SIEIDrive

# ADV200

English

## PID application

GEFRAN

| Index of changes | Date | Author | Description |
|---|---|---|---|
| V0.4 | 4/12/2014 | BRI | Added chapter 1.1 |
| V0.3 | 22/04/2011 | BRI | Changed block diagrams and manual graphic |
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| V0.1 | 25/9/2007 | | First edition, derived from the PID XVy-EV V1.4 manual |

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# 1. GENERAL INFORMATION

The PID function was developed for general uses, including the operation of drive rolls, winders and unwinders and pump and extruder pressure control.
A dancer or a load cell can be used as position/tension transducer.

The inputs (except those concerning transducers) and outputs can be configured and associated with various drive parameters. For example, the PID output can be sent to the ramp or torque regulators.

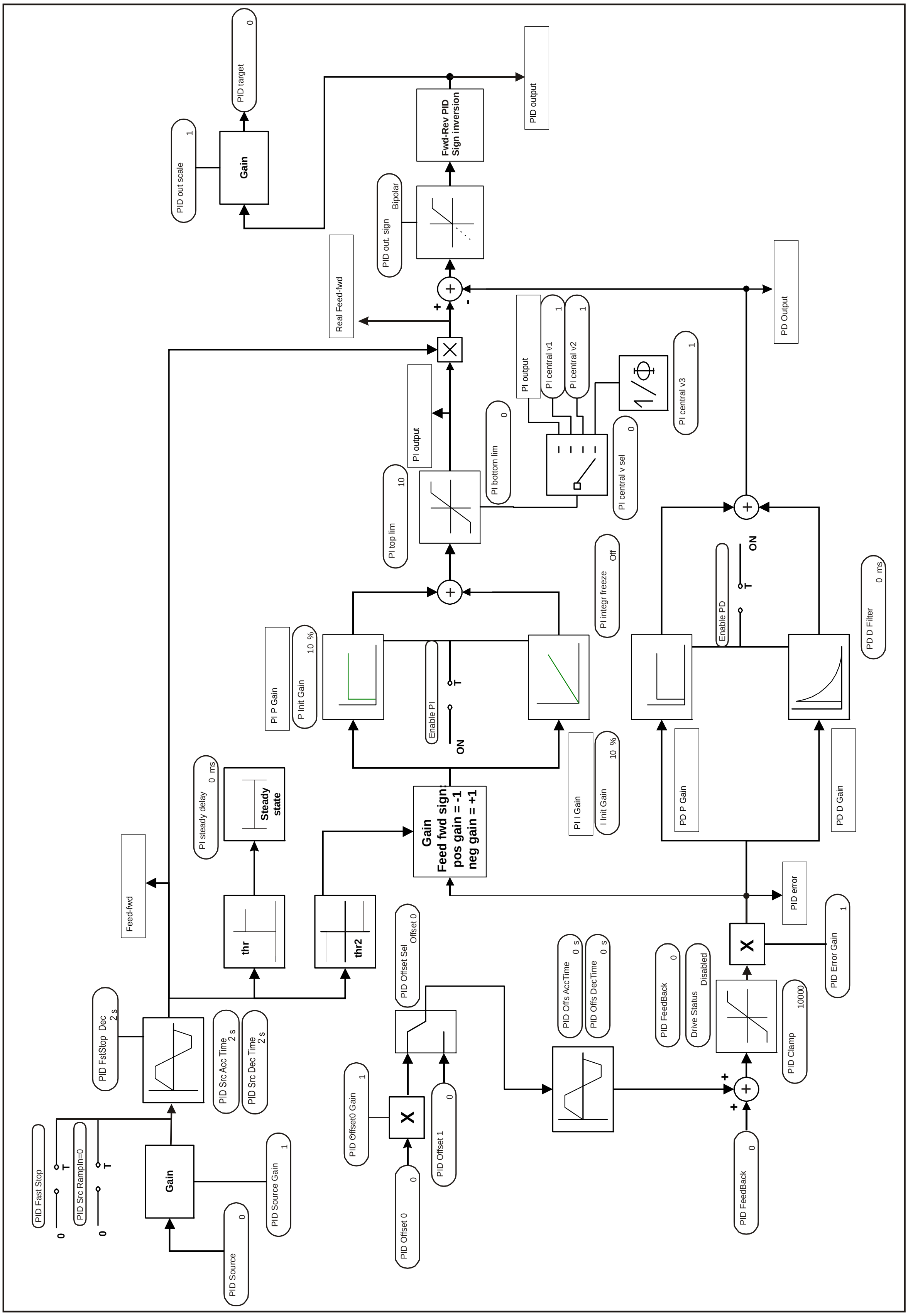
Analog inputs/outputs are sampled/updated every 2 msec.
Digital inputs/outputs are sampled/updated every 8 msec.

## 1.1. Compatibility Application version / Drive firmware

| PID | Drive Firmware |
|---|---|
| 2.0.1 | 5.X.X : 6.X.X ; 7.X.X |

# 2. PID general layout

The general PID function diagrams are shown below.



# 3. PID menu tree

Refer to the following sections for a detailed description of each parameter.
The internal Type column is useful for configuring PDC (fieldbus) channels if programmed as “direct access”.

| Menu | Ipa | Parameter Name | User type | Target type | Mu |
|---|---|---|---|---|---|
| MAIN | | | | | |
| | 11002 | PID Norm Value | Int16 | Int16 | Cnts |
| | 11004 | PID Out Sign | Enum | Boolean | |
| | 11006 | Enable PD | Enum | Boolean | |
| | 11008 | Enable PI | Enum | Boolean | |
| | 11010 | Fwd-Rev PID | Enum | Boolean | |
| | 12000 | PID Feed-fwd | Int16 | Int16 | norm |
| | 12004 | PI Output | Float | Int16 | |
| | 12006 | Real Feed-fwd | Int16 | Int16 | norm |
| | 12008 | PD Output | Int16 | Int16 | norm |
| | 12010 | PID Output | Int16 | Int16 | norm |
| | 12012 | Drive Status | Enum | Int16 | |
| | 12014 | PID Status | Uint16 | Uint16 | |
| PID SOURCE | | | | | |
| | 11012 | PID Source Gain | Float | Int16 | |
| | 11014 | PID Source | Int16 | Int16 | norm |
| | 11016 | PID Src Acc Time | Float | Int32 | sec |
| | 11018 | PID Src Dec Time | Float | Int32 | sec |
| | 11020 | PID FstStop Dec | Float | Int32 | sec |
| | 11022 | PID Src RampIn=0 | Boolean | Boolean | |
| | 11024 | PID Fast Stop | Enum | Boolean | |
| PID REFERENCES | | | | | |
| | 11026 | PID Clamp | Int16 | Int16 | norm |
| | 11028 | PID Offset 0 | Int16 | Int16 | norm |
| | 11030 | PID Offset 1 | Int16 | Int16 | norm |
| | 11032 | PID Feed-back | Int16 | Int16 | norm |
| | 11034 | PID Offset0 Gain | Float | Int16 | |
| | 11036 | PID Error Gain | Float | Int16 | |
| | 11038 | PID Offs AccTime | Float | Int32 | sec |
| | 11040 | PID Offs DecTime | Float | Int32 | sec |
| | 11042 | PID Offset Sel | Enum | Boolean | |
| | 12016 | PID Error | Int16 | Int16 | norm |
| PI CONTROLS | | | | | |
| | 11044 | PI Steady Delay | Uint16 | Uint16 | msec |
| | 11046 | PI Steady Thr | Int16 | Int16 | norm |
| | 11048 | P Init Gain | Float | Int16 | % |
| | 11050 | I Init Gain | Float | Int16 | % |
| | 11052 | PI Top Limit | Float | Int16 | |
| | 11054 | PI Bottom Limit | Float | Int16 | |
| | 11056 | PI Central V1 | Float | Int16 | |
| | 11058 | PI Central V2 | Float | Int16 | |
| | 11060 | PI Central V3 | Float | Int16 | |
| | 11062 | PICentral V Sel | Uint16 | Uint16 | |
| | 11064 | PI Int Freeze | Enum | Boolean | |
| | 12018 | PI Input | Int16 | Int16 | norm |

| Menu | | Ipa | Parameter Name | User type | Target type | Mu |
|---|---|---|---|---|---|---|
| | | 12020 | PI P Gain In Use | Float | Int16 | % |
| | | 12022 | PI I Gain In Use | Float | Int16 | % |
| PD CONTROLS | | | | | | |
| | | 11066 | PD D Filter | Int32 | Int32 | msec |
| | | 12024 | PD D Gain In Use | Float | Int16 | % |
| | | 12026 | PD P Gain In Use | Float | Int16 | % |
| GAINS ADAPTIVE | | | | | | |
| | REGIONS | | | | | |
| | | 11116 | Region A End | Int16 | Int16 | norm |
| | | 11118 | Region B Start | Int16 | Int16 | norm |
| | | 11120 | Region B End | Int16 | Int16 | norm |
| | | 11122 | Region C Start | Int16 | Int16 | norm |
| | PI ADAPTIVE | | | | | |
| | | 11124 | PI P Gain A | Float | Int16 | % |
| | | 11126 | PI I Gain A | Float | Int16 | % |
| | | 11128 | PI Adapt Ref Sel | Enum | Uint16 | |
| | | 11130 | PI Adapt Ref | Int16 | Int16 | norm |
| | | 11132 | PI P Gain B | Float | Int16 | % |
| | | 11134 | PI I Gain B | Float | Int16 | % |
| | | 11136 | PI P Gain C | Float | Int16 | % |
| | | 11138 | PI I Gain C | Float | Int16 | % |
| | | 11140 | PI Adapt Enable | Enum | Boolean | |
| | PD ADAPTIVE | | | | | |
| | | 11142 | PD Adapt Ref Sel | Enum | Uint16 | |
| | | 11144 | PD Adapt Ref | Int16 | Int16 | norm |
| | | 11146 | PD P Gain A | Float | Int16 | % |
| | | 11148 | PD D Gain A | Float | Int16 | % |
| | | 11150 | PD P Gain B | Float | Int16 | % |
| | | 11152 | PD D Gain B | Float | Int16 | % |
| | | 11154 | PD P Gain C | Float | Int16 | % |
| | | 11156 | PD D Gain C | Float | Int16 | % |
| | | 11158 | PD Adapt Enable | Enum | Boolean | |
| PID TARGET | | | | | | |
| | | 11068 | PID Output Scale | Float | Int16 | |
| | | 11070 | PID Target Sel | Enum | Uint16 | |
| | | 12028 | PID Target | Int16 | Int16 | |
| DIAMETER CALC | | | | | | |
| | | 11072 | Diam Calc SpdThr | Int16 | Int16 | % |
| | | 11074 | Line Speed | Int16 | Int16 | norm |
| | | 11076 | Line Speed Gain | Float | Int16 | |
| | | 11078 | Base Omega | Int16 | Int16 | rpm |
| | | 11080 | Diam Calc FilTau | Float | Int32 | s |
| | | 11082 | Diameter Thr 1 | Float | Float | mm/inches |
| | | 11084 | Diameter Thr 2 | Float | Float | mm/inches |
| | | 11086 | Maximum Diameter | Float | Float | mm/inches |
| | | 11088 | Unwind | Boolean | Boolean | |
| | | 11090 | Diameter Calc | Enum | Boolean | |
| | | 11092 | DiamIncDecEnable | Enum | Boolean | |
| | | 12030 | LineSpeed Scaled | Int16 | Int16 | norm |
| | | 12032 | Calc Diameter | Float | Float | mm/inches |

| Menu | | Ipa | Parameter Name | User type | Target type | Mu |
|---|---|---|---|---|---|---|
| | | 12034 | Estimated Diam | Float | Float | mm/inches |
| | | 12036 | Over Diam Thr 1 | Boolean | Boolean | |
| | | 12038 | Over Diam Thr 2 | Boolean | Boolean | |
| | | 12040 | Diam Max Stat | Boolean | Boolean | |
| | | 12042 | Diam Min Stat | Boolean | Boolean | |
| DIAMETER INIT | | | | | | |
| | | 11094 | Dancer Pitches | Uint16 | Uint16 | |
| | | 11096 | Max Deviation | Int16 | Int16 | norm |
| | | 11098 | Positioning Spd | Int16 | Int16 | rpm |
| | | 11100 | Gear Box Ratio | Float | Float | |
| | | 11102 | Minimum Diameter | Float | Float | mm/inches |
| | | 11104 | DancerHalfTravel | Float | Float | mm/inches |
| | | 11106 | Diameter Init | Enum | Boolean | |
| | | 12044 | DiameterInitStatus | Enum | Int16 | |
| | | 12046 | Initial Diameter | Float | Float | mm/inches |
| | | 12048 | DiamInitComplete | Boolean | Boolean | |
| | | 12050 | DiamInit Aborted | Boolean | Boolean | |
| I/O | | | | | | |
| | DIGITAL INPUTS | | | | | |
| | | 11178 | Fwd-Rev PID Sel | Enum | Int16 | |
| | | 11180 | Enable PD Sel | Enum | Int16 | |
| | | 11182 | Enable PI Sel | Enum | Int16 | |
| | | 11184 | PI C V Bit 0 Sel | Enum | Int16 | |
| | | 11186 | PI C V Bit 1 Sel | Enum | Int16 | |
| | | 11188 | PID Offset InSel | Enum | Int16 | |
| | | 11190 | PI Int Freez Sel | Enum | Int16 | |
| | | 11192 | Wind Unwind Sel | Enum | Int16 | |
| | | 11194 | Diam Init Sel | Enum | Int16 | |
| | | 11196 | PIDSrcRamp=0 Sel | Enum | Int16 | |
| | | 11198 | PID FastStop Sel | Enum | Int16 | |
| | DIGITAL OUTPUTS | | | | | |
| | | 11114 | PID Status Dest | Enum | Int16 | |
| | | 11200 | Max Diam Dest | Enum | Int16 | |
| | | 11202 | Min Diam Dest | Enum | Int16 | |
| | | 11204 | Diam Thr 1 Dest | Enum | Int16 | |
| | | 11206 | Diam Thr 2 Dest | Enum | Int16 | |
| | | 11208 | DiamIniCompl Des | Enum | Int16 | |
| | | 11210 | DiamIniAbort Des | Enum | Int16 | |
| | ANALOG INPUTS | | | | | |
| | | 11212 | PID Src Sel | Enum | Uint16 | |
| | | 11214 | FeedBack Sel | Enum | Uint16 | |
| | | 11216 | PIDOffs0 Sel | Enum | Uint16 | |
| | | 11218 | PICentralV3 Sel | Enum | Uint16 | |
| | | 11220 | LineSpeed Sel | Enum | Uint16 | |
| | ANALOG OUTPUTS | | | | | |
| | | 11222 | PID Target Dest | Enum | Int16 | |
| | | 11224 | Calc Diam Dest | Enum | Int16 | |
| | | 11226 | PID Error Dest | Enum | Int16 | |

| Menu | | Ipa | Parameter Name | User type | Target type | Mu |
|---|---|---|---|---|---|---|
| | FIELDBUS | | | | | |
| | | 11000 | PID Rem Cmds Src | Enum | Uint16 | |
| | | 11228 | PID Remote Cmds | Uint16 | Uint16 | |
| SPEED | | | | | | |
| | | 11110 | MainEncSpeedBase | Uint32 | Uint32 | rpm |
| | | 12052 | Actual Speed | Int16 | Int16 | norm |
| ABOUT | | | | | | |
| | | 12056 | APP Version | Float | Float | |
| | | 12058 | MDPlc Version | Float | Float | |
| | | 12060 | GF Version | Float | Float | |

# 4. Machine control states

The PID machine control function states are shown below.

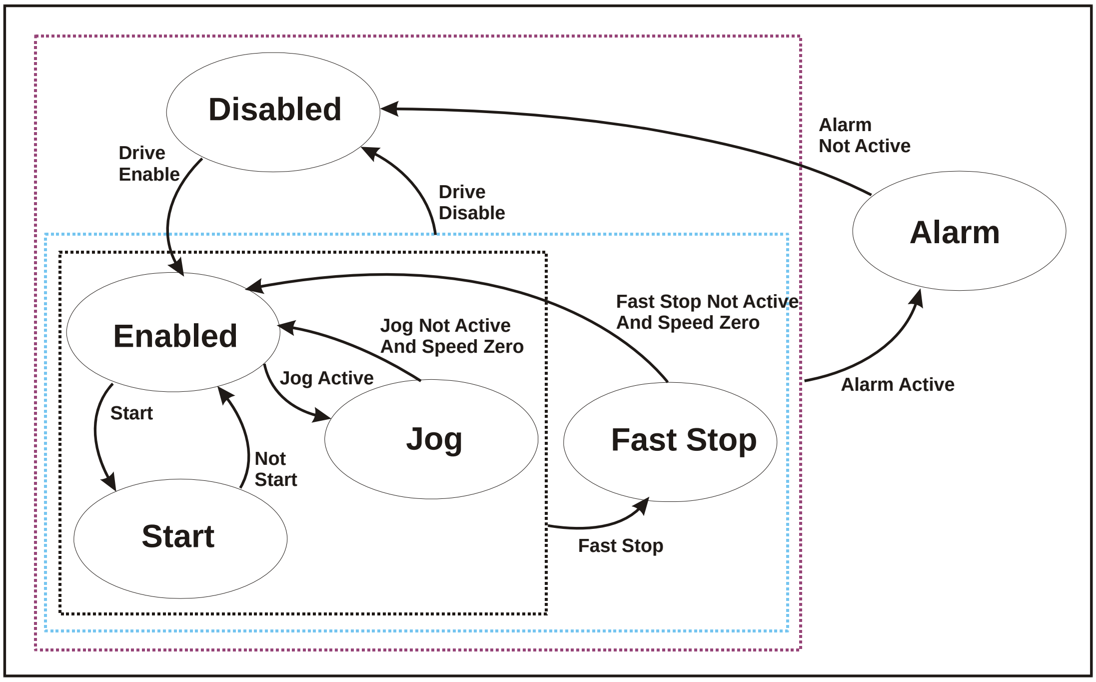



**Fig. 1 - PID machine control states**

There are 6 defined states:

**Disabled** Initial state; the drive is disabled; the PID function is enabled. If **PID Target Sel** is set to a value other than Off, the integral part of the PI regulator and the ramp on PID Source are blocked. The state ceases if the **Enable Cmd** is sent.

**Enabled** This state is activated when **Enable Cmd** is sent; the PID function is enabled. If **PID Target Sel** is set with Dig ramp ref 1, Dig speed ref 1 or Dig torque ref 1, the integral part of the PI regulator and the ramp on PID Source are blocked.

