ABB INDUSTRY SPECIFIC DRIVES

Intelligent Pump Control (IPC) ACQ580/ACH580

This guide explains how to connect ACQ580 or ACH580 drives together as an intelligent pump control system.

Contents

Introduction

To meet peak demand on a pumping system, a user may choose to have one large pump or choose to have multiple smaller pumps paralleled together. The paralleled pumps, or multi-pump systems, are each connected to a separate drive. These systems have gained popularity for a number of reasons: it is more efficient to run a smaller pump(s) during lower demand times compared to a single large pump at reduced speed; it also provides built in redundancy in the system. Multi-pump systems enable a high flexibility in load sharing, balancing the run time between the pumps and keeping each pump running optimally.

In multi-pump systems, If the active pumps cannot meet the demand, the system automatically starts additional pumps one by one. Similarly, as the demand starts to decrease, the system automatically stops the pumps one by one, which keeps the remaining pumps running at optimal efficiency. The used pump order can be set by the efficiency class of each pump (e.g. Pumps with high efficiency are primarily used) or set to balance the runtime (pumps which have run the least, start first). This saves energy and extends the pump longevity.

Multi-pump systems achieve a high-level of redundancy, if one pump fails or requires maintenance, other pumps can take over the operation. Efficiency, continuous operation, and easy maintenance are reasons why multi-pump systems can be found in a variety of different applications such as the water and wastewater industry.

With the ACQ580 and ACH580 drives, ABB provides a drive with a built-in intelligent multi-pump control (IPC).

Intelligent pump control (IPC)

With the IPC function, one drive at a time acts as a master (moving master) while up to seven more drives act as followers. With a moving master strategy, each drive in the multi-pump system can be selected to be eligible as master. The master drive controls the multi-pump-system and has the following tasks:

- activating and deactivating the follower drives
- regulating the systems speed with its internal PID loop control according an internal set-point
- processing the I/O signals (set-point and feedback signals)

The IPC function has a lot of flexibility in the set-up:

- Which drive(s) are allowed to act as a master
- The minimum number of drives/pumps that should run at any time
- The maximum number of drives/pumps that should run at any time
- The determination factor to perform an autochange

Commissioning the drive(s)

How to set up the IPC function

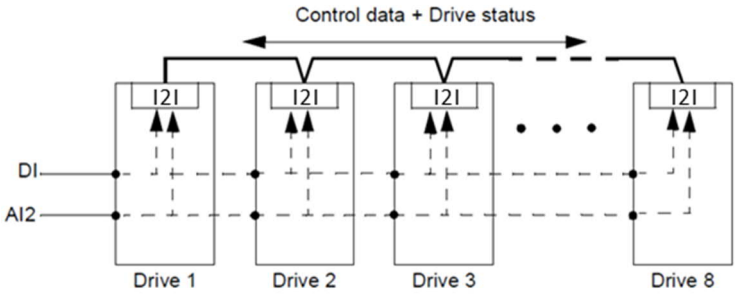
In the following example, three drives/pumps are connected to work in cooperation, using a PID to control the system. A (pressure) sensor must be connected to the system and it will send the actual feedback to the drive(s). The drives are set up in PID mode (Ext2), with the start/stop signal wired to DI1, run permissive signal (e.g. Dry run contact) wired to DI2 and the sensor feedback wired to Analog Input 2; the PID setpoint is an internal constant. The drive(s) are set to run with a moving master strategy, with autochange (of master) set to keep an even wear (run time) between the three drives/pumps.

Please note: This commissioning example shows how to set up the IPC only, other required steps (e.g. First start assistant, Basic operation setup, Basic control setup, Nominal values, and ID run) are not covered in this guide.

Also note: This is an example only and many of the settings must be adjusted for site specific conditions.

