Anti Deviation Device

SAW+ADD

Installation & Operation Manual

Table of Contents

Introduction

SawADD turns the bottom guide into a force sensor, with a range greater than what would be seen when sawing within deviation limits. The resolution of SawADD is a thousand increments just in the range of deviation limits. This means it can measure the forces on the saw that steer it into deviation, allowing for a corrective action to stop it. The earlier detection allows for a substantially higher chance of corrective action. Keep in mind, SawADD measures the force that drives deviation, before actual deviation occurs.

The latest SawADD innovation uses two force sensors per guide holder. One on the leading edge and one on the trailing edge of the guide block. This allows the differential of the two sensors to provide a normalizing of the deviation force measurement or common mode rejection. This allows a gain to be applied for an even faster response. The two sensors also provide a more accurate measurement of the bandmill strain and the percent of strain on the tire line of the saw. These additional diagnostics will help in determining the health of the bandsaw blade and the bandmill strain.

The advancement of the new SawADD technology compared to the old technology makes the difference needed to close the loop for quality control. The old upper guide proximity sensors measure the displacement of the saw blade proximate to the point where a tooth enters the cut. However, any displacement of the saw blade at the top of the cut is preceded by a change in lateral force at the bottom of the cut. Displacement of the blade inherently cannot occur until the tooth has sawn through the cut. Therefore, displacement measurements made above the cut are, “trailing” or, “lagging” measurements.

Lagging signals are inadequate for closed loop control of velocity, particularly at higher feed speed where incipient deviation occurs in microseconds. Thus, all the upper guide systems are ineffective in supporting a rigorous log size control program for optimal yields per log. Only SawADD will react in time to save deviation from occurring and thus is the only Anti Deviation system available today (Patent Pending).

Preparation

Saw ADD LLC will provide:

- The SawADD guide holders; built to the same dimensions as your current guide holders, or within acceptable adjustments in size. They are to receive the same guide blocks.
- Sensors and drivers with 0 to 10-volt output.
- If required for performance, a ControlLogix PLC with 70 series processor and IO.
- Our SawADD PLC program installation and startup.

Our customer will provide:

- Dimensional drawing, or sketch of existing guide holder.
- Four high speed analog input channels for a Twin and 8 for a Quad with RTS of 2 ms (to the PLC that is controlling the log feed speed and in a high speed task of less than 10ms update).
- Three twisted-pair shielded signal wires in conduit from the PLC analog inputs to a J-box, to be mounted on each saw within eight feet of the lower saw guide.
- A J-box on each saw, large enough to hold 2 of the 5x4.5x1 inch din rail mounting sensor driver modules and 2 signal converter modules.
- A signal converter module for each analog channel, from voltage to current if the distance to PLC is over 200ft and the signal wiring are not run in a separate conduit. A recommended converter would be Phoenix Contact model MCR-C-UI-UI-DCI.

This converter will have a 10ms lag in signal and should be avoided if possible.

- Half inch flexible conduit (max 8 ft. length), to each lower guide from the J-boxes and pulling in the sensor cable with prewired connector to the sensor drivers.
- Mounting of the SawADD guides, which will require welding a new sub-base to the band mills.
- Sufficient drive horsepower and braking capacity (braking resistors or regen), to decelerate the log feed at a rate of 150 inches per second squared.
- If required, mounting and wiring a ControlLogix PLC in a 1756-A7 chassis for SawADD.

The installation can be done in one weekend. Installation will require removal of existing guides, welding new guide sub-bases, guide alignment, mounting J-boxes, and electrical termination.

Mounting the electrical J-boxes, ControlLogix PLC, and the conduit can be accomplished in advance.

Guide Installation

The installation includes removal of the existing guide holder, then may require welding the SAWADD™ guide holder sub-base in its place. The procedures should be followed closely to prevent any problems with operation of SawADD.

The SAWADD™ guide holder may be provided with a sub-base for welding to the band mill frame, so that the heat from the welding is not transferred to the stress-relieved guide holder.

