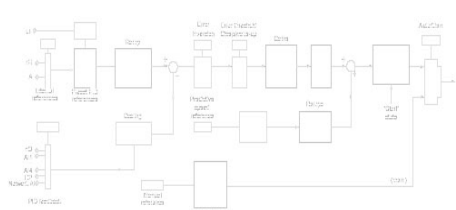


# Application Note - 18

## ATV61 PID Loop Setup and Examples



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## 1. Application Note Introduction

The ATV61 drive covered in this application note is capable of automatically adapting its speed based on a feedback transducer signal. This application note provides information on process control utilising the PID loops of the ATV61 variable speed drive. Basic theory and terminology is presented as well as examples and commissioning steps for the ATV61 drive.

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## 2. PID Definition

The PID algorithm is a method of Feedback control. It stands for Proportional-Integral-Derivative. The most popular method of process control involving an Analog Setpoint and Feedback signal is the PID loop.

The proportional mode adjusts the output signal in direct proportion to the controller input: which is the error signal. The adjustable parameter to be specified is the controller gain. The larger the gain, the more the controller output will change for a given error. For instance, with a gain of 1 an error of 10% of scale will change the controller output by 10% of scale.

A proportional controller reduces error but does not eliminate it, unless the process has naturally integrating properties, i.e. an offset between the actual and desired value will normally exist.

The additional integral mode, often referred to as reset gain, corrects for any offset (error) that may occur between the desired value (setpoint) and the process output automatically over time. The adjustable parameter to be specified is the integral of the controller.

## 3. Preliminary steps for setting up the ATV61 Drive

### 1 - Delivery of the drive

- Check that the drive reference printed on the label is the same as that on the delivery note corresponding to the purchase order.
- Remove the Altivar 61 from its packaging and check that it has not been damaged in transit.

### 2 - Check that the line voltage is compatible with the supply voltage range of the drive (see the drive rating plate).

- The drive will be damaged if the line voltage is not compatible.

### 3 - Fit the drive

#### 4 - Connect the following to the drive:

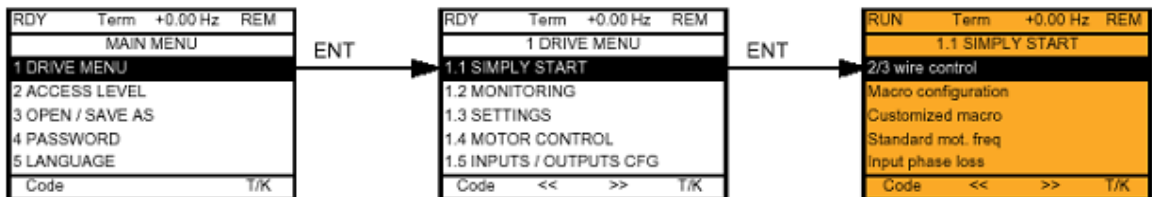
- The line supply, ensuring that it is:
  - **compatible with the voltage range of the drive**
  - **switched off**
- The motor, ensuring that its coupling corresponds to the line voltage
- The control via the logic inputs
- The speed reference via the logic or analog inputs

### 5 - Switch on the drive, but do not give a run command

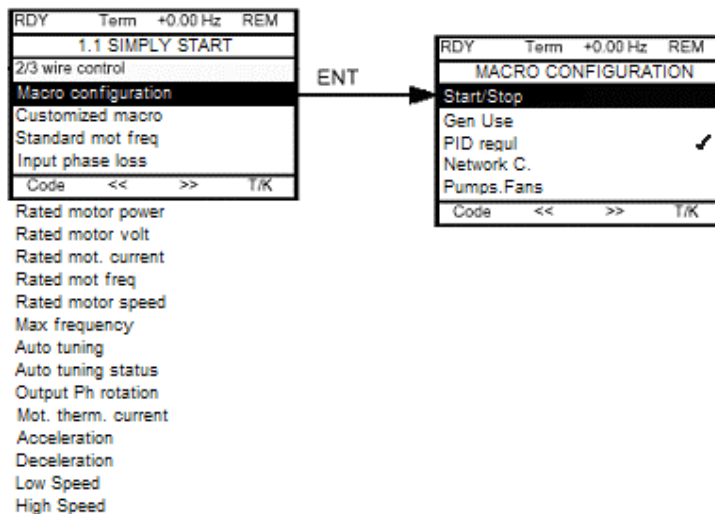
## 4. Simply Start and PID Macro

This section is going to show how to set the Drive up for basic PID control with minimal number of changes. We will configure the Drive to provide PID control using a 0-10v signal as its setpoint reference and a 4-20mA signal as its feedback. The run command will be given by a digital input. It will also allow for selection of other setpoints and provide fault indication.

1) Navigate to Simply Start Menu as below.



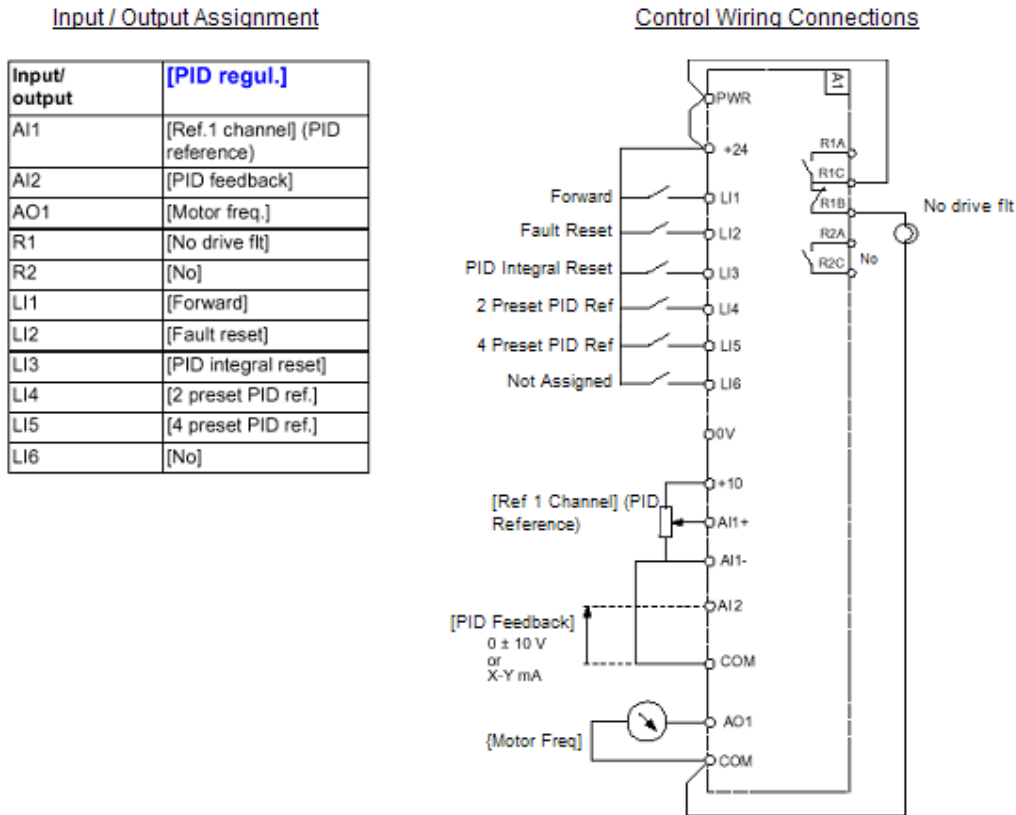
2) In the 1.1 SIMPLY START menu enter the Macro configuration screen and select PID regul, to select this "Enter" must be held down for **2 seconds**. Once configured, a tick will appear next to "PID regul" verifying selection. See Below.



Continue down the 1.1 SIMPLY START menu and set motor nameplate, acceleration / deceleration rates and speed limit parameters up as per normal commissioning, for more information on these parameters consult the full technical manual. . The parameters should be configured in the order they appear, as the later ones are dependant on the first ones.

Once MACRO CONGIURATION is changed to PID regul the assignment of the inputs/outputs becomes that shown in Fig 1.1.

Fig 1.1

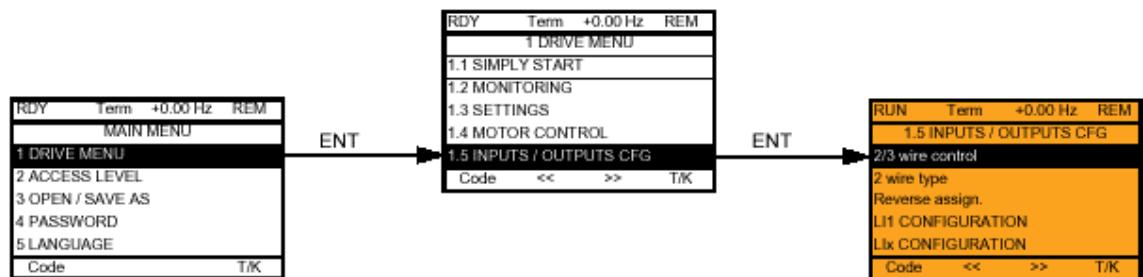


Continue down list and set motor nameplate, acceleration / deceleration rates and speed limit parameters up as per normal commissioning, for more information on these parameters consult the full technical manual.

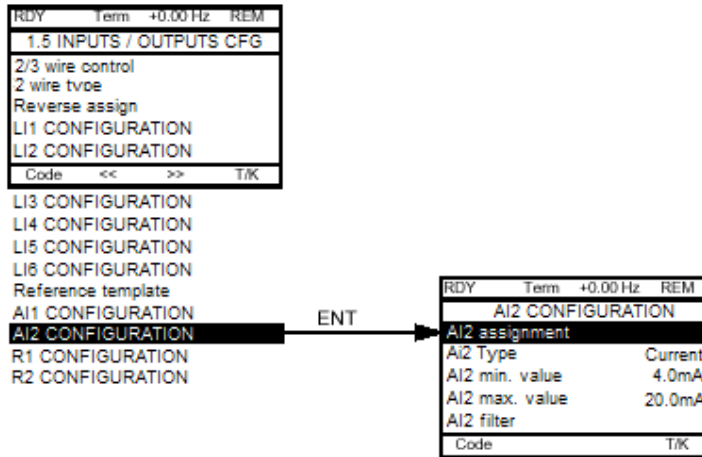
Setting up of the “SIMPLY START” screens as we have done maps the control I/O elements of the PID function as shown in the I/O table but it does not configure them fully. Selection of values and scaling of the PID is still required, see below.

Analogue Configuration

AI1, AI2, AO1 in the Fig 1.1 may require customising to suit the characteristics of the signals to be used. These are configured in the screens under heading **[1.5 INPUTS / OUTPUTS CFG] (I-O)** shown below.

