SPW3 Speed Programmed Winder

Application Handbook

Copyright © 2000 by Eurotherm Drives, Inc.

All rights strictly reserved. No part of this document may be stored in a retrieval system, or transmitted, in any form of by any means to persons not employed by a Eurotherm group company without written permission from Eurotherm Drives, Inc.

Although every effort has been taken to ensure the accuracy of this specification, it may be necessary, without notice, to make amendments or correct omissions in this document. Eurotherm Drives, Inc. cannot accept responsibility for damage, injury, or expenses resulting therefrom.

Printed in the United States of America 0101

HA354823 Issue 1

WARNING

Only qualified personnel who thoroughly understand the operation of this equipment and any associated machinery should install, start-up, or attempt maintenance of this equipment. Non-compliance with this warning may result in serious personal injury and/or equipment damage.

Contents

Chapter 1 Introduction

SPW is the solution to closed-loop center winders (with loadcell or dancer trim) to produce constant tension throughout the roll. It provides the standard features required by a center winder including: Diameter Calculation with diameter memory and preset, Tension and Taper, PID for tension or dancer position control, Over/Under Winding, etc. Additional features provide Stall Tension, Tension Boost, Web Break Detection, Current Memory, and Inertia Compensation. SPW can control unwinds or rewinds for single spindle and turret winders.

The function block can be used with the following Eurotherm Drives AC and DC drives:

590L

590SPL

620L

584SV, 590+, and 690+ with a LINK Techbox

Other LINK solutions are available to meet other common application requirements and are documented by their individual manuals.

Chapter 2 Description

This section describes the operation of the functions in the SPW LINK function Block.

DIAMETER CALCULATOR

The roll diameter is calculated by dividing the LINE SPEED by the WINDER SPEED (diameter is always positive and independent of the polarity of the speeds). The LINE SPEED input should be the actual web speed from the previous section motor speed (the next section in the case of an unwind). The WINDER SPEED is the spindle motor speed.

Whenever the line is stopped, both the winder speed and line speed are zero. As a result, a preset diameter value (either Core 1, Core 2 or Ext Diameter) is used on power up and when the PRESET ENABLE is ON. It will be the output value as long as the minimum speed is not exceeded. Above minimum speed, the calculated diameter is the output. If the line slows below the minimum speed, the last calculated diameter is used. It will continue to be the output diameter until the preset diameter is enabled.

MIN DIAMETER is the calculated diameter value at full (100%) line speed and full (100%) winder speed.

The calculated DIAMETER output is filtered. The filter output tracks the diameter when TENSION ENABLE is ON and Line Speed is above Min Speed, otherwise the diameter is held at its current value.

The diameter filter has a profiled time constant (TC) determined by the winder speed and the filter profiler. The profiler enables a smaller filter at high line speeds and small cores when the change in diameter is fast and a larger filter at larger diameters for stability.

The filter profiler has a FILTER MAX TC at 0% winder speed, FILTER MID TC at FILTER MID SPEED, and FILTER MIN TC at 100% winder speed.

INERTIA COMPENSATION

The SPW function block calculates the torque required to accelerate the mechanical inertia. It is composed of two parts, fixed and variable inertia. The FIXED INERTIA is the inertia of the motor, gearbox and core. The VARIABLE INERTIA is the inertia of the roll and a WIDTH input is available for setting the web width. The total inertia (Inertia Comp) is multiplied by the scaled acceleration rate to produce the torque demand and the polarity is set by the OVER/UNDER selection.

Accelerating a rewind requires additional torque in the same direction as the tension producing torque whereas an unwind requires accelerating torque in the opposite direction to the tension torque. The Master Ramp function block supplies the acceleration rate and connects to the RATE input. If the Master Ramp is not being used, the line speed can be connected to the RATE SP input. The RATE SP input is differentiated to produce a rate.

When the WINDER SPEED exceeds the BASE SPEED the current demand is increased to compensate for the reduced field flux to maintain constant torque demand. This is not required with the 620L or 690+ Vector drive so the BASE SPEED parameter should be left at 100% even when an extended speed range is used.

START STOP

The SPW function block includes logic for START, STOP and JOG with a DRIVE START output to the drive. The drive READY latches the START and resets the START LATCH in the event of a drive fault, program stop, coast stop, or the STOP input. An M-START input is provided for a maintained start from a PLC or for starting using ConfigEd in Run time mode.

SPEED DEMAND

A simple ramp in SPW uses the LINE SPEED SP or JOG SPEED to calculate the SPEED DEMAND. The ramp time is determined by the SPEED DELTA which is the percentage change per update. For example, if the LINE SPEED SP comes from the Master Ramp function block, the update is 100mS. Thus if the SPEED DELTA is set to 2%, the ramp output will change at 2% per 100mS and would take 5 seconds to change 100%.

The ramped speed is summed with the closed-loop trim from the PID scaled by the range. Range, selected by EXTENSIBLE WEB, is either the RANGE NON-EXTN or RANGE EXTN settings. The combined speed demand is divided by the diameter to produce the SPEED DEMAND to the drive.

The polarity of SPEED DEMAND is determined by the OVER-UNDER selection; it is positive for Over, when OVER-UNDER = True.

The SPEED DEMAND is triggered by the FEEDBACK to the PID; thus there must be a regularly updated signal connected to FEEDBACK to obtain a SPEED DEMAND output. An update rate of 30 to 50 mS is recommended.