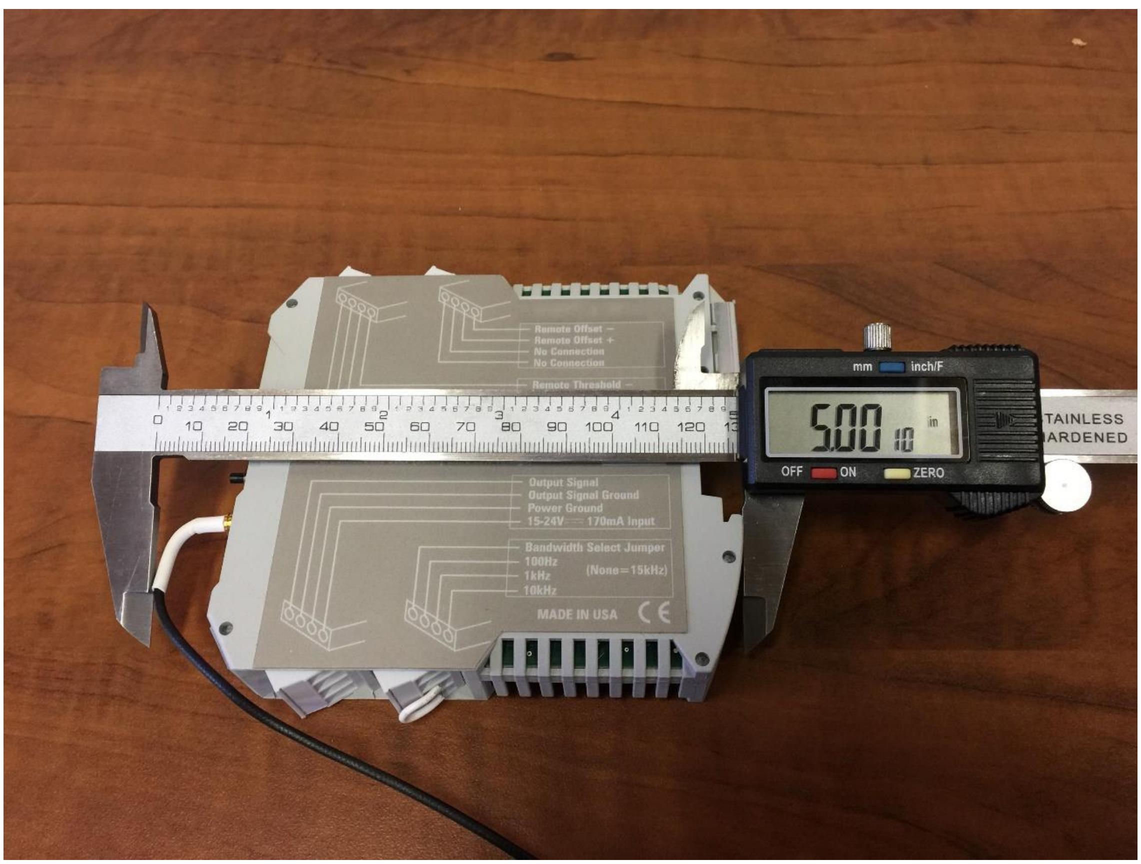
1. Position the SAWADD™ guide holder on the band mill (with the sensor side on the saw teeth side if only one sensor), as close as possible to final position, while bolted to the sub-base, and tight against the alignment lip on the sub-base.
2. Tack weld the sub-base or mounting bracket in place.
3. Remove the guide holder by unbolting it from the sub-base.
4. Stitch weld the sub-base solid by alternating sides to prevent any distortion of the sub-base.
5. Replace the guide holder, tightly against the alignment lip or face, if a sub-base is used and bolt in place.
6. A final alignment should be done by the filers with a spider and running the guide with a feeler gauge on the feed mechanism.
7. If bolting to existing holes in bandmill base, then use gibbing to hold guide in place.

The guide holder should be ready for mounting the SAWADD™ sensor assembly.

PLC Interface

The PLC interface requires an analog input module that will accept 0 - 10 volt or 0 – 20 ma. The analog input module should have 4 channels, be capable of an RTS (Real Time Sample rate) of 2 milliseconds or less, and an RTI (Real Time Interval) communications with the Processor of 5 milliseconds or less. The ControlLogix 1756-IF4FXOF2F or the Flex module 1794-IF4I will provide the fast analog update. The 1756-IF4FXOF2F is preferred.

The J-boxes should be pre-mounted within 8 feet of conduit to the lower guide, and DIN rail mounted in it for two 5" deep by 4.5" high by 1" wide sensor drivers. The sensor cable plugs into the front of the module, requiring a total of 5 inches of depth. The sensor cable will be pulled from the guide to the J-box.



If the distance from the J-box to the PLC analog input is more than 200 feet or not in its own conduit, then a voltage to current converter is recommended but will cause a considerable delay and should not be used if not necessary.

A very convenient converter that is DIN mounted, 24 volts, and about the same size as the driver module, is the Phoenix Contact model MCR-C-UI-UI-DCI, however it will have a lag time of 10ms. The part number for pre-configuration is 2810913/IN03/OUT01/NONE.

A twisted shielded signal pair will be connected from the driver modules (2 per saw) or the converter modules to each PLC analog input. The shield should be grounded at the PLC. A third pair will be used for 24 volt DC to power the modules.

Wiring on the analog modules may be different for current than voltage signal as it is with the ControlLogix 1756-IF4FXOF2F fast analog module.

Sensor Mounting & Adjustment

In this section we will mount the sensor assembly to the SawADD guide holder, torque down the mounting bolts, and adjust the sensor target into the measurement range.

1. The sensor assembly will consist of two mounting blocks. The sensor will be pre-assembled in one block, with the cable protruding. The target side will have a half inch threaded adjustment cylinder, locking nut, and quad ring seal.

