Contents

1. SCOPE OF THIS DOCUMENT

This document is a basic guide outlining the Iris Blue (IB) drive, developed for pump motor control, fans and compressors.

This Guide is addressed to users who are already familiar with the Penta software. It does not cover functionality already described in the Programming Guide of the Sinus Penta and implemented in the IB as well, but describes only those functions that are specific to the IB.

Iris Blue software versus Penta software:

1. The Iris Blue software features no S-ramps; two ramp pairs may be configured instead of four.
   - The IB, however, features N.2 “fast ramps”, one acceleration ramp and one deceleration ramp, specific for the correct control of pumps and compressors (promptly quits the illegal working points).
2. The IB implements 7-point Multispeed instead of 14.
3. The IB does not allow for the reference variation percent from digital input.
4. The IB features 2 selectable motor control algorithms:
   - IFD
   - VTC (the new high-performance sensorless Santerno version)
5. The IB implements multimotor control (MM, or MMC: Multi Motor Control) for systems with multiple parallel-connected pumps.
   - Up to N.4 slave motors, of different types, may be controlled, that can be managed via digital outputs or via modbus serial link.
   - The stability of the system is guaranteed by the possibility of configuring a second IB as a slave in “Backup Master” mode, so that if a fault occurs affecting the first master, the second master automatically activates in order not to stop the plant operation.
6. Implements water-treatment specific functions:
   - Dry-run detection (for cavitation phenomena or no water suction)
   - Pressure loss detection (water leakage or abnormal intake pressure)
   - Pipe Fill control

1.1. Menu Structure

Three macro-areas may be identified by the hundreds.
In particular:

- P/C/R **0**xx – **3**xx
  These parameters are allocated to the same functions as for the Penta software.
- P/C **6**xx
  These are the parameters specific to the Multimotor control implemented for the IB.
- P **7**xx
  These are the parameters characterising the water-treatment specific applications developed for the IB product.

As per the plant measures, the IB implements two additional menus in respect to the Penta: the *Hydraulic Measures menu* and the *Multimotor Measures menu*.
The Hydraulic Measures menu is specific to water treatment, while the Multimotor Measures menu is specific to a multimotor system.

2. WATER TREATMENT

The 3 specific pumping applications that can be controlled by the IB are as follows:

- Dry-run detection (for cavitation phenomena or no water suction)
- Pressure Loss detection (water leakage or abnormal intake pressure)
- Pipe Fill

In the default configuration, all functions specific to water treatment are kept disabled.
Each functionality is detailed below.

2.1. Dry-run Control

Thanks to the Dry-run detection function, the drive is capable of detecting when the pump is working under Dry-run conditions or when cavitation is about to occur.

The Dry-run Control algorithm is based on electrical measurements of the motor and does not require pressure measurements, as these are not always available and, moreover, are dependent on the application. This allows the Dry-run Control to be kept activated even in speed control only.

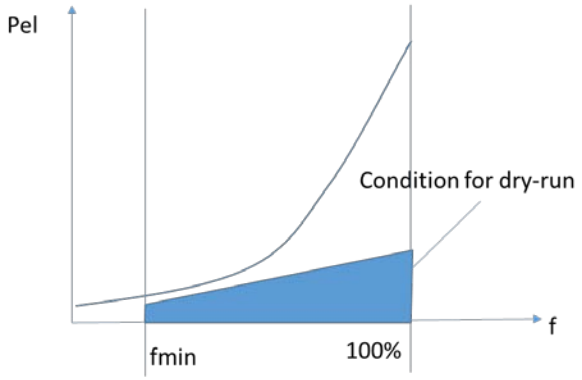
The reference variables for the Dry-run Control conditions may be selected via parameter **P710:**

- Electric power
- Power factor (*cos(ϕ)*)

The latter guarantees greater sensitivity and accuracy.
The user may choose the most suitable measurement based on the type of application.
These values are computed and displayed runtime and are part of the custom measurements to be displayed on the keypad for easier calibration.

2.1.1. Calibration

The Dry-run zone is to be defined based on the plant and the characteristic curves of the connected pump.
As shown in the figure below, the zone is limited by 2 points at two different operating frequency values.