PID & GAIN PROFILERS

The PID provides Proportional, Integral and Derivative control. It supplies the closed-loop trim to the speed demand to control the web tension.

> Note. See the SIGNALP::PID function block data sheet in Appendix for the block diagram, transfer function and functional description of the PID.

The PID calculates an output whenever the FEEDBACK input receives an input. If the PID ENABLE is disabled, the output is zero.

The Proportional and Derivative terms and the drive speed loop gain via the DRIVE P GAIN output are controlled by gain profilers.

The gain profilers provide increasing gain as a function of increasing diameter. The Drive P Gain modifies the speed loop gain to compensate for the increased roll inertia as the diameter increases. The PID Proportional Gain profiles can vary the PID Proportional Gain as a function of diameter. The Derivative Gain profile can be used with dancer position control applications to provide damping at large diameters.

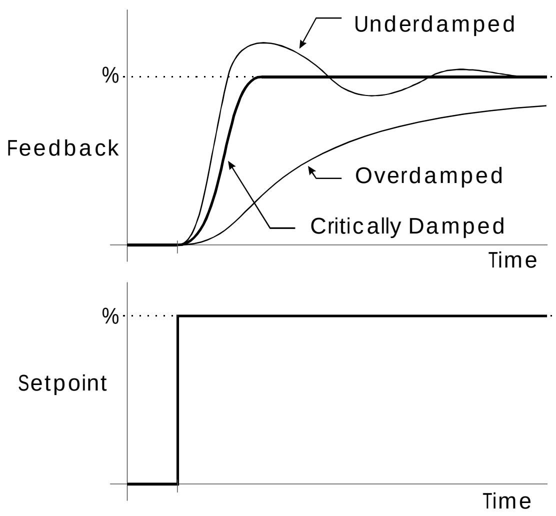


Figure 1 - System Response to a Step-function Input

In each gain profiler, the Min Gain term is a percentage of the Max Gain term. The default Min Gain setting of 100% provides constant gain, equal to Max Gain, throughout the diameter range. The Exponent term determines how quickly the gain falls off as the diameter decreases. At the minimum setting of 1, the profiling is linear. At the maximum setting, 10, maximum gain occurs at maximum diameter and drops of very quickly as diameters decrease.

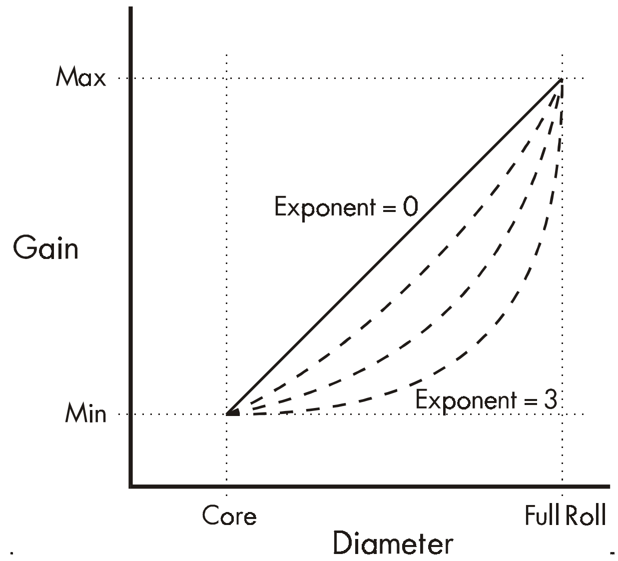


Figure 2 - Gain Profiler

WEB BREAK DETECTOR

The web break detector monitors the FEEDBACK signal, comparing it to the WB THRESHOLD setting.

WB THRESHOLD is set just below minimum tension for loadcell feedback or to the dancer slack limit for dancer feedback. If FEEDBACK is less than WB THRESHOLD, the diameter is held at the current value and the WEB BREAK output goes low indicating a web break. WB DELAY sets the web break delay timer that eliminates nuisance trips.

The WEB BREAK output is overridden when STALL ENABLE is enabled.

UP TO SPEED DETECTOR

The up to speed detector compares the actual line speed with the winder speed multiplied by diameter. When they are the same, within the UTS THRESHOLD, the UP TO SPEED output goes high.

TENSION DEMAND

The Tension Demand section modifies the tension setpoint for taper, stall tension, tension boost and a tension demand ramp.

Taper

The Tension Demand can be modified by one of two Taper profiles. Linear Taper linearly reduces the TENSION SP as the diameter increases. Hyperbolic Taper reduces the TENSION SP more quickly near the core and less as the diameter approaches the full roll.

Stall Tension

Stall tension is a reduced tension used when the line is stopped.

When STALL ENABLE is high, the tension demand is STALL TENSION if STALL SELECT is Fixed, or STALL TENSION multiplied by the TENSION SP if STALL SELECT is Proportional. For example, if the TENSION SP is 80% and the STALL TENSION is 50%, then the tension demand at stall is 50% if the STALL SELECT is Fixed or 40% if Proportional.

Tension Boost

Tension boost increases the tension demand when BOOST ENABLE is high. BOOST SELECT has Fixed and Proportional settings similar to Stall. The fixed or proportional boost is added to the TENSION SP.

Tension Demand Ramp

The Tension Demand Ramp has a TENSION DELTA that sets the rate. The delta is the output change per update where the update is the TENSION TICK TIME, which is normally set to 300mS. For example, if the TENSION DELTA is 10%, TENSION DEMAND can change 10% in 300mS. This setting would require three seconds for a 100% tension change.