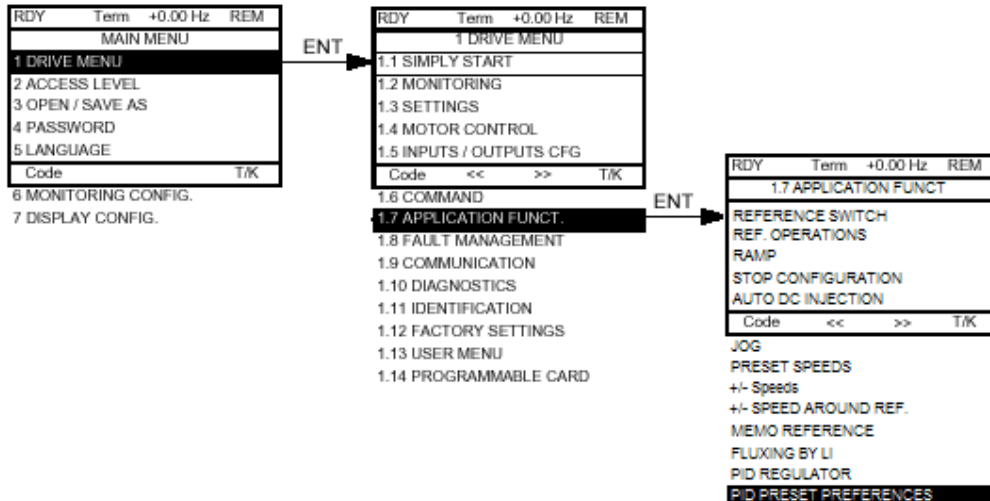


e.g. Once in the [1.5 INPUTS / OUTPUTS CFG] (I-O-) menu scroll down and enter the screen titled **A12 Configuration** to select the type of signal (current or voltage) and to set the min and max values i.e. 4mA and 20mA. See next page.



### Digital Configuration

Most of the digital controls in Fig 1.1 do not need further configuring with the exception of LI4 and LI5. Activation of either of these inputs will use a preset PID reference, these references are found under heading [1.7 APPLICATION FUNCT] (Fun-) shown below.



e.g. Once in the [1.7 APPLICATION FUNCT] (Fun-) menu scroll down and enter the screen titled **PID Preset References (Pr1)**. Adjustment of the Preset values is done by entering screens [PID 2 Preset Ref] and [PID 4 Preset Ref]. If you do not want to use all of the inputs as shown in Fig 1.1 simply don't connect to them.

**IMPORTANT:** Make sure drive is in Remote Mode, REM should be displayed in the top right corner. If LOC is showing the drive is in Local Mode. Press Button **F4** to toggle between Modes.

The Drive should now set up for PID control as Fig 1.1, for most applications the default settings will normally provide adequate control. In cases that the defaults do not provide the required control then there are a number of parameters to meet more specific requirements. The next section is broken into two parts, the first addressing problems with "Tuning the PID Loop" and the second covers "General PID Parameters", other PID parameters a can be found within their associated "Advanced Functions".

## 5. Tuning the PID Loop

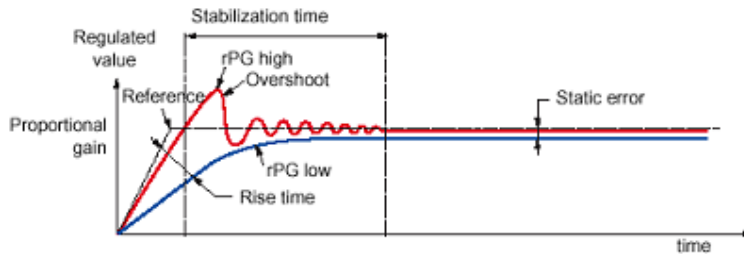
To tune the PID loop, adjust the screens below (rPG or rIG) gradually and independently and observe the effect on the PID feedback in relation to the reference. Generally rdG does not need adjusting.

### [1.7 APPLICATION FUNCT] (Fun-) [PID REGULATOR] (Pid)

**Screen** [PID prop. gain] (rPG)

**Range** 0.01 to 100

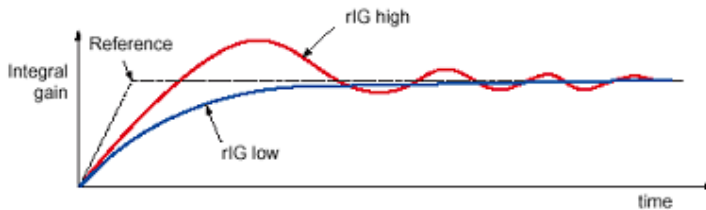
**Description** Proportional Gain, too much will cause overshooting of the Reference setpoint and insufficient cause slow response.



**Screen** [PID integral gain] (rIG)

**Range** 0.01 to 100

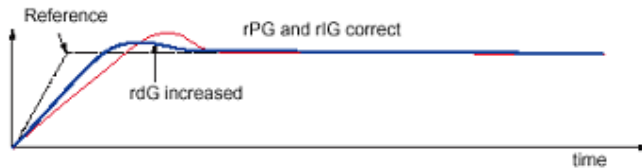
**Description** Integral Gain, this will also overshoot and take longer to settle on the Reference setpoint if set to high. Setting it to low will cause less oscillations but a slower response.



**Screen** [PID derivative. gain] (rdG)

**Range** 0.00 to 100

**Description** Derivative Gain generally the value does not need adjusting.



Do the following if the factory settings are unstable

Perform a test with a speed reference in Manual mode (Refer to Auto / Manual Switching in the “Advanced Functions” Section) Then with the drive on load run through the speed range of the system:

- In steady state, the speed must be stable and comply with the reference and the PID feedback signal must be stable.
- In transient state, the speed must follow the ramp and stabilize quickly and the PID feedback must follow the speed.

To check the Analogue signals go to; [1.2 MONITORING] ► [I/O MAP] ► [ANALOG INPUTS IMAGE]

If they are incorrect, check the settings for the analogue signals and/or sensor signal and cabling.



### If the feedback signals are not the problem then further Tuning of the PID Loop is needed

Change back to the PID mode of control you were using.

- 1) Set auto-adaptation of the ramp to No. This can be found under the path  
[1.7 APPLICATION FUNCT] (Fun-) ► [RAMP] ► [Dec ramp adapt]
- 2) Set the Integral Gain (rIG) to minimum.  
[1.7 APPLICATION FUNCT] (Fun-) ► [PID REGULATOR] (Pid) ► [PID integral gain] (rIG)
- 3) Observe the PID Reference, Feedback, Error and Output.  
[1.2 MONITORING]
- 4) Do several RUN/STOP or vary the load or reference rapidly.
- 5) Set the proportional gain (rPG) in order to ascertain the ideal compromise between response time and stability in transient phases (slight overshoot and 1 to 2 oscillations before stabilizing).  
[1.7 APPLICATION FUNCT] (Fun-) ► [PID REGULATOR] (Pid) ► [PID prop. gain] (rPG)
- 6) If the reference varies from the preset value in steady state, gradually increase the integral gain (rIG), reduce the proportional gain (rPG)
- 7) In the event of instability (pump applications), find a compromise between response time and static precision.
- 8) Perform in-production tests throughout the reference range.

The oscillation frequency depends on the system kinematics.

## 6. General PID Parameters

This section will explain the main parameters and their functions. The parameters are being explained individually and not part of the macro configuration. All parameters are under the heading:

[1.7 APPLICATION FUNCT] (Fun-)  
[PID REGULATOR] (Pid)

<b>Screen</b>	[PID feedback ass.] (PIF)
<b>Range</b>	AI1 (0-10V), or AI2 (V or mA) <i>Note: AI3, AI4, Frequency Input and Encoder Input become available if using the appropriate extension card.</i>
<b>Description</b>	This allows for selection of the desired feedback source. If using AI2 as feedback the user must configure to suit their transducer characteristics, i.e. 0-10V, 0-20mA, 4-20mA
<b>Screen</b>	[Min PID feedback] (PIF1)
<b>Range</b>	0 to [Max PID feedback]
<b>Description</b>	Value of the minimum feedback. Can be used to scale feedback (sensor range).
<b>Screen</b>	[Max PID feedback] (PIF2)
<b>Range</b>	[Min PID feedback] to 32767
<b>Description</b>	Value of the maximum feedback. Can be used to scale feedback (sensor range).
<b>Screen</b>	[Min PID Reference] (PIP1)
<b>Range</b>	[Min PID feedback] to [Max PID Reference]
<b>Description</b>	Value of the minimum Process.
<b>Screen</b>	[Max PID Reference] (PIP2)
<b>Range</b>	[Min PID Reference] to [Max PID Reference]
<b>Description</b>	Value of the maximum Process.
<b>Screen</b>	[PID ramp] (PrP)

<b>Range</b>	0 to 99.9 s
<b>Description</b>	PID acceleration/deceleration ramp, time to go from [Min PID Reference] to [Max PID Reference] and vice versa.
<b>Screen</b>	[PID correct. reverse] (PIC)
<b>Range</b>	No or Yes
<b>Description</b>	If = No then the speed of the motor will increase when the error is positive If = Yes then the speed of the motor will decrease when the error is positive
<b>Screen</b>	[Min PID output] (POL)
<b>Range</b>	-500 to 500
<b>Description</b>	Minimum value of regulator output in Hz, commonly used to maintain minimum flow.
<b>Screen</b>	[Max PID output] (POH)
<b>Range</b>	-500 to 500
<b>Description</b>	Maximum value of regulator output in Hz, could be used to prevent over pressuring pump system.
<b>Screen</b>	[PID Integral reset] (PIS)
<b>Range</b>	Can be activated by LI1 to LI6
<b>Description</b>	If the assigned input bit is at 0 then the PID Integral is enabled. If the assigned input bit is at 1 then the PID Integral is disabled and resets the Integral value.
<b>Screen</b>	[Speed ref. assign] (FP1)
<b>Range</b>	AI1 (0-10V), or AI2 (V or mA) <i>Note: AI3, AI4, Frequency Input, Encoder and comms Inputs become available if using the appropriate extension card.</i>
<b>Description</b>	PID predictive speed input, this can be used to initialize the speed on restarting the process.  e.g. by using the same analogue signal that you are using for the PID reference in combination with the multiplying coefficient [Speed input%] you will be able to set the initial starting speed of the motor to step straight to the known normal operating window for the PID control, effectively reducing ramp up time and taking control of the process much quicker.
<b>Screen</b>	[Speed input%] (PSr)
<b>Range</b>	0 to 100%
<b>Description</b>	Multiplying coefficient for the predictive speed input (see above). This parameter cannot be accessed if [Speed ref. assign] (FP1) is set to [No]

## 7. Advanced Functions

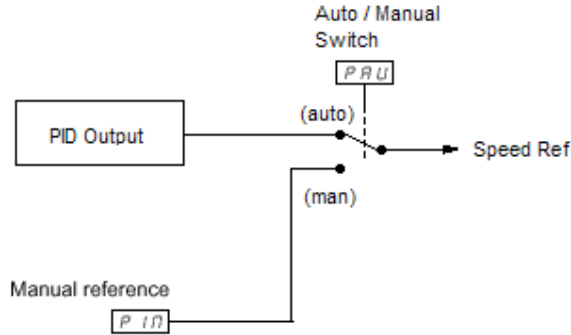
### 7.1 Auto / Manual Switching

At various times when operating with the PID function there may be a need override PID control and directly set the speed of the motor. This may be required during the commissioning stage to verify the feedback transducer (flow, pressure, or temperature) is working correctly.

To do this we use the Auto / Manual switching feature. When this is used we configure one of the Logic Inputs to switch between the Speed Reference of the PID output and a Manual Reference. This is done in screen [Auto/Manual assign] (PAU) shown below.

