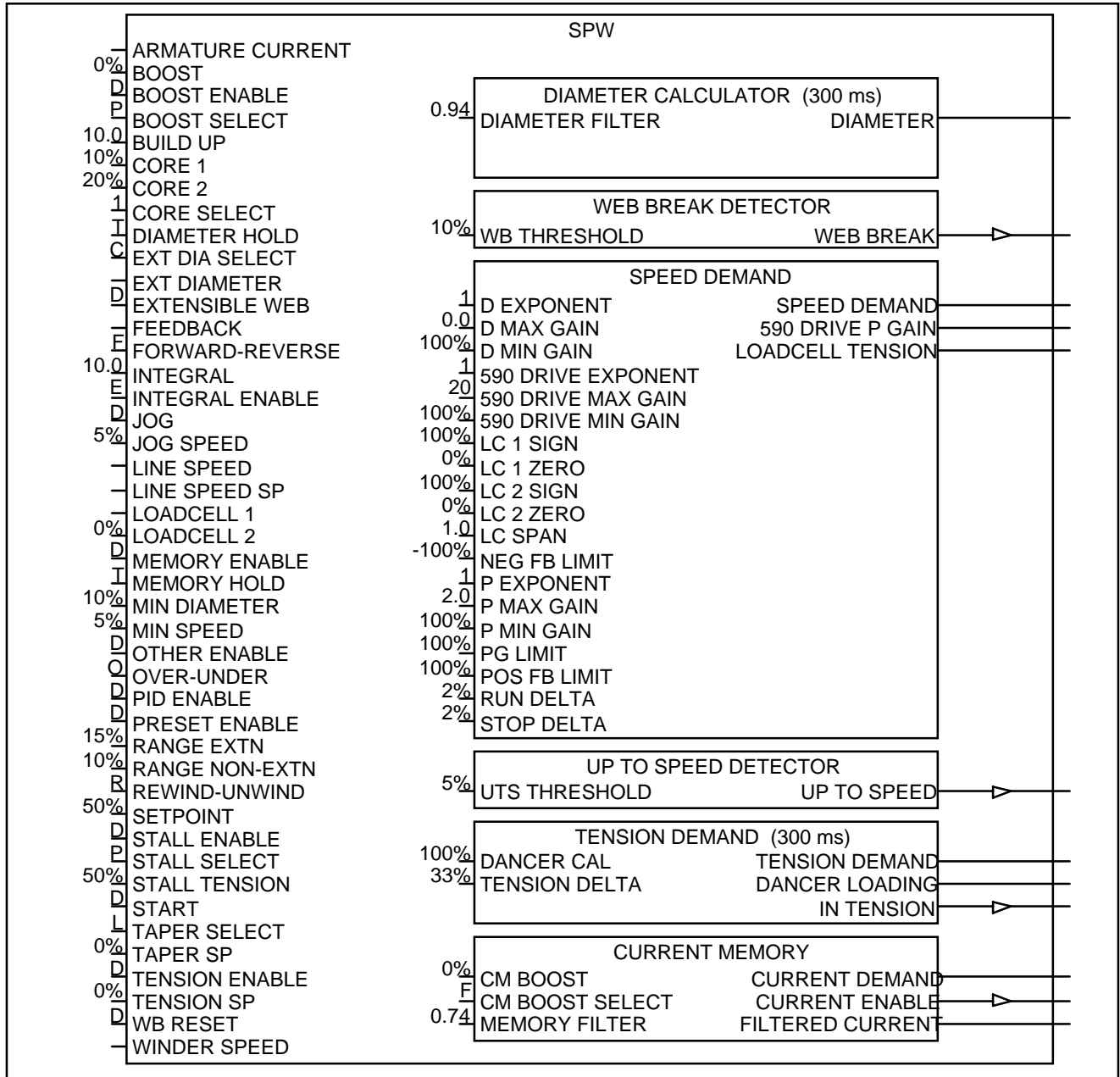## Winders/SPW

This function block implements a Speed Programmed Winder. It is intended to perform the speed demand calculations and associated logic for a closed loop winder. A simplified block diagram is shown below; detailed drawings can be found in the appendix.

This function block is made up of five sub-function blocks: "Diameter Calculator & Web Break Detector", "Up to Speed Detector", "Tension Demand", "Speed Demand", and "Current Memory". Each of these are described below. Unless otherwise noted, all parameters are persistent, can be preset, and have set and get methods. All logic

outputs have built in Logic Senders.