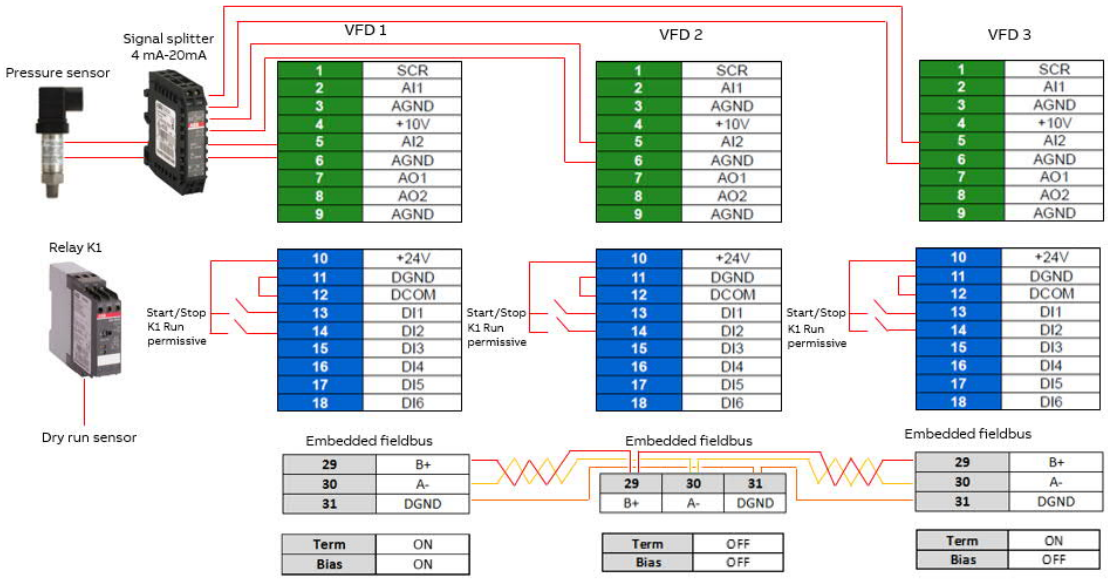
General Connection Diagram, IPC (Auto)

I2I = IPC communication link between drives
DI = Start/Stop signal (DI1) and Run permissive (DI2); can shared to all drives or unique to each drive
AI2 = Process feedback; shared to all drives*



*If a drive is not to be enabled as a master, the signal does not need to be wired to that drive.

Wiring diagram

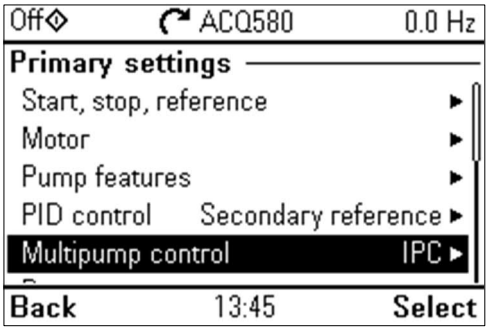


Please note: In case a current signal is used for the sensor feedback, employ a signal splitter to connect the sensor signal to all master drives. Voltage signals do not require a signal splitter and can just be parallel connected to each drive.

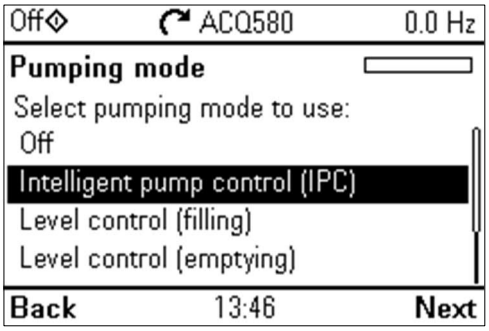
How to set up IPC in the first drive

After all basic drive and motor parameters are set for all three drives, the IPC setup can be done. The ACQ580 offers a synchronization feature (step 4 below) which automatically ensures that all the AI and PID settings are equal. Most of the IPC settings are also synchronized between drives. This helps to avoid mistakes and speeds up the commissioning process.

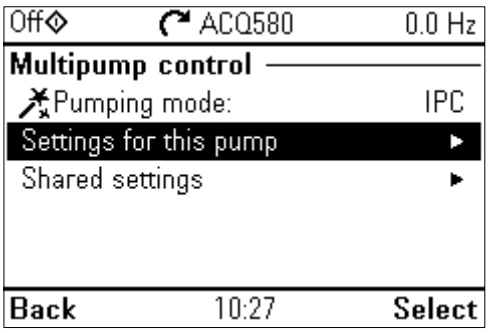
1. To activate the synchronization function, go to Primary settings → Multipump control.