Tension Demand and Dancer Loading

The TENSION DEMAND output is the tension demand modified by the taper, stall, boost and ramp.

With a loadcell, the TENSION DEMAND is connected to the PID Setpoint for a winder.

With a dancer, the PID setpoint is the dancer position setpoint which will be a fixed value of typically 50% for mid position. The loading on the dancer sets the web tension. To control the tension, the DANCER LOADING output is connected via an analog output to an E/P converter that sets the air pressure to load the dancer. The latched TENSION ENABLE input controls the DANCER LOADING output. It permits two DANCER LOADING outputs to control one dancer for a twin-turret winder. The TENSION ENABLE for each drive is connected to the other drive's OTHER ENABLE input to switch the control for the dancer. DANCER CAL provides scaling of the DANCER LOADING output to adjust the desired maximum tension.

CURRENT MEMORY

This function provides short term open-loop tension control by sampling the motor torque and then setting the motor torque at the memorized value. This can be used during transients or when the closed-loop feedback is temporarily isolated from the roll such as during a transfer on an unwind.

The motor current (torque for the 620L or 690+) is filtered and fed to a Track and Hold. The current value is held by MEMORY HOLD or MEMORY ENABLE. MEMORY ENABLE also changes the drive from speed control to torque control by adding an OVERSPEED to speed demand and setting the current limit clamp to the memorized value. Current boost is available, either fixed or proportional set by CM BOOST SELECT, enabled by the CM BOOST ENABLE.

The positive or negative current limit clamp is selected by the REWIND-UNWIND and OVER-UNDER selections. When the Current Memory is not enabled the positive and negative current limits are at the default 200%. The 590L Current Scaler must be set at 100% to give the correct scaling, but the Main Current limit can be set as required to limit the maximum current, typically at 125%.

With the 620L or 690+ Vector drive, the POSITIVE CLAMP and NEGATIVE CLAMP outputs connect to the positive and negative torque limits respectively.

> Note. The drive must be set for independent positive and negative clamps. See Chapter 3 for the proper settings.

Chapter 3 Using SPW

BASICS

Scaling

LINK uses a value range of -1 to +1, normally displayed as -100.00% to +100.00%. To interface with the drive, a "Speed" value of 1 in LINK is equivalent to 120% in the drive and is displayed as 120% in the SPW function block. Similarly a "Current" or "Torque" value of 1 in LINK is equivalent to 200% in the drive and is displayed as 200% in the SPW function block.

590+ and 590 (DC Drive)

The SPW function block controls the Positive and Negative Current clamps (in the current memory mode) in the 590 DC drive and the BASE SPEED parameter sets the compensation for the field range (for the inertia compensation). The Current Scaler must be set to 100%, as this scales the clamps, but the Main Current limit may be set as required. BIPOLAR CLAMPS must be enabled.

690+ and 620 (AC Drive)

With a 690+ or 620 Vector drive, the SPW function block controls the Positive and Negative Torque Limits. SYMMETRIC TQ LIMIT must be false. Since torque is controlled directly, the BASE SPEED parameter is left at the 100% default, as additional compensation above base speed is not required. The Main Torque limit and the Current limit can be set as required.

Tension Enable

The SPW function block has two modes of operation for controlling twin-turret winders.

With the TENSION ENABLE disabled, the drive is speed controlled with the speed compensated by the roll diameter to provide the roll surface speed matched to line speed. This also provides jog with constant surface speed. In this mode the diameter can be preset. It is used when the web is not connected to the winder.

When the TENSION ENABLE is enabled and PID ENABLE is enabled, the closed-loop trim PID trim maintains tension or dancer position. The diameter is calculated as the roll builds up (or builds down for an unwind).

QUICK SET UP

This sections covers a basic single-spindle rewind with loadcell or dancer feedback. It requires the user to have DSD or ConfigEd configuration software to program the SPW function block and make the connections to the drive as part of a LINK network.

Connections

See drawing RF354823 for connections and the detailed block diagram.

Inputs

Feedback	From a dancer or loadcell via an Analog Input with a 30 mS update rate
Line Speed SP	From the Master Ramp Output
Line Speed	Should be the actual web speed from the previous section motor speed (or the next section for an unwind)
Winder Speed	Spindle motor speed
Rate	From the Master Ramp Rate Output
Tension Enable	From SPW Start Latch output
PID Enable	From SPW Start Latch output
Preset Enable	Used to reset the diameter to core (from pushbutton)
Tension SP	From the Tension potentiometer
Taper SP	From the Taper potentiometer
Start Stop Jog	Pushbutton inputs
Ready	From the drive ready output

Outputs

Drive Start	590L – to Start input slot 52 620L – to Start input tag 38 590+ and 690+ – Drive Start
Speed Demand	590L – to Speed Input 0 slot 2066 620L – to Main Spd Spt tag 176 590+ and 690+ – Speed Setpoint
Drive P Gain	590L – to Speed Loop Prop Gain slot 2130 620L – to Speed Loop Prop Gain tag 161 590+ and 690+ – Speed Loop P Gain
Aux I Demand	590L – to Current Loop Aux current demand slot 2116 620L – to Aux Torque Demand tag 559 590+ and 690+ – Aux I Demand
Start Latch	Connect to Tension Enable and PID Enable inputs
Tension Demand (loadcell only)	Connect to Setpoint input
Dancer Loading (dancer only)	Connect to dancer E/P to set dancer tension

Parameters

Min Diameter	Core Diameter ÷ Full Roll Diameter × 100% (for 60” full roll and 6” core, Min Diameter = 10%
Core 1	Core Diameter ÷ Full Roll Diameter × 100% (for 60” full roll and 6” core, Core = 10%

Note. All other parameters should be at default values.