2. Screw the half inch cylinder thread in enough to assemble the two blocks together. At this point, the dowel pins should line up with the dowel holes on the guide holder. Insure that the quad ring seal is in place on the target, or in the sensor block. Fit the sensor assembly onto the guide's side, with the sensor block facing upwards. The dowel pins should go in snug, and the assembly should now be seated flush against the side of the guide.
3. Screw in the eight mounting bolts, using the lock washers supplied, but do not tighten.
4. Using the 1" wrench provided, adjust the half inch cylinder thread out of the bottom block (with the one-inch hex) until it bottoms out in the top block. Apply enough pressure with the wrench to force the alignment of both sensor blocks. They should be free to pivot on the dowel pins to align themselves.
5. Tighten down the eight bolts with a torque wrench to 140 in lbs.
6. Pull the sensor cable and a signal pair through conduit into the driver junction box. Plug the sensor cable into the driver module. Put the twisted pair on the screw terminals for the driver voltage output, along with the signal cable to the PLC analog input or converter module. The twisted pair to the guide will be used with a volt meter to adjust the sensor into range at the guide and then capped off.
7. Power up the driver 24-volt DC supply, and the near or far LED on the driver module should illuminate red.
8. Connect a DC-volt meter to the twisted pair with probe clips (connected to the driver output voltage from step 6).

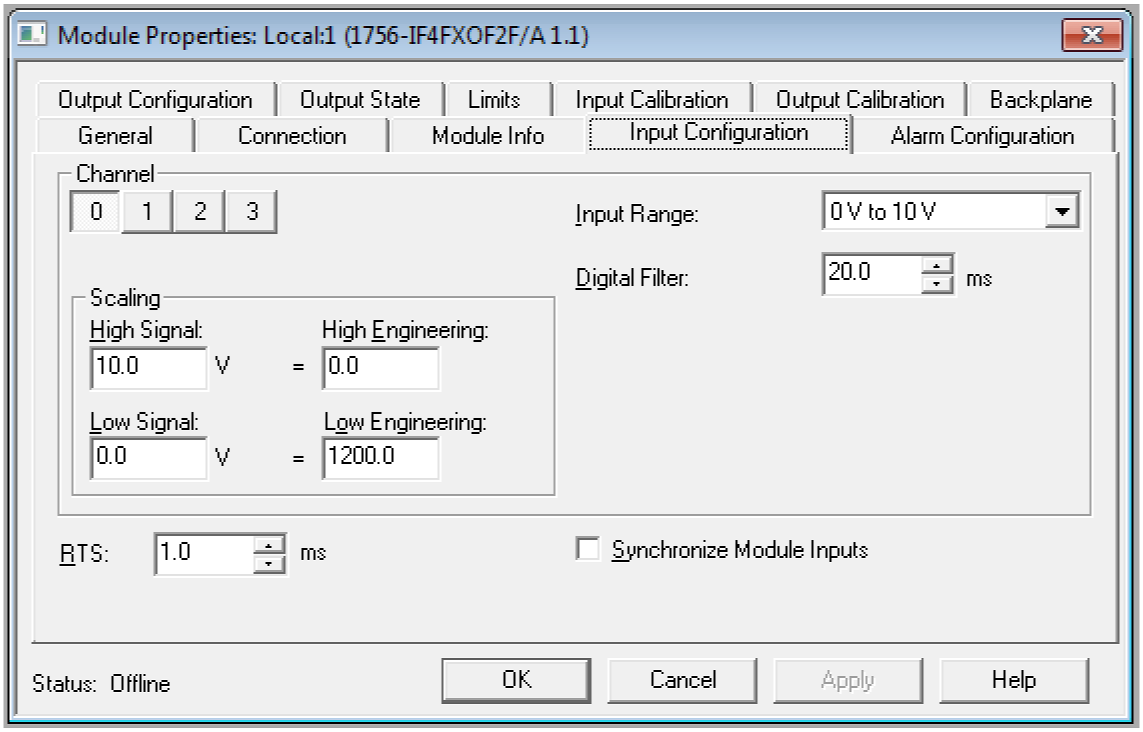
9. With the bandmill strain down, back off on the adjustment cylinder thread until the voltage reading is between 6.0, and 6.5 volts (about one half turn). Be aware that the voltage will wrap around to 10 volt when the target is bottomed out in the sensor block. While backing off the reading will drop to zero and then begin to climb again to 6.0 volts.

10. Apply a force by pulling on the guide block on the side with the sensor. A strong man should be able to pull about 100 pounds or so, and get a reading change of about 1 volt.

11. Lock down the adjustment thread with the locking nut, using the two supplied wrenches (1 inch and 11/16 inch), while watching the meter to keep the reading as described above. It is a good practice to use blue Loctite under the locking nut.