Secondly we need to select where the Manual reference is derived from as detailed in [Manual reference] (PII) screen shown below. e.g. you may be using AI1 as the PID Setpoint reference, but this can also be used as the Manual reference only it will directly set the motor speed and bypass the PID function. (Access level would need to be set to "Advanced")

## Manual Auto Switching



To configure for Manual / Auto control, configure the screens in the following location.

### [1.7 APPLICATION FUNCT] (Fun-)

[PID REGULATOR] (Pid)

**Screen** [Auto/Manual assign] (PAU)  
**Range** Not Assigned or Assigned to L1 to L6  
**Description** If assigned input bit is at 0 then PID Control is active  
 If assigned input bit is at 1 then manual operation is active. Set manual reference as per next screen.

**Screen** [Manual reference] (PIΠ)  
**Range** AI1 (0-10V), or AI2 (V or mA) *Note: AI3, AI4, Frequency Input and Encoder Input become available if using the appropriate extension card.*  
**Description** If assigned input bit is at 0 then PID Control is active  
 If assigned input bit is at 1 then manual operation is active. Set Manual Reference as per next screen.

## 7.2 PID Alarms

Using the PID feedback signal we can monitor for any undesirable operating conditions and raise and alarm with a relay output. First step in configuring the alarms is to set the required threshold level alarms to the PID, the second is to assign alarms to relay outputs.

Looking first at the PID settings, we are able to set a threshold values for “Minimum Feedback Alarm”, “Max Feedback Alarm” and “Minimum Error Alarm”. Below are the details of the screens to configure, the description assumes that a relay will be assigned to the alarm.

### [1.7 APPLICATION FUNCT] (Fun-)

[PID REGULATOR] (Pid)

**Screen** [Min fbk alarm] (PAL)  
**Range** [Min PID feedback] (PIF1) to [Max PID feedback] (PIF2)  
**Description** Minimum regulator feedback. If feedback signal falls below this value the alarm will set the relay, the relay will remain set until the PID is disabled regardless of whether the signal returns above the threshold level.

**Screen** [Max fbk alarm] (PAH)  
**Range** [Min PID feedback] (PIF1) to [Max PID feedback] (PIF2)  
**Description** Maximum regulator feedback. If feedback signal rises above this value the alarm will set the relay, the relay will remain set until the PID is disabled regardless of whether the signal returns below the threshold level.

**Screen** [Min error alarm] (PEr)  
**Range** 0 to 65,535

**Description** Regulator error monitoring threshold. If the measured error (difference between PID Reference and PID Feedback) become greater than the value set in this screen the alarm will set the relay, the relay will reset as soon as the measured error becomes less than the set value.

The second part to configuring the alarms is assigning the alarms above to relay outputs. This is done in the relay screens. There are two standard relay outputs R1 & R2, a further two (R3 & R4) are available if using an extension card. For the purpose of this exercise we will focus on R2.

**[1.5 INPUTS / OUTPUTS CFG] (I-O-)**

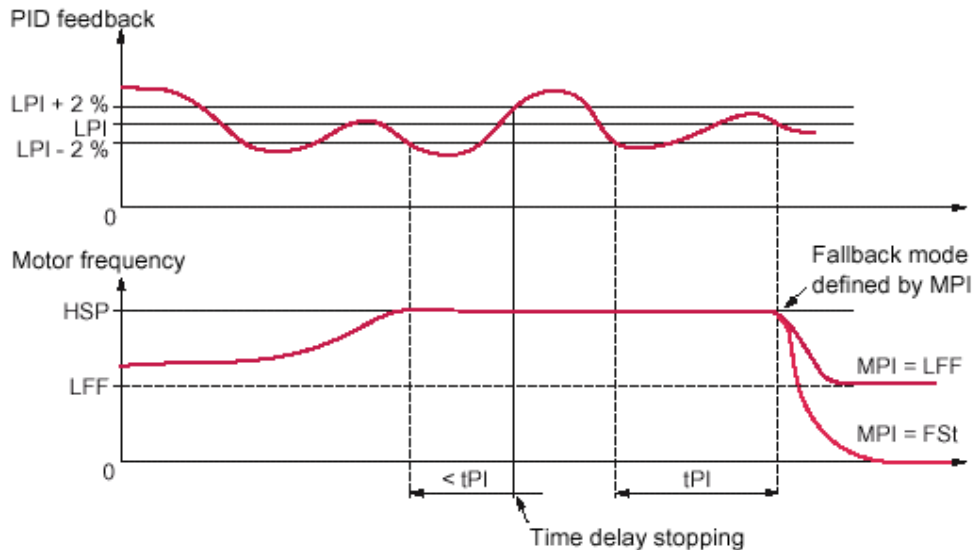
**Screen** [R2 Configuration] (r2)  
**Range** For full range refer to Technical Manual. For this exercise we will look at [PID error al], [PID fdbk al], [PID high al] and [PID low al]  
**Description** By selecting one of the above options the relay will operate as follows:  
 [PID error al], relay will operate as per description for [Min error alarm] (PEr).  
 [PID fdbk al], relay will operate if either [Min fbk alarm] (PAL) or [Max fbk alarm] (PAH) thresholds are breached.  
 [PID high al], relay will operate if [Max fbk alarm] (PAH) thresholds are breached.  
 [PID low al], relay will operate if Min error alarm] (PEr) thresholds are breached.

**7.3 PID Feedback Supervision**

Used to define the operating mode in the event of detection of a PI feedback:

- Lower than the limit set if [PID correct. reverse] (PIC) = [No] (nO)
- Higher than the limit set if [PID correct. reverse] (PIC) = [Yes] (YES)

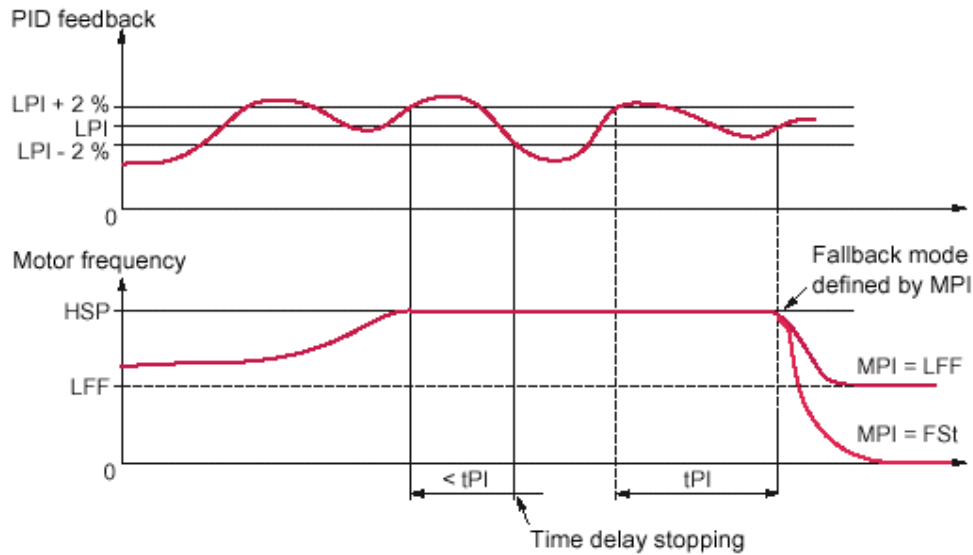
Where [PID correct. reverse] (PIC) = [No] (nO)



If, once maximum speed has been reached ([High speed] (HSP)), the PID feedback is lower than the supervision threshold [PID Threshold] (LPI) -2%, a time delay  $t_{PI}$  is launched. If at the end of this time delay the value of the PID feedback is still lower than the supervision threshold [PID Threshold] (LPI) + 2%, the drive switches to fallback mode as defined by parameter MPI.

In all cases the drive reverts to PID regulation mode as soon as the PID feedback exceeds the supervision threshold [PID Threshold] (LPI) +2%.

Where [PID correct. reverse] (PIC) = [Yes] (YES)



If, once maximum speed has been reached ([High speed] (HSP)), the PID feedback is higher than the supervision threshold [PID Threshold] (LPI) +2%, a time delay  $t_{PI}$  is launched. If at the end of this time delay the value of the PID feedback is still higher than the supervision threshold [PID Threshold] (LPI) -2%, the drive switches to fallback mode as defined by parameter MPI.

In all cases the drive reverts to PID regulation mode as soon as the PID feedback undershoots the supervision threshold [PID Threshold] (LPI) -2%.

#### 1.7 APPLICATION FUNCT] (Fun-) [PID REGULATOR]

**Screen** [PID Threshold] (LPI)  
**Range** [Min PID feedback] (PIF1) to [Max PID feedback] (PIF2) if not assigned then next three parameters are unavailable  
**Description** PID regulator feedback supervision threshold (alarm can be assigned to a relay or a logic output)

**Screen** [PID Ctrl time delay] ( $t_{PI}$ )  
**Range** 0 to 600 seconds  
**Description** PID regulator feedback supervision time delay.

**Screen** [PID Control Management] ( $\Pi$ PI)  
**Range** [Ignore] (nO), [Freewheel] (YES), [fallback spd] (LFF), [Ramp stop] (rMP) and [Fast stop] (FSt).  
**Description** Type of stop for PID regulator feedback supervision fault.

**Screen** [Fallback speed] (LFF)  
**Range** 0 to 500 or 1000Hz according to rating  
**Description** Fallback speed for PID regulator feedback supervision fault. Active if screen [PID Control Management] ( $\Pi$ PI) is set to fallback spd] (LFF).

#### 7.4 4-20mA Loss

The loss of a 4-20mA feedback signal is undesirable for most PID applications, e.g, for a flow or pressure application the loss of the feedback signal would indicate no flow or under pressure, this would cause the motor to accelerate to restore flow or pressure and will end up providing excess flow or pressure.

To avoid this dangerous situation, loss of the 4 – 20mA signal is detected and appropriate action taken. To activate this protection set the appropriate action for the loss of the analogue

input. For this exercise AI2 is used. Equally applicable to AI3 & AI4 if using appropriate extension card.