Running Checks

This requires ConfigEd run time(SAM) to set and monitor the SPW function block and the drive.

1. Check that the winder is safe to run and that E-stop is reset.
2. Fit an empty core onto the winder. Do NOT splice a web onto the core or start the line.
3. Verify that DIAMETER in SPW is at core, the diameter preset. Set TENSION SP to 50%.
4. Start the winder in JOG. The winder should run at 5% speed in the correct direction. If the direction is wrong, change OVER-UNDER to Under.
5. Change the JOG SPEED to 50%. Check the core surface speed, it should be at 50% of maximum rated web speed. Adjust the speed, if required, using the Tach or Encoder cal in the drive as appropriate.
6. Use START to enable the TENSION ENABLE while maintaining the Jog. With the TENSION SP at 50% and no web, the speed should increase.
7. Reduce TENSION SP to zero and apply force to the loadcell or move the dancer to the tight position. The winder should slow down.
8. Remove the JOG and START; the drive should switch off.
9. Enable the PRESET ENABLE. The DIAMETER should be preset to core.
10. Set the JOG SPEED back to 5%.

This completes the Quick set up. The winder will now control tension but the dynamic performance may need optimizing.

Setting Inertia Compensation Using Speed Control

For this method of measuring the inertia compensation the drive is run independently of the SPW tension control. The drive is run in speed control using the drive ramp to control acceleration and deceleration. Typically the drive will be started and the speed demand to the ramp, set via SAM.

Note. Where load is specified, read current demand for the 590L or 590+ and read torque demand for the 620L or 690+.

Note. Where Base Speed is specified, this is the actual base speed (% of max speed) at the calibrated maximum volts, not necessarily the motor nameplate base speed. This is the same as the BASE SPEED parameter in SPW.

Inertia Compensations

Determine the fastest Master Ramp ramp time for the machine that maintains tension control. For example, if the run time is 30 seconds and the stop time is 20 seconds, use 20 seconds; ignore the E-stop settings.

Set the RATE CAL in SPW to 20% ÷ Ramp time. This is a calibration setting and still permits the Master Ramp times to be reduced (up to 25%) or increased (no limit). For example, if the fastest specified ramp time is 20 seconds, set RATE CAL to 20% ÷ 20 = 1%.

Fixed Inertia

1. Install a core.
2. Set the drive ramp time, accel and decel to the time used for the Rate Cal above.

Without a Field Range

3. Start the drive at 1% speed and record the load and then set ramp speed demand to 100%. Read the change in load during acceleration. At full speed the load should return to a steady value; record the load.
4. Set the ramp speed demand back to 1% and read the deceleration load change. The load at 1% speed should return to the same as recorded above.
5. The acceleration and deceleration load changes should be equal and opposite. This value is the Fixed Inertia compensation.

   For example, the load at 1% speed = 0.5% and the load at 100% speed = 2%. When accelerating the load starts at 4% and increases to 5.5% just before full speed. This is 3.5% change. Decelerating the load starts at -1.5% and decreases to -3.0% just before zero speed. This is a 3.5% change. The average of the acceleration and deceleration load is the value for Fixed Inertia.

With a Field Range

6. The procedure is exactly the same as without a field range, above, except the high speed demand must be limited to base speed (preferably just below).

   For example, the load at 1% speed = 0.5% and the load at base speed = 2%. When accelerating the load starts at 4% and increases to 5.5% just before base speed. This is 3.5% change. Decelerating the load starts at -1.5% and decreases to -3.0% just before zero speed. This is a 3.5% change. The average of the acceleration and deceleration load is the value for Fixed Inertia.

Variable Inertia

Determine the roll build up ratio. This is the maximum full roll diameter divided by the core diameter. The ramp rates and speed demand must be modified by the build up. The ramp time is multiplied by the build up and the speed demand divided by the build up.

For this example the Core OD = 6”, the Full Roll diameter = 48”and the Ramp Time = 20 sec.

The build up is 48/6 = 8.

The drive accel and decel ramp time is set to $20 \times 8 = 160$sec.

The high speed demand is $100 \div 8 = 12.5\%$. This speed will be equal to or less than base speed so no special procedure is required for a field range.

1. Fit a full roll or as near a full roll as possible (not larger). Measure the actual size; for the correction factor for less than full roll, see later section.
2. Start the drive at 1% speed, then set ramp speed demand to value calculated above. Read the change in load during acceleration. Set the ramp speed demand back to 1% and read the change in load during deceleration. Take the average of the accel/decel load change values similarly to the Fixed Inertia procedure.
3. Subtract the Fixed inertia component from the full roll accel/decel load change and then correct for the roll size.

$$\text{Variable Inertia} = (\text{load change value from Step 2} - (\text{Fixed Inertia} \div \text{Build up})) \times (100\% \div \text{Roll Size}\%)^3$$

The following example has a build up = 8, Fixed inertia = 3.5% and Roll size = 90% of a full roll. The measured load change is 12%.