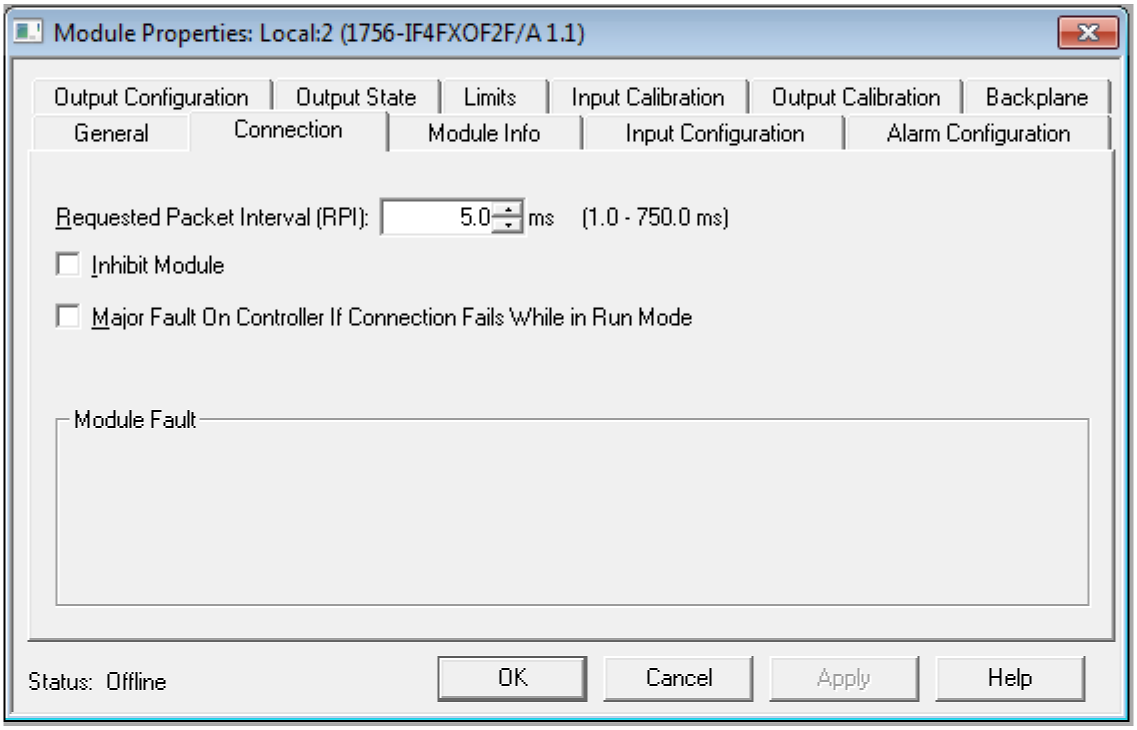
Configuration & Scaling

The scaling of the analog input can be done by the PLC module properties input configuration if using the ControlLogix 1756 module. A window from RSLogix 5000, Input Configuration is shown below.



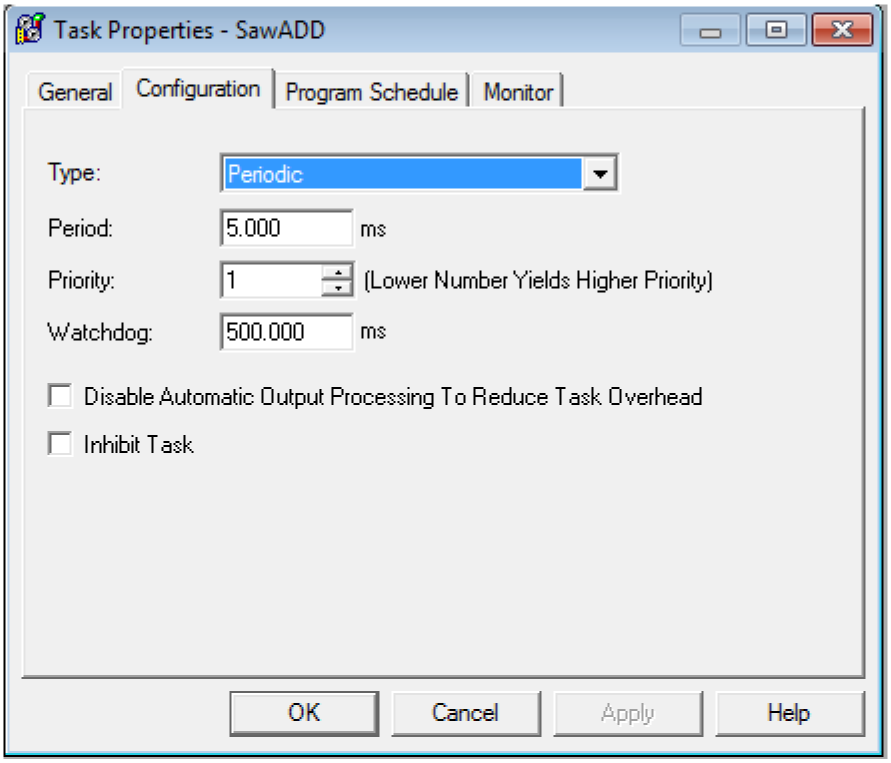
- In some cases, the distance to the controller will require the voltage to current converter, and the input range, be set for 0 ma to 20 ma.
- The Scaling of the input range to engineering units of pound force on the guide, and inverted by the High Engineering units set to 0.0, and the Low set to 1200.
- The RTS should be set as low as the module will achieve. This will allow the Digital Filter of 20.0 ms, to provide some smoothing.