**Jog** This state is started when the **Jog** commands are active; the drive is enabled, the PID function is enabled. If **PID Target Sel** is set to a value other than Off, the integral part of the PI regulator and the ramp on PID Source are blocked.

**Start** This state is activated when **Start cmd** is sent. The drive is enabled, the PID function is enabled. Jog commands can no longer be sent. The state ceases when **Start cmd** is removed.

**Fast Stop** In the Enabled, Jog and Start states, the drive can be stopped in the **Fast Stop** condition; the drive is enabled, the PID function is enabled. If **PID Target Sel** is set to a value other than Off, the integral part of the PI regulator and the ramp on PID Source are blocked.

**Alarm** In each of the states described above, if an alarm occurs the drive enters Alarm mode; the drive is disabled, the PID function is enabled. If **PID Target Sel** is set to a value other than Off, the integral part of the PI regulator and the ramp on PID Source are blocked. The state ceases when none of the alarms are active any more and the user has sent an **Alarm Reset** command.

# 5. General parameters

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Norm Value | 11002 | 0 | 16383 | 10000 | |
| Drive Status | 12012 | See below | | | |
| PID Status | 12014 | 0 | FFFF Hex | 0 | |

**PID Norm Value** This parameter indicates the full scale value at the PID analog inputs/outputs; this value is usually set to 10000, but it can be changed to suit particular requirements. The unit of measure for parameters normalised according to this value is the "**norm**".

**Drive Status** Machine condition according to drive states (see "Machine control states")

0 - Disabled

1 - Enabled

2 - Start Active

3 - JOG Active

4 - Fast Stop Active

5 - Alarm!

**PID Status** PID status bitwords.

Bit 0 : Drive ready

Bit 1 : Drive enabled status

Bit 2 : Maximum diameter reached

Bit 3 : Minimum diameter reached

Bit 4 : Diameter threshold exceeded 1

Bit 5 : Diameter threshold exceeded 2

Bit 6 : Diameter initialisation complete

Bit 7 : Diameter initialisation aborted

Bit 8 : Zero speed status

# 6. Inputs/Outputs

## 6.1. Regulation inputs/outputs

**PID Source** Feedforward input normally programmed on analog input.

**PID Feed-back** Analog input for the position/tension transducer (dancer/load cell).

**PID Offset 0** Offset from analog input added to **PID Feed-back**. It can be used to adjust the dancer position.

**PI Central V3** Setting of the initial value of the integral component of the regulator (corresponding to the initial diameter). It can be programmed on an analog input connected, for example, to an ultrasonic transducer used to measure the diameter of a winder/unwinder.

**Line Speed** Line speed used to measure the roll diameter.

**PID Target** Parameter associated with the regulator output; it is normally programmed on the drive ramp reference.

**PID Output** Analog output of the regulator. It can be used to perform reference cascades in multi-drive systems.

**Calc Diameter** Output of the roll diameter calculation.

**Input commands (programmable on digital inputs)**

**Enable PI** Enabling of the PI part (proportional – integral) of the regulator. Input L – H transition also requires the automatic acquisition of the power value of the integral component (corresponding to the initial diameter).

**Enable PD** Enabling of the PD part (proportional – derivative) of the regulator.

**PID Src RampIn=0** The PID Source ramp input is set to 0.

**PID Fast Stop** PID Fast Stop acts on the PID Source ramp and differs from the general Fast Stop command. The PID Source ramp input is set to 0 and the deceleration time is selected on the basis of the **PID FstStop Dec** parameter.

**PI Int Freeze** The current condition of the regulator integral component is frozen.

**PID Offset Sel** Selection of the offset added to the **PID Feed-back** parameter: L = **PID Offset 0**, H = **PID Offset 1**.

**PI C V Bit0 Sel** Initial PI block output selector. When the **PI C V Bit0** parameter has been defined through binary selection, 4 different initial integral level settings can be selected (corresponding to the initial diameter).

**PI C V Bit1 Sel** Initial PI block output selector. When the **PI C V Bit1** parameter has been defined through binary selection, 4 different initial integral level settings can be selected (corresponding to the initial diameter).

**Diameter Init** Enabling of the diameter initialisation function.

**Unwind** Used to indicate to the diameter calculation procedure that the drive is in the unwinding phase.

**Fwd-Rev PID** Used to invert the PID Output signal if the mechanical ratio is reversed.

**Output states (programmable on digital outputs)**

**Max Diameter** The diameter calculation procedure has detected the maximum diameter.

**Min Diameter** The diameter calculation procedure has detected the minimum diameter.

**Over Diam Thr 1** The diameter calculation procedure has detected that the diameter exceeds the Diameter Thr 1 parameter.

**Over Diam Thr 2** The diameter calculation procedure has detected that the diameter exceeds the Diameter Thr 2 parameter.

**DiamInitComplete** The diameter initialisation procedure is complete.

**DiamInit Aborted** The diameter initialisation procedure has been aborted

# 7. Feedforward

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Source | 11014 | -32767 | +32767 | 0 | 1 |
| PID Source Gain | 11012 | -100.000 | +100.000 | 1 | |
| PID Feed-fwd | 12000 | PID Norm Value | +PID Norm Value | 0 | |
| PID Src Acc Time | 11016 | 0.01 | 200 | 0.1 | |
| PID Src Dec Time | 11018 | 0.01 | 200 | 0.1 | |
| PID FstStop Dec | 11020 | 0.01 | 200 | 2 | |
| PID Src RampIn=0 | 11022 | 0- Off | 1- On | 0-Off | 2 |
| PID Fast Stop | 11024 | 0 -Active | 1-Not Active | Not Active | 3 |
| | | | | | |

1 The PID **Source** value can be sampled from a list of selectable sources; refer to the PID **Src AnInpSel** parameter in the I/O\Analog Inputs menu.
2 PID **Src RampIn=0** can be sampled from a list of digital inputs; refer to the **PIDSrcRamp=0 Sel** parameter in the I/O\Digital Inputs menu
3 PID **Fast Stop** can be sampled from a list of digital inputs; refer to the **PID FastStop Sel** parameter in the I/O\Digital Inputs menu

When in use, the feedforward signal is the main reference of the regulator. Inside the regulator, the signal is reduced or amplified by the PID function and output as a reference signal for the drive.

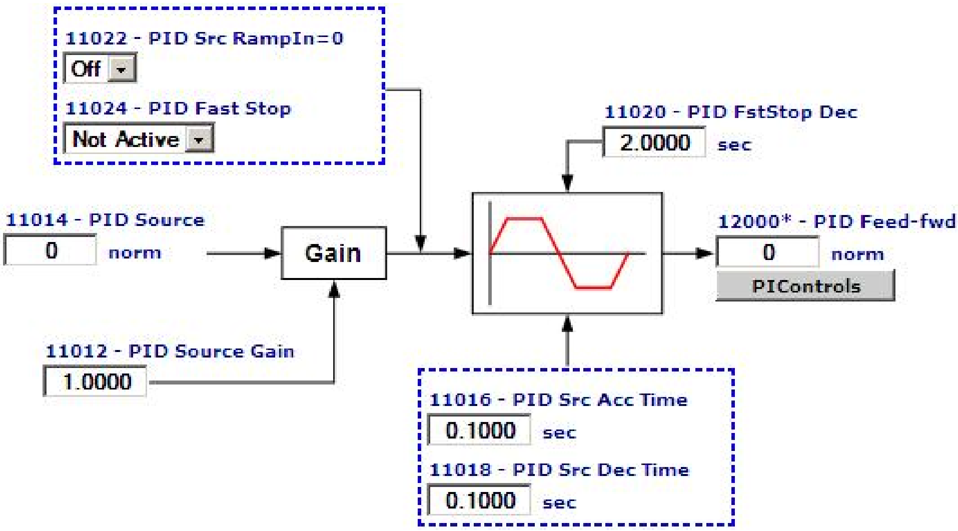



**Fig. 2 – description of the feedforward block**

**PID Source** **PID Source** value.

**PID Source Gain** Multiplication factor of the input value in relation to the **PID Source** parameter.

**PID Feed-fwd** Feedforward value

**PID Src Acc Time** Ramp acceleration time of the **PID Source** parameter; the value indicates the time required for the ramp output to go from zero to [**PID Norm Value**] (e.g. from 0 to 10000). The predefined value is low so that the ramp is not present.

**PID Src Dec Time** Ramp deceleration time of the **PID Source** parameter; the value indicates the time required for the ramp output to go from [**PID Norm Value**] to zero (e.g. from 10000 to 0). The predefined value is low so that the ramp is not present.

**PID Fst Stop Dec** Ramp deceleration time of the **PID Source Fast Stop** parameter; the value indicates the time required for the ramp output to go from [**PID Norm Value**] to zero (e.g. from 10000 to 0).

**PID Src RampIn=0** Input of the **PID Source Ramp** parameter set to 0; if enabled, the ramp input is immediately set to 0 and the output reaches the zero value in the time set in the **PID Src Dec Time** parameter.

**PID Fast Stop** **PID Fast stop** command; if activated, the ramp input is immediately set to 0 and the output reaches the zero value in the time set in the **PID Fst Stop Dec** parameter.

*Nota!* If the regulator is used as "generic PID" without the feedforward function, the Feed - fwd parameter must be set to its maximum value.

This must be done by setting the PID Source parameter using the same value as that set in PID Norm value

# 8. PID function

The PID function is divided into three blocks:
- Feedback input “**PID References**”
- Proportional - integral control block “**PI Controls**”
- Proportional - derivative control block “**PD Controls**”

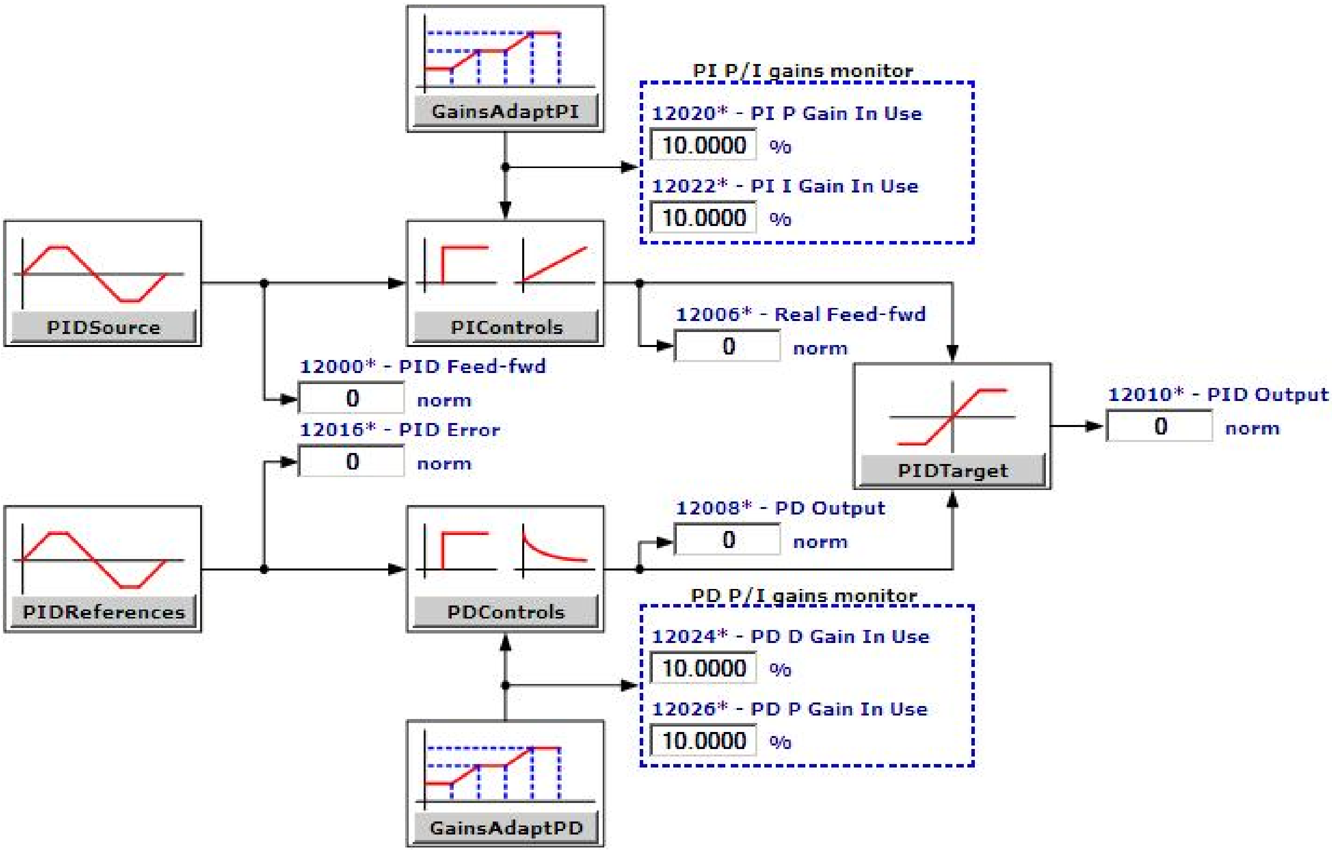



Fig. 2-A – Overwiev PID function

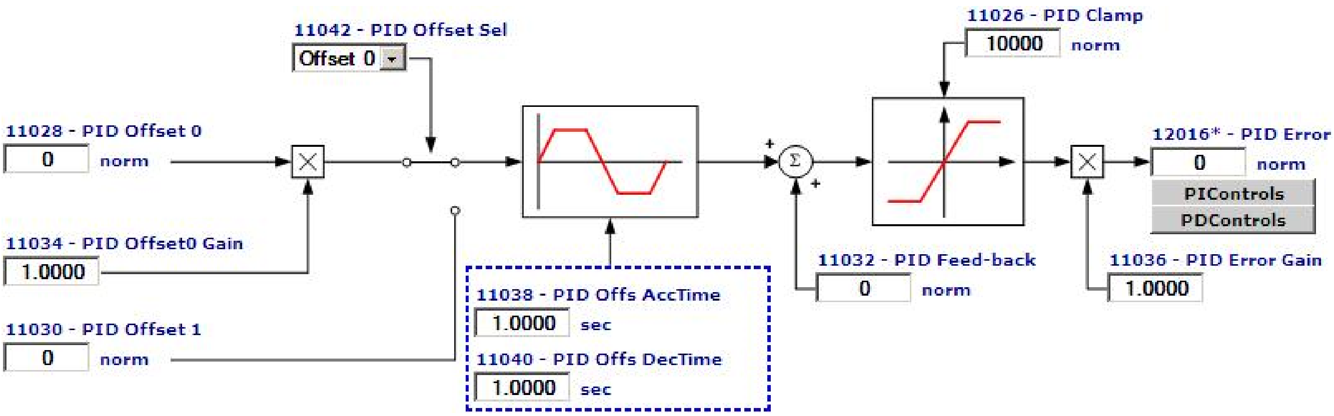



Fig. 3-B – description of the feedback block

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Error | 12016 | -PID Norm Value | +PID Norm Value | 0 | 1 |
| PID Feed-back | 11032 | -PID Norm Value | +PID Norm Value | 0 | 2 |
| PID Offset Sel | 11042 | 0 | 1 | 0 | 3 |
| PID Offset0 Gain | 11034 | -10.00 | +10.00 | 1 | |
| PID Offset 0 | 11028 | -PID Norm Value | +PID Norm Value | 0 | 4 |
| PID Offset 1 | 11030 | -PID Norm Value | +PID Norm Value | 0 | |
| PID Offs Acc time | 11038 | 0.0 | 900.0 | 1.0 | |
| PID Offs Dec time | 11040 | 0.0 | 900.0 | 1.0 | |
| PID Error Gain | 11036 | -10.00 | +10.00 | 1 | |
| PID Clamp | 11026 | -PID Norm Value | +PID Norm Value | 10000 | |

T6279i

1 The PID Error value can be set on a programmable analog output; refer to the I/O\Analog Outputs menu.

2 The PID Feed-back value can be sampled from a list of selectable sources; refer to the FeedBack AnInpSel parameter in the I/O\Analog Inputs menu.

3 PID Offset Sel can be sampled from a list of digital inputs; refer to the PID Offset InSel parameter in the I/O\Digital Inputs menu

4 The PID Offset 0 value can be sampled from a list of selectable sources; refer to the PIDOffs0 AnInpSel parameter in the I/O\Analog Inputs menu.

**PID Error** Reading of the error input to the PID function (**PID Clamp** block output).

**PID Feed-back** Reading of the feedback value from the position (dancer) or tension (load cell) transducers.

**PID Offset Sel** Selection of the offset added to **PID Feed-back**. This parameter can be set from a programmable digital input.

0 = **PID Offset 0** 1 = **PID Offset 1**

**PID Offset 0** Offset 0 added to **PID Feed-back**. This parameter can be set via an analog input, for example to set the tension when using a load cell as feedback.

**PID Offset0 Gain** Gain of **PID Offset 0**

**PID Offset 1** Offset 1 added to **PID Feed-back**.

**PID Offs AccTime** Ramp acceleration time in seconds after the **PID Offset** parameter block.

**PID Offs DecTime** Ramp deceleration time in seconds after blocking the **PID Offset** parameter block.

**PID Error Gain** Gain of **PID error**

**PID Clamp** The clamp allows the controlled system, winder or unwinder, to be tensioned smoothly, when the “**Errore. L'origine riferimento non è stata trovata.**” function cannot be used.

When the drive is enabled with the dancer at the minimum full scale, so that the **PID Error** is at its maximum value, the motor could accelerate suddenly to move the dancer to its central working position.

If **PID Clamp** is set to a sufficiently low value, for instance 1000, after enabling the drive and the **Enable PD** parameter, the **PID Error** value is limited to 1000 until the signal coming from the dancer (**PID Feed-back**) falls below the clamp value. The **PID Clamp** value is then automatically restored to the maximum value corresponding to the **PID**

**Norm Value** parameter. The clamp is kept at this value until the drive or the **Enable PD** parameter is disabled again.

The feedback input is supplied to connect the analog transducers such as the dancer, to the relative potentiometer or load cell. However, the input block can be used as a point of comparison between two generic input signals of + / - 10V.

**Connection to a dancer via potentiometer connected with an interval of between - 10 and + 10V.**

The cursor of the potentiometer can be connected to one of the analog inputs of the drive.
The selected input must be programmed in **FeedBack AnInpSel** in the I/O\Analog Inputs menu.
The position of the dancer can be adjusted through the **PID Offset 0** or **PID Offset 1** parameters.

**Connection to a load cell with maximum voltage + 10V.**

The output of the load cell can be connected to one of the analog inputs of the drive.
The selected input must be programmed in **FeedBack AnInpSel** in the I/O\Analog Inputs menu.
The tension setting, with a value of 0...-10V, can be sent to one of the remaining programmable analog inputs and programmed using the **PIDOffs0 AnInpSel** parameter in the I/O\Analog Inputs menu.

