will be reactivated automatically when the switch is released and the crane has come to a stop.

Alternatively, during commissioning you can specify that the slowest speed increment will always operate without antisway correction.

Emergency Stop Switch

One or more emergency stop switches may be installed in series, in locations where workers can bring the crane to a stop in case of emergency. Use the commissioning mode to determine whether this switch brings the crane to a spot with or without antisway control.
Anti-sway power-interrupt switches

While the anti-sway controller is designed to run continuously, there may be an occasional need to interrupt power. It is safe to momentarily remove power from the controller while the crane is at rest, to allow the system to restart automatically.
7 Parts List and Ordering Information

Read this chapter to determine what equipment is supplied for various options, and to prepare an order.

Preliminary Inquiries

Use the following questionnaire for preliminary inquiries. All are part of SmartCrane Product SC-00, with different options

☐ Manual antisway for one direction of travel without Slow Zone (Proximity) sensors
☐ Manual antisway for one direction of travel with Slow Zone (Proximity) sensors
☐ Manual antisway for two directions of travel without Slow Zone (Proximity) sensors
☐ Manual antisway for two directions of travel with Slow Zone (Proximity) sensors
☐ Manual and automatic Antisway for one direction of travel without Slow Zone (Proximity) sensors
☐ Manual and automatic Antisway for one direction of travel without Slow Zone (Proximity) sensors
☐ SmartCrane-supplied metal cabinet, equipment pre-installed

Contact SmartCrane at sales@smartcrane.com or +1.757.303.0167 for price quote and delivery times.
Ordering Information

The AntiswayComplete™ product SC-00 Basic includes mobile controller, basic display, multi-turn hoist encoder and cabling, trolley activation relays, power supply, controller connector cable and strip connectors, and 2 DIN rail sections. There are two basic configurations of the AntiswayComplete™ product and a number of options to consider.

**Configuration 1:** Manual Assist Antisway for one or two dimensions (Trolley and Gantry/ Crane). This configuration includes one encoder (hoist) and relays for two motion dimensions.

**Configuration 2:** Manual Assist Antisway for one dimension plus automatic move and automatic hoist. This configuration has an additional multi-turn encoder and cabling for trolley position burt relays for only one dimension of motion.

Table 4 gives features and options for each configuration.
Table 4. SmartCrane AntiswayComplete™ Features and Options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
<th>Configura tion 1</th>
<th>Configura tion 2</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning display with dashboard</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dimensions of antisway assist for operator speed demands</td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Encoders supplied</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Horizontal motion relays supplied</td>
<td></td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Brakes control relays supplied (optional)</td>
<td>✓</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ANTISWAY/SUSPEND input</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EMERGENCY STOP input</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td>(1)</td>
</tr>
<tr>
<td>Speed inputs, with companion REVERSE signal</td>
<td></td>
<td>4</td>
<td>4</td>
<td>(2)</td>
</tr>
<tr>
<td>Number of separate speed inputs. FORWARD or REVERSE, without companion REVERSE signal</td>
<td>3</td>
<td>3</td>
<td></td>
<td>(2)</td>
</tr>
<tr>
<td>Automatic motion to saved destinations</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Maximum number of saved destinations</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Automatic move destination inputs</td>
<td></td>
<td></td>
<td>5</td>
<td>(3)</td>
</tr>
<tr>
<td>Automatic move destination cycle input (NEXT)</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td>(3)</td>
</tr>
<tr>
<td>Automatic or operator hoist control with destination</td>
<td>✓</td>
<td>1</td>
<td></td>
<td>(4)</td>
</tr>
<tr>
<td>Automatic move START input</td>
<td>✓</td>
<td>1</td>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Automatic move DEADMAN input</td>
<td>✓</td>
<td>1</td>
<td></td>
<td>(5)</td>
</tr>
<tr>
<td>Antisway active output (Green beacon optional)</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Warning output (Red beacon optional)</td>
<td>✓</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trolley FWD/REV outputs</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Trolley speed reference 0-10VDC</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Trolley brakes OPEN output</td>
<td>✓</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gantry/Grane FWD/REV outputs</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gantry/Grane speed reference 0-10VDC</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gantry/Grane brake OPEN output</td>
<td>✓</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hoist UP/DOWN outputs</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hoist STOP output</td>
<td>✓</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hoist speed reference 0-10VDC</td>
<td>✓</td>
<td></td>
<td>1</td>
<td>(6)</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Automatically detected if wired (must be normally closed). During commissioning select stopping method: with or without antisway (but with ramp time). Could be wired to interrupt power but this is dangerous and not recommended.
2. Set speed inputs to x%, y%, (z%) during commissioning; last one is always 100%.
3. Up to five destinations may be stored at one time. If "cycle destinations" option is selected, then Automatic move START input signal must be provided and destination 1 becomes the "NEXT" signal.
4. All recorded destinations have defined TRAVEL and DESTINATION hang lengths (square move). Automatic hoist UP/DOWN output option may be set during commissioning. The system will delay trolley motion until correct TRAVEL hang length is reached, by either automatic or operator control.
5. START and DEADMAN can be selected together; if DEADMAN is selected without START, then the DEADMAN signal will trigger the start of moves.
Options:

• SubPanel and Labor for Factory Wiring

• Stainless Steel Cabinet Plus Mounting Labor

• Steel Cabinet Plus Mounting Labor

• Magnetic Slow Zone Sensors and Cabling for One Horizontal Dimension

• Red Beacon Alerts Indicator

• Green Beacon Operation Ready Indicator

• Extra Patch Cords for Sensors, 5m length

• Emergency Stop Button and Label

• Lighted Buttons for Destination Selection or Speed Level

• Cube Relays and bases for brake activation for trolley or hoist motion