Diameter Calculator & Web Break Detector

This block performs the Diameter calculation used by the other sub-function blocks. Simply, the diameter is calculated by dividing the absolute value of the **Line Speed** by the absolute value of the **Winder Speed**. This result is scaled by the Build Up parameter[1]. This result goes to a filter block who's output can be held and is then clamped giving the final diameter output. **Diameter Filter** is used to set the filter rate and the diameter input to the filter is held when **Preset Enable** is false and **Diameter Hold** is true, or when **Preset Enable** is false and **Tension Enable** is false or **Line Speed** is less than **Min Speed**. Note that only the input diameter is held, the filter output may continue to change in the held state until it matches the held diameter. **Min Diameter** is the minimum diameter value for the the clamp. The **Diameter** output will not go below this value.

It is also possible to use a Diameter Preset (**Core 1**, **Core2** and **Ext**ernal **Diameter**, selected by **Core Select** and **Ext Dia Select**). The Diameter Preset is used as both the input and output of the filter if **Preset Enable** is true and **Tension Enable** is false or **Line Speed** is less than **Min Speed**. The Diameter Preset is also loaded into the filter whenever the module is restarted.

The Web Break Detector takes the difference between the computed diameter and the previously computed diameter and based on **Rewind**-**Unwind** and **Forward**-**Reverse**, adds or subtracts it to an internal accumulator[2] . When the internal accumulator is greater than **WB Threshold**, the **Web Break** output becomes true, otherwise it is false. The internal accumulator can be reset to zero by either **WB Reset** going true or **Tension Enable** going false.

Diameter Tick Time can only be preset and specifies the rate at which the diameter is calculated.

Up to Speed Detector

This block compares a computed line speed (uses **Winder Speed, Diameter** and **Build Up**) with **Line Speed SP**. If the absolute value of the difference is is less than **UTS Threshold**, the **Up to Speed** output is set true.

Tension Demand

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[1] The *Link* system uses a normalized numbering system. All values are represented as numbers between -1 and 1. When the result of a calculation would be a value outside this range, the result is saturated to -1 or 1 so that it will be a legal value. Thus, many intermediate calculations need to be scaled to prevent saturation.

[2] The accumulator is clamped so that it never goes below 0. The sum added in is clamped to **WB Threshold**/4.

This block computes a tension demand. The first part of the tension demand calculation involves computing a taper term. This term is based on **Diameter**, **Taper SP**, the selected core (**Core 1** or **Core 2**), and the type of **Taper Select**ed (see drawings for details). The taper term is multiplied by **Tension SP**, and if **Stall Enable** and **Boost Enable** are false, is the input to the ramp. If **Stall Enable** is true, this term is multiplied by **Stall Tension** and input into the ramp if **Stall Select** is proportional, otherwise, just the **Stall Tension** term is presented to the ramp. If **Boost Enable** is true and **Stall Enable** is false, a boost is added before the value is input to the ramp. The amount of boost is based on **Boost Select**. If it is fixed, the amount of boost will be **Boost**. If it is proportional, the amount will **Boost** multiplied by the tension term. **Tension Delta** controls the ramp rate and specifies the amount the ramp may change each **Tension Tick Time** (the rate at which tension demand is calculated). The ramp output is also the **Tension Demand** output. The tension demand can be multiplied by **Dancer Cal** to compute the **Dancer Loading** output. This message is sent only when **Tension Enable** is true and **Other Enable** is false. This condition also sets the **In Tension** output.

Speed Demand

This block calculates the **Speed Demand** output. The **Start** and **Jog** select wether the **Line Speed** or the **Jog Speed** is input into the ramp. If either **Start** or **Jog** is true, **Run Delta** is use as the ramp rate, otherwise, **Stop Delta** is used for the stop rate and the ramp input is zero. The ramp output is divided by **Build Up** (see Diameter Calculator), then the scaled PID trim is added and finally it is divided by the signed **Diameter** (determined by **Over-Under**) to produce the **Speed Demand** output.

See the **G Profiler/Generic** data sheet for a description on how the PID output is generated. This output is multiplied by the selected Range and added as a trim to the **Speed Demand** being calculated.

Current Memory

This block calculates the **Current Demand** output. This output is simply the filtered value of the **Armature Current** input (**Memory Filter** specifies the filter time constant) which has **CM Boost** (selected by **CM Boost Select**) added to it and is then passed through a track and hold block. The hold function is enabled by either the **Memory Hold** input being true or the **Memory Enable** input being in the enable state and **Web Break** (see "Diameter Calculator & Web Break Detector" description) being false.

