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Closed-Loop Constant Tension Loadcell-Controlled Center Winder Quick Start Guide

⚠ Warning!

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Introduction

A Constant Tension Center Winder (CTCW) controls the web tension through the entire wind of product from an empty core to full roll.

An automatic taper tension function is necessary in some cases to increase or decrease the tension as the roll builds in order to protect the product or ensure a stable finished roll.

Web tension is equal to the torque at the winder shaft divided by the radius of the roll.

T = Web Tension
τ = Winder Shaft Torque
r = Roll Radius
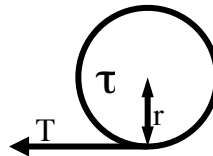
$$T \text{ (lbs)} = \tau \text{ (lb-ft)} \div r \text{ (ft)}$$

As roll diameter builds up, torque at the winder shaft must increase for constant web tension.

As roll diameter builds up, shaft rotational velocity - reel speed - must decrease for a constant web surface speed.

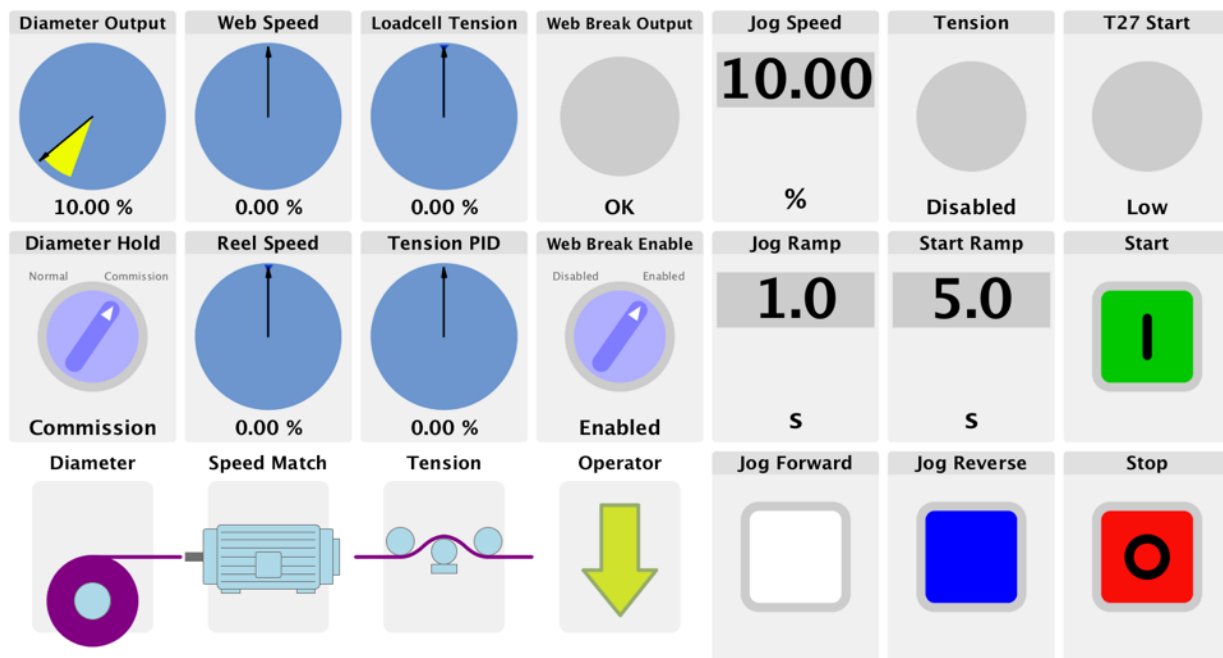With loadcell feedback, the winder reel speed is adjusted to maintain constant tension.

Best control is achieved when the winder reel speed is also governed with diameter calculation from web speed and roll diameter. The diameter is defined by the formula -

[(Web Speed) / (Reel Speed)]

It is essential to accurately calibrate the web and reel speeds!