# 9. Proportional - integral control block

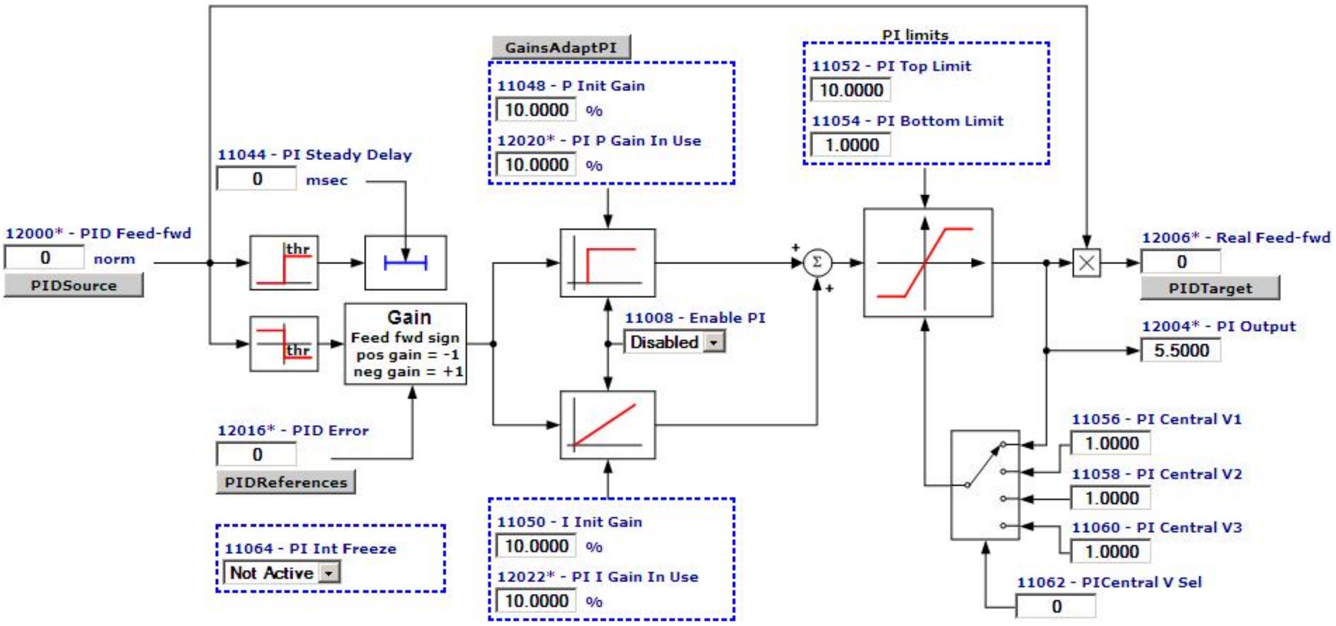



**Fig. 4 – description of the PI block**

The PI block receives the **PID Error** parameter as an input: this is the error to be processed by the regulator. The PI block performs a proportional - integral regulation; the output is identified by parameter **PI output.** After being suitably adapted according to the system to be controlled, it is used as the **PID Feed-fwd** multiplication factor in order to obtain the correct drive speed reference value (**Real Feed-fwd)**.

The PI block is enabled by setting **Enable PI** = Enable. If the **Enable PI** parameter is programmed on a digital input, it must be set to a high logic level (+24V).

| Parameter | N. | Value | | | Standard |
|---|---|---|---|---|---|
| | | min | max | factory | configuration |
| Menu | | | | | |
| Enable PI | 11008 | 0-Disabled | 1-Enabled | Disabled | 1 |

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1 **Enable** PI can be sampled from a list of digital inputs; refer to the **Enable** PI **Sel** parameter in the I/O\Digital Inputs menu

| | | |
|---|---|---|
| **Enable PI** | Enabled | Enables the proportional - integral block |
| | Disabled | Disables the proportional - integral block. |

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PI Input | 12018 | -PID Norm Value | +PID Norm Value | 0 | |
| PI P Gain In Use | 12020 | 0.00 | 100.00 | 10.00 | |
| PI I Gain In Use | 12022 | 0.00 | 100.00 | 10.00 | |
| PI Steady Thr | 11046 | 0 | 10000 | 500 | |
| PI Steady Delay | 11044 | 0 | 60000 | 0 | |
| P Init Gain | 11048 | 0.00 | 100.00 | 10.00 | |
| I Init Gain | 11050 | 0.00 | 100.00 | 10.00 | |
| PICentral V Sel | 11062 | 0 | 3 | 1 | 1 |
| PI Central V 1 | 11056 | PI Bottom Lim | PI Top Limit | 1.00 | |
| PI Central V 2 | 11058 | PI Bottom Lim | PI Top Limit | 1.00 | |
| PI Central V 3 | 11060 | PI Bottom Lim | PI Top Limit | 1.00 | 2 |
| PI Top Limit | 11052 | PI Bottom Lim | 10.00 | 10.00 | |
| PI Bottom Limit | 11054 | -10.00 | PI Top Limit | 0.00 | |
| PI Int Freeze | 11064 | 0 | 1 | 0 | 3 |
| PI Output | 12004 | 0 | 1000 x PI Top Limit | 0.00 | |
| Real Feed-fwd | 12006 | -10000 | +10000 | 0 | |

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1 PI Central V Sel can be sampled from a list of digital inputs; refer to the PI C V Bit 0 Sel and PI C V Bit 1 Sel parameters in the I/O\Digital inputs menu

2 The PI Central V 3 value can be sampled from a list of selectable sources; refer to the PICentralV3AnInp parameter in the I/O\Analog Inputs menu.

3 PI Int Freeze can be sampled from a list of digital inputs; refer to the PI Int Freez Sel parameter in the I/O\Digital inputs men

**PI Input** PI input signal (PID Error after converting the sign)

**PI P Gain In Use** Proportional gain of the PI block; this value indicates the output of the PI Proportional Gain Adaptive parameter. If the adaptive function is disabled, this value corresponds to that of **PI P Gain A.**

**PI I Gain In Use** Integral gain of the PI block; this value indicates the output of the PI Proportional Gain Adaptive parameter. If the adaptive function is disabled, this value corresponds to that of **PI I Gain A.**

**PI Steady Thr** Threshold for feedforward measurement. If **PID Feed-fwd** is less than **PI Steady Thr,** integral regulation stops and the proportional gain assumes the value set in **P Init Gain**.

When **PID Feed-fwd** exceeds the limit, integral regulation is enabled with the gain set in **I Init Gain**. The PI block maintains the **P Init Gain** and **I Init Gain** parameters according to the time set in **PI Steady Delay**; at the end of this delay, they are automatically brought back to **PI P Gain In Use** and **PI I Gain In Use**.

**PI Steady Delay** The time required to maintain the gains in **P Init Gain** and **I Init Gain** operational after the feedforward limit set in **PI Steady Thr** has been exceeded.

The **PI Steady Delay** time and consequent functions in relation to the change in the initial gains, are also operational in the L – H transition of the **Enable PI** parameter.

**P Init Gain** Initial proportional gain. See the **PI Steady Thr** parameter for a detailed description.

**I init gain PID** Initial integral gain. See the **PI Steady Thr** parameter for a detailed description.

**PI Central V Sel** Selection of the output for PI block initialisation. **PI Central V Sel** (0...3) determines which of the 4 possible settings for the initial value of the integral component of the regulator (corresponding to the initial diameter) must be used.

The **PI Central V Sel** parameter can be set directly via keypad and serial line/bus or via two digital inputs (see **PI C V Bit 0 Sel** and **PI C V Bit 1 Sel** in the I/O\Digital inputs menu).
If **PI Central V Sel = 0** is selected with the PI block disabled (**Enable PI** = Disable), the last value of the integral portion that was calculated is stored (corresponding to the core diameter). The value in question is displayed in **PI Output**. Once the block has been re-enabled, the regulation re-starts from that value. The same function is also available if the drive is switched off. This type of operation can be used when, while controlling a winder, for example, the machine has to be stopped for any reason and the drive must be disabled or the control panel must be disconnected from the power supply.
When **PI Central V Sel** = 1-2-3 is selected after disabling the PI block, the value of **PI Output** is set to the value programmed according to the corresponding central value (x1000).
When the drive is re-started after being switched off, the value of **PI Output** at the time of the last break is only automatically restored if, when the drive is switched on, the digital input programmed as **Enable PI** is already set to high.

**PI Central V 1** Setting of the first initial value of the regulator's integral component (corresponding to initial diameter 1). The value of **PI Central V 1** must be within the set limits.

**PI Top Limit** and **PI Bottom Limit**.

**PI Central V 1** is selected by setting the **PI Central V Sel** parameter to 1.

**PI Central V 2** Setting of the second initial value for the regulator's integral component (corresponding to initial diameter 2). The value of **PI Central V 2** must be within the set limits.
**PI Top Limit** and **PI Bottom Limit**.

**PI Central V 2** is selected by setting the **PI Central V Sel** parameter to 2.

**PI Central V 3** Setting of the third initial value for the regulator's integral component (corresponding to initial diameter 3). The value of **PI Central V 3** must be within the set limits.

**PI Top Limit** and **PI Bottom Limit**.

**PI Central V 3** is selected by setting the **PI Central V Sel** parameter to 3.

**PI Top Limit** Indicates the upper limit for the PI adjustment adaptive block.

**PI Bottom Limit** Indicates the lower limit for the PI adjustment adaptive block.

The PI block output is the feedforward multiplication factor. This value must be adjusted by the regulator according to the maximum limits between +**PID Norm Value** and –**PID Norm Value** and defined by **PI Top Limit** and **PI Bottom Limit**. The value of these parameters is defined on the basis of the the system to be controlled. Further details are provided in the "Examples of application" section.

**PI Int Freeze** The integral component of the regulator stops in the present condition.

**PI Output** PI block output, adapted to the values between the **PI Top Limit** and **PI Bottom Limit** parameters. When the drive is switched on, the **PI Output** parameter automatically acquires the value selected in **PI Central V Sel**.

Example: if **PI Central V 2** = 0.5 and PI Central V Sel = 2,
at start-up the **PI Output** parameter is set to = 500 (0.5x1000).
When **Enable PI** is activated, the **PI Output** parameter can, depending on the input error, integrate the value up to the limits set in **PI Top Limit** or **PI Bottom Limit** multiplied by 1000.

Example: **PI Top Limit** = 2, **PI Output** max = 2000.

The PI block output is also limited by saturation of the **Real Feed-fwd** parameter (see the corresponding parameter).

As described previously, the **PI Output** parameter acts as a feedforward multiplication factor to obtain the angular speed reference of the motor. For this reason, if the PID function is used to control a winder/unwinder, its value is inversely proportional to the core diameter.
Winding performed at a constant peripheral speed can satisfy the following equation:
$\omega 0 * \Phi 1 = \omega 1 * \Phi 1$

where:

$\omega_0$ = angular speed at minimum diameter
$\Phi_0$ = minimum diameter
$\omega_0$ = angular speed at current diameter
$\Phi_0$ = current diameter
$\omega_1 = \omega_0 \text{ x } (\Phi_0/\Phi_1)$

When the drive is correctly adjusted $\omega$ is equal to the maximum feedforward value, so that the **PI Output** parameter depends on $(\Phi_0/\Phi_1)$.
Considering the internal coefficients of the firmware, the following formula is obtained:

**PI Output** = $(\Phi_0/\Phi_1)$ x 1000

This formula can be used to verify the accuracy of the setting while the system is working or the initial diameter calculation procedure.

**Real Feed-fwd** Indicates the feedforward value re-calculated according to the PI correction. This is calculated using the following formula:

**Real Feed-fwd** = (**PID Feed-fwd** / 1000 ) x **PI Output**

The maximum value of the **Real Feed-fwd** parameter is equal to +/- **PID Norm Value**. If this limit is reached, any further increase in the value of **PI Output** is prevented, to avoid dangerous situations in connection with regulator saturation.

Example: PID Feed-fwd = + 8000, PID Norm Value = 10000, the positive limit for PI Output is automatically set to: 10000 / ( 8000 / 1000 ) = 1250.

# 10. Blocco di controllo proporzionale – derivativo

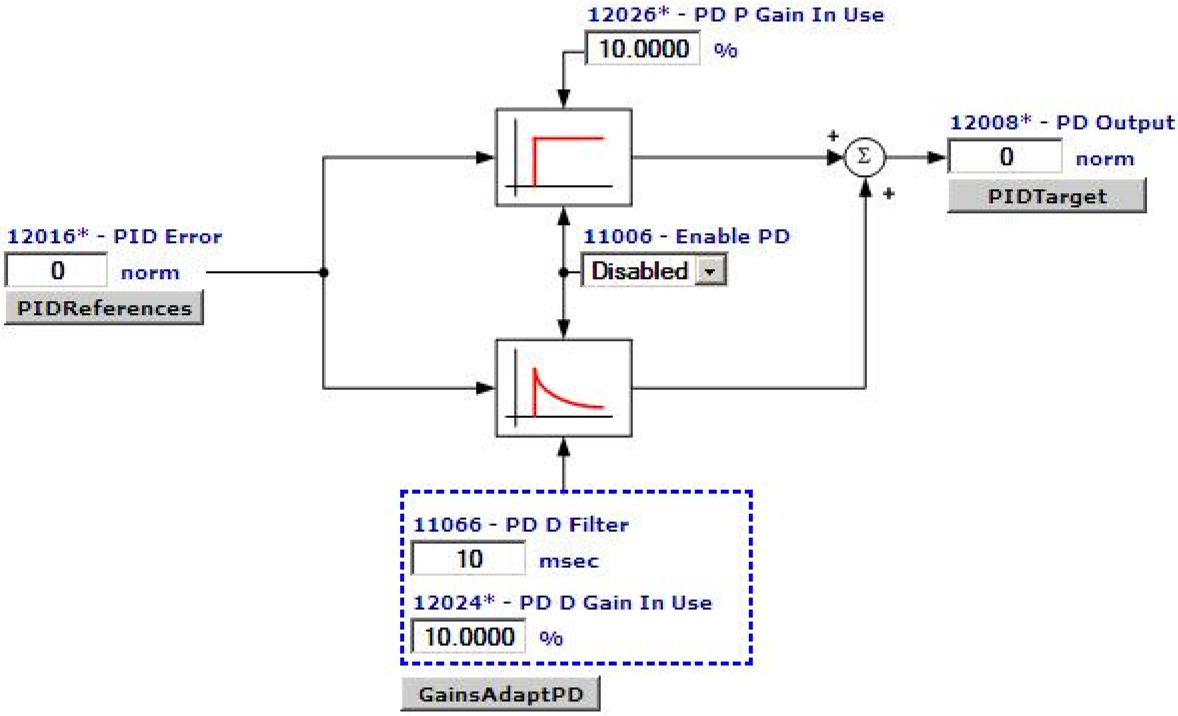


**Fig. 5 – description of the PD block**

The PD block receives the **PID Error** parameter as an input: this is the error to be processed by the regulator. The PD block performs a proportional - derivative regulation; its output identified by **PD Output** is added directly to the **Real Feed-fwd** parameter.
The PD block is enabled when **Enable PD** = Enable. If the **Enable PD** parameter is programmed on a digital input, it must be set to a high logic level.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Menu | | | | | |
| Enable PD | 11006 | 0- Disabled | 1-Enabled | Disabled | 1 |

1 Enable PD can be sampled from a list of digital inputs; refer to the Enable PD Sel parameter in the I/O\Digital Inputs menu

**Enable PD PID** Enabled Enables the proportional - derivative block
Disabled Disables the proportional - derivative block.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PD P Gain In Use | 12026 | 0.00 | 100.00 | 10.00 | |
| PD D Gain In Use | 12024 | 0.00 | 100.00 | 10.00 | |
| PD D Filter | 11066 | 0 | 1000 | 10 | |
| PD Output | 12008 | -32767 | +32767 | 0 | |

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**PD P Gain In Use** Proportional gain of the PD block; this value indicates the output of the PD Proportional Gain Adaptive parameter. If the adaptive function is disabled, this value corresponds to that of **PD P Gain A.**

**PD P Gain In Use** Derivative gain of the PD block; this value indicates the output of the PD Derivative Gain Adaptive parameter. If the adaptive function is disabled, this value corresponds to that of **PD D Gain A.**

**PD D Filter** Time constant of the derivative filter expressed in milliseconds.

**PD Output** PD block output.

# 11. Output reference

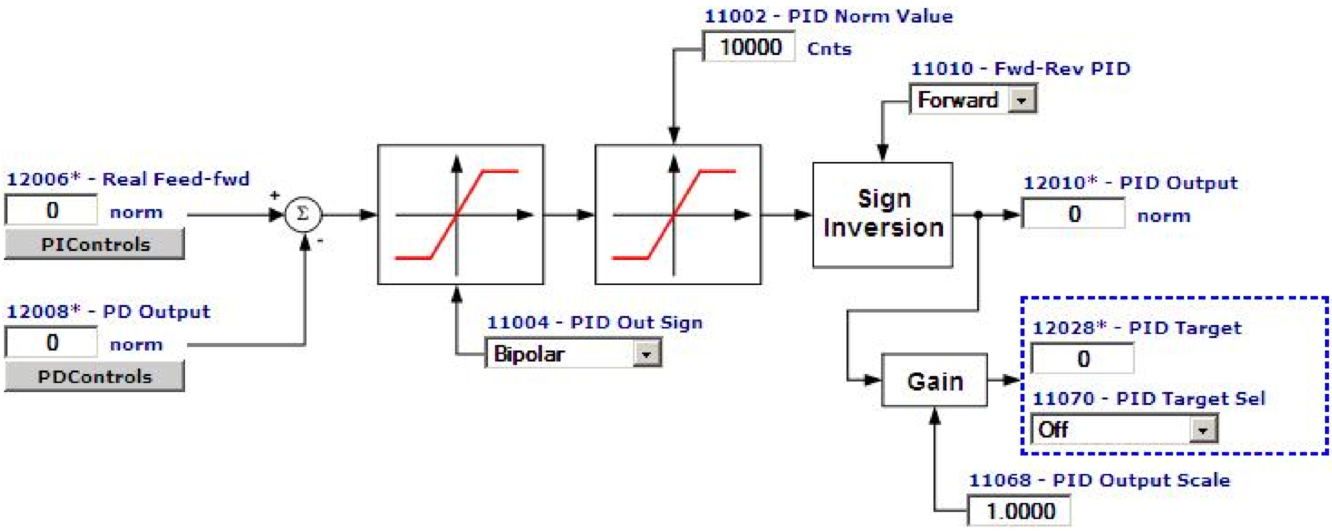


**Fig. 6 – description of the output reference block**

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Out Sign | 11004 | 0-Only Positive | 1-Bipolar | Bipolar | |
| Fwd-Rev PID | 11010 | 0-Forward | 1-Reverse | Forward | 1 |
| PID Output | 12010 | -PID Norm Value | +PID Norm Value | 0 | 2 |

1 Fwd-Rev PID can be sampled from a list of digital inputs; refer to the Fwd-Rev PID Sel parameter in the I/O\Digital Inputs menu
2 This parameter can be set on a programmable analog output, refer to the I/O\Analog Outputs menu.