In the Connection tab of the configuration, the RTI should be set at least as fast as the periodic task that the SawADD program is running in. That way, the data is fresh each time the program is executed.

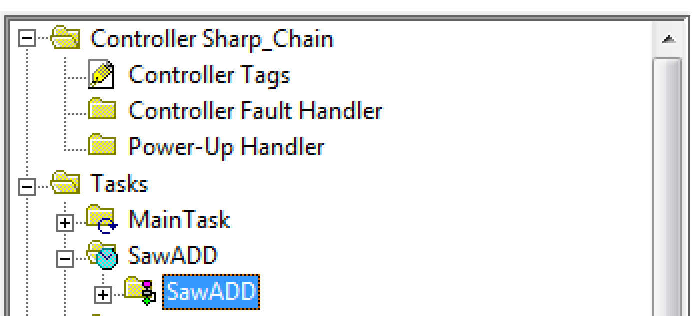


PLC Program

A PLC program for SawADD is provided in ControlLogix Ladder Diagram format. The program should be put in a Periodic Task, with an update of 5ms and a high priority.



A program will be supplied, so that it can be copied and pasted into the SawADD task. It will also be provided in an .LK5 format if you need to import into an older version.



The analog input tags will need to be addressed in the program to your PLC physical channel locations.

This program will read the analog inputs for the SawADD sensors, along with limits provided from an HMI, to produce a proportional multiplier that will be used to reduce feed speed when necessary. The limit setpoint or limit adjustments and reduction maximums will be described in the following sections on the HMI Display and Limit Setup.

HMI Display

Some displays, adjustments, meters, and trends should be added to the production HMI, as well as the operators HMI. A few of these should be adjustable from an HMI like the example of FactoryTalk View SE shown below. The bar meters below are a simple way to display the saw pressures for the operator and production personnel.

It is nice if one meter is the reverse of the other, so that they move the same way the saws are trying to move. Movement to the outside of either of the meters represents pressure increase on the guides, and movement toward the center is negative, which represents decreasing pressure on the guides. The meters will be zero when only saw strain pressure is present on the guides. The bars will change color when the sawing pressure reaches the limit settings.

Saw Pressure Limits

The Pressure Limit 1 is in a yellow box and the bar meter will turn yellow when the pressure on that saw exceeds the Limit 1. The speed reduction begins when this limit is exceeded and is limited to the Max Reduction box value in the box of the same color below it.

The purpose of the Max Reduction with Limit 1 is to allow a quick response to excessive pressure but not over compensate. It should be set to reduce only to a very conservative speed that will minimize deviation.

A Pres Limit 2 is in a red box and the bar meters will turn red when the pressure exceeds Limit 2. The Max Reduction for Limit 2 will need to be lower than for Limit 1. This will allow a greater reduction to save a saw in an extreme pressure without coming to a stop to allow sawing out of the log.

Sensor Readings

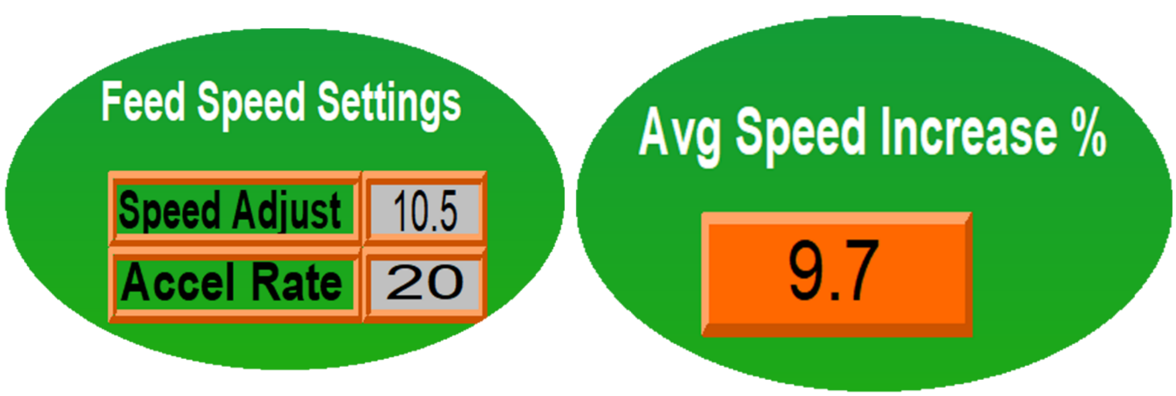
The display for each saw shows three values for the front and rear SawADD sensors plus a Total Strain and % Diff for that saw as follows:

1. Strain Up, is a live reading when there is no log in the saws and is scaled in the analog input card to pounds between 0 and 1200.
2. Strain Down, is updated from the analog input card only when strain up is first initiated so that a reading with no guide pressure is taken. When strain down is initiated the Strain Down reading is zeroed, ready to receive a new reading. If the strain down reading drops below 100 or increase above 0900, the sensor should be readjusted.
3. Front Strain/Rear Strain, is the Strain Up minus the Strain Down for the front and the rear sensors.
4. Total Strain, is the sum of the Front Strain and the Rear Strain, updated while no log is in the saws.