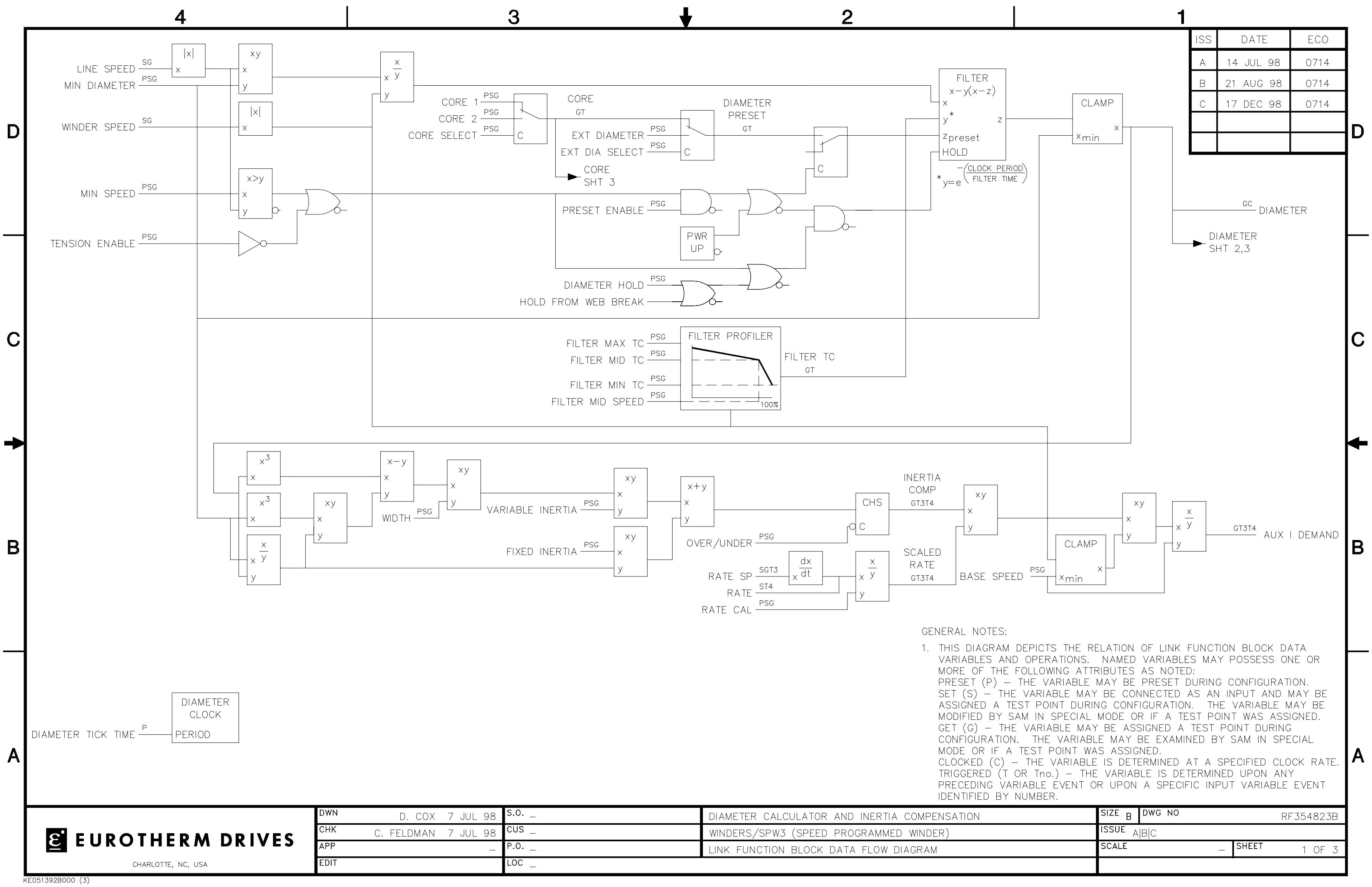
$$\text{Variable Inertia} = (12 - (3.5 \div 8)) \times (100\% \div 90\%)^3 = 15.86\%$$