**PID Out Sign** This parameter can be used to set the type of regulator output as either bipolar or positive only (negative clamp values).

**Fwd-Rev PID** This parameter can be used to reverse the sign of the **PID Output** value, which is useful when the mechanical ratio is inverted.

**PID Output** The regulator output is displayed. This parameter can be programmed on an analog output in order to perform reference cascades in multi-drive systems.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Target Sel | 11070 | 0 – Off | 7- Trq curr lim Neg | 0-Off | |
| PID Output Scale | 1005 | - | - | 1.000 | |
| PID Target | 7015 | -32767 | +32767 | 0 | |

**PID Target Sel**

Selection of the destination of the PID Target parameter; this value can be set as follows:

1. **Off:** Target not assigned
2. **Dig ramp ref 1:** the target is assigned to reference 1 dof the drive's standard ramp generator. If the **PID Output Scale** parameter is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Full scale speed** on **PID Target** (ramp reference).
3. **Dig ramp ref 2:** the target is assigned to reference 2 dof the drive's standard ramp generator. If the **PID Output Scale** parameter is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Full scale speed** on **PID Target** (ramp reference).
4. **Dig speed ref 1:** the target is assigned to reference 1 of the drive's speed regulator. If the **PID Output Scale** is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Full scale speed** on **PID Target** (reference speed).
5. **Dig speed ref 2:** the target is assigned to reference 2 of the drive's speed regulator. If the **PID Output Scale** is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Full scale speed** on **PID Target** (reference speed).
6. **Dig torque ref 1:** the target is assigned to the drive's current regulator reference. If the **PID Output Scale** parameter is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Drive cont current** on **PID Target** (current reference).
7. **Trq curr lim Pos:** the target is assigned to the positive limit of the drive's current regulator. If the **PID Output Scale** parameter is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Drive cont current** on **PID Target** (current limit).
8. **Trq curr lim Neg:** the target is assigned to the negative limit of the drive's current regulator. If the **PID Output Scale** parameter is set to 1, a **PID Norm Value** on **PID Output** corresponds to a value equal to **Drive cont current** on **PID Target** (current limit).

**PID Output scale**

**PID Output** and **PID Target** parameter adjustment factor. Increase or decrease this value to set a factor other than 1 in the speed and torque ratios described in **PID Target Sel.**

**PID Target**

Current PID target value after setting the PID Output Scale parameter.

# 12. Gains adaptive

The gains of the PI and PD blocks can be fixed or variable, depending on machine characteristics.
For example, PD block gains can be dynamically modified according to the speed or a proportional analog input to a unit measured by the system. This unit therefore acts as an adaptive reference for the PD Adaptive.

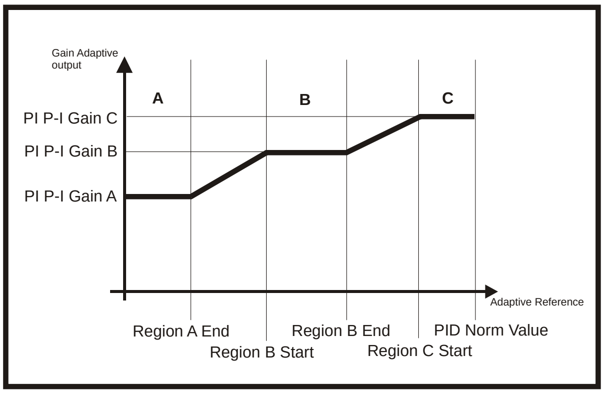


**Fig. 7 – Adaptive gains**

The regulator can be configured with the best settings, depending on the specific requirements, by defining 3 different sectors, in which the gains assume 3 different constant values. Linear interpolation is used to switch between sectors.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Region A End | 11116 | 0 | PID Norm Value | 0 | |
| Region B Start | 11118 | 0 | PID Norm Value | 0 | |
| Region B End | 11120 | 0 | PID Norm Value | 0 | |
| Region C Start | 11122 | 0 | PID Norm Value | 0 | |

**Region A End** End of the first sector with constant gains.

**Region B Start** Start of the second sector with constant gains.

**Region B End** End of the second sector with constant gains.

**Region C Start** Start of the third sector with constant gains.

The unit that is selected as the adaptive reference is first normalised according to the **PID Norm Value** parameter, which is also the Region C End value.
The normalisation procedure according to the selected reference is described below:

**Analog Input(s)** PID Norm Value corresponds to an analog input set to 10V (with input scale set to 1)

| | |
|---|---|
| **Main Encoder Speed** | PID Norm Value corresponds to a speed equal to that in **MainEncSpeedBase** |
| **Motor Torque** | PID Norm Value corresponds to the **maximum torque that can be supplied by the drive** |
| **Calc Diameter** | PID Norm Value corresponds to **Maximum Diameter** |
| **PI Output** | The PI Output parameter is already scaled to the PID Norm Value |
| **Pads** | Set the PID Norm Value as the full scale in the Pads |
| **Fieldbus M->Sx** | Set the PID Norm Value as the full scale in the processing channels |

## 12.1. PI Adaptive

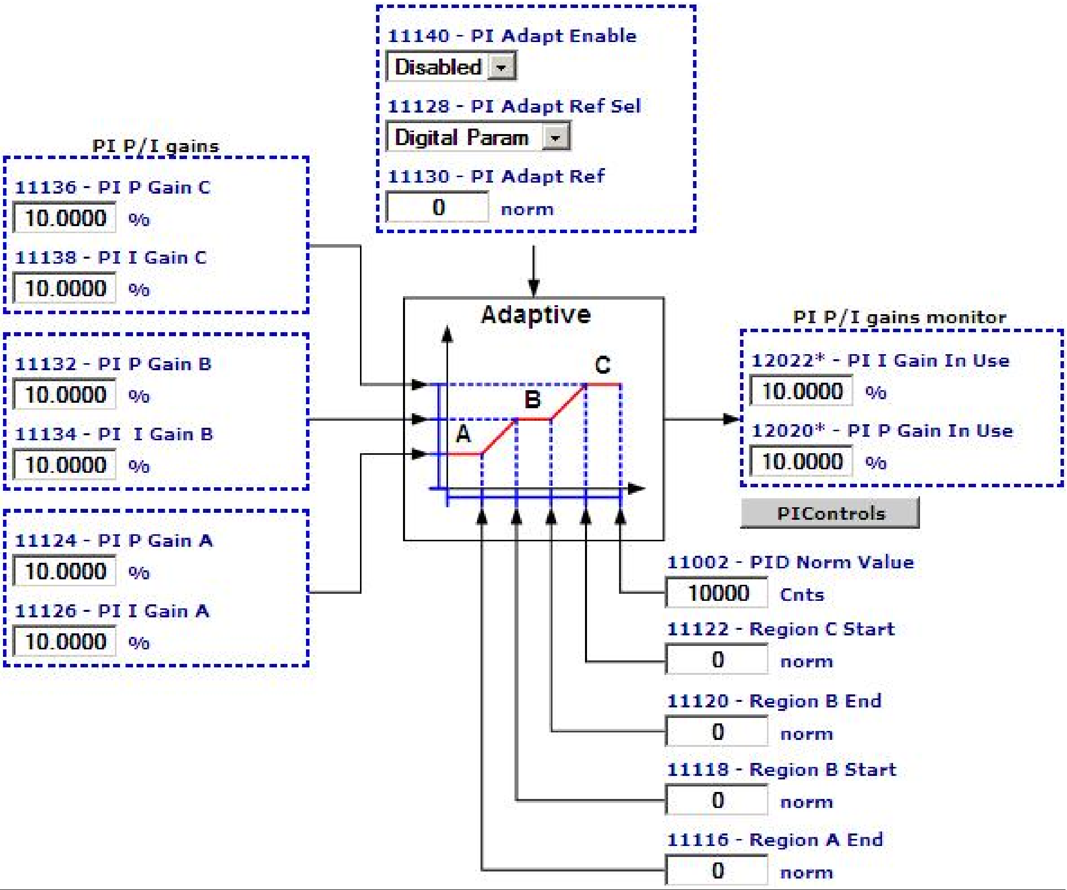


**Fig. 8– PI Adaptive**

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PI Adapt Enable | 11140 | 0 – Disabled | 1-Enabled | Disabled | |
| PI Adapt Ref Sel | 11128 | - | - | 1.000 | |
| PI Adapt Ref | 11130 | -PID Norm Value | +PID Norm Value | 0 | |
| PI P Gain A | 11124 | 0 | 100% | 10 | |
| PI I Gain A | 11126 | 0 | 100% | 10 | |
| PI P Gain B | 11132 | 0 | 100% | 10 | |
| PI I Gain B | 11134 | 0 | 100% | 10 | |
| PI P Gain C | 11136 | 0 | 100% | 10 | |
| PI I Gain C | 11138 | 0 | 100% | 10 | |

**PI Adapt Enable** Enabling of the PI regulator adaptive; if disabled, the PI Adaptive output gains stay fixed at the values of parameters **PI P Gain A** and **PI I Gain A**.

**PI Adapt Ref Sel** Selection of the **PI Adapt Ref** source. If set to Digital Parameter, the PI Adaptive reference value can be set directly in **PI Adapt Ref.**

| | |
|---|---|
| **PI Adapt Ref** | Current PI Adaptive reference value. If **PI Adapt Ref Sel** is set to Digital Parameter, the PI Adaptive reference value can be set directly in **PI Adapt Ref.** |
| **PI P Gain A** | Proportional gain in region A. This value is also set as the proportional gain output of the PI adaptive if the **PI Adapt Enable** parameter is disabled. |
| **PI I Gain A** | Integral gain in region A. This value is also set as the integral gain output of the PI adaptive if the **PI Adapt Enable** parameter is disabled. |
| **PI P Gain B** | Proportional gain of region B. |
| **PI I Gain B** | Integral gain of region B. |
| **PI P Gain C** | Proportional gain of region C. |
| **PI I Gain C** | Integral gain of region C. |

The output values of the PI adaptive are stored in the **PI P Gain In Use** and **PI I Gain In Use** parameters, which are used as actual gains of the PI regulator.

## 12.2. PD Adaptive

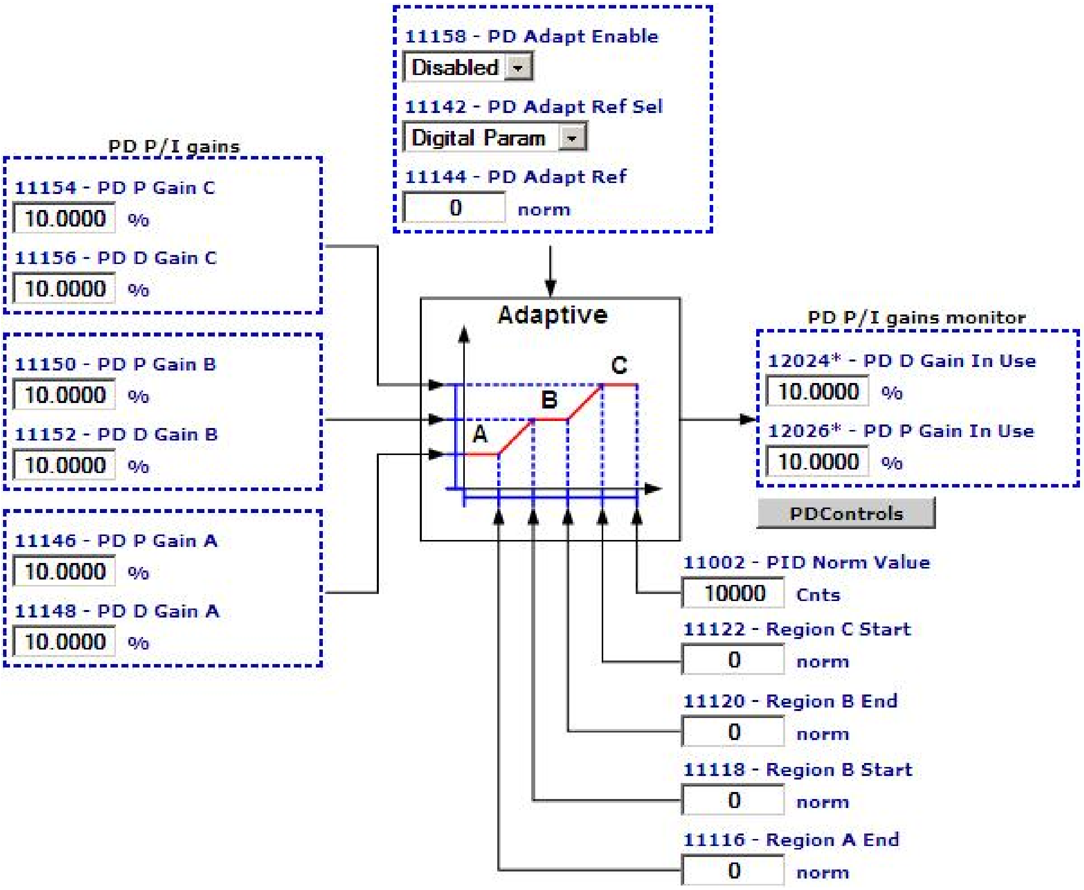


**Fig. 9 – PD Adaptive**

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PD Adapt Enable | 11158 | 0 – Disabled | 1-Enabled | Disabled | |
| PD Adapt Ref Sel | 11142 | - | - | 1.000 | |
| PD Adapt Ref | 11144 | -PID Norm Value | +PID Norm Value | 0 | |
| PD P Gain A | 11146 | 0 | 100% | 10 | |
| PD D Gain A | 11148 | 0 | 100% | 10 | |
| PD P Gain B | 11150 | 0 | 100% | 10 | |
| PD D Gain B | 11152 | 0 | 100% | 10 | |
| PD P Gain C | 11154 | 0 | 100% | 10 | |
| PD D Gain C | 11156 | 0 | 100% | 10 | |

**PD Adapt Enable** Enabling of the PD Adaptive; if disabled, the PD Adaptive output gains stay fixed at the values of the **PD P Gain A** and **PD I Gain A** parameters.

**PD Adapt Ref Sel** Selection of the **PD Adapt Ref** source. If set to Digital Parameter, the PD Adaptive reference value can be set directly in **PD Adapt Ref.**

**PD Adapt Ref** Current PD Adaptive reference value. If **PD Adapt Ref Sel** is set to Digital Parameter, the PD Adaptive reference value can be set directly in **PD Adapt Ref.**

**PD P Gain A** Proportional gain of region A. This value is also set as the proportional gain output of the PD adaptive if the **PD Adapt Enable** parameter is disabled.

**PD D Gain A** Derivative gain of region A. This value is also set as the integral gain output of the PD adaptive if the **PD Adapt Enable** parameter is disabled.

**PD P Gain B** Proportional gain of region B.

**PD D Gain B** Derivative gain of region B.

**PD P Gain C** Proportional gain of region C.

**PD D Gain C** Derivative gain of region C.

The output values of the PD adaptive are stored in the **PD P Gain In Use** and **PD D Gain In Use** parameters, which are used as actual gains of the PD regulator.

# 13. Initial diameter calculation

This function performs a preliminary calculation of the diameter of a winder/unwinder before starting the line. This ensures better control, preventing any undesirable deviations of the dancer.
The calculation is based on the measurement of the movement of the dancer from the maximum deviation to the central working position, and the measurement of the angular movement of the drum during the initial phase.

NB: The initial diameter can only be calculated if the winder/unwinder is controlled by a dancer (not by a load cell).

The result of the calculation is assigned to the **PI Output** parameter and indicates the feedforward multiplication factor, to obtain the angular speed reference of the motor.
Its value is inversely proportional to the core diameter.

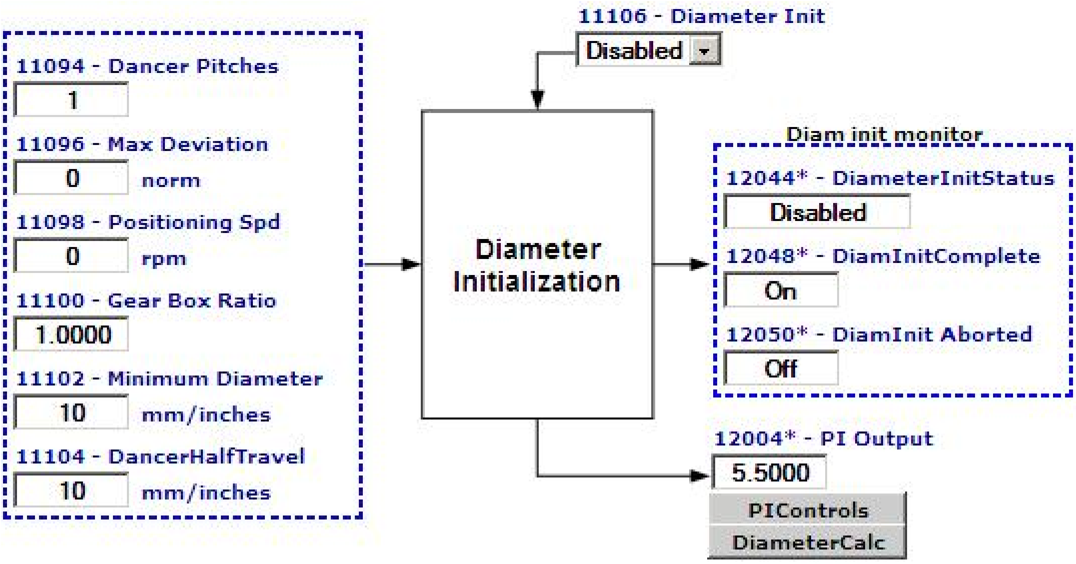


**Fig. 10 – description of the diameter initialisation block**

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Diameter Init | 11106 | 0 – Disabled | 1 – Enabled | Disabled | 1 |
| Positioning Spd | 11098 | -100 | +100 | 0 | |
| Max Deviation | 11096 | -PID Norm Value | +PID Norm Value | 0 | |
| Gear Box Ratio | 11100 | 0.001 | 1.000 | 1.000 | |
| Dancer Pitches | 11094 | 1 | 100 | 1 | |
| DancerHalfTravel | 11104 | 0.001 | - | 10 | |
| Minimum Diameter | 11102 | 0.001 | - | 10 | |
| Initial Diameter | 12046 | 0.001 | - | 0 | |
| DiameterInitStatus | 12044 | 0 - Disabled | - | Disabled | |
| DiamInitComplete | 12048 | 0 – Off | 1 – On | 0 – Off | 2 |
| DiamInit Aborted | 12050 | 0 – Off | 1 – On | 0 – Off | 3 |

1. **Diameter Init** can be sampled from a list of digital inputs; refer to the **Diam Int Sel** parameter in the I/O\Digital inputs menu
2. **DiamInitComplete** can be set on a programmable digital output; refer to the I/O\Digital Outputs menu
3. **DiamInit Aborted** can be set on a programmable digital output; refer to the I/O\Digital Outputs menu

**Diameter Init** Enabling of the initial diameter calculation. The calculation is performed by setting **Diameter Init** = Enabled. If the **Diameter Init** parameter is programmed on a digital input, it must be set to a high logic level.