Parameter	Description	Default
	Diameter Calculator - Main Parameters	
Min Diameter	Minimum value of Diameter Calculator output. Full diameter = 100% Min = 100%/Build Up	10%
Diameter Filter	Diameter Filter value = $e^{-\text{Tick Time}/\text{Filter Time}}$ (if Tick Time = 300ms and Filter Time = 5 seconds, then Filter value = 0.94).	0.94
Diameter Hold	Initial condition of Diameter Filter.	Track
Preset Enable	Initial condition of Diameter Preset. Preset loads value of Core or External Diameter into Diameter Filter.	Disabled
Min Speed	Line Speed value below which Diameter is held.	5%
Build Up	Ratio of Full Roll Diameter to Core Diameter.	10
Diameter Tick Time	Clock period for Diameter calculation. Filter Time is proportional to Tick Time.	300 ms
	Diameter Calculator - Web Break Parameters	
WB Threshold	Internal accumulator threshold value to detect a web break. Represented as a % of full roll diameter.	10%
Rewind-Unwind	Selects application for Rewinding or Unwinding. Rewind = true, Unwind = false. See Forward-Reverse.	Rewind
Forward-Reverse	Initial condition of line Direction. Only used in reversing lines. In Reverse, unwind becomes rewind and rewind becomes unwind. Forward = true, Reverse = false.	Forward
WB Reset	Initial condition of Web Break Counter Reset.	Disabled
Tension Enable	Initial condition of Tension Enable.	Disabled
	Diameter Calculator - Core Parameters	
Ext Diameter	Initial value of External Diameter input (% Full roll).	100%
Ext Dia Select	Selects source of Diameter Preset (see Preset Enable).	Core

Core 1	Value of Core 1 (% Full roll).	10%
Core 2	Value of Core 2 (% Full roll).	20%
Core Select	Initial core selection (Core 1 = false, Core 2 = true).	Core 1
	Speed Demand - Jog Parameters	
Run Delta	Run Ramp increment per Tick Time (Speed Demand Tick determined by update rate of Line Speed SP input, typically 100ms). 2% in 100ms = Ramp time to 100% of 5 seconds.	2%
Stop Delta	Stop Ramp increment, when Start and Jog are Disabled (see Run Delta above).	2%
Jog Speed	Value of Jog Speed	5%
Start	Initial condition of Start input	Disabled
Jog	Initial condition of Jog input	Disabled
	Speed Demand - PID Parameters	
Setpoint	Dancer Position Setpoint or initial value for Tension Setpoint.	50%
PID Enable	Initial condition of PID Enable.	Disabled
Integral Enable	Initial condition of PID Integral Enable.	Enabled
PG Limit	If absolute value of proportional output is > PG Limit, then Integral is held at current value.	100%
Pos FB Limit	If Feedback value is > Pos FB Limit, then Integral is held at current value.	100%
Neg FB Limit	If Feedback value is < Neg FB Limit, then Integral is held at current value.	-100%
Integral	Integral Time Constant in seconds.	10

	Speed Demand - Profile Parameters	
	The Gain Profiler provides the ability to vary the gain with diameter. Three parameters are available: Max Gain which sets the output at maximum diameter, Min Gain which sets the percentage of Max Gain at minimum diameter, and Exponent which sets the profile between the max and min gain output values.	
Drive Max Gain	590 Drive Speed loop proportional Gain at Maximum Diameter (if connected).	20
Drive MinGain	Drive Speed loop proportional Gain at Minimum Diameter (if connected).	100%
Drive Exponent	Drive Speed loop proportional Gain profile between Drive Max gain and Drive Min gain.	1
D Max Gain	PID Derivative Gain at Maximum Diameter.	0
D Min Gain	PID Derivative Gain at Minimum Diameter.	100%
D Exponent	PID Derivative Gain profile between D Max Gain and D Min Gain.	1
P Max Gain	PID Proportional Gain at Maximum Diameter.	2
P Min Gain	PID Proportional Gain at Minimum Diameter.	100%
P Exponent	PID Proportional Gain profile between P Max Gain and P Min Gain.	1
	Speed Demand - Loadcell Parameters	
LC Span	LC Span is the Gain of the Loadcell Amplifier. Range is -10 to 10.	1
LC 1 Sign	Sign of Loadcell 1 input. 100% = Positive, -100% = Negative.	100%
LC 1 Zero	Zero offset for Loadcell 1 input.	0%
LC 2 Sign	Sign of Loadcell 2 input. 100% = Positive, -100% = Negative.	100%
LC 2 Zero	Zero offset for Loadcell 2 input.	0%
Loadcell 2	Initial value of Loadcell 2 input.	0%