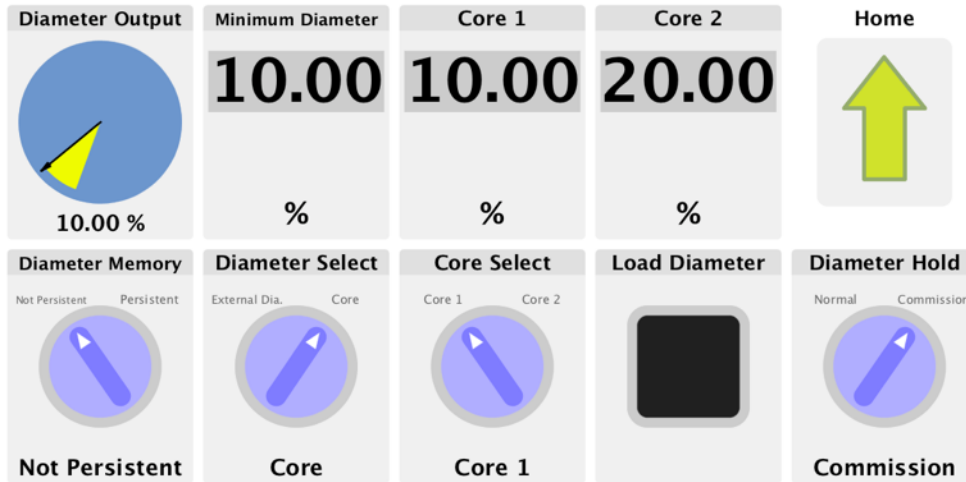# Loadcell Winder Commissioning - Speed Calibration

1. Ensure the system hardware is wired, installed and safety approved for powering up.

2. Setup and completely commission the web and reel drives according to manufacturer's instructions and recommendations.

3. Install and setup your **smarty**® **dw210-1103**, the Ethernet network and your computer according the **smarty** user manual, HG502513.

4. Use **drive.web savvy**® software on a computer or a **drive.web savvyPanel**® operator interface such as **dw230 savvyPanel Touch**, 7" screen, or **savvyPanel**, the free app for Apple® mobile digital devices; iPad®, iPhone®, and iPod Touch®.

5. Add the case-sensitive *savvyPanel Password*, "**loadcelL**" . Use the *savvyPanel* menu on a computer, the setup dialog for **dw230**, or touch the **drive.web** icon at lower-left in the Apple app. No **savvyPanel** tiles are shown if the password is not added in that display device!

6. The initial page is the home page, by default. This can be changed in the preferences for the particular **savvyPanel** operator device. The home page is unique because it can be accessed from any page via the home button which is always visible. The home button can be secured with a home password that is set for the particular **savvyPanel** operator device.

7. The home page of this configuration is intended for engineering and commissioning and not for typical operator use. A link is provided to an operator's page.

8. The home page provides links to three additional commissioning pages which guide the installation.

Loadcell Winder Commissioning - Speed Calibration continued…

9. Press the ***Diameter*** page link.

Diameter Output	Minimum Diameter	Core 1	Core 2	Home
10.00 %	10.00 %	10.00 %	20.00 %	↑

Diameter Memory	Diameter Select	Core Select	Load Diameter	Diameter Hold
Not Persistent	Core	Core 1	■	Commission

10. Determine the minimum diameter percentage. You must measure the smallest possible core and the largest possible full roll. Calculate -

    100 * [(Minimum Diameter) / (Maximum Diameter)]

11. Enter the percentage in both ***Minimum Diameter*** and in ***Core 1***.

12. Set ***Diameter Select*** switch to ***Core***. Set ***Core Select*** to ***Core 1***.

13. Press the black pushbutton, ***Load Diameter*** and make sure that the ***Diameter Output*** matches the ***Minimum Diameter***.