**Positioning Spd** Indicates the speed of the motor according to whether the dancer is to be placed in the central working position during the initial diameter calculation phase. This value is expressed in rpm.

**Max Deviation** Value of the **PID Feed-back** parameter, corresponding to the maximum deviation position of the dancer. The initial measurement of the dancer movement during the initial diameter calculation is associated with this value.

During the preliminary start-up phase, the analog inputs must be set so that the maximum deviation corresponds to the **PID Norm Value**. To guarantee accurate calculation of the movement, the **Max Deviation** parameter must be set to a slightly lower value. (**Max Deviation** standard = 8000 if **PID Norm Value** is 10000).

**Gear Box Ratio** Reduction ratio between motor and core (< = 1).

**DancerHalfTravel** Expresses the measurement in millimeters corresponding to half the total quantity of material in the dancer.

**Dancer Pitches** Indicates the number of dancer pitches.

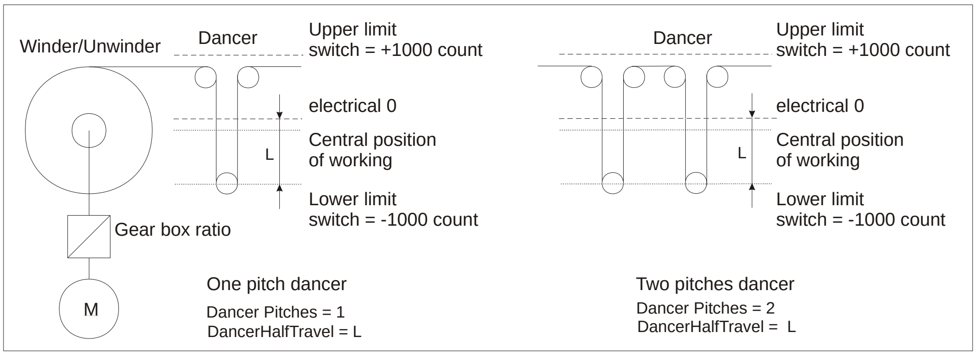


**Fig. 11 – diameter initialisation**

**Measuring DancerHalfTravel:**
With the dancer at the lowest deviation, set the analog input programmed as **PID Feed-back** to obtain –**PID Norm Value**.
Set the dancer so that the **PID Feed-back** displays the value 0 (electrical 0 position); measure the distance in millimeters between the lowest deviation and the current dancer position. Enter the distance in the **DancerHalfTravel** parameter.

**Minimum diameter** Minimum diameter of the core (nucleus) expressed in millimeters or inches.

**Initial Diameter** Initial diameter calculated in millimeters or inches. This value is the result of the diameter initialisation function.

**DiameterInitStatus** Status of the diameter initialisation procedure, which can assume the following values:

**Disabled:** Function not enabled

**Wait Drive Enab:** The **Diameter init** command has been sent; the drive is waiting for the **Enable cmd** and **Start cmd** commands.

**Wait Max Deviat:** Start of operations; the motor starts turning to allow the dancer to reach the value in **Max Deviation**

**Wait Pos A:** Max Deviation value reached; the motor starts turning in the opposite direction to allow the dancer to reach a value equal to 90% of **Max Deviation** (Pos A).

**Wait Pos B:** Pos A detected; the motor continues to turn until the dancer reaches a value of 5% of **Max Deviation** (Pos B).

**Completed:** Pos B detected; the **Initial Diameter** calculation has been performed correctly and the **PI Output** value has been set. The drive waits for the **Diameter Init** command to be removed to set the state to Disabled again, in order to perform a new diameter initialisation.

**Aborted:** Diameter initialisation has been aborted because the **Enable cmd, Start cmd** or **Diameter Init** command was removed during the procedure. To reset the state to Disabled, remove the **Diameter Init** command.

**DiamInitComplete** Set to On when the diameter initialisation procedure is complete. The status can be monitored via a digital output. Important note: check the **DiamInit Aborted** value to establish whether the procedure failed.

**DiamInit Aborted** This is set to On when diameter initialisation is aborted because the **Enable cmd, Start cmd** or **Diameter init** command was removed during the procedure. To reset this signal, remove the **Diameter init** command. The status can be monitored via a digital output.

## 13.1. Description of the initial diameter calculation

This calculation is based on the measurement of the movement of the dancer from the maximum deviation to the central working position, and the measurement of the angular movement of the drum during tensioning; it is therefore important to make sure that, during this procedure, the material is blocked by the roll downstream of the unwinder or upstream of the winder. The roll drive adjustment must therefore be enabled with speed reference = 0.

If the line rolls are also controlled by dancers or load cells, first the diameter must be calculated and the winders/unwinders tensioned, and then the rolls must be tensioned.

The **PI Central V Sel** parameter must be set to 0 to prevent the **PI Output** value from being automatically set to a predefined level.
When a high logic level (+24V) is assigned to the digital input programmed as **Diameter Init**, the procedure can be activated, provided the drive is enabled and the **Start cmd** command is active; in this phase the **Enable PI** and **Enable PD** parameters are automatically disabled.
The adjustment process checks the signal coming from the dancer potentiometer; if this is too high compared that set in the **Max Deviation** parameter, the motor starts with a speed reference equal to that set in **Positioning Spd** in order to wind the material on the drum and move the dancer to the central working position.
If the adjustment process detects that the signal coming from the dancer potentiometer is lower than that set in the **Max Deviation** parameter, the motor starts with a speed reference equal to that set in **Positioning Spd** in order to unwind the material and move the dancer to the point set in **Max Deviation**. The reference is then inverted to move the dancer to the central working position.
When the dancer has reached the central position, the **PI Output** parameter is set to a value that is inversely proportional to the diameter and the **DiamInitComplete** digital output, which indicates the end of the diameter calculation phase, is set to a high logic level.

At this stage, if **Enable PI** and/or **Enable PD** are enabled, the system automatically proceeds to the adjustment phase; the digital inputs programmed as **Diameter Init, Enable PI** and/or **Enable PD** are therefore usually set simultaneously to a high logic level.
The **DiamInitComplete** output signal can be used to reset the **Diameter Init** command. This is active on the positive edge of the digital input, and so must be set to a high logic level after starting the drive and then reset when the initial diameter calculation phase is complete.

The **PI Output** value is calculated according to the following formula:

**PI Output** = (**Min Diameter x PI Top Limit**) / **Initial Diameter**

The **PI Top Limit** and **PI Bottom Limit** parameters in the **PI Controls** menu must be set according to the maximum and minimum drum diameter; for further information, refer to the **Errore. L'origine riferimento non è stata trovata.** - **Errore. L'origine riferimento non è stata trovata.** section.

# 14. Run-time diameter calculation

This function uses the Line Speed, Motor Speed and Maximum Diameter data to calculate the roll diameter. If enabled, the calculation is performed when the line speed exceeds a given threshold, in order to measure the current diameter accurately.

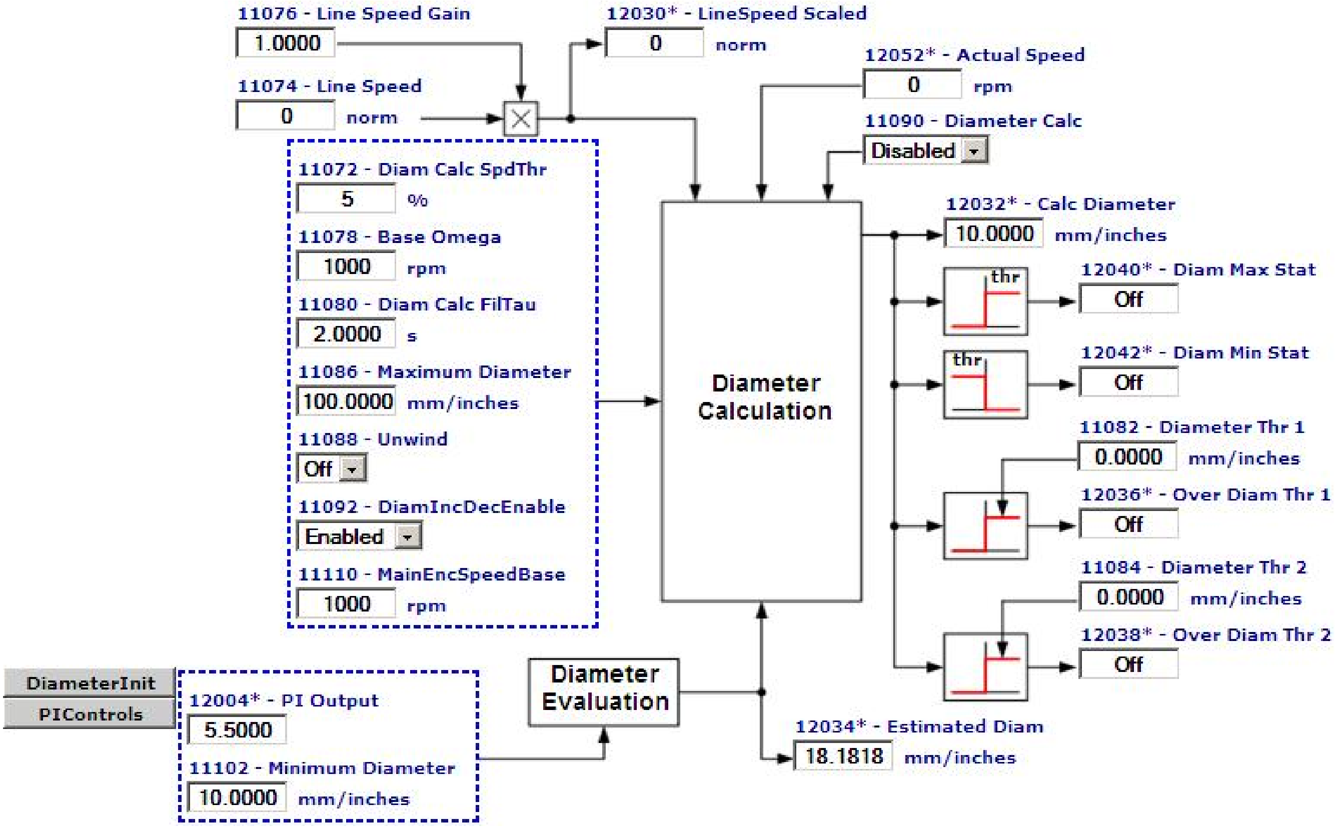


**Fig. 12 – description of the diameter calculation block**

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Diameter Calc | 11090 | 0 – Disabled | 1 – Enabled | Disabled | |
| Maximum Diameter | 11086 | 0.001 | - | 100 | |
| Line Speed | 11074 | -PID Norm Value | +PID Norm Value | 0 | 1 |
| Line Speed Gain | 11076 | -100 | +100 | 1 | |
| LineSpeed Scaled | 12030 | -PID Norm Value | +PID Norm Value | 0 | |
| Base Omega | 11078 | 1 | 30000 | 1000 | |
| Diam Calc SpdThr | 11072 | 1% | 100% | 5 | |
| Diam Calc FilTau | 11080 | 0 | 100 | 2 | |
| Unwind | 11088 | 0-Off | 1-On | Off | 2 |
| DiamIncDecEnable | 11092 | 0-Disabled | 1-Enabled | Disabled | |
| Diameter Thr 1 | 11082 | 0 | - | 0 | |
| Diameter Thr 2 | 11084 | 0 | - | 0 | |
| Calc Diameter | 12032 | 0 | - | 0 | 3 |
| Estimated Diameter | 12034 | 0 | - | 0 | |
| Diam Max Stat | 12040 | 0-Off | 1-On | 0-Off | 4 |
| Diam Min Stat | 12042 | 0-Off | 1-On | 0-Off | 4 |
| Over Diam Thr 1 | 12036 | 0-Off | 1-On | 0-Off | 4 |

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Over Diam Thr 2 | 12038 | 0-Off | 1-On | 0-Off | 4 |

1. **Line Speed** can be sampled from a list of sources; refer to the **LineSpeedAnInSel** parameter in the I/O\Analog Inputs menu
2. **Unwind** can be sampled from a list of digital inputs; refer to the **Wind Unwind Sel** parameter in the I/O\Analog Inputs menu
3. **Calc Diameter** can be set on a programmable analog output, refer to the I/O\Analog Outputs menu
4. **Diam Max Stat**, **Diam Min Stat**, **Over Diam Thr 1** and **Over Diam Thr 2** can be set on a programmable digital output, refer to the I/O\Digital Outputs menu

**DiameterCalc** Enabling of the run-time diameter calculation. The calculation is performed by setting **Diameter Calc**= Enabled.

**Maximum Diameter** Indicates the maximum roll diameter, expressed in millimeters or inches. This value and that of the **Minimum Diameter** parameter, in the **Diameter Init** menu, and of the **PI Top Limit** and **PI Bottom Limit** in the PI Controls menu must be known in order to calculate the current diameter.

**Line Speed** Measurement of the line speed normalised according to the PID Norm Value parameter (=maximum line speed).

**Line Speed Gain** Gain relating to the line speed measurement. The setting depends on the line speed sampling source; this parameter is used to obtain the maximum value for **LineSpeed Scaled** = **PID Norm Value.**

**LineSpeed Scaled** **Line Speed** multiplied by **Line Speed Gain**.

**Base Omega** **Motor speed** corresponding to **Minimum Diameter** at maximum **Line Speed**.

**Diam Calc SpdThr** Line speed threshold above which diameter calculation is activated. The value is expressed as a percentage and refers to the full scale value.

**Diam Calc FilTau** Time constant of the filter of the Diameter Calculation output value (**Calc Diameter**).

**Unwind** Input signal indicating to the diameter calculation procedure whether the system is in the winding or unwinding phase; in the latter case, the signal must be set to On (high level).

**DiamIncDecEnable** Enabling of the increase/reduction in the calculated diameter. During the winding phase the diameter can usually only increase, and the procedure therefore ignores reductions in the calculated diameter. In the unwinding phase the process is reversed. The controls are disabled when this parameter is enabled, allowing the calculated diameter to be increased or reduced freely.

**Diameter Thr 1** Calculated diameter threshold, above which the **Over Diam Thr 1** output signal is set to high.

**Diameter Thr 2** Calculated diameter threshold, above which the **Over Diam Thr 2** output signal is set to high.

| | |
|---|---|
| **Calc Diameter** | Value output by the Diameter Calculation parameter, expressed in millimeters or inches. If programmed on an analog output, 10V corresponds to **Maximum Diameter**. |
| **Estimated Diam** | Estimated diameter based on the current **PI Output** value, which is used to initialise the **Calc Diameter** value when **PICentral V Sel** changes and the "**Errore. L'origine riferimento non è stata trovata.**" procedure is active. This allows the diameter to be calculated starting from a more accurate value. In order to calculate the **Estimated Diam** value, the **PI Top Limit** and **PI Bottom Limit** parameters must coincide, with a certain degree of precision, respectively with the minimum and maximum diameter. |
| **Diam Max Stat** | Output signal indicating that the **Calc Diameter** value has reached that set in **Maximum Diameter.** This signal can be sent to the digital outputs. |
| **Diam Min Stat** | Output signal indicating that the **Calc Diameter** value has reached that set in **Minimum Diameter.** This signal can be sent to the digital outputs. |
| **Over Diam Thr 1** | Output signal indicating that the **Calc Diameter** value has exceeded that set in **Diameter Thr 1.** This signal can be sent to the digital outputs. |
| **Over Diam Thr 2** | Output signal indicating that the **Calc Diameter** value has exceeded that set in **Diameter Thr 2.** This signal can be sent to the digital outputs. |

## 14.1. Description of the diameter calculation procedure

As described previously, the diameter calculation is based on the Line Speed parameter reading and the angular speed of the drive roll (Motor Speed).

These two units are first of all normalised to the **PID Norm Value**. For the Line Speed parameter, this depends on the source that is selected (see **LineSpeedAnInSel** in 16.3 -

). For the Motor Speed parameter, **PID Norm Value** corresponds to **Base Omega** (motor speed corresponding to **Minimum Diameter** at maximum **Line Speed**).

If the **Diameter Calc** parameter is enabled, when the normalised **Line Speed** value is greater than the **Diam Calc SpdThr** percentage with reference to the full scale value, the diameter calculation is activated. This check is performed to prevent inaccurate calculation at low speeds. If the speed in question is less than the predefined threshold, the Calc Diameter value remains unchanged.

The system calculates the current diameter according to the following formula:
**Calc Diameter** = **Norm Line Speed** / **Norm Motor Speed** * **Minimum Diameter**

The **Calc Diameter** value is filtered by means of a low-pass filter with tau = **Diam Calc FilTau.**

As described previously, if the **DiamIncDecEnable** parameter is enabled, the calculated diameter can be increased or reduced freely. If it is disabled, the system runs a check on the Unwind signal: if set to Off (winder) the calculated diameter cannot be reduced; if set to On (unwinder), the diameter cannot be increased.

The Calc Diameter value is initialised according to the **Estimated Diam** parameter (conversion of the **PI Output** value) when **PICentral V Sel** changes (the user selects a different preset diameter). It is thus possible to select the initial diameter calculated according to the **PI Central V Sel** value.
Therefore, to obtain a correct **Estimated Diam** value, **PI Top Limit** and **PI Bottom Limit** must coincide, with a certain degree of precision, respectively with the minimum and maximum diameter.

The **Estimated Diam** value is also updated after the “**Errore. L'origine riferimento non è stata trovata.**” procedure, so that at the end the value is stored in **Calc Diameter**.

The initialisation of **Calc Diameter** with **Estimated Diameter**, as described above, is only performed if Line Speed is less than the **Diam Calc SpdThr** percentage.