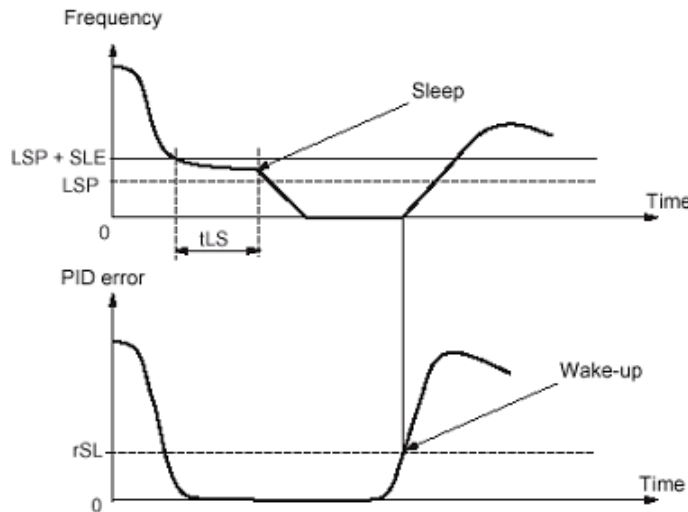
**[1.8 FAULT MANAGEMENT] (FLt-)**  
[4-20mA LOSS]

**Screen** [AI2 4-20mA loss] (LFL2)  
**Action** **[Ignore]** (nO): Fault ignored. This configuration is the only one possible if [AI2 min. value] (CrL3) is not greater than 3 mA.  
**[Freewheel]** (YES): Freewheel stop.  
**[Per STT]** (Stt): Stop according to configuration of [Type of stop] (Stt), without fault tripping. In this case the fault relay does not open and the drive is ready to restart as soon as the fault disappears, according to the restart conditions of the active command channel (e.g., according to [2/3 wire control] (tCC) and [2 wire type] (tCt) if control is via the terminals). Configuring an alarm for this fault is recommended (assigned to a logic output, for example) in order to indicate the cause of the stop.  
**[fallback spd]** (LFF): Switch to fallback speed, maintained as long as the fault is present and the run command is not disabled.  
**[Spd maint.]** (rLS): The drive maintains the speed being applied when the fault occurred, as long as the fault is present and the run command is not disabled.  
**[Ramp stop]** (rMP): Stop on ramp  
**[Fast stop]** (FSt): Fast stop  
**[DC injection]** (dCI): DC injection stop. This type of stop cannot be used with certain other functions.

**7.5 Sleep/Wake-up**

This function supplements the PID regulator, in order to avoid prolonged operation at excessively low speeds when neither useful nor desirable.

- It stops the motor after a period of operation at reduced speed. This time and speed can be adjusted.
- It restarts the motor if the PID error or feedback exceeds an adjustable threshold.



**Sleep:**

Following operation at a speed less than [Low speed] (LSP) + [Sleep Offset Thres.] (SLE) for a period of time greater than or equal to [Low speed time out] (tLS), the motor is stopped on a ramp.

**Wake-up:**

If the PID error exceeds [PID wake up thresh.] (rSL) (see the example opposite) or if the PID feedback exceeds [PID Wakeup Thres.] (UPP), the PID regulator is reactivated.

**[1.7 APPLICATION FUNCT] (Fun-)**  
[SLEEPING / WAKE UP]

**Screen** [Low speed timeout] (tls)  
**Range** 0 to 999.9s  
**Description** Maximum operating time at [Low speed] (LSP)

Following operation at LSP for a defined period a motor stop is requested automatically. The motor restarts if the reference exceeds (SLP + SLE) and if a run command is still present.

Caution: value 0 corresponds to an unlimited period.

<b>Screen</b>	[Low speed] (LSP)
<b>Range</b>	0 to [High speed] (HSP)
<b>Description</b>	When the motor frequency reaches this level, the Low speed timeout will commence.
<b>Screen</b>	[Sleep Offset Thres.] (SLE)
<b>Range</b>	0 to 500 or 1000Hz according to rating
<b>Description</b>	Adjustable restart threshold (offset) following a stop after prolonged operation at [Low speed] (LSP), in Hz. The motor restarts if the reference rises above (LSP + SLE) and if a run command is still present.
<b>Screen</b>	[PID wake up thresh] (rSL)
<b>Range</b>	0 to [Max PID feedback] (PIF2)
<b>Description</b>	If the "PID" and "Low speed operating time" tLS functions are configured at the same time, the PID regulator may attempt to set a speed lower than LSP. This results in unsatisfactory operation, which consists of starting, operating at low speed then stopping and so... Parameter rSL (restart error threshold) can be used to set a minimum PID error threshold for restarting after a prolonged LSP. The function is inactive if the PID function has not been configured or if tLS=0 or if rSL=0.

**WARNING** Check that unintended restarts will not present any danger.  
**Failure to follow these instructions can result in death or serious injury.**

<b>Screen</b>	[PID Wakeup Thresh] (UPP)
<b>Range</b>	Not assigned or Min PID feedback] (PIF1) to [Max PID feedback] (PIF2)
<b>Description</b>	<p>If the "PID" and "Low speed operating time" tLS functions are configured at the same time, the PID regulator may attempt to set a speed lower than LSP. This results in unsatisfactory operation, which consists of starting, operating at low speed then stopping and so...</p> <p>Parameter UPP (restart feedback threshold) can be used to set a PID feedback threshold for restarting after a stop due to prolonged LSP. This threshold is a minimum if [PID correct reverse] (PIC) = [No] (nO) and maximum if [PID correct reverse] (PIC) = [Yes] (YES)..</p> <p>The function is inactive if the PID function has not been configured or if tLS=0 or if UPP= [No] (nO) or if rSL is active (not 0)</p> <p><b>WARNING</b> Check that unintended restarts will not present any danger.</p> <p><b>Failure to follow these instructions can result in death or serious injury.</b></p>



## 7.6 Sleep on Basis of low flow detection

Parameters can be accessed in [Expert] mode.

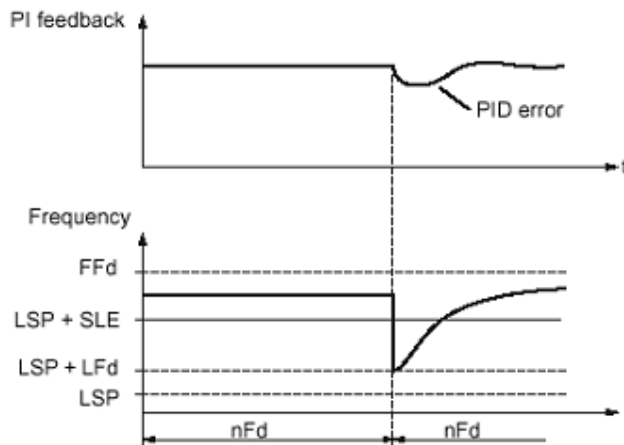
This function is only active when the motor frequency is less than [NoFlo.Freq.Thres.Ac.] (FFd). This function is used in applications where zero flow cannot be detected by the sleep function alone. At periodic intervals (based on time [No Flow Period Det.] (nFd)), it forces the drive's frequency reference to [Low speed] (LSP) + [No Flow Offset] (LFd) in order to test for zero flow.

Set the sleep function so that the drive switches to sleep mode when zero flow is detected ([No Flow Offset] (LFd) y [Sleep Offset Thres.] (SLE)).

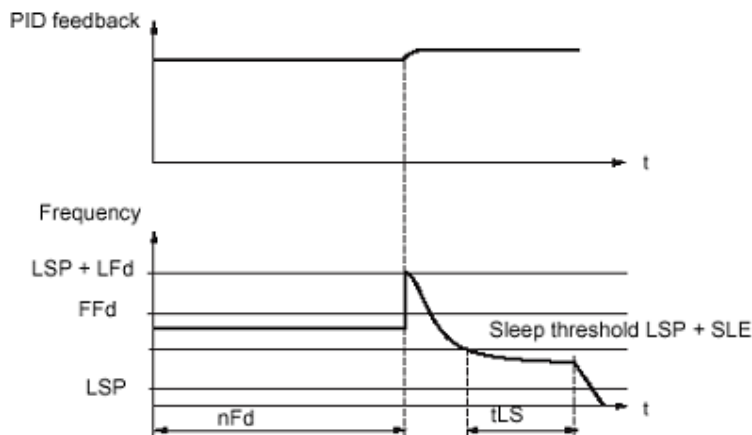
The test can be carried out at underpressure or overpressure as appropriate for the type of installation.

**Test at underpressure:  $(LSP + LFd) < FFd$**

- If the request is still present, the PID regulator error increases (at underpressure), causing the drive to restart at its previous speed above the sleep threshold.

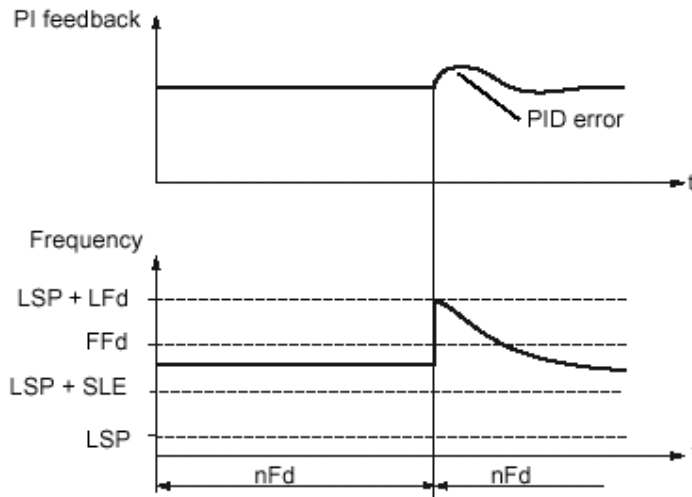


- If the request is no longer present (zero flow), the PID regulator error will not increase, and the speed will remain below the sleep threshold, thereby inducing a stop.

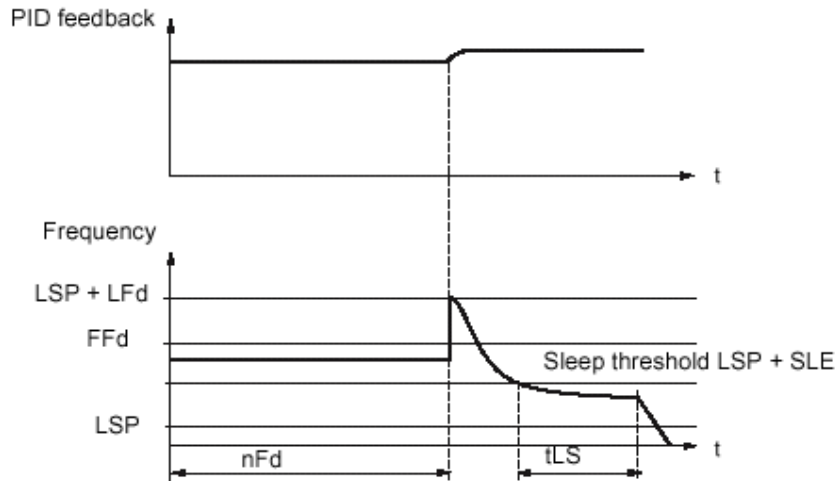


**Test at overpressure:  $(LSP + LFd) > FFd$**

- If the request is still present, the PID regulator error increases (at overpressure), causing the drive to decelerate. If flow is detected, the speed will stabilize at its previous level, above the sleep threshold.



- If the request is no longer present (zero flow), the PID regulator error increases (at overpressure), causing the drive to decelerate. The absence of flow maintains the overpressure and the speed falls below the sleep threshold, causing the drive to stop.



**[1.7 APPLICATION FUNCT] (Fun-)**  
**[SLEEPING / WAKE UP]**

**Screen** [No Flow Period Det.] (nFd)  
**Range** 0 to 20min  
**Description** Zero flow detection interval in minutes  
 The parameter can be accessed if [PID feedback ass.] (PIF) is not [No] (nO)

**Screen** [No Flow Freq.Thres.Ac.] (FFd)  
**Range** 0 to 500 or 1000Hz according to rating  
**Description** Zero flow detection activation threshold. The parameter can be accessed if [PID feedback ass.] (PIF) is not [No] (nO) and if [No Flow Period Det] (nFd) is not 0.