5. % Diff, is the front Strain minus the rear Strain divided by the Total Strain. This provide an indication of how much tighter the front tire line is compared to the back. While sawing this can provide an indication that the saw has been stretched and should be changed.

Speed Control Settings

SawADD's HMI allows your production personnel to easily make changes to the feed-speed on the fly, without having to change complex tables. With SawADD you simply type in a single number for the desired percentage speed increase, across the board.



The Accel Rate is the rate of increase of the feed speed, (if not being reduced by excess pressure) to the Speed Adjust increase setting or to the speed before being reduced by excess pressure. It should be run as high as possible without causing oscillation in the feed speed.

SawADD's HMI also has an average speed increase meter, for the last 20 logs, as a way to gage your saw performance. When the average goes below a predetermined level or negative you are losing production and an alarm can be set to change a saw.

Feed Speed

The feed speed multiplier will be a real number from 1.0 to a reduction limit (i.e. 0.8), that must be used in your existing program to multiply times the feed speed before it is output to the drives. It is important to multiply this reduction with all of the drives that will be affecting the log motion or gap control. If the multiplier is used on the sawing speed then the gap control logic will handle the drives.

The feed speeds can generally be increased by as much as 15%, with SawADD feedback to slow down to the conservative speed when necessary to preserve lumber sizes. If the reduction in speed is too much and affecting production, then a saw change should be considered.

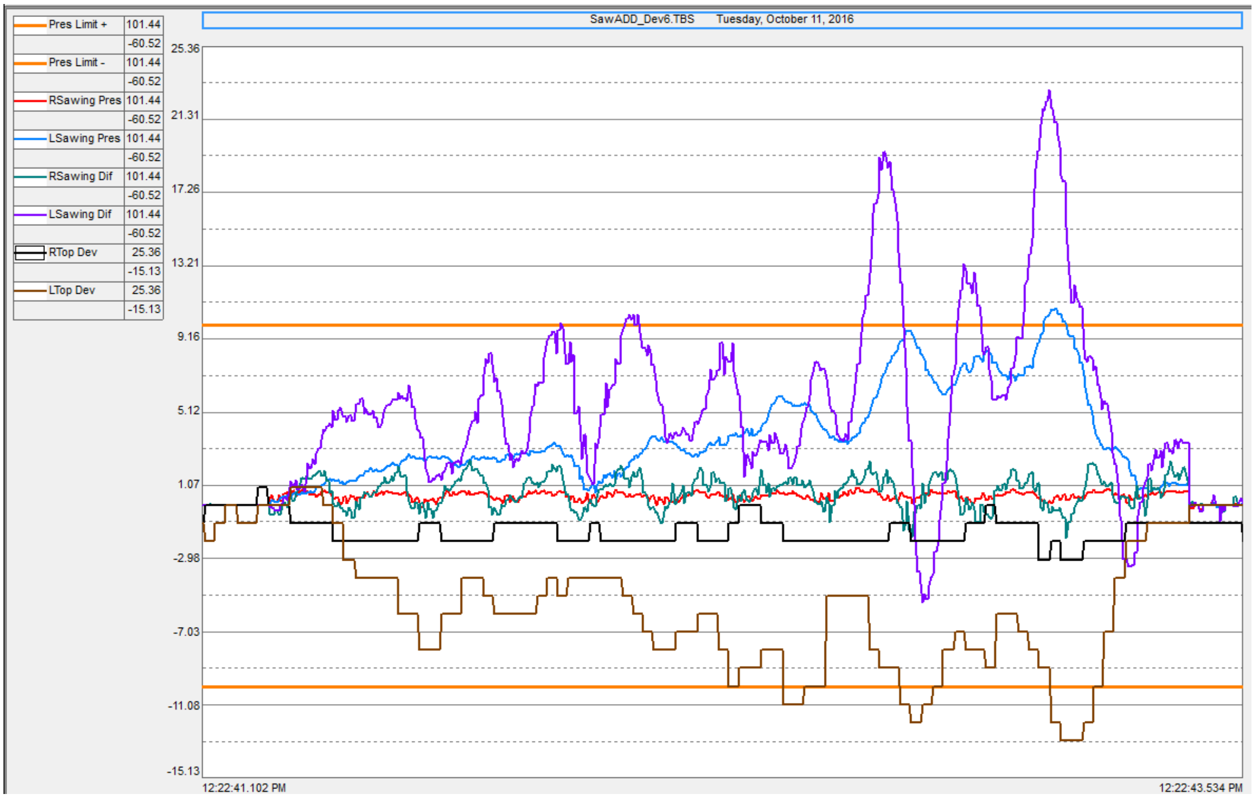
The deceleration rate for the drive should be set as high as possible without being too aggressive, at least 150 in/sec/sec. The higher the decel rate the more deviation that will be prevented. The acceleration rate while in the cut should be limited to a much lower rate (25 in/sec/sec or 125fpm/sec) as a method of providing some damping to prevent repeated decel and accel oscillation.