The two Dry-run points are set in parameters **P710a-P710b** and **P710c-P710d.**
Parameter **P711** inhibits the Dry-run detection below a preset operating frequency.

The calibration guidelines for two different applications are given below:

1) **Speed control, without pressure PID**
   - Stop water flow from the plant (valve closure).
   - Reach maximum speed and set **P710c**.
   - Set **P710d** to a value lower than the selected Dry-run measurement (electric power or power factor).
   - Repeat the steps above by adopting a low speed reference.

2) **When using active PID pressure**
   - Stop water flow from the plant (valve closure).
   - Set the pressure reference at maximum desired plant pressure.
   - From the speed measurement, set **P710c**.
   - Set **P710d** to a value lower than the selected Dry-run measurement (electric power or power factor).
   - Repeat the steps above by adopting a low speed reference.

2.1.2. Dry-run Activation

The Dry-run function activates if both the following conditions are true:
- Operation in Dry-run zone
- Speed reference greater than the minimum value between **P711** and **C029** (with suitable adjustment of the units of measures controlled internally to the drive)

If the Dry-run condition persists for a time longer than **P712**, the action defined in **P716** is carried out.
To facilitate testing or expand activation logics, parameter **P715** is available, allowing allocating an MDI to the deactivation of the Dry-run function.

If the Dry-run function is active, resetting its activation is possible either manually (by pressing the reset button on the keypad) or automatically if the system quits the Dry-run detection mode for a time longer than **P713**.
When **P716** is set as Alarm or Warning, the countdown of the automatic reset is displayed.
The automatic reset allows for the service re-activation without manual activation after a transient condition has occurred, such as a transient lower level of water in a well.

2.1.3. List of Parameters P710 to P716

Parameter	FUNCTION	Access Level	DEFAULT VALUE	MODBUS Address
P710	Variable for Dry-run Detection	ADVANCED	Power Factor	888
P710a	Low Frequency for Dry-run Threshold	ADVANCED	0.00%fnom	889
P710b	Low Frequency Dry-run Threshold	ADVANCED	0	890
P710c	High Frequency for Dry-run Threshold	ADVANCED	100.00%fnom	891
P710d	High Frequency Dry-run Threshold	ADVANCED	0	892
P711	Min. Disable Frequency	ADVANCED	0.00%fnom	893
P712	Trip Time	ADVANCED	20.0 s	894
P713	Autoreset Time	ADVANCED	30 s	895
P714	Filter Time Constant for Variable	ADVANCED	300 ms	896
P715	Disable Digital Input	ADVANCED	Disable	897
P716	Trip Action	ADVANCED	Disable	898

P710 Variable for Dry-run Detection

P710			
	Range	0 ÷ 1	0: Electrical Power 1: Power Factor
	Default	1	1: Power Factor
	Level	ADVANCED	
	Address	888	
	Function	Defines the measurement for the Dry-run detection.	

P710a Low Frequency for Dry-run Threshold

P710a			
	Range	0 ÷ 10000	0 ÷ 100.00 %fnom
	Default	0	0.00 %fnom
	Level	ADVANCED	
	Address	889	
	Function	Speed for the first point defining the Dry-run function. Expressed as a percentage of **C015**: nominal motor frequency.	

P710b Low Frequency Dry-run Threshold

P710b			
	Range	0 ÷ 10000	0 ÷ 100.00
	Default	0	0.00
	Level	ADVANCED	
	Address	890	
	Function	Value of the Dry-run detection measurement, selected in **P710**, at first point speed **P710a**.	

P710c High Frequency for Dry-run Threshold

P710c			
	Range	0 ÷ 10000	0 ÷ 100.00 %fnom
	Default	10000	100.00 %fnom
	Level	ADVANCED	
	Address	891	
	Function	Speed for the first point defining the Dry-run function. Expressed as a percentage of **C015**: nominal motor frequency.	

P710d High Frequency Dry-run Threshold

P710d			
	Range	0 ÷ 10000	0 ÷ 100.00
	Default	0	0.00
	Level	ADVANCED	
	Address	892	
	Function	Value of the Dry-run detection measurement, selected in **P710**, at second point speed **P710c**.	