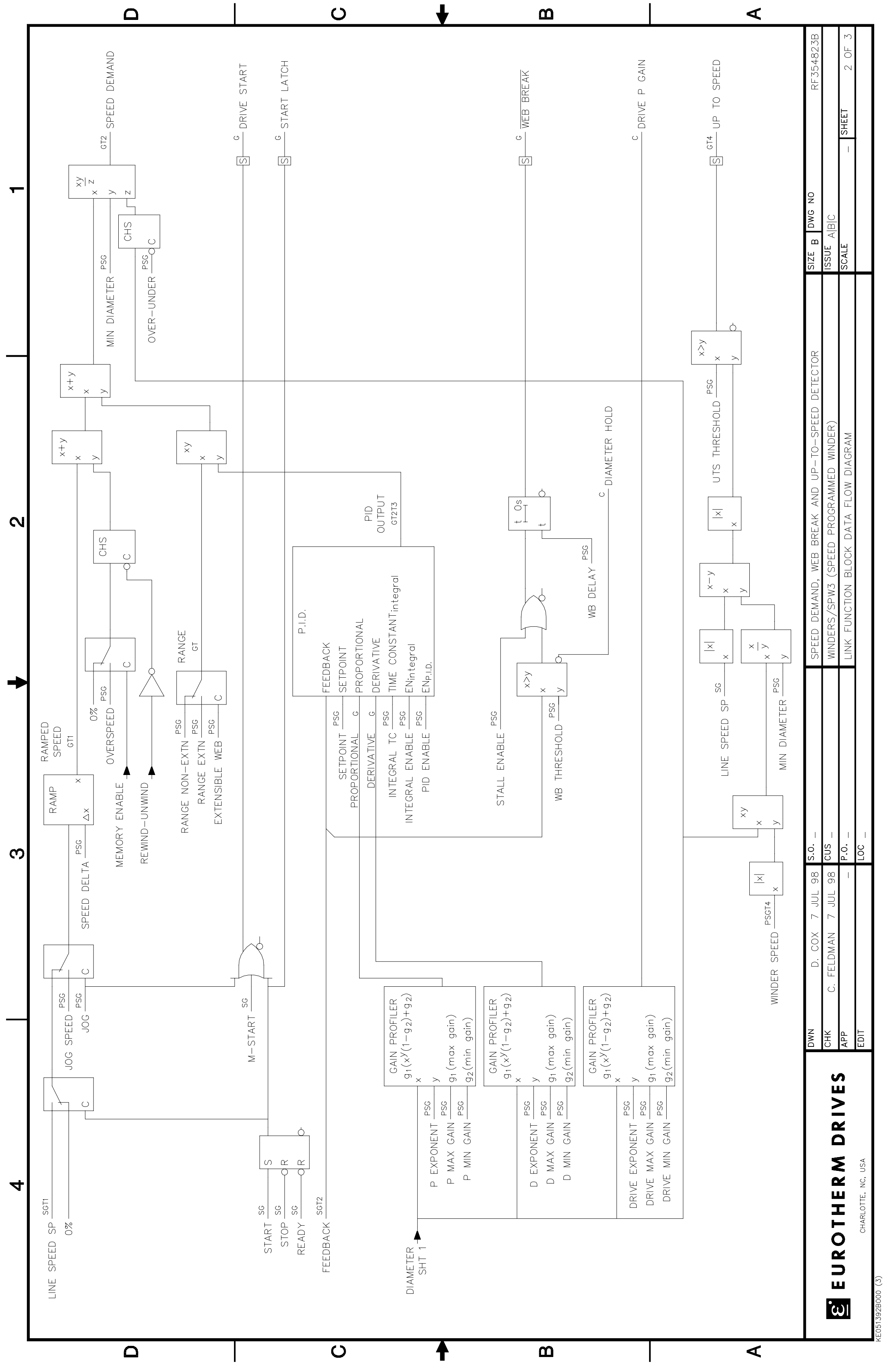
Use this value for SPW Variable Inertia.

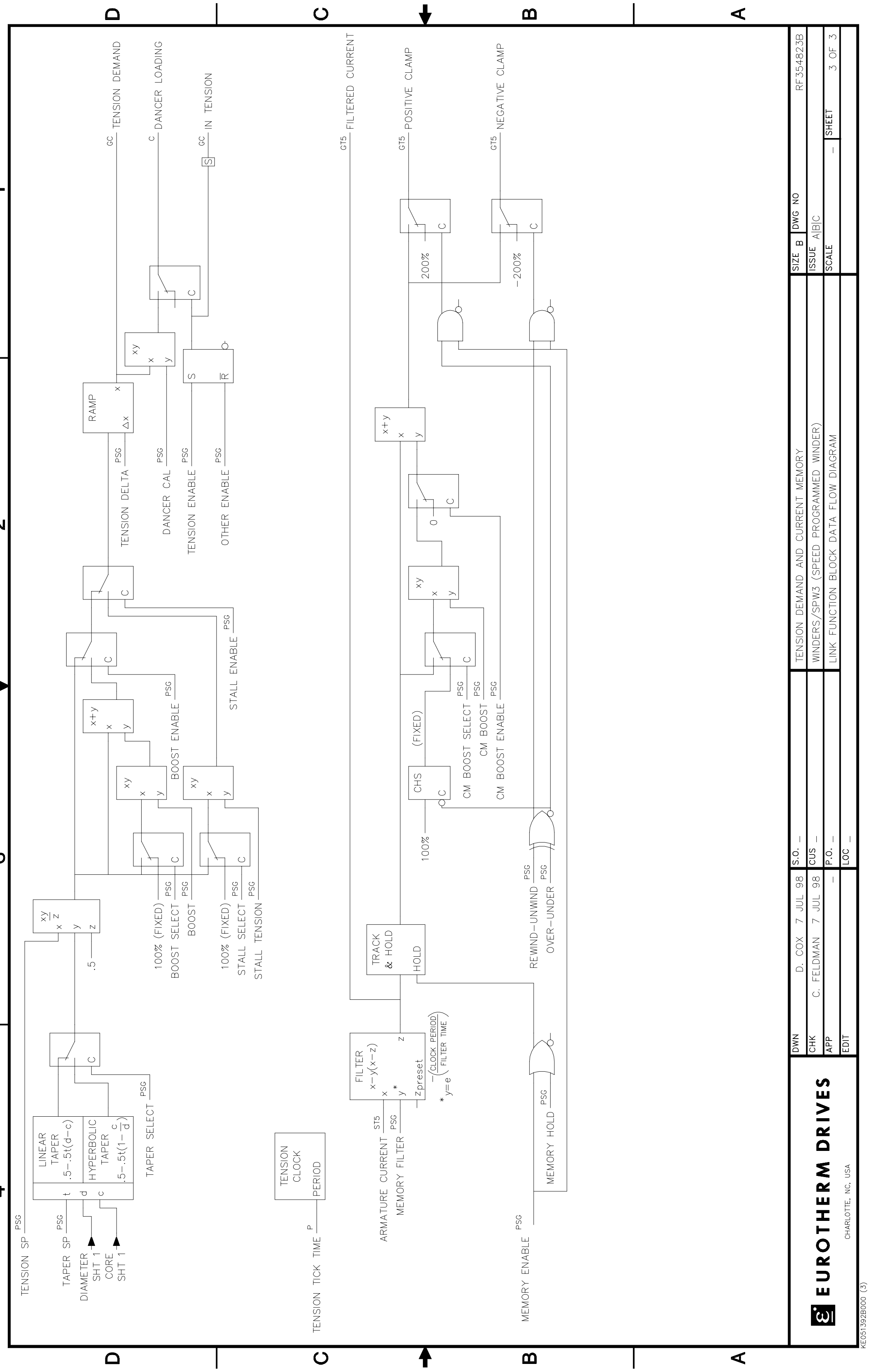
If the winder uses a gearbox with multiple ratios or uses one or two motors, it will be necessary to measure the compensations for each motor and gearbox ratio combination. The different compensations must be switched into the SPW for each combination.