14. Set ***Diameter Hold*** to ***Commission***.

15. Return to the home page.

16. Insert an empty core into the winder reel.

17. Set the controls as follows:

Control	Tension Enable	Diameter Hold	Start	Start	Fast Stop	Web Speed
smarty Terminal	T30	savvyPanel	T27	savvyPanel	T24	System
State	Off	Commission	On	Start	On	100%

18. Press the ***Speed Match*** page link.

Web Speed	Reel Speed	Diameter Output	Tension	Start
0.00 %	0.00 %	10.00 %	Disabled	▌

Web Speed Scaling	Reel Speed Scaling	Diameter Hold	Tension Enable	Stop
10.000 ∨	10.000 ∨	Commission	Terminals	O

Loadcell Winder Commissioning - Speed Calibration continued…

19. Determine what the maximum web speed shall be. This is usually limited by a system component, gearing ratio or by a consideration of the product requirements.

   19.1. Start the web drive(s) and ramp up to maximum web speed.

   19.2. Adjust the **Web Speed Scaling** parameter so that **Web Speed** parameter = 100%.

20. It is very helpful to have a handheld tachometer with surface speed measurement capability. If you do not have access to this tool you will have to determine the surface speed by calculation using rotational speed, gearing ratios and roller diameters.

   20.1. With the web drive(s) running at 100% web speed, measure the surface speed of the driving rollers.

   20.2. Adjust the maximum speed scaling of the winder reel drive so that the surface speed of the empty winder core matches the surface speed of the driven web rollers. With the web speed at 100% and tension disabled, the analog speed demand output at T21 is 9.5VDC.

   20.3. Ensure that your motor does not exceed the maximum speed indicated on its name plate. If it does, you must decrease the maximum allowable speed of the entire system accordingly.

   20.4. Adjust the **Reel Speed Scaling** parameter so that **Reel Speed** parameter = 100%.

21. Ramp the speed down, this concludes the speed calibration. You are now ready to thread product into the machine.

Loadcell Winder Commissioning - PID Tuning & Taper Tension

Best winder performance is achieved by tuning PID response to the loadcell feedback signal. This is a typical PID controlled closed-loop feedback system referred to as PID henceforth. A typical strategy for tuning PID is to iteratively increase the demands on the system while adjusting parameters to optimize performance. The task is complete when the system performance is acceptable under all foreseeable machine conditions.

1. Return to the home page, then press the **Tension** page link.
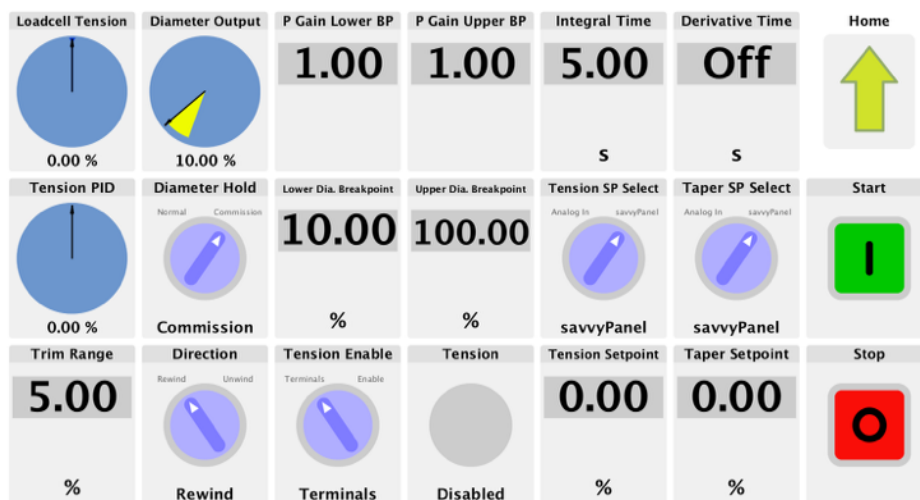
Loadcell Winder Commissioning - PID Tuning continued…

2. When the product is loaded and threaded onto an empty core and personnel are clear of the machine, set the controls:

Control	Tension Enable	Diameter Hold	Diameter Hold	Start	Start	Fast Stop
smarty Terminal	savvyPanel	T32	savvyPanel	T27	savvyPanel	T24
State	Enabled	Off	Normal	On	Start	On

Note that the **Load Diameter** signal is momentarily applied every time a new core is loaded. This is typically via a digital signal at **T31**. A button is provided on the **Diameter** page which provides the same function.