**Screen** [No Flow Offset.] (nFd)  
**Range** 0 to 500 or 1000Hz according to rating

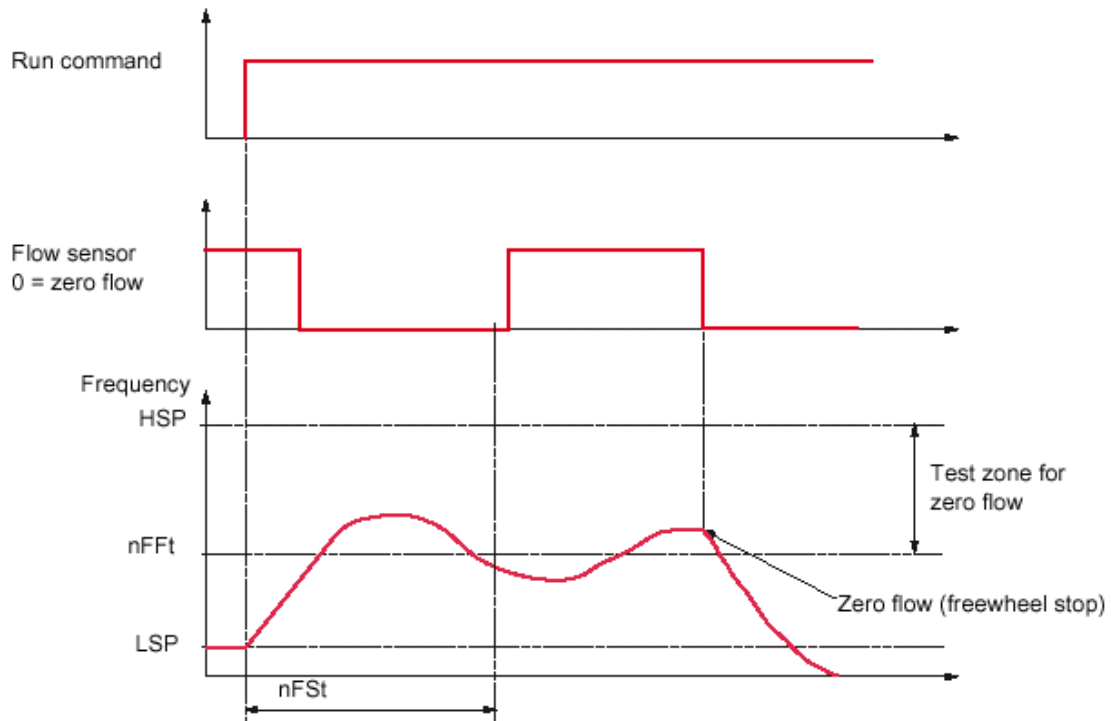
**Description** Zero flow detection offset. The parameter can be accessed if [PID feedback ass.] (PIF) is not [No] (nO) and if [No Flow Period Det] (nFd) is not 0.

### 7.7 Zero fluid or zero flow detection via sensor

In the case of a pump, for example, this function can be used to avoid operation when there is no fluid or if the conduits are blocked. Although this function is independent of the “Sleeping on the basis of flow detection” function, the two can be used in tandem.

The function uses a fluid sensor assigned to a logic input. The fault is triggered if the frequency exceeds an adjustable threshold [Freq.Th.Sensor. Act.] (nFFt) and the input assigned to the sensor is at zero. The fault is ignored on startup for an adjustable time delay [Flow Times Ctrl] (nFSt) in order to avoid untimely triggering due to a transient state.

This fault triggers a freewheel stop.



#### [1.7 APPLICATION FUNCT] (Fun-) [NO FLOW DETECTION]

**Screen** [No Flow Sensor.] (nFS)

**Range** Not assigned or LI1 to LI6, further assignments possible with extension cards.

**Description** If the assigned input is at 0, this indicates that there is no fluid present.

**Screen** [Freq.Th.Sensor.Act.] (nFFt)

**Range** 0 to 500 or 1000Hz according to rating

**Description** Zero flow detection activation threshold. The parameter can be accessed if [No Flow Sensor.] (nFS) is not [No] (nO).

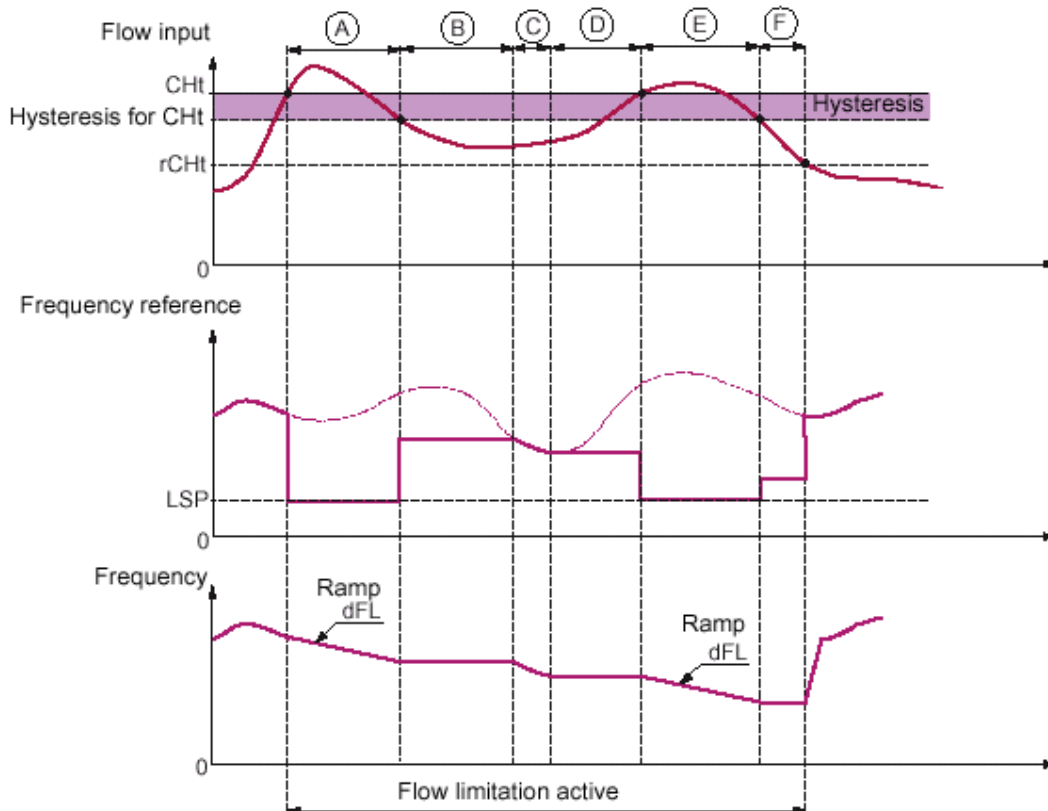
**Screen** [Flow Times Ctrl] (nFd)

**Range** 0 to 999 seconds

**Description** Zero fluid detection activation time delay. The parameter can be accessed if [No Flow Sensor.] (nFS) is not [No] (nO).

## 7.8 Flow Limitation

This function can be used to limit the flow of a fluid, in the case of a pump, for example. The function uses a flow sensor assigned to an analog input, the “pulse in” input or the encoder input. It limits the frequency reference. In the case of regulation with PID, it affects the PID regulator output reference.



- **Before A** – The signal on the input assigned to the flow measurement has not reached the activation threshold [Flow.Lim.Th.Active]  
(CHt): Flow limitation is not activated and the input reference is applied.
- **A** – The signal on the input assigned to the flow measurement has reached the threshold [Flow.Lim.Th.Active] (CHt): Flow limitation is activated, the reference is limited to [Low speed] (LSP) and the frequency decelerates along the ramp [Dec. Flow. limit] (dFL).
- **B** – The signal on the input assigned to the flow measurement has fallen below the hysteresis of the threshold [Flow.Lim.Th.Active]  
(CHt): The current frequency is copied and applied as the reference.
- **C** – The input reference has fallen below the reference **B** and is continuing to fall: It is applied.
- **D** – The input reference starts to rise again: The current frequency is copied and applied as the reference.
- **E** – The signal on the input assigned to the flow measurement has reached the threshold [Flow.Lim.Th.Active] (CHt): The reference is limited to [Low speed] (LSP) and the frequency decelerates along the ramp [Dec. Flow. limit] (dFL).
- **F** – The signal on the input assigned to the flow measurement has fallen below the hysteresis of the threshold [Flow.Lim.Th.Active]  
(CHt): The current frequency is copied and applied as the reference.
- **After F** – The signal on the input assigned to the flow measurement has fallen below the deactivation threshold [Flo.Lim.Thres. Inact.]  
(rCHt): Flow limitation is no longer active and the input reference is applied.

### [1.7 APPLICATION FUNCT] (Fun-) [FLOW LIMITATION]

<b>Screen</b>	[Flow.Sensor.Inf] (CHI)
<b>Range</b>	Not assigned or AI1 (0-10V), or AI2 (V or mA) <i>Note: AI3, AI4, Frequency Input and Encoder Input become available if using the appropriate extension card.</i>
<b>Description</b>	Selects which analogue input is to be used for setting the frequency reference limits.
<b>Screen</b>	[Flow.Lim.Th.Active] (CHT)
<b>Range</b>	0 to 100%
<b>Description</b>	Function activation threshold, as a % of the max signal of the assigned input. The parameter can be accessed if [Flow.Sensor.Inf] (CHI) is not [No] (nO).
<b>Screen</b>	[Flow.Lim.Th.Inact] (rCHt)
<b>Range</b>	0 to 100%
<b>Description</b>	Function deactivation threshold, as a % of the max signal of the assigned input. The parameter can be accessed if [Flow.Sensor.Inf] (CHI) is not [No] (nO).
<b>Screen</b>	[Dec.Flow.Lim.] (dFL)
<b>Range</b>	0.1 to 9,000 seconds
<b>Description</b>	Time to decelerate from the [Rated motor freq.] (FrS) to 0. Make sure that this value is compatible with the inertia being driven. The parameter can be accessed if [Flow.Sensor.Inf] (CHI) is not [No] (nO).

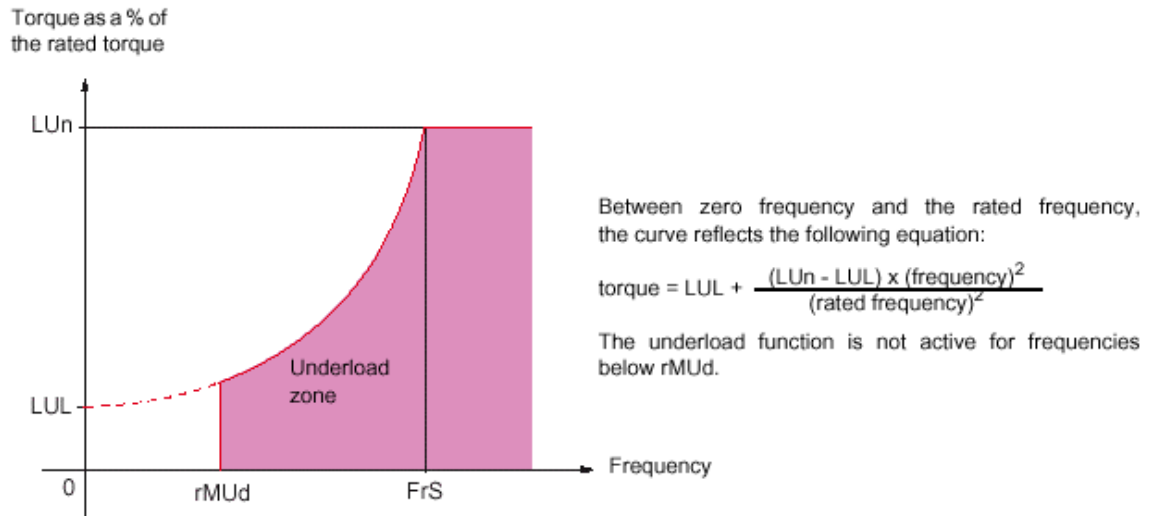
### 7.9 Process Under load Fault

A process underload is detected when the next event occurs and remains pending for a minimum time (ULt), which is

configurable:

- The motor is in steady state and the torque is below the set underload limit (LUL, LUn, rMUd parameters).