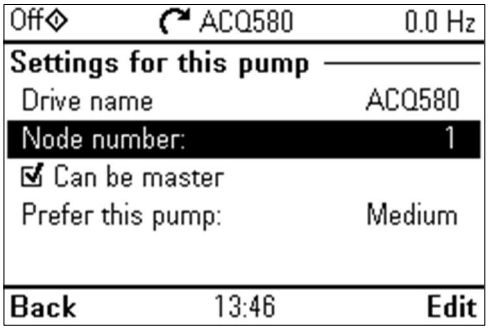


2. Select Intelligent pump control (IPC) for the pumping mode.



3. Select Settings for this pump and adjust the following settings.





Drive name: Keep the default name or give an individual name.

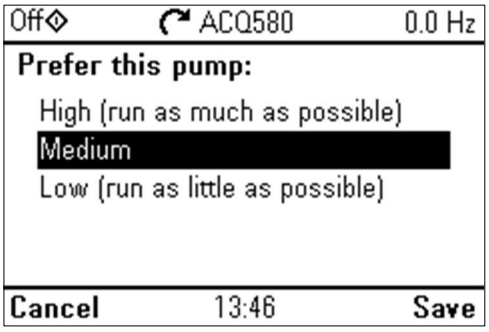
Node number: This number must be greater than 1 and unique for each drive in the IPC-Network. In this example, we are using 1 for the first drive, 2 for the second drive, 3 for the third drive.

Can be master: ☑ (Selected) In this example all three drives can act as a master. Redundant operation requires a moving master. In case this is not selected, the drive can only operate as follower.

Prefer this pump → Medium. The pumps can be prioritized based on energy efficiency and process

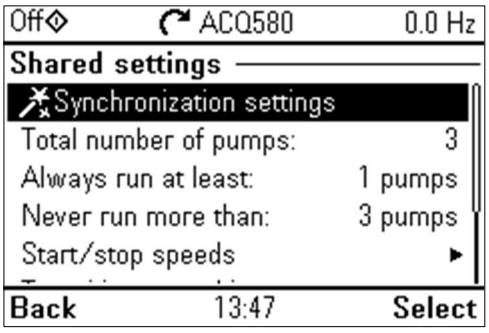
demand: *High* – more energy efficient pumps, *Medium* – less energy efficient pumps, *Low* – pumps which do not run unless process demands.

Similar pumps are recommended to be used in booster applications.

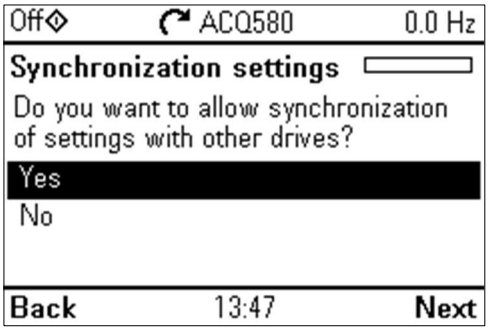


4. Select Shared settings → Synchronization settings. Adjust the following settings:

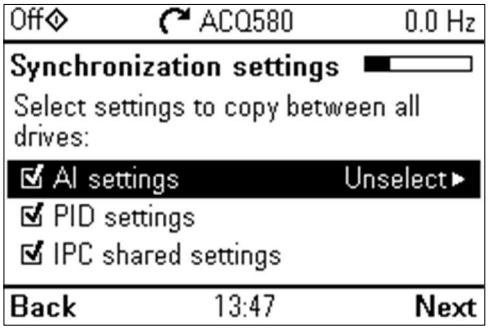
   "Do you want to allow synchronization of settings with other drives?" → Yes.



   Synchronization will save a significant amount of time for the total system configuration. It also ensures that values within selected parameter groups are the same in each drive. When a parameter is changed in any drive in the synchronized system, the setting is sent to all other drives in the system.