# 15. Speed parameters

Speed parameters cover a series of functions:
Setting of Full scale speed, Zero Speed measurement, ramp settings, Jog mode operation, setting of Encoder Base Speed.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Actual Speed | 12052 | - | - | 0 | |
| MainEncSpeedBase | 11110 | 1 | 30000 | 1000 | |

1. Actual Speed can be set on a programmable analog output, refer to the I/O\Analog Outputs menu
2. Speed Zero State can be set on a programmable digital output; refer to the I/O\Digital Outputs menu
3. Speed Reached can be set on a programmable digital output; refer to the I/O\Digital Outputs menu

**Actual Speed** Actual speed of the motor normalised according to the PID Norm value (corresponding to Full scale speed).

**MainEncSpeedBase** Parameter used to indicate the correspondence between **PID Norm Value** and the maximum speed of the main encoder. This value is expressed in rpm.

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# 16. I/O programming

A set of specific parameters can be used to program the drive's inputs and outputs.

## 16.1. Digital inputs

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| Enable PD Sel | 11180 | See below | | Digital Param | |
| Enable PI Sel | 11182 | See below | | Digital Param | |
| PI C V Bit 0 Sel | 11184 | See below | | Digital Param | |
| PI C V Bit 1 Sel | 11186 | See below | | Digital Param | |
| PID Offset InSel | 11188 | See below | | Digital Param | |
| PI Int Freez Sel | 11190 | See below | | Digital Param | |
| Wind Unwind Sel | 11192 | See below | | Digital Param | |
| Diam Init Sel | 11194 | See below | | Digital Param | |
| PIDSrcRamp=0 Sel | 11196 | See below | | Digital Param | |
| PID FastStop Sel | 11198 | See below | | Digital Param | |
| Fwd-Rev PD Sel | 11178 | See below | | Digital Param | |

**Enable PD Sel** Selection of the source relating to the **Enable PD** command:

-2 - **Remote Command**: See relative bit in the **PID Remote Cmds** parameter

-1 - **Digital Param**: The source is the actual digital command; it can be set using the keypad and serial line.

**0 - Dig inp 1**: Standard digital input 1

**1 - Dig inp 2**: Standard digital input 2

**2 - Dig inp 3**: Standard digital input 3

**3 - Dig inp 4**: Standard digital input 4

**4 - Dig inp 5**: Standard digital input 5

**5 - Dig inp 6**: Standard digital input 6

**8 - Dig inp 1X**: Expansion card, digital input 1

**9 - Dig inp 2X**: Expansion card, digital input 2

**10 - Dig inp 3X**: Expansion card, digital input 3

**11 - Dig inp 4X**: Expansion card, digital input 4

**12 - Dig inp 5X**: Expansion card, digital input 5

**13 - Dig inp 6X**: Expansion card, digital input 6

**14 - Dig inp 7X**: Expansion card, digital input 7

**15 - Dig inp 8X**: Expansion card, digital input 8

**30 – Pad 1**: parameter Pad 1

**31 – Pad 2**: parameter Pad 2

**32 – Pad 3**: parameter Pad 3

**33 – Pad 4**: parameter Pad 4

**34 – Pad 5**: parameter Pad 5

**35 – Pad 6**: parameter Pad 6

**36 – Pad 7**: parameter Pad 7

**37 – Pad 8**: parameter Pad 8
**38 – Pad 9**: parameter Pad 9
**39 – Pad 10**: parameter Pad 10
**40 – Pad 11:** parameter Pad 11
**41 – Pad 12**: parameter Pad 12
**42 – Pad 13**: parameter Pad 13
**43 – Pad 14**: parameter Pad 14
**44 – Pad 15**: parameter Pad 15
**45 – Pad 16**: parameter Pad 16
**50 – Fieldbus M->S1**: processing channel Master-Slave 1
**51 – Fieldbus M->S2**: processing channel Master-Slave 1
**52 – Fieldbus M->S3**: processing channel Master-Slave 1
**53 – Fieldbus M->S4**: processing channel Master-Slave 1
**54 – Fieldbus M->S5**: processing channel Master-Slave 1
**55 – Fieldbus M->S6**: processing channel Master-Slave 1
**56 – Fieldbus M->S7**: processing channel Master-Slave 1
**57 – Fieldbus M->S8**: processing channel Master-Slave 1
**58 – Fieldbus M->S9**: processing channel Master-Slave 1
**59 – Fieldbus M->S10**: processing channel Master-Slave 10
**50 – Fieldbus M->S11**: processing channel Master-Slave 11
**51 – Fieldbus M->S12**: processing channel Master-Slave 12
**52 – Fieldbus M->S13**: processing channel Master-Slave 13
**53 – Fieldbus M->S14**: processing channel Master-Slave 14
**54 – Fieldbus M->S15**: processing channel Master-Slave 15
**55 – Fieldbus M->S16**: processing channel Master-Slave 1
**70 – Bit0 decomp mon**: bit 0 Word decomp
**71 – Bit1 decomp mon**: bit 1 Word decomp
**72 – Bit2 decomp mon**: bit 2 Word decomp
**73 – Bit3 decomp mon**: bit 3 Word decomp
**74 – Bit4 decomp mon**: bit 4 Word decomp
**75 – Bit5 decomp mon**: bit 5 Word decomp
**76 – Bit6 decomp mon**: bit 6 Word decomp
**77 – Bit7 decomp mon**: bit 7 Word decomp
**78 – Bit8 decomp mon**: bit 8 Word decomp
**79 – Bit9 decomp mon**: bit 9 Word decomp
**70 – Bit10 decomp mon**: bit 10 Word decomp
**71 – Bit11 decomp mon**: bit 11 Word decomp
**72 – Bit12 decomp mon**: bit 12 Word decomp
**73 – Bit13 decomp mon**: bit 13 Word decomp
**74 – Bit14 decomp mon**: bit 14 Word decomp
**75 – Bit15 decomp mon**: bit 15 Word decomp

**Enable PI Sel** Selection of the source of the **Enable PI** command (see above for the list of possible selections).

**PI C V Bit 0 Sel** Selection of the source of the **PICentral V Sel bit 0** command (see above for the list of possible selections).

**PI C V Bit 1 Sel** Selection of the source of the **PICentral V Sel bit 1** command (see above for the list of possible selections).

**PID Offset InSel** Selection of the source of the **PID Offset Sel** command (see above for the list of possible selections).

**PI Int Freez Sel** Selection of the source of the **PI Int Freeze** command (see above for the list of possible selections). NB: **Remote Command** cannot be selected for the current version.

**Wind Unwind Sel** Selection of the source of the **Unwind** command (see above for the list of possible selections).

**PIDSrcRamp=0 Sel** Selection of the source of the **PID Src RampIn=0** command (see above for the list of possible selections).

**PID FastStop Sel** Selection of the source of the **PID Fast Stop** command (see above for the list of possible selections).

**Fwd-Rev PID Sel** Selection of the source of the **Fwd-Rev PID** command (see above for the list of possible selections).

## 16.2. Digital outputs

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Status Dest | 11114 | See below | | Off | |
| Max Diam Dest | 11200 | See below | | Pad 4 | |
| Min Diam Dest | 11202 | See below | | Pad 5 | |
| Diam Thr 1 Dest | 11204 | See below | | Pad 6 | |
| Diam Thr 2 Dest | 11206 | See below | | Pad 7 | |
| DiamIniCompl Des | 11208 | See below | | Pad 8 | |
| DiamIniAbort Des | 11210 | See below | | Pad 9 | |

**PID Status Dest** Destination of the PID Status parameter:

0 Off
1 Pad 1
2 Pad 2
3 Pad 3
4 Pad 4
5 Pad 5

| | |
|---|---|
| 6 | Pad 6 |
| 7 | Pad 7 |
| 8 | Pad 8 |
| 9 | Pad 9 |
| 10 | Pad 10 |
| 11 | Pad 11 |
| 12 | Pad 12 |
| 13 | Pad 13 |
| 14 | Pad 14 |
| 15 | Pad 15 |
| 16 | Pad 16 |
| 20 | Dig FB S->M1 |
| 21 | Dig FB S->M2 |
| 22 | Dig FB S->M3 |
| 23 | Dig FB S->M4 |
| 24 | Dig FB S->M5 |
| 25 | Dig FB S->M6 |
| 26 | Dig FB S->M7 |
| 27 | Dig FB S->M8 |
| 28 | Dig FB S->M9 |
| 29 | Dig FB S->M10 |
| 30 | Dig FB S->M11 |
| 31 | Dig FB S->M12 |
| 32 | Dig FB S->M13 |
| 33 | Dig FB S->M14 |
| 34 | Dig FB S->M15 |
| 35 | Dig FB S->M16 |

**Max Diam Dest** Destination of the **Diam Max Stat** signal (see above for list)

**Min Diam Dest** Destination of the **Diam Min Stat** signal (see above for list)

**Diam Thr 1 Dest** Destination of the **Over Diam Thr 1** signal (see above for list)

**Diam Thr 2 Dest** Destination of the **Over Diam Thr 2** signal (see above for list)

**DiamIniCompl Des** Destination of the **DiamInitComplete** signal (see above for list)

**DiamIniAbort Des** Destination of the **DiamInitAborted** signal (see above for list)

## 16.3. Analog Inputs

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Src Sel | 11212 | See below | | Digital Param | |
| FeedBack Sel | 11214 | See below | | Digital Param | |
| PIDOffs0 Sel | 11216 | See below | | Digital Param | |
| PICentralV3 Sel | 11218 | See below | | Digital Param | |
| LineSpeed Sel | 11220 | See below | | Digital Param | |

**PID Src AnInpSel** Selection of the source of the **PID Source** parameter; see below for the list of possible selections:

**0 - Digital Param**: The value of the parameter corresponding to that being used; it can be set using the keypad, serial line and fieldbus.

**1 - Analog input 1**: The parameter value derives from analog input 0; the value in **PID Norm Value** corresponds to the analog input set to 10V.

**2 - Analog input 2**: The parameter value derives from analog input 1.

**3 – Analog inp 1X**: The parameter value derives from Analog input 1 on the expansion card.

**4 - Analog inp 2X**: The parameter value derives from Analog input 2 on the expansion card.

**5 - Encoder 1**: The parameter value derives from the speed of the encoder 1; the value of **PID Norm Value** corresponds to a speed equal to **MainEncSpeedBase.**

**6 - Encoder 2**: The parameter value derives from the speed of the encoder 2; the value of **PID Norm Value** corresponds to a speed equal to **MainEncSpeedBase.**

**7 - Motor Torque**: The value of the parameter derives from the actual motor torque; the value of **PID Norm Value** corresponds to a torque equal to the **maximum torque supplied by the drive.**

**9 - Calc Diameter**: The parameter value derives from the current value of **Calc Diameter**; the value of **PID Norm Value** corresponds to **Maximum Diameter.**

**10 - PI Output**: The parameter value derives from the current value of **PI Output; PI Output** is already set to **PID Norm Value.**

**30 - Pad 1**: the parameter value corresponds to that of Pad 1**.**

**31 - Pad 2**

**32 - Pad 3**

**33 - Pad 4**

**34 - Pad 5**

**35 - Pad 6**

**36 - Pad 7**

**37 - Pad 8**

**38 - Pad 9**

**39 - Pad 10**

**40 - Pad 11**

**41 - Pad 12**

**42 - Pad 13**

**43 - Pad 14**

**44 - Pad 15**

**45 - Pad 16**

**50 - Fieldbus M->S1**: The parameter value corresponds to that sent to processing channel 1**.**

**51 - Fieldbus M->S2**

**52 - Fieldbus M->S3**

**53 - Fieldbus M->S4**

**54 - Fieldbus M->S5**

**55 - Fieldbus M->S6**

**56 - Fieldbus M->S7**

**57 - Fieldbus M->S8**

**58 - Fieldbus M->S9**

**59 - Fieldbus M->S10**

**60 - Fieldbus M->S11**

**61 - Fieldbus M->S12**

**62 - Fieldbus M->S13**

**63 - Fieldbus M->S14**

**64 - Fieldbus M->S15**

**FeedBackAnInpSel** Selection of the source of the **PID Feed-back** parameter (see above for the list of possible selections).

**PIDOffs0 AnInSel** Selection of the source of the **PID Offset 0** parameter (see above for the list of possible selections).

**PICentralV3AnInp** Selection of the source of the **PI Central V3** parameter (see above for the list of possible selections); the ratio between the normalised analog input value (0…PID Norm value) and **PI Central V3** is:

**PI Central V 3** = **PI Bottom Limit** * **PID Norm Value** / Analog Input Normalised Value

**LineSpeedAnInSel** Selection of the source of the **Line Speed** parameter (see above for the list of possible selections).

## 16.4. Analog Outputs

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Target Dest | 11222 | See below | | Pad 1 | |
| Calc Diam Dest | 11224 | See below | | Pad 2 | |
| PID Error Dest | 11226 | See below | | Pad 3 | |

**PID Target Dest** Selection of the destination of the **PID Target** value:

0 Off
1 Pad 1
2 Pad 2
3 Pad 3
4 Pad 4
5 Pad 5
6 Pad 6
7 Pad 7
8 Pad 8
9 Pad 9
10 Pad 10
11 Pad 11
12 Pad 12
13 Pad 13
14 Pad 14
15 Pad 15
16 Pad 16
20 Dig FB S->M1
21 Dig FB S->M2
22 Dig FB S->M3
23 Dig FB S->M4
24 Dig FB S->M5
25 Dig FB S->M6
26 Dig FB S->M7
27 Dig FB S->M8
28 Dig FB S->M9
29 Dig FB S->M10
30 Dig FB S->M11
31 Dig FB S->M12
32 Dig FB S->M13
33 Dig FB S->M14
34 Dig FB S->M15
35 Dig FB S->M16

**Calc Diam Dest** Selection of the destination of the **Calc Diameter** value, see above for the list of possible selections.

**PID Error Dest** Selection of the destination of the **PID Error value**, see above for the list of possible selections.

## 16.5. Fieldbus

Some commands can be programmed to be sent via fieldbus; also refer to the **Errore. L'origine riferimento non è stata trovata.** - **Errore. L'origine riferimento non è stata trovata.** section for programming the command source.

| Parameter | N. | Value | | | Standard configuration |
|---|---|---|---|---|---|
| | | min | max | factory | |
| PID Remote Cmds | 1017 | 0 | FFFF Hex | 9001 Hex | |

**PID Remote Cmds** Remote command bitwords; the meaning of each bit is shown below:

Bit 0 : Not used
Bit 1 : Not used
Bit 2 : PD Enable
Bit 3 : PI Enable
Bit 4 : Fwd-Rev PID
Bit 5 : Diameter Init
Bit 6 : Unwind
Bit 7 : PI Central V Sel Bit 0
Bit 8 : PI Central V Sel Bit 1
Bit 9 : PID Offset Sel
Bit 10 : Not used
Bit 11 : Not used
Bit 12 : Not used
Bit 13 : Not used
Bit 14 : PID Src RampIn=0
Bit 15 : PID Fast Stop

# 17. Examples of application

All of the following examples refer to a **PID Norm Value** parameter setting of **10000**.

## 17.1. Control using dancer

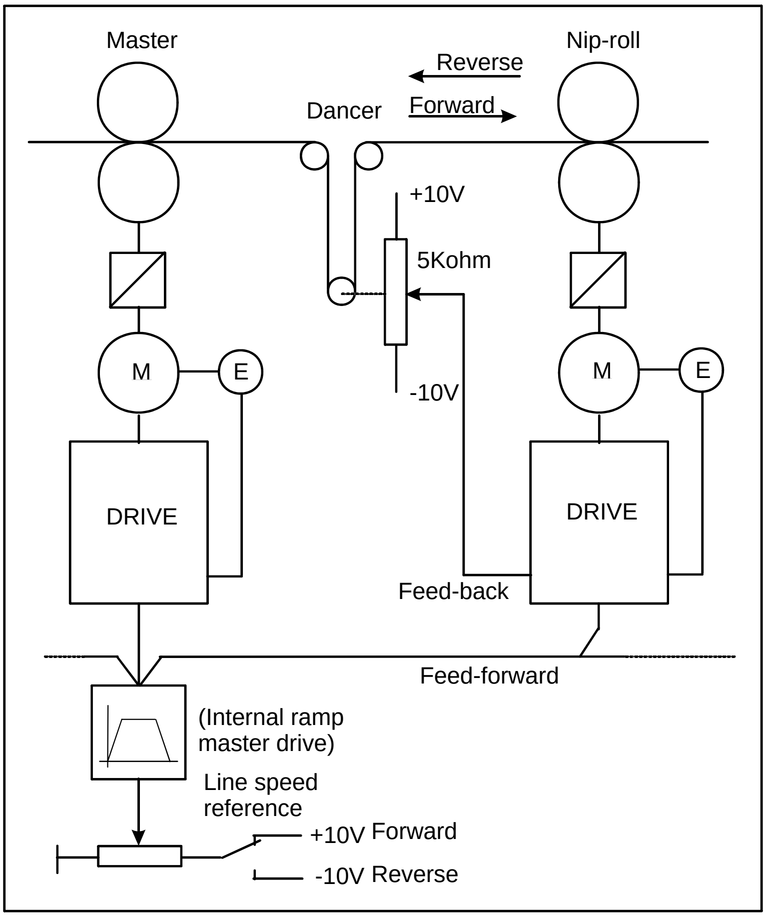


**Fig. 13 – control using dancer**

Machine data:

Rated speed of the slave motor in Vn = 3000 rpm
Slave motor speed corresponding to maximum line speed = 85% Vn = 2550 rpm
Maximum dancer adjustment = +/- 15% of line speed = +/- 382.5 rpm

Connect the line speed and dancer position analog signals (with potentiometer supplied via terminals with a voltage of between -10V... +10V) and the digital commands to enable PID control to the roll drive.
The output of the regulator is sent to the **Dig speed ref 1** (**PID Target Sel**) parameter.

Drive settings: (only those relating to the PID function are described below)

Inputs/outputs
Set **Analog input 1** as the input for the dancer cursor.
**FeedBackAnInpSel = Analog input 1**

Set **Analog input 2** as the feedforward input:
**PID Src AnInpSel = Analog input 2**

Set **Digital Input 2** as the input enabling the PI block of the PID
**Enable PI Sel = Dig inp 2**

Set **Digital Input 3** as the input enabling the PD block of the PID
**Enable PD Sel = Dig inp 3**

Parameters
Set **Full scale speed** with a value equal to the rated speed of the motor.
**Full scale speed** = 3000 rpm

Set **PID Source Gain** so that, in correspondence with the maximum analog value of Analog input 2, **PID Feed-fwd** reaches 85% of the maximum value = 10000 x 85%.
**PID Source Gain** = 0.85

Set **PID Target Sel** as **Ramp Reference**.

Set **PID Output Scale** to **1** so that, in correspondence with the maximum analog value of **Analog input 2** (**PID Feed-fwd** = 8500) and **Enable PI** and **Enable PD** = Disable, the **Ramp Reference** parameter is equal to 2550 rpm.