The motor is in steady state when the offset between the frequency reference and motor frequency falls below the configurable threshold (Srb).



A relay or a logic output can be assigned to the signaling of this fault in the [1.5 INPUTS / OUTPUTS CFG] (I-O-) menu.

### [1.8 FAULT MANAGEMENT] (FLt-) [PROCESS UNDERLOAD] (ULtd-)

**Screen** [UnId T. Del. Detect] (ULt)

<b>Range</b>	0 to 100 seconds
<b>Description</b>	Underload detection time delay. A value of 0 deactivates the function and renders the other parameters inaccessible.
<b>Screen</b>	[Unld.Thr.Nom.Speed] (LUn)
<b>Range</b>	20 to 100 %
<b>Description</b>	Underload threshold at rated motor frequency [Rated motor freq.] (FrS), as a % of the rated motor torque.
<b>Screen</b>	[Unld.Thr.0.Speed] (LUL)
<b>Range</b>	0 to [Unld.Thr.Nom.Speed] (LUn)
<b>Description</b>	Underload threshold at zero frequency, as a % of the rated motor torque.
<b>Screen</b>	[Unld. Freq. Thr. Det.] (rΠUd)
<b>Range</b>	0 to 500 or 1000Hz according to rating
<b>Description</b>	Minimum frequency underload detection threshold.
<b>Screen</b>	[Hysteresis Freq.Att.] (Srb)
<b>Range</b>	0.3 to 500 or 1000Hz according to rating
<b>Description</b>	Maximum deviation between the frequency reference and the motor frequency, which defines steady state operation.
<b>Screen</b>	[Underload Mangmt.] (UdL)
<b>Range</b>	<b>[Ignore]</b> (nO): Fault ignored <b>[Freewheel]</b> (YES): Freewheel stop <b>[Ramp stop]</b> (rMP): Stop on ramp <b>[Fast stop]</b> (FSt): Fast
<b>Description</b>	Behavior on switching to underload detection.
<b>Screen</b>	[Underload T.B.Rest.] (FtU)
<b>Range</b>	0 to 6 minutes
<b>Description</b>	This parameter cannot be accessed if [Underload Mangmt.] (UdL) = [Ignore] (nO). Minimum time permitted between an underload being detected and any automatic restart. In order for an automatic restart to be possible, the value of [Max. restart time] (tAr) must exceed that of this parameter by at least one minute.

### 7.10 Process Overload Fault

A process overload is detected when the next event occurs and remains pending for a minimum time (tOL), which is

configurable:

- The drive is in current limitation mode.
- The motor is in steady state and the current is above the set overload threshold (LOC).

The motor is in steady state when the offset between the frequency reference and motor frequency falls below the configurable threshold (Srb).

A relay or a logic output can be assigned to the signaling of this fault in the [1.5 INPUTS / OUTPUTS CFG] (I-O-) menu.

#### [1.8 FAULT MANAGEMENT] (FLt-) [PROCESS OVERLOAD] (OLd-)

<b>Screen</b>	[Unld Time Detect.] (tOL)
<b>Range</b>	0 to 100 seconds
<b>Description</b>	Overload detection time delay. A value of 0 deactivates the function and renders the other parameters inaccessible.
<b>Screen</b>	[Ovld Detection Thr.] (LOC)
<b>Range</b>	70 to 150 %

**Description** Overload detection threshold, as a % of the rated motor current [Rated mot. current] (nCr). This value must be less than the limit current in order for the function to work.

**Screen** [Hysteresis Freq.Att.] (Srb)

**Range** 0.3 to 500 or 1000Hz according to rating

**Description** Maximum deviation between the frequency reference and the motor frequency, which defines steady state operation.

**Screen** [Ovld.Proces.Mngmt] (OdL)

**Range** **[Ignore]** (nO): Fault ignored

**[Freewheel]** (YES): Freewheel stop

**[Ramp stop]** (rMP): Stop on ramp

**[Fast stop]** (FSt): Fast

**Description** Behavior on switching to overload detection.

**Screen** [Overload T.B.Rest.] (FtO)

**Range** 0 to 6 Minutes

**Description** This parameter cannot be accessed if [Ovld.Proces.Mngmt] (OdL) = [Ignore] (nO). Minimum time permitted between an overload being detected and any automatic restart. In order for an automatic restart to be possible, the value of [Max. restart time] (tAr) must exceed that of this parameter by at least one minute.

## 8. Typical Configuration

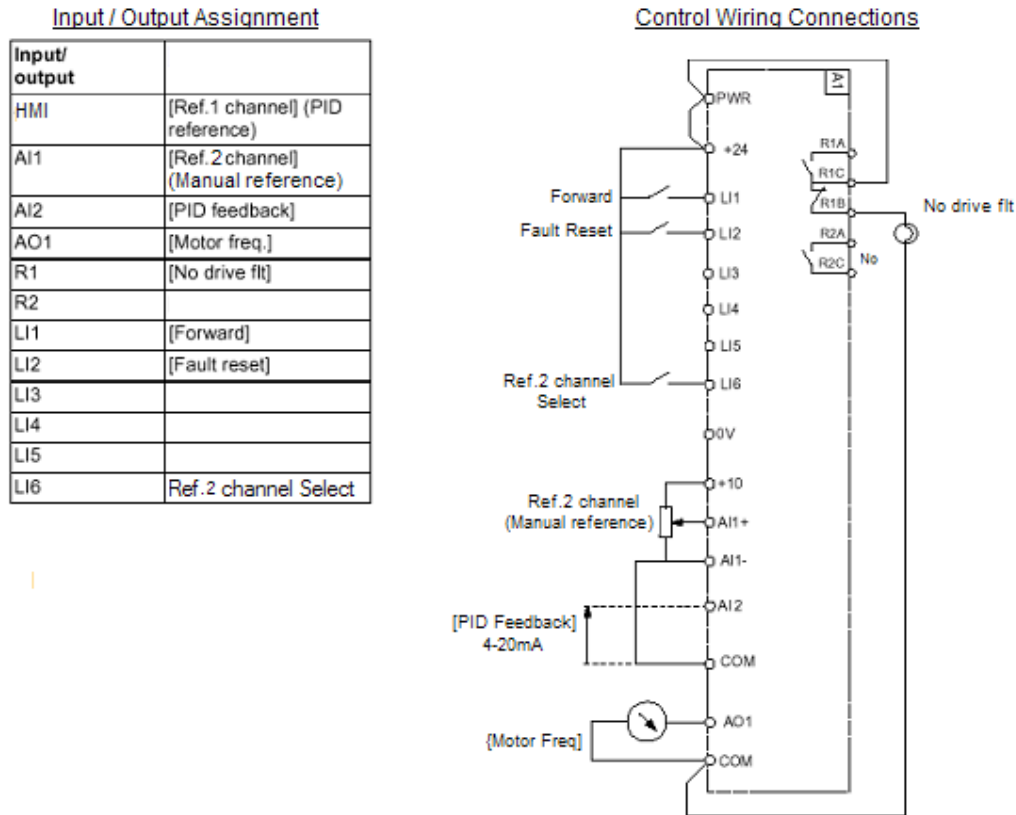
The following example is typical of many PID control configurations.

We will configure the drive to run from a Start/Stop input, use the HMI for the PID Setpoint and a 4 – 20mA signal as the PID feedback. As an option we will included the ability to bypass PID control and manually set the speed of the drive, this reference will come from a 0 – 10 volt signal.

Below in figure 1.2 are the input and output assignments that we want to achieve along with the control wiring connections to be used. The connection of the Fault Indication Lamp and Motor Frequency Meter are optional.

Looking at the Inputs and Outputs we see that starting and stopping is from LI1 (Logic Input 1), LI2 is a Fault Reset and as an option LI6 can be the Ref.2 channel (Manual Setpoint) select input. If you choose not to use Ref.2 channel feature simply ignore “Step 5 - Ref.2 channel (Manual Setpoint)” and leave LI6 disconnected.

Figure 1.2



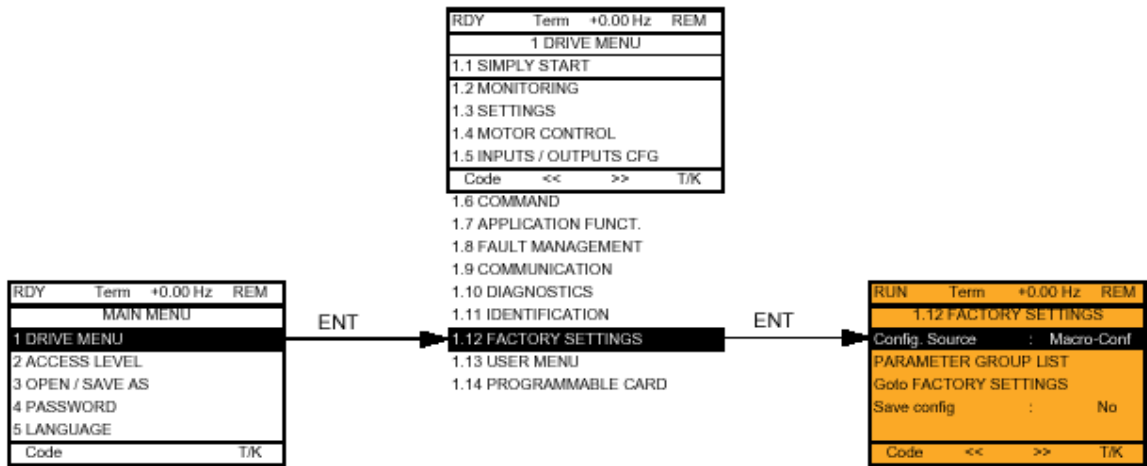
The explanation on how to configure the above is laid out in the following steps.