Limit Setup

The guide pressure limit for accurate sawing, good size control, and reducing target size is typically set to around 40 pound. The limit can run as high as 80 pounds when pushing for more production, allowing for a larger variation or standard deviation, and hence larger target size. Tougher sawing species like Douglas Fir will require a high limit.

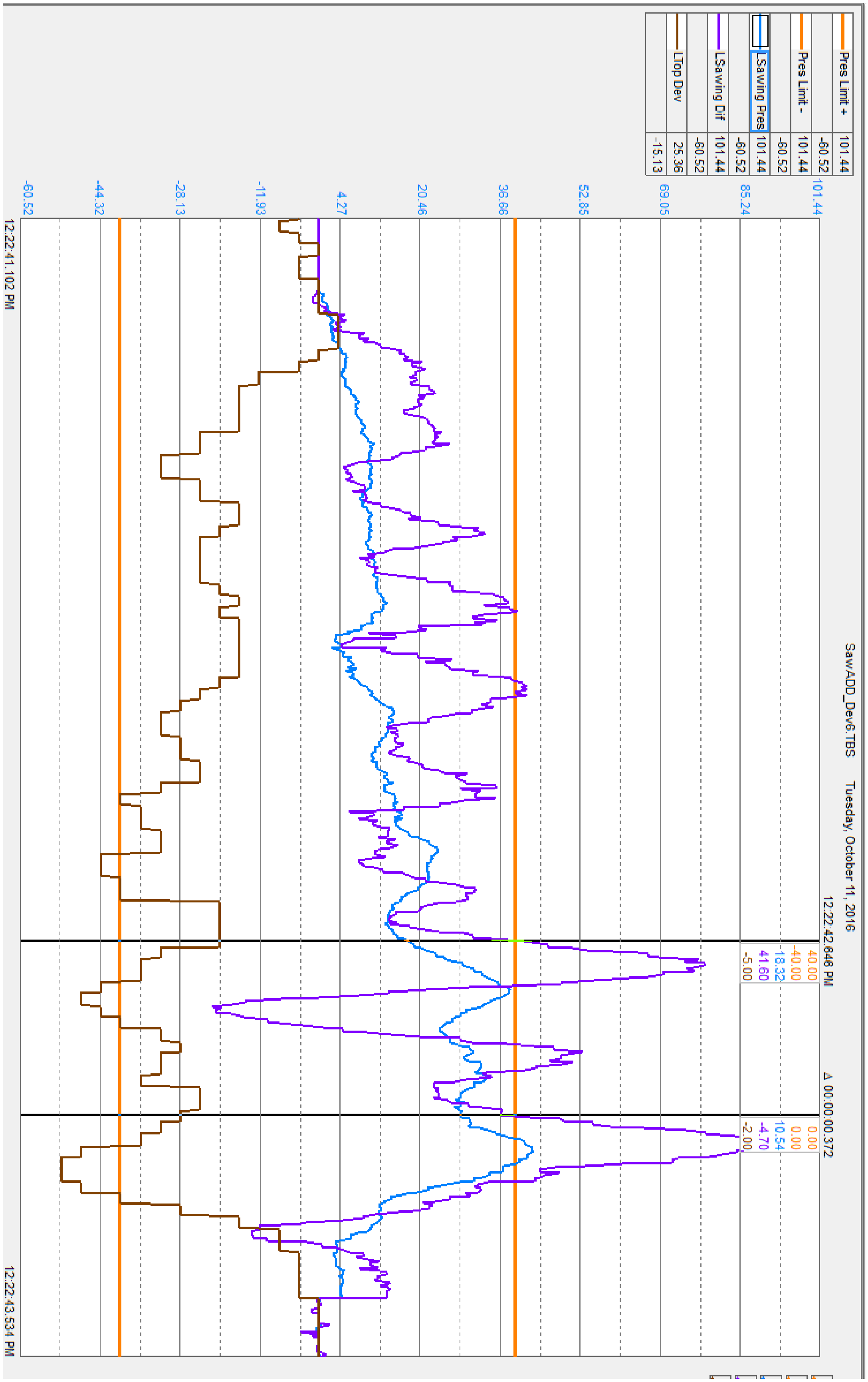
A speed limit max reduction is used to prevent over correcting. We will typically use two sets of pressure limits and two sets of reduction limits. That way the primary Limit 1 (40 to 80) can be associated with a conservative Limit 1 Max Reduction to about 80% (down to speeds that would be run without SawADD). A second limit may be set higher than normal operation, to provide a safety net for extremes… Which may save a saw. For example, the sawing pressure Limit 2 can be 100 pound and Max Reduction limit to 30%, but never to 0% which would stop the feed without the ability to recover.