	Tension Demand - **Main Parameters**	
Tension Tick Time	Clock period for Tension Demand calculation.	300 ms
Stall Tension	Tension value when Stall Enabled.	50%
Stall Select	Stall value - "Fixed" = Stall Tension, "Proportional" = Stall Tension * Set Tension.	Proportional
Stall Enable	Initial condition of Stall Enable	Disabled
Boost	Determines Boost value when Boost Enabled.	0%
Boost Select	Boost value - "Fixed" = Boost, "Proportional" = Boost ^{x} Set Tension.	Proportional
Boost Enable	Initial condition of Boost Enable.	Disabled
Tension SP	Initial value of Tension Setpoint.	0%
Taper SP	Initial value of Taper Setpoint.	0%
Taper Select	Selects "Linear" or "Hyperbolic" Taper profile.	Linear
	Tension Demand - **Output Parameters**	
Dancer Cal	Scaling of output for Dancer loading.	100%
Tension Delta	Tension Ramp increment per Tension Tick Time. For Tension Tick Time of 300 ms and Tension Delta of 33%, 100% ramp time = 1 second.	33%
	Current Memory - **Main Parameters**	
CM Boost	Increase in current when Current Memory enabled.	0%
CM Boost Select	Boost value - "Fixed" = Boost, "Proportional" = Boost ^{x} Measured Current.	Fixed
Memory Filter	Memory Filter value = $e^{-\text{Tick Time}/\text{Filter Time}}$ (if Tick Time = 300ms and Filter Time = 1 second, then Filter value = 0.74).	.74

	Current Memory - Control Parameters	
Memory Hold	Initial condition of Memory Track and Hold (use if the current must be sampled before enabling current memory).	Track
Memory Enable	Initial condition of Current Memory Enable (Memory Enable also enables Memory Hold).	Disabled
	Miscellaneous Parameters	
UTS Threshold	Up to Speed Threshold. Up to Speed Output is true when Winder Surface Speed is within Threshold of Line Speed.	5%
Over-Under	Selects Winding Direction. Also used for direction of Jog for payout and takeup.	Over
Range Non-Extn	Trim range, as a percentage of full speed, of the PID loop when Extensible Web is Disabled.	10%
Range Extn	Trim range, as a percentage of full speed, of the PID loop when Extensible Web is Enabled.	15%
Extensible Web	Selects the PID Trim Range for two web types: Extensible or Non-Extensible.	Disabled
Other Enable	Disconnects Dancer Loading output when other spindle Tension is Enabled.	Disabled

Operation	Description
Armature Current	Current Memory input. Expects a value between -200% and 200%.
Boost	Tension Demand input. Expects a value between -100% and 100%.
Boost Enable	Tension Demand input. Expects Enabled (true) or Disabled (false).
Boost Select	Tension Demand input. Expects Proportional (true) or Fixed (false).
Build Up	General Input. Expects a value between 1 and 20.
CM Boost	Current Memory input. Expects Proportional (true) or Fixed (false).
CM Boost Select	Current Memory input. Expects a value between -100% and 100%.
Core 1	Diameter Calc. input. Expects a value 0.1% to 100% Full Roll.
Core 2	Diameter Calc. input. Expects a value 0.1% to 100% Full Roll.
Core Select	Diameter Calc. input. Expects Core 2 (true) or Core 1 (false).
D Exponent	Speed Demand input. Expects an ordinal between 1 and 10.
D Max Gain	Speed Demand input. Expects a value between -5 and 5.
D Min Gain	Speed Demand input. Expects a value 0 to 100% (of Max Gain).
Dancer Cal	Tension Demand input. Expects a value between -100% and 100%.
Diameter Filter	Diameter Calc. input. Expects a value between 0 and 1.0.
Diameter Hold	Diameter Calc. input. Expects Hold (true) or Track (false).
Drive Exponent	Speed Demand input. Expects an ordinal between 1 and 10.
Drive Max Gain	Speed Demand input. Expects a value between 0 and 200.
Drive Min Gain	Speed Demand input. Expects a value 0 to 100% (of Max Gain).
Ext Dia Select	Diameter Calc. input. Expects External (true) or Core (false).
Ext Diameter	Diameter Calc. input. Expects a value 0.1% to 100% Full Roll.
Extensible Web	Speed Demand input. Expects Enabled (true) or Disabled (false).
Feedback	Speed Demand input. Expects a value between -100% and 100%.
Forward-Reverse	Diameter Calc. input. Expects Forward (true) or Reverse (false).
Jog	Speed Demand input. Expects Enabled (true) or Disabled (false).
Jog Speed	Speed Demand input. Expects a value between -120% and 120%.
LC 1 Sign	Speed Demand input. Expects a value between -100% and 100%.