- STEP 1 – FACTORY SETTINGS
- STEP 2 – CONFIGURE PID MACRO AND MOTOR NAMEPLATE
- STEP 3 – CONFIGURE PID FEEDBACK SIGNAL
- STEP 4 – REF.1 CHANNEL (INTERNAL PID SETPOINT)
- STEP 5 – REF.2 CHANNEL (MANUAL SETPOINT)
- STEP 6 – ADJUSTING INTERNAL PID SETPOINT
- STEP 7 – SCALING PID FEEDBACK AND REFERENCE

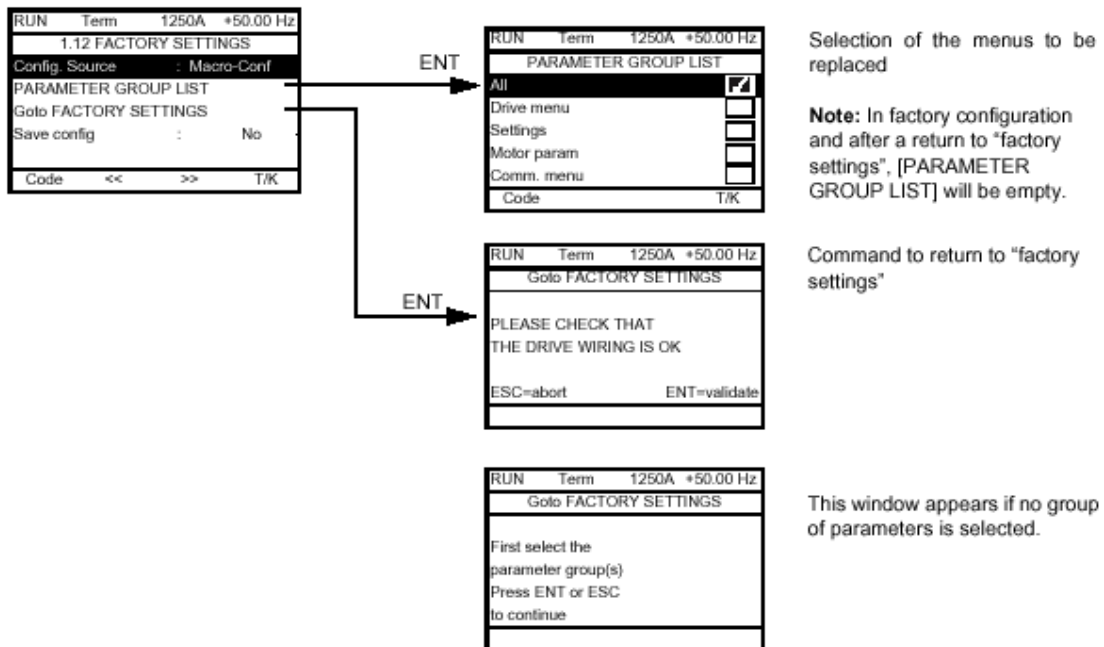


## STEP 1 – FACTORY SETTINGS

1) Navigate to Factory Settings menu as below.

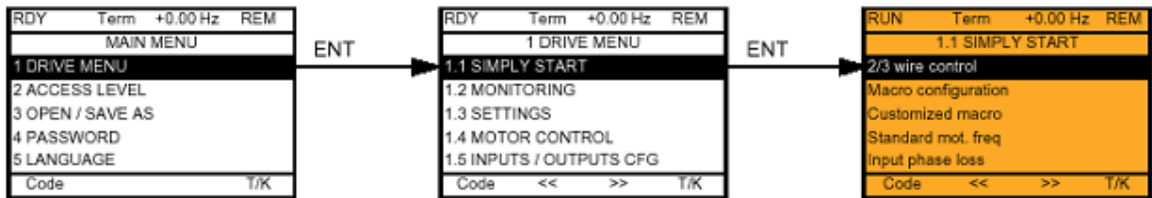


2) Enter PARAMETER GROUP LIST and select "All", then Enter Goto FACTORY SETTINGS and press enter to reset all parameters to factory settings.

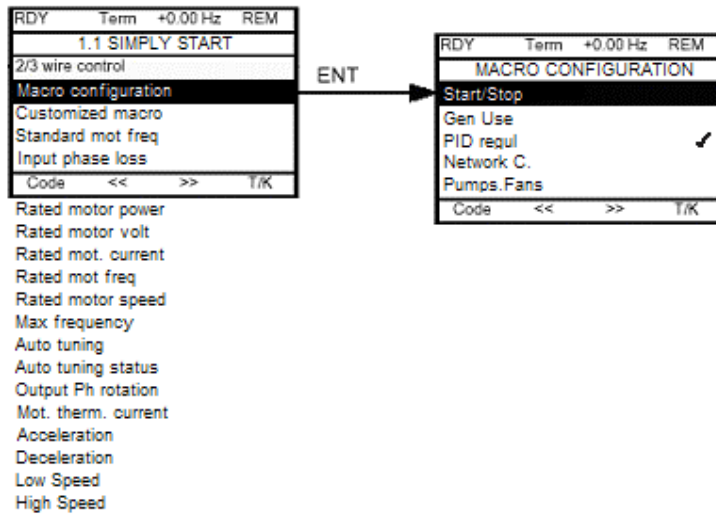


## STEP 2 – CONFIGURE PID MACRO AND MOTOR NAMEPLATE

1) Navigate to Simply Start Menu as below.



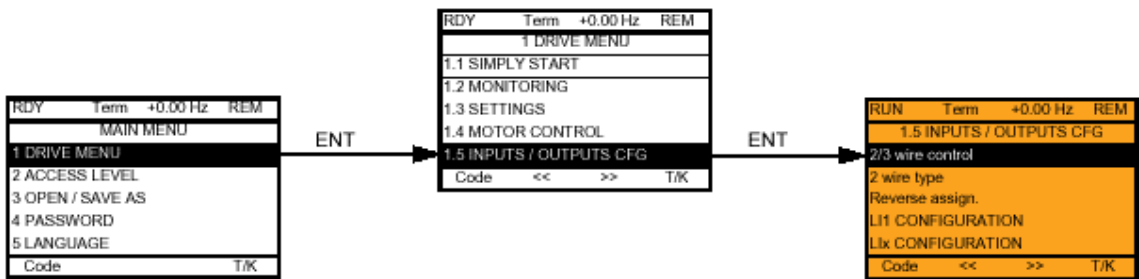
2) In the 1.1 SIMPLY START menu enter the Macro configuration screen and select PID regul, to select this “Enter” must be held down for **2 seconds**. Once configured, a tick will appear next to “PID regul” verifying selection. See Below.



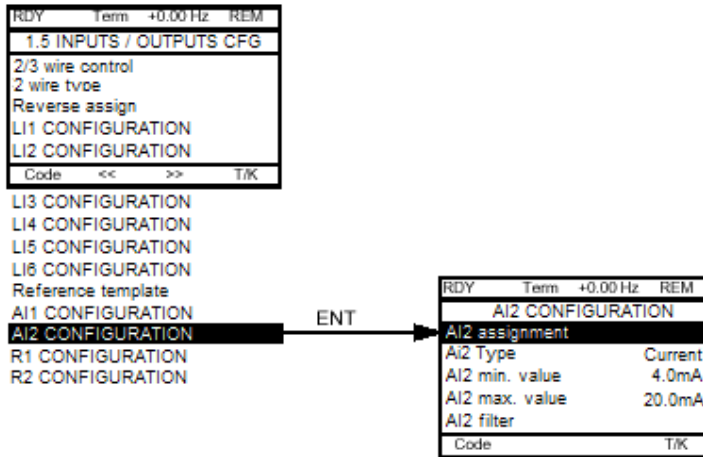
Continue down the 1.1 SIMPLY START menu and set motor nameplate, acceleration / deceleration rates and speed limit parameters up as per normal commissioning, for more information on these parameters consult the full technical manual.

## STEP 3 – CONFIGURE PID FEEDBACK SIGNAL

1) Navigate to Inputs / Outputs Menu as below.

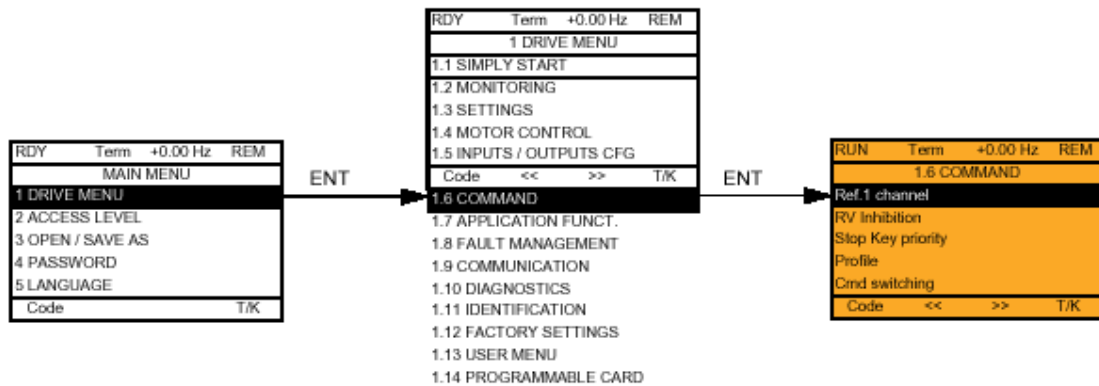


2) In the AI2 CONFIGURATION menu set “AI2 min. value” to 4.0mA as shown in the screen below.

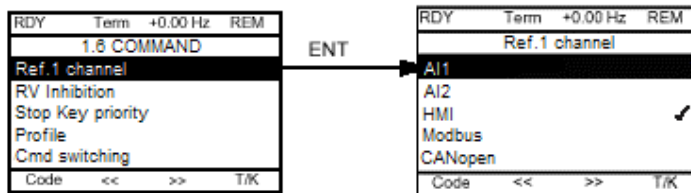


#### STEP 4 – REF.1 CHANNEL (INTERNAL PID SETPOINT)

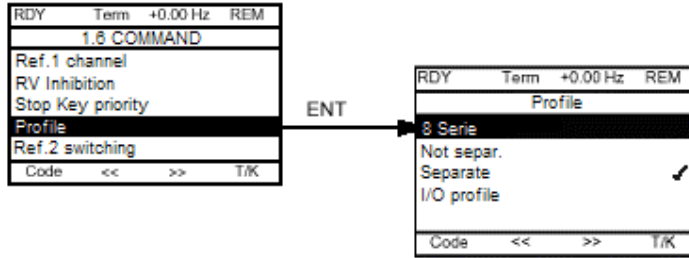
1) Now we will set up Ref.1 channel (PID Reference) to come from the HMI. Navigate to the COMMAND menu shown below.



2) In the 1.6 COMMAND menu enter the Ref.1 channel screen and select HMI. Once configured, a tick will appear next to “HMI” verifying selection.

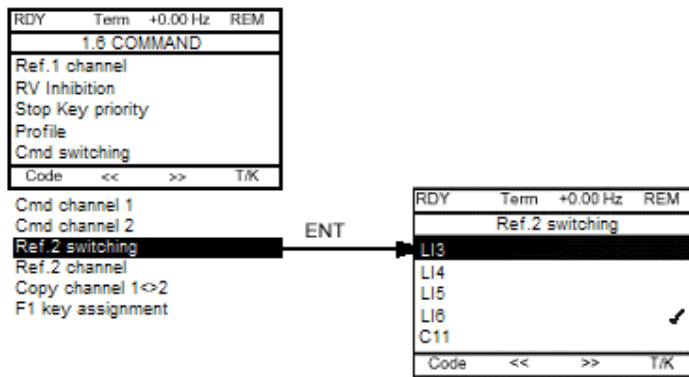


3) Still in the 1.6 COMMAND menu enter the Profile screen and select Separate, Once configured, a tick will appear next to “Separate” verifying selection. See Below.