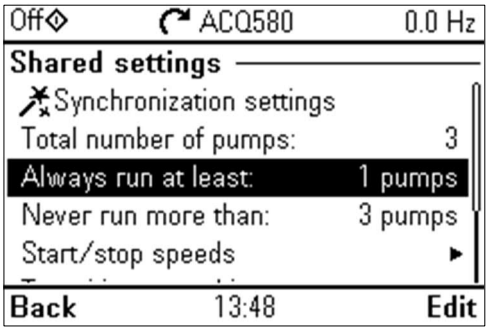


   "Select settings to copy between all drives"
   → Select all:
   ☑ AI settings
   ☑ PID settings
   ☑ IPC shared settings
   → Press Next

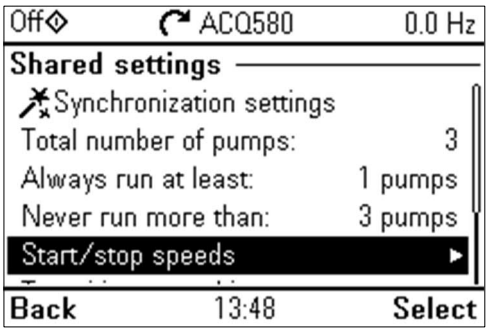


5. From Shared settings set the Total number of pumps to 3.
   Always run at least: 1 pump
   Never run more than: 3 pumps.

   Please note: Never run more than does not need to equal Total number of pumps (it can be lower if required by the system). Please see the Additional Notes (Hints) section at the end of this guide for some more information on this feature.



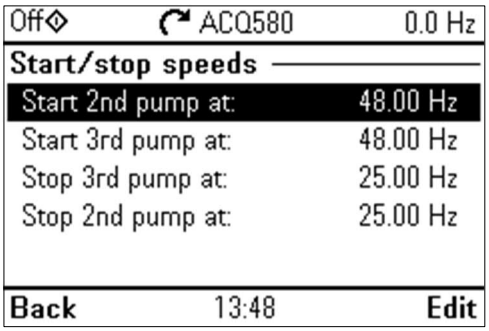
6. Start/stop speeds
Next, it is necessary to define, when a pump should be started or stopped by the system in order to meet the demand, keeping the target pressure.



Example values:

Start 2nd pump at: 48 Hz
Start 3rd pump at: 48 Hz

If the first pump can't keep the pressure and exceeds 48 Hz, the second pump will be activated. If the demand is still rising and both pumps exceed 48 Hz the third pump will be activated.

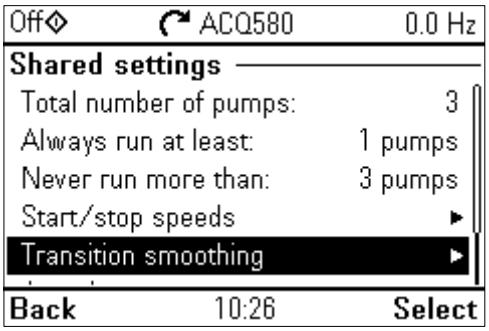


Stop 3rd pump at: 25 Hz
Stop 2nd pump at: 25 Hz

If the demand declines and the three activated pumps fall under 25 Hz, one pump (3rd) will be deactivated. If the demand is still low and the remaining two pumps fall below 25 Hz, another pump (2nd) will be deactivated.

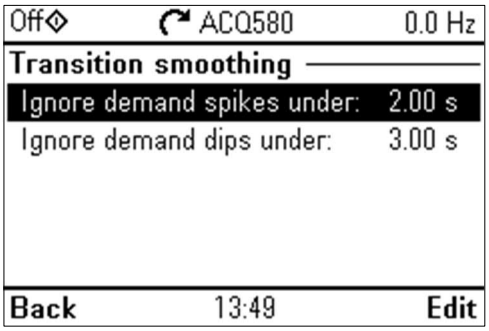
These values must be defined according to the system. In many applications the start and stop speeds fall in narrow range (e.g. 40 – 45Hz).

7. Transition smoothing
The spike time describes how long the output frequency needs to be over, in this case, 48 Hz until the IPC starts the next pump. The dip time describes how long the frequency needs to stay below 25 Hz until the IPC stops one pump. This smooths the IPC behavior and avoids unnecessary starts and stops of the pumps.