Diagnostic Trending

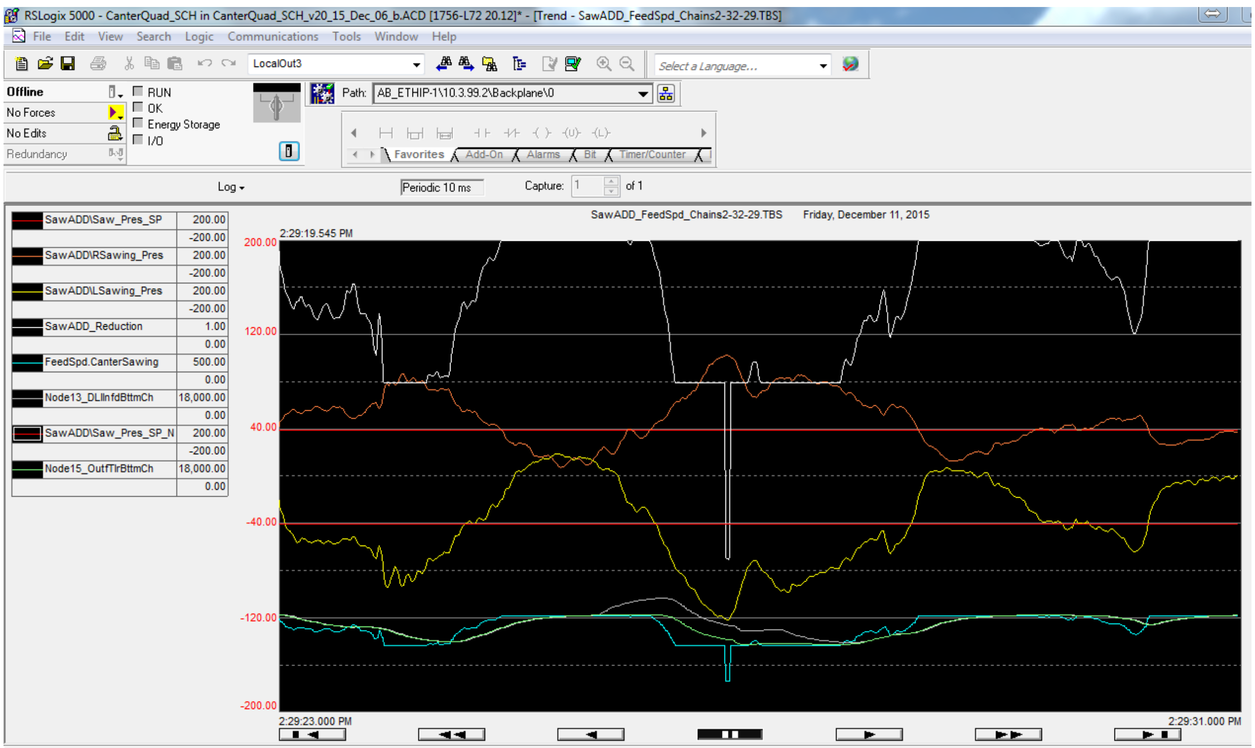


A ControlLogix trend is available on the PLC that shows plus and minus Pressure Limit-1 along with the right and left saw front sensor press, differential press and top guide deviation. Together they are hard to read, however right clicking on the trend and selecting Chart Properties and then the Pens tab will allow turning off visibility of some pens. Enlarged for more readability below is a trend for one log. Note that the Top Deviation sensor signal is opposite in polarity to the SawADD pressure. SawADD is negative away from the guide.

It is very evident that the SawADD LSawingDif exceeds the limit substantially before the LTop-Dev Sensor. This provides the ability to react and minimize the deviation but requires minimizing the reaction time for the drive to receive a speed reduction command from the PLC. This may require a faster PLC.


SawADD_Dev6.TBS Tuesday, October 11, 2016
Pres Limit +
Pres Limit -
LSawing Pres
LSawing Dif
LTop Dev
12:22:41.102 PM
12:22:42.646 PM
Δ 00:00:00.372
12:22:43.534 PM

Another invaluable diagnostic of trending is the detection of a log moving in the cut. This can be seen in the following trend from the almost symmetrical and opposite polarity of the pressure on the right and left saws.



It is also good to put the drive commanded and actual velocity on the same trend as the SawADD Reduction Multiplier to measure the reaction time of the PLC and the drive actual to commanded.

Advanced Tuning

The SawADD PLC program provides some advanced tuning adjustments that should only be attempted by someone experience in closed loop control.

The proportional gain algorithm is reverse acting, in order to provide a speed reduction multiplier. It uses the saw pressure error compared to the saw pressure setpoint and scaled by the setpoint times a P-Gain parameter. The default value for the P-Gain is 0.3 to provide a minimal over correction.

The two sensor differential pressure is multiplied by a D-Gain parameter to provide a faster reacting process variable that can also be used with the same limits and P-Gain. The default value of the D-Gain is 5.0.

The highest value of the front (leading edge) sensors and the front to rear differentials, for the right and left guides is used to compare with the limits and produce the speed reduction multiplier.