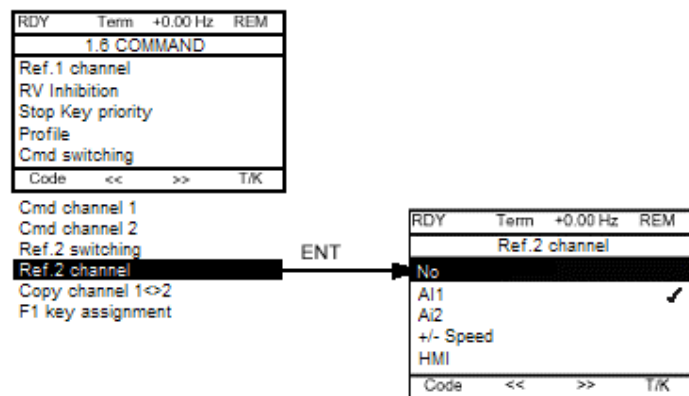


**STEP 5 – REF.2 CHANNEL (MANUAL SETPOINT)**

2) Still in the 1.6 COMMAND menu enter the Ref.2 switching screen and scroll down to select LI6, Once configured, a tick will appear next to “LI6” verifying selection. See Below.



3) Still in the 1.6 COMMAND menu enter the Ref.2 channel and select AI1 (this is a 0 – 10v input), Once configured, a tick will appear next to “AI1” verifying selection. See Below.

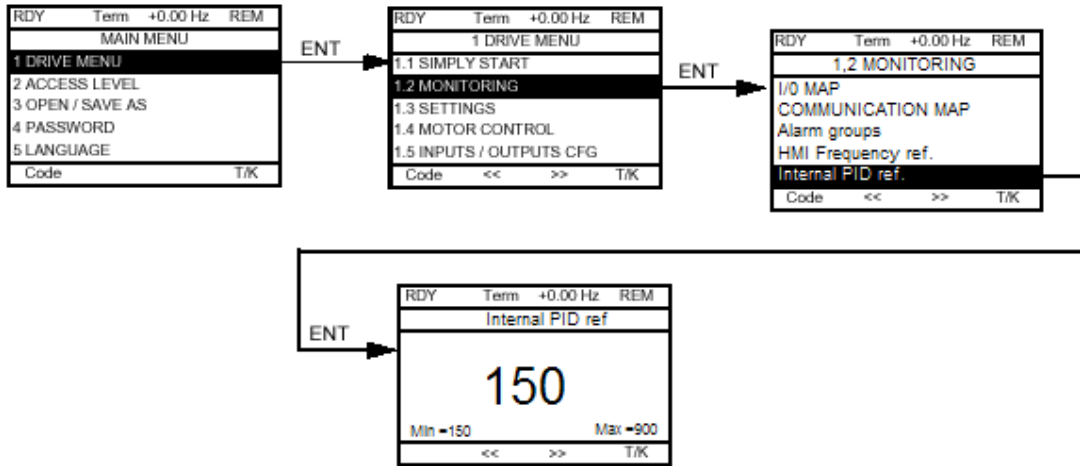


The drive is now configured with Ref.1 channel and Ref.2 channel selected via LI6, states as follows:

- LI6=0, Ref.1, Internal PID Setpoint.
- LI6=1, Ref.2, AI1 for Speed Reference.

## STEP 6 – ADJUSTING INTERNAL PID SETPOINT

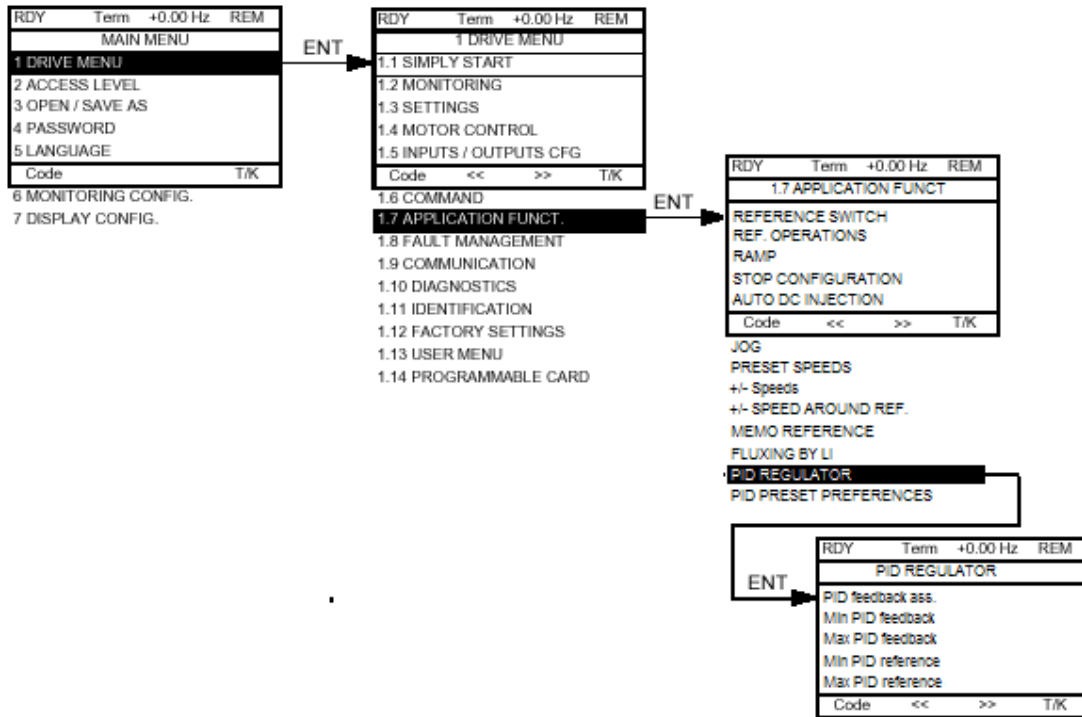
To adjust the PID Setpoint navigate to Internal PID ref screen and set as required.



NOTE: Scrolling down further in the “1.2 MONITORING” menu allows PID feedback, PID error and PID output to be viewed, this is useful during commissioning.

## STEP 7 – SCALING PID FEEDBACK AND REFERENCE

To Scale the PID Feedback Signal and PID Reference signal, navigate to PID REGULATOR screen shown below.



## ADDENDUM: Configuring a Custom Pressure Reading on the ATV61

We have found that some customers using the PID regulator in the ATV61/71 would like to display the PID Feedback value in scaled engineering units on the drives HMI. The ATV61/71 parameters can be re-named and scaled and thus PID Feedback can be re-named, scaled and selected as a default displayed parameter.

The examples below are typical scenarios that may be encountered when commissioning an Altivar 61/71 with PID regulator and will hopefully explain how to provide a useful local display. *EXAMPLE 1* explains how to set up, rename and scale a basic default display. *EXAMPLE 2* explains how to introduce an offset for zero correction and details how to rescale the displayed value taking into account the error offset.

*EXAMPLE 1:* The customer wishes to display PID Feedback as “Pressure” from a 4-20mA transducer with a range of 0 to 250Kpa. The drives PID Regulator has been configured with a Min PID feedback of 0 and with a Max PID Feedback of 1000.

From the Drives [Main Menu](#)...

- Scroll to the [Access Level](#) (menu 2) and press “enter”.
- Scroll down to [Advanced](#) and press “enter” to select.
- Press ESC and then scroll to the [Display Config.](#) (menu 7) and press “enter”.
- Press “enter” on [User Parameters](#) (menu 7.1) and press “enter”.
- Scroll to the [Parameter Selection](#) menu and press “enter”.
- Scroll to the [Monitoring](#) (menu 1.2) and press “enter”.
- Scroll until [PID Feedback](#) and press “enter” to select.
- Press ESC twice and then scroll to the [Customized Selection](#) menu and press “enter”.
- Press “enter” on [PID Feedback](#).
- Press “enter” on [User name](#) and change the [User Name](#) to “Pressure” by using the jog dial/enter knob to scroll through letters. The F1 function key will toggle between upper and lower case, numbers and characters. The F2 and F3 function keys move the cursor position. Once you have selected your new [User name](#) press “enter”.
- Scroll to [Unit](#) and press “enter”.
- Scroll to [Unit](#) and press “enter” to select.
- In the [Unit](#) screen you can create “Kpa” as an engineering unit by using the jog dial/enter knob to scroll through letters. The F1 function key will toggle between upper and lower case, numbers and characters. The F2 and F3 function keys move the cursor position. Once you have selected your Engineering Unit press “enter”.
- Scroll to [Divisor](#) and press “enter”.
- Change the [Divisor](#) to 4 to rescale the PID Feedback to 0 to 250Kpa ( $1000 / 4 = 250$ )
- Press ESC four times and then scroll up to [Monitoring Config.](#) (menu 6) and press “enter”.
- Scroll to [Monitor Screen Type](#) (menu 6.2) and press “enter”.
- If [Display value type](#) is not set to [Digital](#) press “enter” on [Display value type](#).
- Press “enter” and select [Digital](#).
- Scroll down to [Parameter Selection](#) and press “enter”.
- Scroll through the list of parameters and select the relabeled [Pressure](#) (originally [PID feedback](#)).
- Scroll back up the list and un-tick [Frequency ref.](#)
- Press ESC four times the [PID Feedback](#) parameter will now be displayed relabeled “Pressure” in Engineering Units (Kpa) and scaled 0 to 250.

If your pressure transducer has an erroneous reading at atmospheric pressure that can't be zeroed e.g. with the pipe empty the mA output from the transducer is 4.38mA you can introduce an offset into the customized selection to compensate for the error.

The procedure to compensate for error and rescaling of displayed "Pressure" is as follows –

*EXAMPLE 2:* Following on from the previous example the connected pressure transducer has an erroneous reading at atmospheric pressure of 4.38mA and the "Pressure" custom display is showing a value of 6Kpa with an empty pipe.

From the Drives [Main Menu](#)...

- Scroll to the [Display Config.](#) (menu 7) and press "enter"
- Press "enter" on [User Parameters](#) (menu 7.1).
- Scroll to the [Customized Selection](#) menu and press "enter".
- Press "enter" on [PID Feedback](#).
- Scroll to the [Offset](#) and press "enter".
- Enter a value of -6.00 to compensate for transducer error of 6Kpa and press "enter".
- Scroll up to [Multiplier](#) and press "enter".
- Enter a value of 100 to increase the resolution ( $100 \times 1000 = 100000$ ) and press "enter".
- To rescale the PID Feedback to compensate for the error offset add the error offset to the full scale ( $6 + 250 = 256$ ).
- Now divide the sum of the [Multiplier](#) \* [Max PID Feedback](#) by the full scale + the error offset ( $100000 / 256 = 390.625$ ) round this value to the nearest whole number (391).
- Now scroll to [Divisor](#) and press "enter".
- Enter the value 391 into the [Divisor](#) and press "enter".
- Press ESC four times the [PID Feedback](#) parameter will now be displayed relabeled "Pressure" in Engineering Units (Kpa) with an offset of -6Kpa to compensate for the transducer zero error of 0.38mA and the full scale reading (20mA) will be 250Kpa.

*TIP:* To enter a space into the [User name](#) use the F1 key to select special characters and then use the F2 key to move the cursor along.

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