Chapter 4 Function Block Diagram

This chapter contains the software block diagrams for the SPW3 function Block. The pages are printed on the following pages.

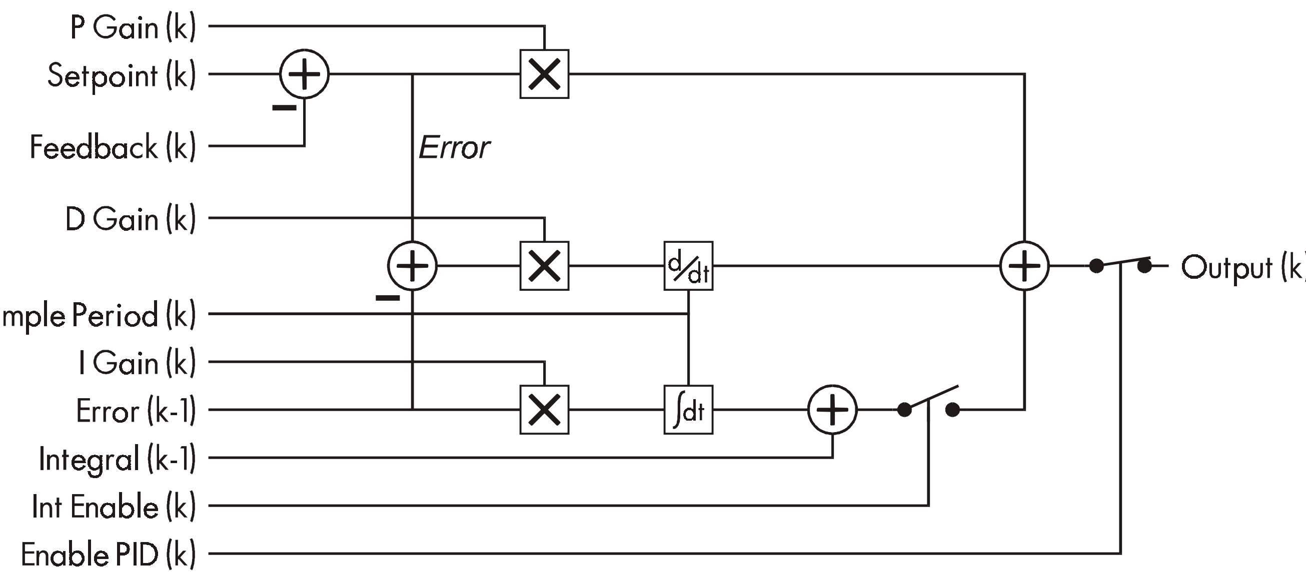

4
3
2
1
D
C
B
A
ISS | DATE | ECO
A | 14 JUL 98 | 0714
B | 21 AUG 98 | 0714
C | 17 DEC 98 | 0714
LINE SPEED
SG
MIN DIAMETER
PSG
WINDER SPEED
SG
MIN SPEED
PSG
TENSION ENABLE
PSG
|x|
xy
x>y
x/y
CORE 1
CORE 2
CORE SELECT
PSG
CORE
GT
CORE SHT 3
EXT DIAMETER
EXT DIA SELECT
DIAMETER PRESET
GT
PRESET ENABLE
PWR UP
DIAMETER HOLD
HOLD FROM WEB BREAK
FILTER
x−y(x−z)
zpreset
HOLD
*y=e^−(CLOCK PERIOD / FILTER TIME)
CLAMP
xmin
GC
DIAMETER
DIAMETER SHT 2,3
FILTER MAX TC
FILTER MID TC
FILTER MIN TC
FILTER MID SPEED
FILTER PROFILER
100%
FILTER TC
GT
x³
x−y
WIDTH
PSG
VARIABLE INERTIA
FIXED INERTIA
x+y
OVER/UNDER
CHS
INERTIA COMP
GT3T4
RATE SP
SGT3
RATE
ST4
RATE CAL
dx/dt
SCALED RATE
GT3T4
BASE SPEED
GT3T4
AUX I DEMAND
DIAMETER TICK TIME
P
DIAMETER CLOCK PERIOD
GENERAL NOTES:
1. THIS DIAGRAM DEPICTS THE RELATION OF LINK FUNCTION BLOCK DATA VARIABLES AND OPERATIONS. NAMED VARIABLES MAY POSSESS ONE OR MORE OF THE FOLLOWING ATTRIBUTES AS NOTED:
PRESET (P) − THE VARIABLE MAY BE PRESET DURING CONFIGURATION.
SET (S) − THE VARIABLE MAY BE CONNECTED AS AN INPUT AND MAY BE ASSIGNED A TEST POINT DURING CONFIGURATION. THE VARIABLE MAY BE MODIFIED BY SAM IN SPECIAL MODE OR IF A TEST POINT WAS ASSIGNED.
GET (G) − THE VARIABLE MAY BE ASSIGNED A TEST POINT DURING CONFIGURATION. THE VARIABLE MAY BE EXAMINED BY SAM IN SPECIAL MODE OR IF A TEST POINT WAS ASSIGNED.
CLOCKED (C) − THE VARIABLE IS DETERMINED AT A SPECIFIED CLOCK RATE.
TRIGGERED (T OR Tno.) − THE VARIABLE IS DETERMINED UPON ANY PRECEDING VARIABLE EVENT OR UPON A SPECIFIC INPUT VARIABLE EVENT IDENTIFIED BY NUMBER.
EUROTHERM DRIVES
CHARLOTTE, NC, USA
DWN D. COX 7 JUL 98
CHK C. FELDMAN 7 JUL 98
APP −
EDIT
S.O. −
CUS −
P.O. −
LOC −
DIAMETER CALCULATOR AND INERTIA COMPENSATION
WINDERS/SPW3 (SPEED PROGRAMMED WINDER)