P711 Min. Disable Frequency

P711			
	Range	0 ÷ 10000	0 ÷ 100.00 %fnom
	Default	0	0.00 %fnom
	Level	ADVANCED	
	Address	893	
	Function	Frequency below which the Dry-run condition detection is kept disabled. Expressed as a percentage of **C015**: nominal motor frequency.	

P712 Trip Time

P712			
	Range	0 ÷ 32000	0 ÷ 3200.0 s
	Default	200	20.0 s
	Level	ADVANCED	
	Address	894	
	Function	Minimum time for the Dry-run condition to be true before triggering the function activation as per **P716**.	

P713 Autoreset Time

P713	Range	0 ÷ 3200	0 ÷ 3200 s
	Default	30	30 s
	Level	ADVANCED	
	Address	895	
	Function	Timeout for condition reset from the latest Dry-run detection event. If **P716** is set as Alarm or Warning, this value is the start point of the reset countdown.	

P714 Filter Time Constant for Variable

P714	Range	0 ÷ 32000	0 ÷ 32000 ms
	Default	300	300 ms
	Level	ADVANCED	
	Address	896	
	Function	First order filter time constant applied to the reference variable chosen in **P710.** Useful in case of electric noise affecting the variable.	

P715 Disable Digital Input

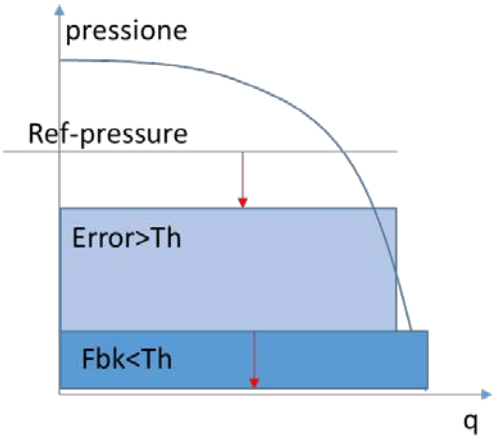
P715	Range	0 ÷ 24	0 ÷ 24:XMDI8
	Default	0	0: Disable
	Level	ADVANCED	
	Address	897	
	Function	If a digital input is set, when the signal is high, the Dry-run detection is disabled.	

P716 Trip Action

P716	Range	0 ÷ 3	0: Disable 1: Alarm 2: Warning 3: Only MDO
	Default	0	0: Disable
	Level	ADVANCED	
	Address	898	
	Function	When a Dry-run condition is detected for a time equal to at least the time set in **P712**, the selected action is executed. The default setting is “No action”. The possibile options are the triggering of an alarm (inverter stop) or a warning signal (displayed on the keypad, but the inverter is kept running). If an MDO for Dry-run detection is allocated to this function from the **Digital Outputs** menu, its status will be changed in cases 1, 2 and 3. Option 3 is required to have only the **MDO** command without any additional signal.	

2.2. Pressure Loss Control

The Pressure Loss detection function is useful to identify water leakage or faults in the hydraulic system.
A pressure PID regulator is required.
The pressure loss condition is based on PID measurements, errors or feedback, according to what is set in **P720**.
The function activation based on the error is required to enable the function for all the working points and is based on an offset percent in respect to the PID error. The logic based on the feedback PID measurement is required to prevent the system from operating below a given pressure threshold. This is very useful when the Pressure Loss function is adopted to fight cavitation, a phenomenon that could occur due to the excessive flow required to compensate for a fault leading to sudden pressure loss.



The threshold parameter is **P721** and its meaning is dependent on the setting in **P720**.

2.2.1. List of Parameters P720 to P723

Parameter	FUNCTION	Access Level	DEFAULT VALUE	MODBUS Address
P720	Threshold Type Selector for Alarm Tripped	ADVANCED	1: PID error >	900
P721	Trip Threshold	ADVANCED	15.00 %err	901
P722	Trip Time	ADVANCED	30.0s	902
P723	Trip Action	ADVANCED	disable	903

P720 Threshold Type Selector for Alarm Tripped

P720	**Range**	0 ÷ 1	0: PID feedback < 1: PID error >
	Default	1	1: PID error >
	Level	ADVANCED	
	Address	900	
	Function	Defines the measurement to be considered for the Pressure Loss logic between PID error greater than the threshold and PID smaller than the threshold. The threshold parameter is **P721**.	