Set **PICentral V Sel** = 1
Set **PI Central V1** = 1

If no corrections are performed by the PI block of the regulator, the line speed reference (feedforward) must be multiplied by 1 and sent directly to the drive speed regulator.

In this type of application, the regulator usually only performs proportional control. The correction is indicated as a percentage of the line speed, from 0 to the maximum.

Program **PI Top Limit** and **PI Bottom Limit** so that, with maximum dancer deviation (maximum value of analog input 0 = Feed-back), when the proportional gain of the PI block is set to 15%, there is an equal proportional correction of the feedforward. To do this, set:
**PI Top Limit** = 10
**PI Bottom Limit** = 0.1

Set **PI P Gain In Use** = 15%
Set **PI I Gain In Use** = 0%

With this type of configuration, in case of a proportional correction of the line speed, the PI block is unable to position the dancer at speed=0. The PD block must be used for tensioning in a stop condition.

Set a value for **PD P Gain In Use** that allows the dancer to be positioned without large dynamic variations. For example:
**PD P Gain In Use** = 1%

If necessary, use the derivative component to dampen the response of the system during changes in speed, by running a programming procedure as described in the example below.
**PD D Gain In Use** = 5%
**PD D Filter** = 20 ms
If this is not necessary, keep these parameters = 0.

If cascade references are necessary for another drive, set **PID Target** on an analog output, for example:
**PID Target Dest= Pad 1**
**Analog out 1 src = Pad 1**
(with **Real Feed-fwd** = 10000 counts, **Analog output 1** = 10V).

## 17.2. Control using load cell

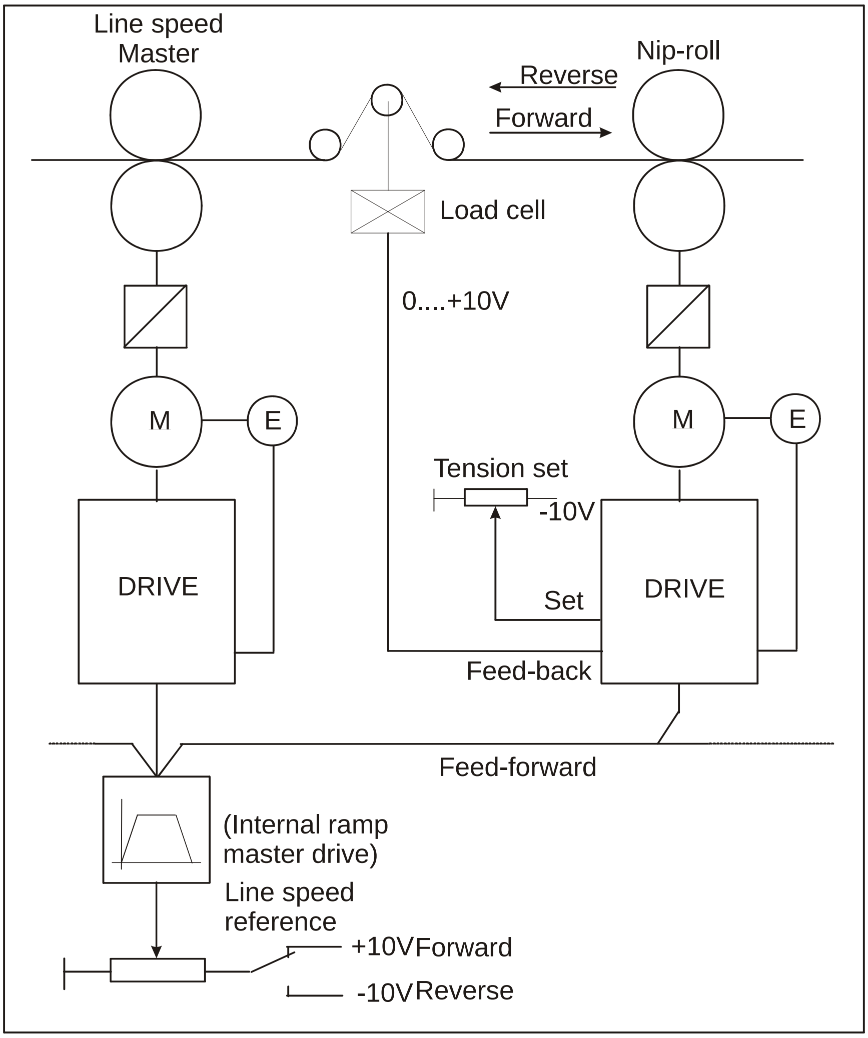


**Fig. 14 – control using load cell**

Machine data:

Rated speed of the slave motor in Vn = 3000 rpm
Slave motor speed corresponding to maximum line speed = 85% Vn = 2550 rpm
Maximum dancer adjustment = +/- 20% of line speed = +/- 510 rpm

Connect the line speed and load cell analog signals (with potentiometer supplied with a voltage of between 0....+10V) to the slave drive and the digital commands to enable PID control.
The output of the regulator is sent to the **Dig speed ref 1** (**PID Target Sel**) parameter.

Drive settings: (only those relating to the PID function are described below)
Inputs/outputs

Set **Analog input 1** as the load cell input:
**FeedBackAnInpSel = Analog input 1**

Set **Analog input 2** as the feedforward input:
**PID Src AnInpSel = Analog input 2**

Set the expansion card (optional **Analog input 1** as the input for the tension setting (**PID Offset 0)**:

**PIDOff0AnInSel = Analog inp 1X**

Set **Digital Input 2** as the input enabling the PI block of the PID
**Enable PI Sel = Dig inp 2**

Set **Digital Input 3** as the input enabling the PD block of the PID
**Enable PD Sel = Dig inp 3**

Parameters

Set **Full scale speed** with a value equal to the rated speed of the motor.
**Full scale speed** = 3000 rpm

Set **PID Source Gain** so that, in correspondence with the maximum analog value of Analog input 2, **PID Feed-fwd** reaches 85% of the maximum value = 10000 x 85%.
**PID Source Gain** = 0.85

Set **PID Target Sel** as **Ramp Reference**.

Set **PID Output Scale** to **1** so that, in correspondence with the maximum analog value of **Analog input 2** (**PID Feed-fwd** = 8500) and **Enable PI** and **Enable PD** = Disable, the **Ramp Reference** parameter is equal to 2550 rpm.

Set **PICentral V Sel** = 1
Set **PI Central V1** = 1

If no corrections are performed by the PI block of the regulator, the line speed reference (feedforward) must be multiplied by 1 and sent directly to the drive speed regulator.

In this type of application, the regulator usually performs a proportional-integral control.
The correction is indicated as a percentage of the line speed, from 0 to the maximum.

Program **PI Top Limit** and **PI Bottom Limit** so that the maximum correction of the PI block corresponds to 20% of the line speed.
The **PI Top Limit** and **PI Bottom Limit** parameters are the maximum and minimum feedforward value multiplication factor.
At maximum line speed they correspond to 2550 rpm of the motor (maximum feedforward).
Maximum correction = 2550 x 20% = 510 rpm

2550 + 510 = 3060 rpm —> **PI Top Limit** = 3060 / 2550 = 1.2

2550 - 510 = 2040 rpm —> **PI Bottom Limit** = 2040 / 2550 = 0.80

which means multiplying the value of **PI Central V1** (= 1) by + 20% (1.2) and - 20% (0.80).

With this type of configuration, in case of a proportional correction of the line speed, the PI block is unable to apply a tension at speed=0. The PD block must be used for tensioning in a stop condition.

The gains of the single components must be set with the machine loaded; tests can start using the values shown below (predefined values):

Set **PI P Gain In Use** = 10%
Set **PI I Gain In Use** = 10%
Set **PD P Gain In Use** = 10%

If necessary, use the derivative component to dampen the response of the system during changes in speed, by running a programming procedure as described in the example below:
**PD D Gain In Use** = 5%

**PD D Filter** = 20 ms
If this is not necessary, keep these parameters = 0.

If cascade references are necessary for another drive, set **PID Target** on an analog output, for example:
**PID Target Dest= Pad 1**
**Analog out 1 src = Pad 1**
(with **Real Feed-fwd** = 10000 counts, **Analog output 1** = 10V).

*NB:* To implement a system with integral regulation enabled and feedforward = 0, capable of achieving a zero tensioning error with the machine stopped, refer to the "Generic PID" section.

## 17.3. Winder/unwinder control using dancer

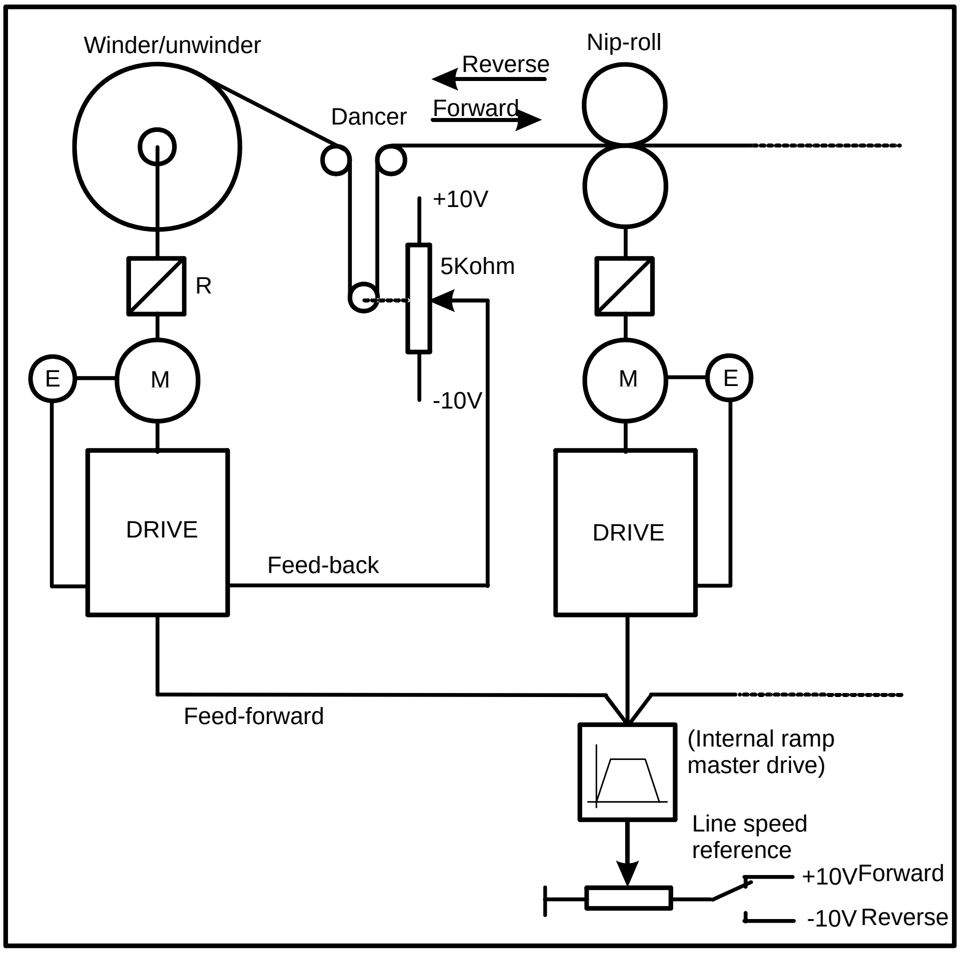


**Fig. 15 - winder/unwinder control using dancer**

Machine data:
Maximum line speed = 400 m/min
Rated speed of the drum motor in Vn = 3000 rpm
Maximum drum diameter = 700 mm
Minimum drum diameter = 100 mm
Motor-core reduction ratio = 0.5
One-pitch dancer
Dancer travel from lower limit switch to the electrical zero position = 160 mm.

Connect the line speed and dancer position analog signals (with potentiometer supplied via terminals with a voltage of between -10V... +10V) and the digital commands to enable PID control to the winder/unwinder drive.
The output of the regulator is sent to the **Ramp Reference** (**PID Target Sel**) parameter.
Drive settings: (only those relating to the PID function are described below)

Inputs/outputs

Set **Analog input 1** as the input for the dancer cursor.
**FeedBackAnInpSel = Analog input 1**

Set **Analog input 2** as the feedforward input:
**PID Src AnInpSel = Analog input 2**

Set **Digital Input 2** as the input enabling the PI block of the PID

**Enable PI Sel = Dig inp 2**

Set **Digital Input 3** as the input enabling the PD block of the PID
**Enable PD Sel = Dig inp 3**

Set **Digital Input 4** as the input enabling the initial diameter calculation function.
**Diam Init Sel = Dig inp 4**

**Digital Output 1** signals the end of the initial diameter calculation.
**DiameterInitCompl Des = Pad 8**
**Digital output 1 src = Pad 8**

Parameters

Set **Full scale speed** with a value equal to the rated speed of the motor.
**Full scale speed** = 3000 rpm

Set **PID Source Gain** and **PID Output Scale** so that, in correspondence with the maximum analog value of **Analog input 2** and when there is no PID correction (**Enable PI** and **Enable PD** = Disable), the peripheral speed of the core with the minimum diameter (core) is the same as the maximum line speed.

Calculation of motor speed in the conditions described above:

$Vp = \pi \times \Phi min \times \omega \times R$
where:
Vp = core peripheral speed = line speed
$\Phi$min = minimum core diameter [m]
$\omega$ = angular speed of the motor [rpm]
R = motor - core reduction ratio

$\omega = Vp / \pi \times \Phi min \times R = 400 / (\pi \times 0.1 \times 0.5) = 2546$ rpm = approx 2550 rpm
Maintaining a margin of 15% as the regulator saturation limit (10000 counts), set **PID Source Gain** so that **PID Feed-fwd** reaches, in conjunction with the maximum analog value of **Analog input 2**, 85% of its maximum value.
**PID Source Gain** = 0.85

When **PID Output** assumes the value of 8500 (10000 * 0.85), **Ramp Reference** must assume the value of 2550 (motor speed corresponding to the maximum line speed with the minimum diameter); given that **Full scale speed** is 3000 rpm (corresponding to 10000 in **PID Target**), PID Output Scale must be set as follows:
**PID Output Scale** = (2550/3000) * (10000 / 8500) = 1

Set **PID Target Sel** as **Ramp Reference**.

Set **PICentral V Sel** = 0

With this configuration and using the appropriate procedure, the initial diameter can be calculated. The last diameter that was calculated is stored in case the machine stops or the electric panel is switched off.

As described previously, the procedure determines the theoretical feedforward multiplication factor (**PI Output**) in relation to the calculated diameter, in order to send the correct angular speed value to the drive.

*NB:* When PICentral V Sel = 0 is selected and the PI block is disabled, the system stores (or, if switched off, automatically resets) the last PI Output value that was calculated. If this parameter value has to be set in order to obtain an incorrect reference output that is equal to the feedforward value, a digital input can be configured as a corrective reset.

Configure as follows:

**PI C V Bit0 Sel= Dig inp 4**
**PI Central V1** = 1.00

When a high logic level is assigned to the digital input, **PI Output** is reset.

Set **PI Top Limit** and **PI Bottom Limit** according to the core diameter ratio.
The **PI Top Limit** and **PI Bottom Limit** parameters can be considered, respectively, as the maximum and minimum feedforward multiplication factor.
Bearing in mind that the angular speed of the motor and the corresponding reference change inversely in relation to the diameter of the winder/unwinder, set:
**PI Top Limit** = 1
**PI Bottom Limit** = $\Phi$min / $\Phi$max = 100 / 700 = 0.14
The above settings are explained below.
Calculation of the angular speed of the motor:
$\omega$ max. = Vl / ($\pi$ x $\Phi$min x R) and $\omega$ min = Vl / ($\pi$ x $\Phi$max. x R)
where:
$\omega$ max. = angular speed of the motor with minimum diameter [rpm]
$\omega$ min = angular speed of the motor with maximum diameter [rpm]
Vl = line speed
$\Phi$min = minimum core diameter [m]
$\Phi$max. = maximum core diameter [m]
R = motor - core reduction ratio

Therefore:
$\omega$ max. / $\omega$ min = $\Phi$max. / $\Phi$min thus $\omega$ min = ($\Phi$min / $\Phi$max) x $\omega$ max.

Bearing in mind that the **PI Top Limit** and **PI Bottom Limit** parameters can be considered, respectively, as the maximum and minimum feedforward multiplication factor.
By multiplying the feedforward by **PI Top Limit** = 1, the maximum speed reference in relation to the minimum diameter is obtained.
By multiplying the feedforward by **PI Bottom Limit** = 0.14, the minimum speed reference in relation to the maximum diameter is obtained.
This application requires the system to perform a proportional-integral control.
The gains of the various components are set experimentally with the machine loaded. Tests can start using the following values:
Set **PI P Gain In Use** = 15%
Set **PI I Gain In Use** = 8%
Set **PD P Gain In Use** = 5%

If necessary, use the derivative component to dampen the response of the system during changes in speed, by running a programming procedure as described in the example below:
**PD D Gain In Use** = 20%
**PD D Filter** = 20 ms

If cascade references are necessary for another drive, set **PID Output** on an analog output, for example:
**An Output 0 Sel = PID Output**
(with **Real Feed-fwd** = 10000 counts, **Analog output 0** = 10V).