LC 2 Sign	Speed Demand input. Expects a value between -100% and 100%.
LC 1 Zero	Speed Demand input. Expects a value between -100% and 100%.
LC 2 Zero	Speed Demand input. Expects a value between -100% and 100%.
LC Span	Speed Demand input. Expects a value between -10 and 10.
Line Speed	Diameter Calc. input. Expects a value between -120% and 120%.
Line Speed SP	Speed Demand input. Expects a value between -120% and 120%.
Loadcell 1	Speed Demand input. Expects a value between -100% and 100%.
Loadcell 2	Speed Demand input. Expects a value between -100% and 100%.
Memory Enable	Current Memory input. Expects Enabled (true) or Disabled (false).
Memory Filter	Current Memory input. Expects a value between 0 and 1.0.
Memory Hold	Current Memory input. Expects Hold (true) or Track (false).
Min Diameter	Diameter Calc. input. Expects a value 0.1% to 100% Full Roll.
Min Speed	Diameter Calc. input. Expects a value between -120% and 120%.
Other Enable	Tension Demand input. Expects Enabled (true) or Disabled (false).
Over-Under	Tension Demand input. Expects Over (true) or Under (false).
P Exponent	Speed Demand input. Expects an ordinal between 1 and 10.
P Max Gain	Speed Demand input. Expects a value between -30 and 30.
P Min Gain	Speed Demand input. Expects a value 0 to 100% (of Max Gain).
Preset Enable	Diameter Calc. input. Expects Enabled (true) or Disabled (false).
Range Extn	Speed Demand input. Expects a value between -100% and 100%.
Range Non-Extn	Speed Demand input. Expects a value between -100% and 100%.
Rewind-Unwind	Tension Demand input. Expects Rewind (true) or Unwind (false).
Run Delta	Speed Demand input. Expects a value between 0 and 100%.
Stall Enable	Tension Demand input. Expects Enabled (true) or Disabled (false).
Stall Select	Tension Demand input. Expects Proportional (true) or Fixed (false).
Stall Tension	Tension Demand input. Expects a value between -100% and 100%.
Start	Speed Demand input. Expects Enabled (true) or Disabled (false).
Stop Delta	Speed Demand input. Expects a value between 0 and 100%.

Taper SP	Tension Demand input. Expects a value between -100% and 100%.
Taper Select	Tension Demand input. Expects Hyperbolic (true) or Linear (false).
Tension Delta	Tension Demand input. Expects a value between 0 and 1.0.
Tension Enable	Tension Demand input. Expects Enabled (true) or Disabled (false).
Tension SP	Tension Demand input. Expects a value between -100% and 100%.
UTS Threshold	Up to Speed input. Expects a value between -120% and 120%.
WB Threshold	Diameter Calc. input. Expects a value between 0 and 100%.
WB Reset	Diameter Calc. input. Expects Enabled (true) or Disabled (false).
Winder Speed	General input. Expects a value between -120% and 120%.
Get Boost	Returns the current state: Value between -100% and 100%.
Get Boost Enable	Returns the current state: Enabled (true) or Disabled (false).
Get Boost Select	Returns the current state: Proportional (true) or Fixed (false).
Get Build Up	Returns the current state: Value between 1 and 20.
Get CM Boost	Returns the current state: Value between -100% and 100%.
Get CM Boost Select	Returns the current state: Proportional (true) or Fixed (false).
Get Core	Returns the current state: % (Full Roll = 100%).
Get Core 1	Returns the current state: % (Full Roll = 100%).
Get Core 2	Returns the current state: % (Full Roll = 100%).
Get Core Select	Returns the current state: Core 2 (true) or Core 1 (false).
Get Current Demand	Returns the current state: Value between -200% and 200%.
Get D Exponent	Returns the current state: Ordinal 1 to 10.
Get D Max Gain	Returns the current state: Value between 0% and 100%.
Get D Min Gain	Returns the current state: % of Max Gain.
Get Dancer Cal	Returns the current state: Value between -100% and 100%.
Get Diameter	Returns the current state: % (Full Roll = 100%).
Get Diameter Filter	Returns the current state: Value between -1.0 and 1.0.