P721 Trip Threshold

P721	Range	0 ÷ 32000	0 ÷ 320.00 %err
	Default	1500	15.00 %err
	Level	ADVANCED	
	Address	901	
	Function	Threshold value for the activation of the Pressure Loss function. The meaning of this parameter is dependent on the selector in **P720**. It is worth PID error percent (if exceeded, the Pressure Loss function activates) or PID feedback percent (if the PID feedback value drops below the preset threshold, the Pressure Loss function activates).	

P722 Trip Time

P722	Range	0 ÷ 32000	0 ÷ 3200.0 s
	Default	300	30.0 s
	Level	ADVANCED	
	Address	902	
	Function	Minimum time for the Pressure Loss condition to be true before triggering the function activation as per **P723**.	

P723 Trip Action

P723	Range	0 ÷ 3	0: Disable 1: Alarm 2: Warning 3: Only MDO
	Default	0	0: Disable
	Level	ADVANCED	
	Address	898	
	Function	When a Pressure Loss condition is detected for a time equal to at least the time set in **P712**, the selected action is executed. The default setting is “No action”. The possibile options are the triggering of an alarm (inverter stop) or a warning signal (displayed on the keypad, but the inverter is kept running). If an MDO for Pressure Loss detection is allocated to this function from the **Digital Outputs** menu, its status will be changed in cases 1, 2 and 3. Option 3 is required to have only the **MDO** command without any additional signal.	