## *Parameters for calculating the initial diameter*

This function is always necessary when controlling an unwinder or if the starting diameter is not known.
Set the rpm value of **Positioning Spd** with which to perform initial dancer positioning. For example:
**Positioning Spd** = 15 rpm

Set **Max Deviation** to a value slightly lower than that corresponding to the maximum acceptable mechanical deviation of the dancer.
The drive's analog inputs must always be set during commissioning; in particular, set analog input 0 so that, with the dancer at the lowest edge of the interval, PID Feed-back is equal to -10000. Thus, to guarantee accurate calculation, set:
**Max Deviation** = 8000 (predefined value)
Set **Gear Box Ratio** with a value equal to that of the reduction ratio between the motor and core.
**Gear Box Ratio** = 0.5

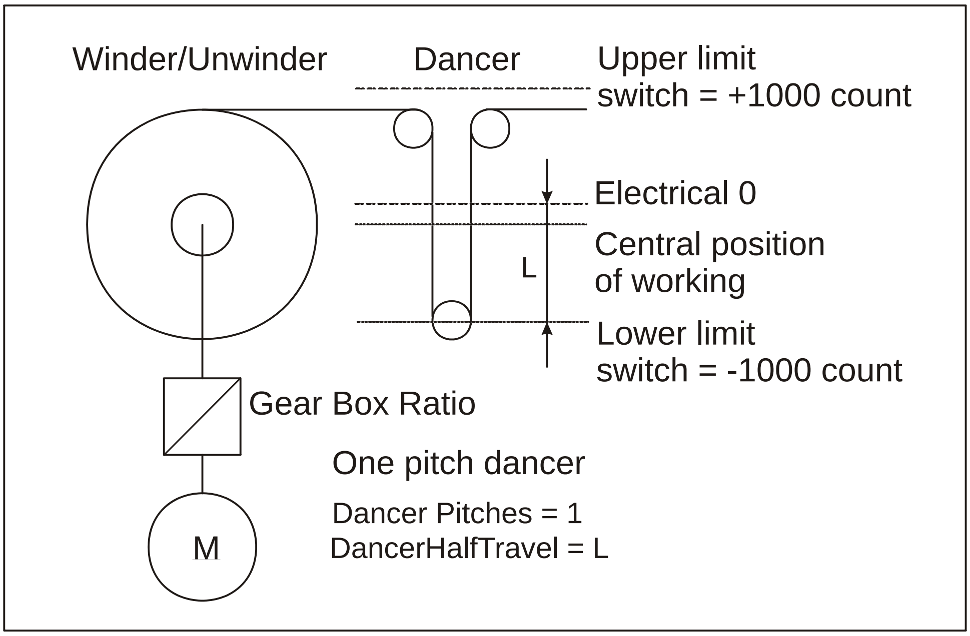


**Fig. 16 - diameter calculation**

**Measurement of DancerHalfTravel:**
With the dancer at the lowest deviation, set the analog input programmed as PID Feed-back to obtain -10000.
Set the dancer so that the PID Feed-back displays the value of 0 (0 electrical position); measure the distance in millimeters between the lowest deviation and the dancer's current position.
Enter the distance in the **DancerHalfTrave**l parameter.
Since the dancer has one pitch, set **Dancer Pitches** to 1.

Set **Minimum Diameter** to a value equal to the minimum core diameter [mm]:
**Minimum diameter** = 100 mm

## 17.4. Use of the diameter sensor

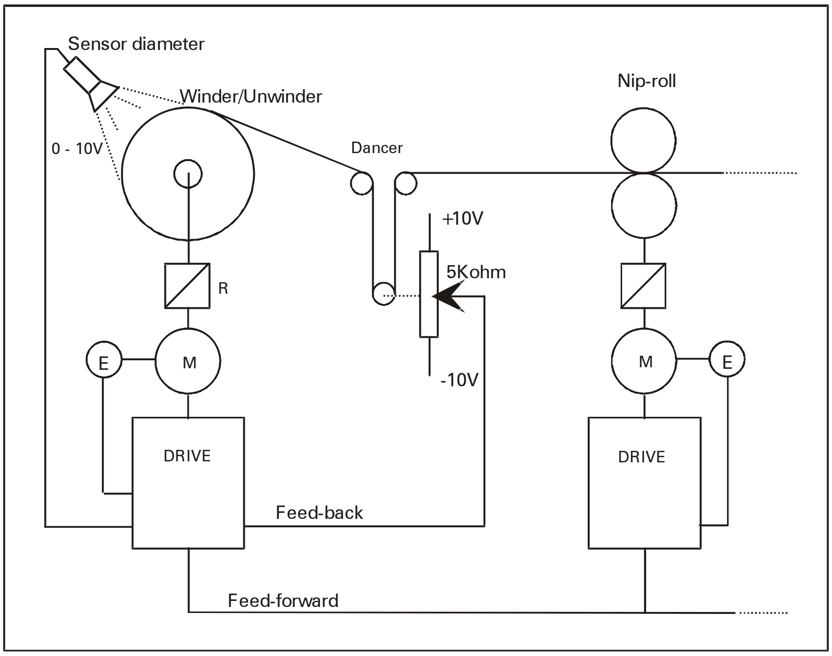


**Fig. 17 – winder/unwinder control with diameter sensor**

The diameter sensor is particularly useful when using unwinding systems with automatic change.
In these systems, the initial diameter must be known, in order to calculate the angular speed reference of the motor before inserting the new spool.
The transducer must be set to send a tension signal proportional to the core Diameter.

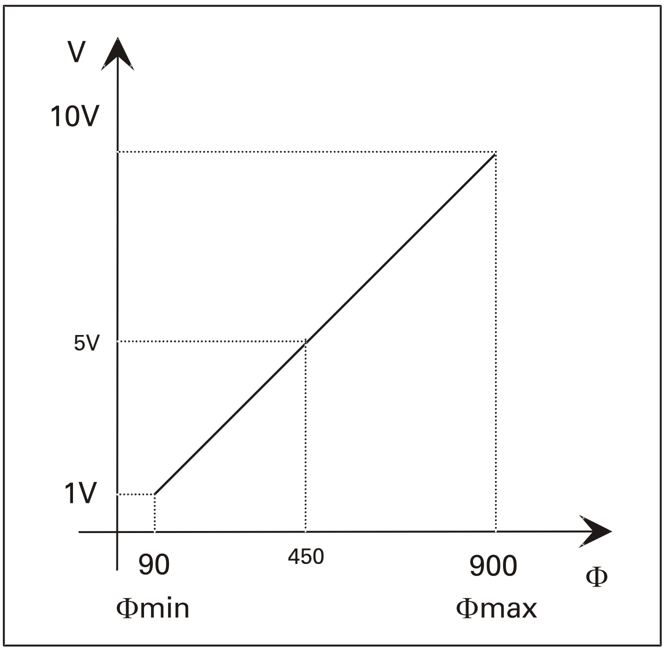


**Fig. 18 – ratio between transducer signal and core signal**

Example:

| | | |
|---|---|---|
| Φmin = 90 mm | transducer output = | 1V |
| Φmax = 900 mm | transducer output = | 10V |
| Φ = 450 mm | transducer output = | 5V |

**PI Central V3** must be programmed for the analog input to which the sensor is connected.
Set **PICentralV3AnInp** by selecting this input.
The value of **PICentral V Sel** must be = 3.
When **Enable PI** = disable, the value of **PI Central V3** is shown in **PI Output** and used as the feedforward multiplication factor.

As described previously in this manual, the value of **PI Output** depends on the ratio of the diameters, and the tension signal proportional to the diameter is automatically recalculated using the following formula:

**PI Central V3** = $(\Phi_0 / \Phi_1)$

Where: $\Phi_0$ = minimum winder diameter
$\Phi_1$ = current diameter

*NB:* During commissioning, check that the signal from the sensor really is proportional to the diameter and that its maximum value is 10V (if necessary set the analog input).

Also make sure that the PI Top Limit and PI Bottom Limit parameters have been programmed.

## 17.5. Pump and extruder pressure control

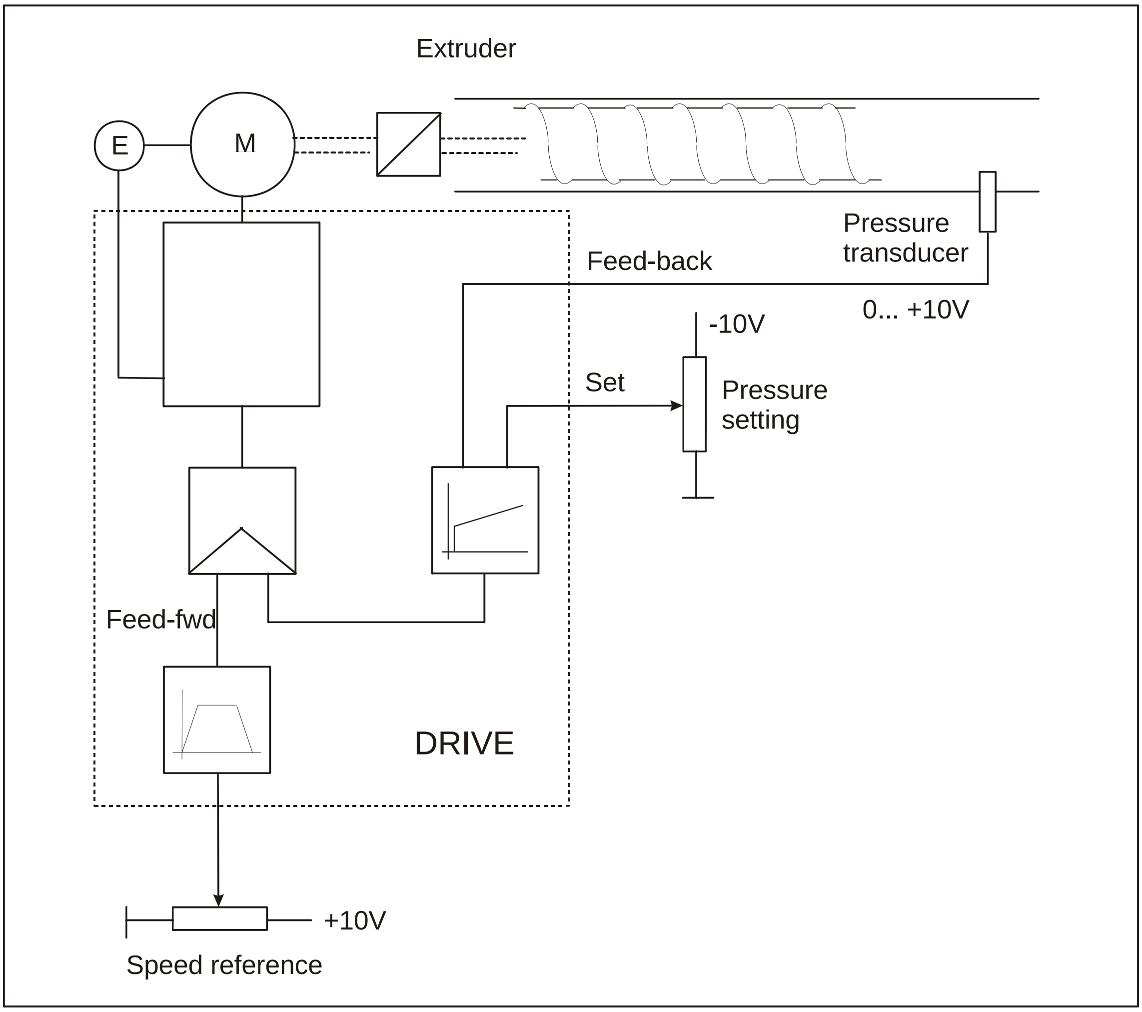


**Fig. 19 – pump and extruder pressure control**

Machine data:
Rated speed of the extruder motor in Vn = 3000 rpm
Transducer pressure 0... +10V

Send the following to the extruder slave drive: the analog signals relating to the speed reference, transducer pressure, pressure-setting potentiometer (supplied with a voltage of between 0V... -10V) and the digital commands to enable PID control.
The output of the regulator is sent to the **Dig speed ref 1** (**PID Target Sel**) parameter.

Drive settings: (only those relating to the PID function are described below)

Inputs/outputs

Set **Analog input 1** as the transducer pressure input.
**FeedBackAnInpSel = Analog input 1**

Set **Analog input 2** as the feedforward input:
**PID Src AnInpSel = Analog input 2**

Set **Analog input 1** of the expansion card (optional) as the tension reference input (**PID Offset 0)**:

**PIDOff0AnInSel = Analog input 1X**

Set **Digital Input 2** as the input enabling the PI block of the PID
**Enable PI Sel = Dig inp 2**

Set **Digital Input 3** as the input enabling the PD block of the PID
**Enable PD Sel = Dig inp 3**

Set **Digital Input 4** as PID Src RampIn = 0
**PISSrcRamp=0 Sel = Dig inp 4**

The **Start cmd** command must be set to On.

Parameters

Set **Full scale speed** with a value equal to the rated speed of the motor.
**Full scale speed** = 3000 rpm

Set **PID Src Acc Time** and **PID Src Dec Time** to the time required for the feedforward to pass from 0 to 10000 and from 10000 to 0.

Set **PID Source Gain** to 1.

Set **PID Target Sel** as **Ramp Reference**.

Set **PICentral V Sel** = 1
Set **PI Central V1** = 1

If no corrections are performed by the PI block of the regulator, the line speed reference (feedforward) must be multiplied by 1 and sent directly to the drive speed regulator.
In this type of application, the regulator usually performs a proportional-integral control.

Program **PI Top Limit** and **PI Bottom Limit** so that the maximum correction of the PI block corresponds to 100% of the speed reference.
The **PI Top Limit** and **PI Bottom Limit** parameters can be considered, respectively, as the maximum and minimum feedforward multiplication factor.

**PI Top Limit** = 1
**PI Bottom Limit** = 0

The gains of the various1" complexscriptssize="12"> Tests can start using the following values (predefined values):
Set **PI P Gain In Use** = 10%
Set **PI I Gain In Use** = 20%
Set **PD P Gain In Use** = 10%

If necessary, use the derivative component to dampen the response of the system during changes in speed, by implementing the settings as described in the example below:
**PD D Gain In Use** = 5%
**PD D Filter** = 20 ms
If this is not necessary, keep these parameters = 0.

## 17.6. Generic PID

Drive settings: (only those relating to the PID function are described below)

Inputs/outputs

Program **Analog input 1** as the input of the variable to be regulated (feedback).
**FeedBackAnInpSel = Analog input 1**

Set **Analog input 2** as the setpoint input signal (**PID Offset 0**).
**PIDOff0AnInSel = Analog input 2**

Set **Digital Input 2** as the input enabling the PI block of the PID
**Enable PI Sel = Dig inp 2**

Set **Digital Input 3** as the input enabling the PD block of the PID
**Enable PD Sel = Dig inp 3**

Parameters
If using the regulator as "generic PID", thus not dependant on the feedforward function, set **PID Feed-fwd** to the maximum value. To do this, set **PID Source** = 10000.

Set **PID Source Gain** = 1.

Set **PID Target Sel** with the parameter with which the regulator output is associated (Ramp Reference or Torque reference).

*NB:* The firmware of the drive does not control the polarity of the value that is sent; if the regulator output is positive only, set PID Out Sign = Only positive

**Set PICentral V Sel** = 1
**Set PI Central V1** = 0

In this configuration, when switching the parameters enabling the PID function from Off/On, the regulator output starts from 0.
To store the last value that was calculated even with the machine disabled, use a digital input programmed as bit 0 selection of the PI Central value.

**PI C V Bit0 Sel =Dig inp xx**
**PI Central V1** = 0

When the digital input has a low logic level (L), the last value of **PI Output** that was calculated is stored, while this value is reset if a high logic level is set (H).
Program **PI Top Limit** and **PI Bottom Limit** to obtain a PID block correction equal to 100% of its maximum value.

**PI Top Limit** = 1
**PI Bottom Limit** = -1

In this configuration, the output of the PID block is both positive and negative.
Set **PI Top Limit** = 0, to block the positive part.
Set **PI Bottom Limit**= 0, to block the negative part.
The gains of the various components must be set experimentally with the machine loaded.
Tests can start using the following values:
Set **PI P Gain In Use** = 10%
Set **PI I Gain In Use** = 4%

Set **PD P Gain In Use** = 10%

If necessary, use the derivative component to dampen the system, by implementing the settings in the example below:
**PD D Gain In Use** = 5%
**PD D Filter** = 20 ms
If this is not necessary, keep these parameters = 0.

## 17.7. Application notes

**Dynamic modification of PI block integral gain**

The PID integral gain is usually set so that the lower its value the higher the diameter ratio of the core being controlled. A value that is too high would enable good control with small diameters but lead to significant swinging at larger core diameters.

On the contrary, excessively reduced integral gain values with the minimum diameter could cause the dancer to move from the electrical zero position, the value of which would increase the greater the line speed. This phenomenon is due to the fact that the integral component is loaded and unloaded more quickly than the time in which the diameter varies.

With a high diameter ratio, the value of the **PI I Gain In Use** parameter may have to be dynamically modified according to the current diameter.
This can be done by using the adaptive gains of the **PI regulator (PI Adaptive**, see paragraph 12)

Suppose, for example, a winder with a diameter ratio of 1/10 is being controlled.

The integral component of the regulator must function in an inversely proportional manner in relation to the diameter.
The value of the **PI Output** parameter already acts in this way, as it changes according to the ratio $\Phi_0$ / $\Phi_{act}$.

Where: $\Phi_0$ = minimum core diameter
$\Phi_{act}$ = current core diameter

To perform the desired operation, set the following parameters:
**PI Top Limit** = 1
**PI Bottom Limit** = 0.1
**Region A End** = 1000
**Region B Start** = 6000
**Region B Start** = 6000
**Region C Start** = 10000

**PI I Gain A** = 4%
**PI I Gain B** = 15%
**PI Gain C** = 40%

With a similar configuration, the minimum diameter corresponds to an integral gain = 40%, while the maximum diameter corresponds to an integral gain = 4%; between the two setpoints the gain changes according to the following curve:

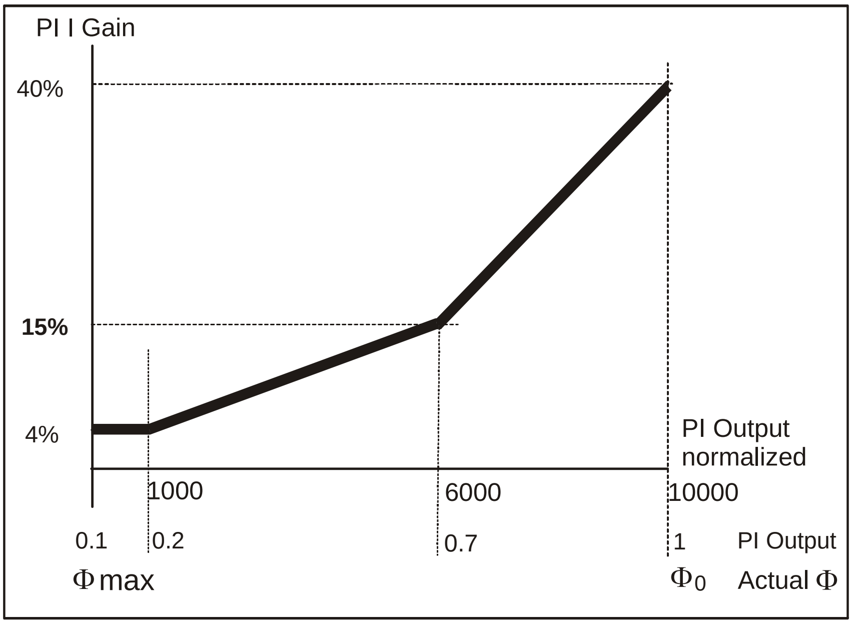


Fig. 20 – PI I Gain In Use e PI Output

As shown in paragraph. 12, the PI Output value is normalised to the PID Norm Value, which corresponds to PI Top Limit (in this case 1).
The value of **PI I Gain In Use** is displayed in the relative parameter in the **PI Controls** submenu.
The same procedure can also be used to change **PI P Gain In Use**.