LINK FUNCTION BLOCK DATA FLOW DIAGRAM
SIZE B
DWG NO RF354823B
ISSUE A|B|C
SCALE −
SHEET 1 OF 3
KE051392B000 (3)


SPEED DEMAND
DRIVE START
START LATCH
WEB BREAK
DRIVE P GAIN
UP TO SPEED
MIN DIAMETER
OVER-UNDER
UTS THRESHOLD
DIAMETER HOLD
PID OUTPUT
P.I.D.
FEEDBACK
SETPOINT
PROPORTIONAL
DERIVATIVE
TIME CONSTANT
WB DELAY
STALL ENABLE
WB THRESHOLD
LINE SPEED SP
WINDER SPEED
RAMPED SPEED
RAMP
SPEED DELTA
JOG SPEED
JOG
OVERSPEED
MEMORY ENABLE
REWIND-UNWIND
RANGE
RANGE NON-EXTN
RANGE EXTN
EXTENSIBLE WEB
SETPOINT
PROPORTIONAL
DERIVATIVE
INTEGRAL TC
INTEGRAL ENABLE
PID ENABLE
M-START
START
STOP
READY
FEEDBACK
DIAMETER SHT 1
GAIN PROFILER
P EXPONENT
P MAX GAIN
P MIN GAIN
D EXPONENT
D MAX GAIN
D MIN GAIN
DRIVE EXPONENT
DRIVE MAX GAIN
DRIVE MIN GAIN
SPEED DEMAND, WEB BREAK AND UP-TO-SPEED DETECTOR
WINDERS/SPW3 (SPEED PROGRAMMED WINDER)
LINK FUNCTION BLOCK DATA FLOW DIAGRAM
RF354823B
D. COX 7 JUL 98
C. FELDMAN 7 JUL 98
SHEET 2 OF 3
EUROTHERM DRIVES
CHARLOTTE, NC, USA



TENSION DEMAND
DANCER LOADING
IN TENSION
FILTERED CURRENT
POSITIVE CLAMP
NEGATIVE CLAMP
RAMP
TENSION DELTA
DANCER CAL
TENSION ENABLE
OTHER ENABLE
STALL ENABLE
BOOST ENABLE
100% (FIXED)
BOOST SELECT
BOOST
STALL SELECT
STALL TENSION
TENSION SP
TAPER SP
DIAMETER SHT 1
CORE SHT 1
LINEAR TAPER
HYPERBOLIC TAPER
TAPER SELECT
TENSION CLOCK PERIOD
TENSION TICK TIME
ARMATURE CURRENT
MEMORY FILTER
FILTER
TRACK & HOLD
HOLD
MEMORY ENABLE
MEMORY HOLD
REWIND-UNWIND
OVER-UNDER
CHS
CM BOOST SELECT
CM BOOST
CM BOOST ENABLE
200%
-200%
TENSION DEMAND AND CURRENT MEMORY
WINDERS/SPW3 (SPEED PROGRAMMED WINDER)
LINK FUNCTION BLOCK DATA FLOW DIAGRAM
D. COX 7 JUL 98
C. FELDMAN 7 JUL 98
RF354823B
3 OF 3
EUROTHERM DRIVES
CHARLOTTE, NC, USA

Appendix A PID CONTROLLER



Proportional Term

p(k) = Kp * e(k)

Integral Term

i(k) = Ki * Ts * e(k – 1) + i(k – 1)

Derivative Term

d(k) = (Kd / Ts) * [e(k) – e(k – 1)]

Notes

(k) = sample

(k - 1) = previous sample

Kp = P Gain

Ki = I Gain

Kd = D Gain

Ts = Sample Period setting