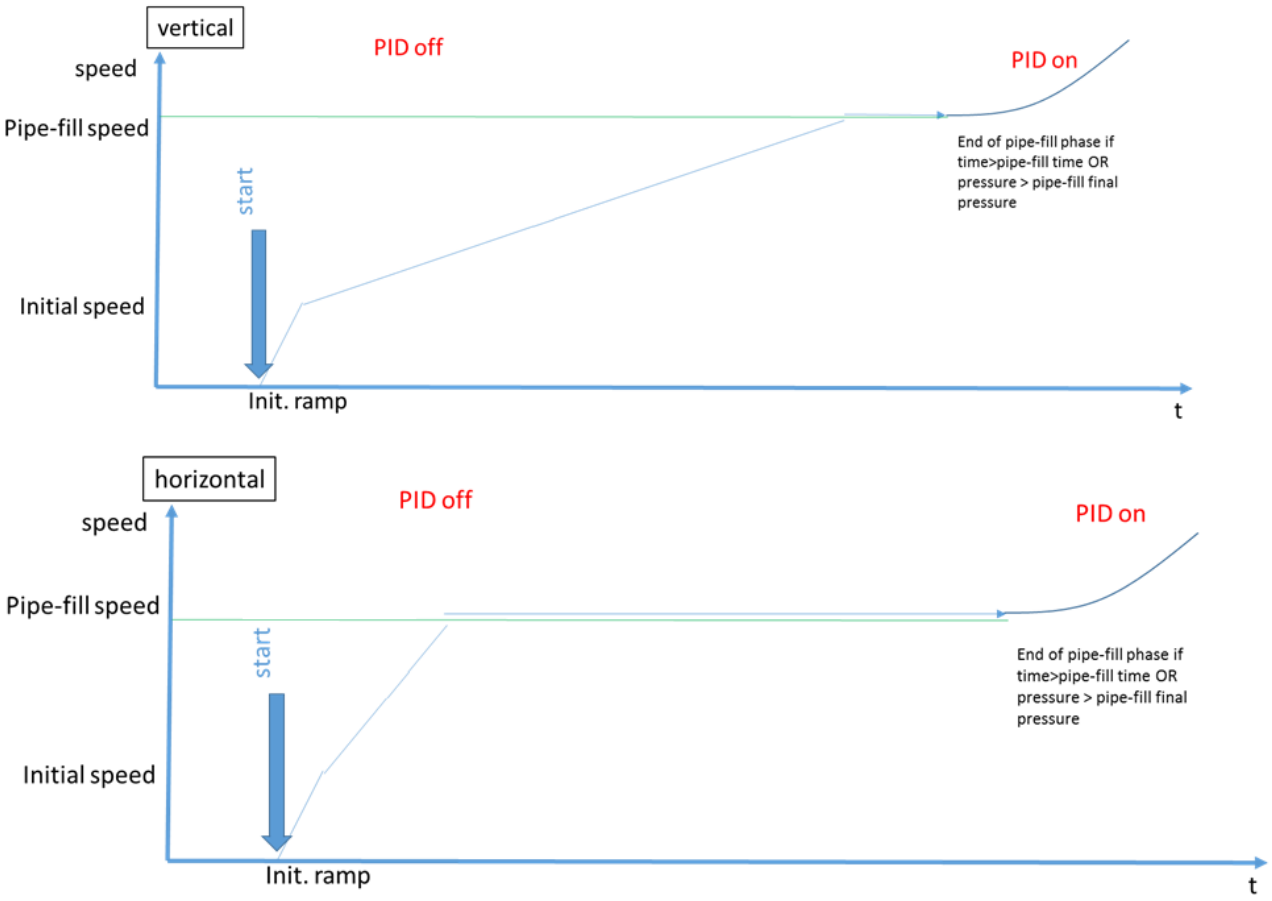
2.3. Pipe Fill Control

The hydraulic systems are affected by the “water hammer” phenomenon, occurring in case of sudden changes in pressure and that may damage piping, thus adversely affecting the lifetime of the system.
The water hammer phenomenon may occur if pipes are filled in an abrupt way.
The Pipe Fill function has been developed to smoothly control pipe fill and avoid water hammer phenomena damaging hydraulic outlets (such as irrigation nozzles) by limiting the system filling rate.

The Pipe Fill logic is a general-purpose one to better meet the customer’s application requirements, i.e. vertical or horizontal systems:

- In vertical systems, the more pipes are full, the greater the pressure. In that case, the acceleration ramp must be slower and maintain constant flow rate for the time required for pressure stabilization.
- In horizontal systems, pressure does not increase during pipe fill, so the pipe fill rate may be attained quickly and can be kept constant for the time required to fill the whole pipe length.

The figures below show the pipe fill rate trend over time in case of vertical and horizontal plant.



If the PID regulator is adopted, parameter **P734** allows choosing whether to stop pipe fill when the preset fill time is over, or even when the PID reference is attained.
When the PID is disabled, the Pipe Fill function will stop when the preset fill time is achieved and will be resumed to reach the reference fill rate via the active ramps.

2.3.1. List of Parameters P730 to P734

Parametr	FUNCTION	Access Level	DEFAULT VALUE	MODBUS Address
P730	Pipe Fill Ramp	ADVANCED	10.0 s	932
P731	Pipe Fill Rate	ADVANCED	30.00%fnom	933
P732	Pipe Fill Time	ADVANCED	5s	934
P734	Pipe Fill Enable Mode	ADVANCED	Disable	936

P730 Pipe Fill Ramp

P730			
	Range	0 ÷ 32000	0 ÷ 3200.0 s
	Default	100	10.0 s
	Level	ADVANCED	
	Address	932	
	Function	Determines the time taken to go from zero rpm to the value set in **P731**.	

P731 Pipe Fill Rate

P731			
	Range	0 ÷ 32000	0 ÷ 320.00 % Fnom
	Default	3000	30.00 % Fnom
	Level	ADVANCED	
	Address	933	
	Function	Determines the pipe fill rate for the reference during the Pipe Fill stage.	

P732 Pipe Fill Time

P732			
	Range	0 ÷ 32000	0 ÷ 32000 s
	Default	5	5 s
	Level	ADVANCED	
	Address	934	
	Function	Indicates the time when the pipe fill rate is kept at the value set in **P731**.	

P734 Pipe Fill Enable Mode

P734			
	Range	0 ÷ 2	0: Disabled 1: Enabled 2: Enabled + PID feedback
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	936	
	Function	0: Disabled The Pipe Fill function is inactive and the active ramps are implemented. 1: Enabled The function is active; exiting the Pipe Fill mode is conditioned only when the preset times are over 2: Enabled + PID feedback The function is active; exiting the Pipe Fill mode is conditioned when the preset times are over or when the PID reference is attained.	