3. Set the system acceleration and deceleration rates slower than the desired setting at first, if possible.

4. Start the system while watching the action of the PID.

   4.1. It may be helpful to perform a dock trend on the PID output. (This requires **drive.web savvy** software. Right-click on **Tension PID** and choose **Add to Parameter Dock**. In the dock window, choose **Show Trend** under the **Dock** menu. In the trend window, change the time span to the minimum, 10s.

   4.2. The PID output should exhibit an ideal, damped response without undershoot or overshoot. Tension should build in the web to an acceptable level. You should adjust the tension setpoint at this time to produce minimal acceptable web tension.

   4.3. PID tuning can be an iterative process. Start by tuning the proportional term with a long integral time, e.g. 10 seconds, to reduce the integral contribution.

   4.4. Note that the proportional gain is profiled as the diameter builds. It will be necessary to verify the tuning both with a full and empty roll and set the gain for each.

   4.5. Change the web speed by 10% to 20% and observe the response. Assuming that the buildup is small at this point, adjust **P Gain at Lower BP** to achieve the best damped response.

   4.6. Here is a link to a Wikipedia page with details and methods for PID tuning

   https://en.wikipedia.org/wiki/PID_controller

5. If the PID moves to or slowly moves toward the output clamps and stays there, you must repeat the speed calibration procedure.

6. Stop the system, increase the tension and the system acceleration and deceleration rates to the desired settings and restart while watching the response. Repeat steps 5.2.1 through 5.2.4.

7. Stop the system, increase the system speed setpoint to 100% and restart while watching the response.

8. Observe the complete wind-up of a roll in order to determine if any **Taper Setpoint** is appropriate. A positive setpoint will cause the tension to decrease as the roll diameter increases. A negative setpoint gives increased tension with diameter.

## Loadcell Winder Commissioning - PID Tuning continued…

9. As the roll approaches its maximum diameter it is important to verify the stability of the PID response, especially during acceleration and deceleration. Stop and start the system with a full roll while observing the response.

> 9.1. A full roll is heavier and may require increased gain.

> 9.2. Adjust *P Gain at Upper Breakpoint* parameter.

10. Finally, decrease *Integral Time* to a minimal value while ensuring that the response is stable. If the integral time is too short, instability will result.

11. An additional *Alarms* page is available when an alarm is active. Press the yellow triangle to view this page.
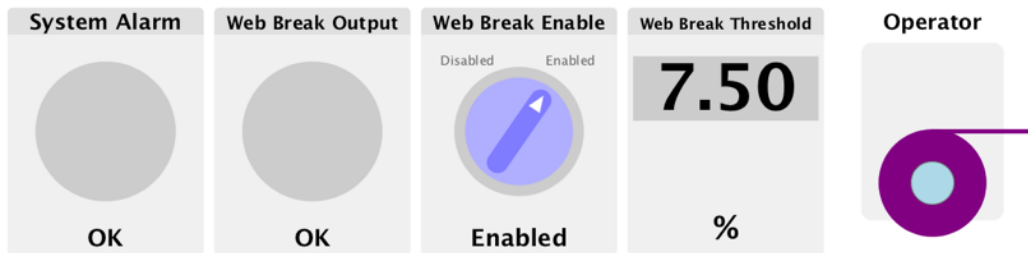
> 11.1. A web break alarm occurs when the unfiltered diameter output differs from the filtered output by more than *Web Break Threshold*. The filter time constant is settable via *drive.web savvy* software, in the *Diameter Calculator* function block.

This is a quick start procedure and there is no attempt to discuss all aspects of risk or system optimization. There is no replacement for expertise and experience and the installer must be aware that expert consultancy may be necessary.

Contact us at *bardac drives*, *drive.web* for assistance.

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