Get Diameter Hold	Returns the current state: Holding (true) or Tracking (false).
Get Diameter Preset	Returns the current state: % (Full Roll = 100%).
Get Drive Exponent	Returns the current state: Ordinal 1 to 10.
Get Drive Max Gain	Returns the current state: Value between 0 and 200.
Get Drive Min Gain	Returns the current state: % of Max Gain.
Get Drive P Gain	Returns the current state: Value between 0 and 200.
Get Ext Dia Select	Returns the current state: Enabled (true) or Disabled (false).
Get Ext Diameter	Returns the current state: % (Full Roll = 100%).
Get Extensible Web	Returns the current state: Enabled (true) or Disabled (false).
Get Feedback	Returns the current state: Value between -100% and 100%.
Get Filtered Current	Returns the current state: Value between -200% and 200%.
Get Forward-Reverse	Returns the current state: Forward (true) or Reverse (false).
Get Jog	Returns the current state: Enabled (true) or Disabled (false).
Get Jog Speed	Returns the current state: Value between -120% and 120%.
Get LC 1 Sign	Returns the current state: Value between -100% and 100%.
Get LC 2 Sign	Returns the current state: Value between -100% and 100%.
Get LC 1 Zero	Returns the current state: Value between -100% and 100%.
Get LC 2 Zero	Returns the current state: Value between -100% and 100%.
Get LC Span	Returns the current state: Value between -10 and 10.
Get Line Speed	Returns the current state: Value between -120% and 120%.
Get Line Speed SP	Returns the current state: Value between -120% and 120%.

Get Loadcell 1	Returns the current state: Value between -100% and 100%.
Get Loadcell 2	Returns the current state: Value between -100% and 100%.
Get Memory Enable	Returns the current state: Enabled (true) or Disabled (false).
Get Memory Filter	Returns the current state: Value between 0 and 1.0.
Get Memory Hold	Returns the current state: Holding (true) or Tracking (false).
Get Min Diameter	Returns the current state: % (Full Roll = 100%).
Get Min Speed	Returns the current state: Value between -120% and 120%.
Get Other Enable	Returns the current state: Enabled (true) or Disabled (false).
Get Over-Under	Returns the current state: Over (true) or Under (false).
Get P Exponent	Returns the current state: Ordinal 1 to 10.
Get P Max Gain	Returns the current state: Value between 0% and 100%.
Get P Min Gain	Returns the current state: % of Max Gain.
Get Preset Enable	Returns the current state: Enabled (true) or Disabled (false).
Get Ramped Speed	Returns the current state: Value between -120% and 120%.
Get Range	Returns the current state: Value between -100% and 100%.
Get Range Extn	Returns the current state: Value between -100% and 100%.
Get Range Non-Extn	Returns the current state: Value between -100% and 100%.
Get Rewind-Unwind	Returns the current state: Rewind (true) or Unwind (false).
Get Run Delta	Returns the current state: Value between 0% and 100%.
Get Speed Delta	Returns the current state: Value between 0% and 100%.
Get Speed Demand	Returns the current state: Value between -120% and 120%.
Get Stall Enable	Returns the current state: Enabled (true) or Disabled (false).

Get Stall Select	Returns the current state: Proportional (true) or Fixed (false).
Get Stall Tension	Returns the current state: Value between -100% and 100%.
Get Start	Returns the current state: Started (true) or Off (false).
Get Stop Delta	Returns the current state: Value between 0% and 100%.
Get Taper SP	Returns the current state: Value between -100% and 100%.
Get Taper Select	Returns the current state: Hyperbolic (true) or Linear (false).
Get Tension Delta	Returns the current state: Value between -100% and 100%.
Get Tension Demand	Returns the current state: Value between -100% and 100%.
Get Tension Enable	Returns the current state: Enabled (true) or Disabled (false).
Get Tension SP	Returns the current state: Value between -100% and 100%.
Get UTS Threshold	Returns the current state: Value between -120% and 120%.
Get Up to Speed	Returns the current state: true or false.
Get WB Threshold	Returns the current state: Value between 0% and 100%.
Get WB Reset	Returns the current state: Enabled (true) or Disabled (false).
Get Web Break	Returns the current state: Enabled (true) or Disabled (false).
Get Winder Speed	Returns the current state: Value between -120% and 120%.