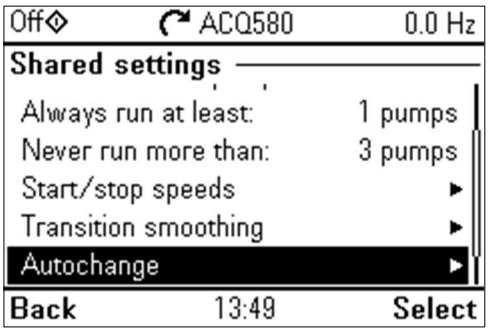


Set the following values:

Ignore demand spikes under: 2.00 s
Ignore demand dips under: 3.00 s

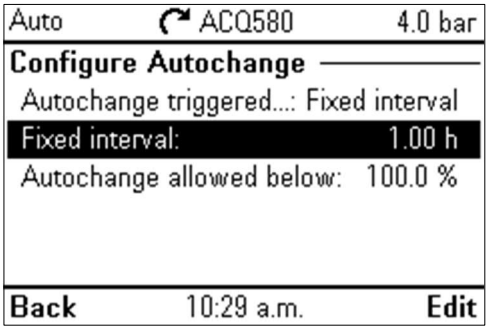


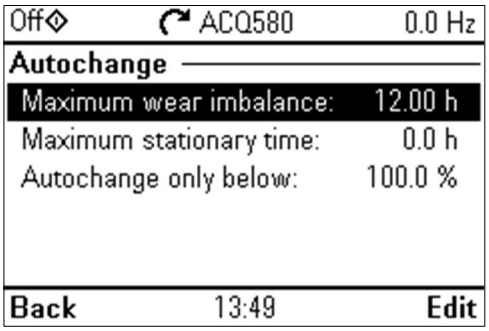
8. The Autochange function ensures, that the run time of all drives in the system is balanced.



There are many options to select from regarding what triggers the autochange:

- Not selected
  - Autochange is disabled.
- Fixed interval
  - Autochange will occur at a predetermined Fixed interval.
- Even wear
  - Autochange will occur as needed to keep the drives' run times within a desired window.
  - The Maximum wear imbalance specifies the maximum difference in the running time between two drives in an IPC system.
  - The Maximum stationary time ensures the pump gets exercised frequently. This protects a lower prioritized pump from pump blockages. A setting of 0.0 h disables the function.
- All stopped
  - Autochange will only occur when all drives are stopped but will change every time all drives are stopped. The PID sleep feature is required to get the acting master to stop.
- Timed function
  - Autochange will occur on the dates/times specified in the corresponding timer configuration (Group 34)
- DI
  - Autochange will occur upon the rising edge of the selected digital input.

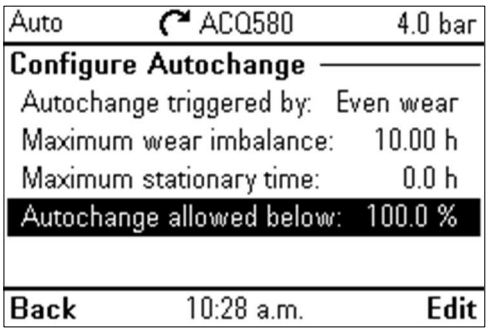




Please note: There are several factors that affect when the autochange actually occurs, the above trigger is only one of those factors.

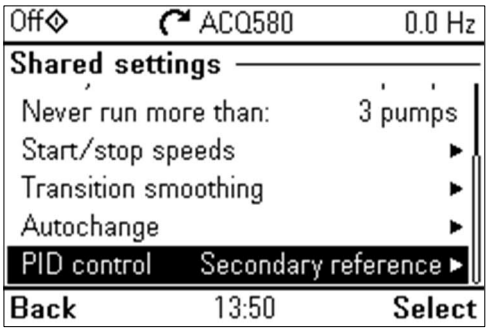
The Autochange only below value specifies the maximum speed when a pump change is allowed. The default value of 100.0 % allows a pump change action whenever it is triggered (and all other factors are met).
Setting this value to a lower number (e.g. 90.0 %) prevents the autochange while the drive(s) are at full speed but ensures uninterrupted pumping when maximum flow/pressure is required.

Please see the Additional Notes (Hints) section at the end of this guide for some more information on this feature.



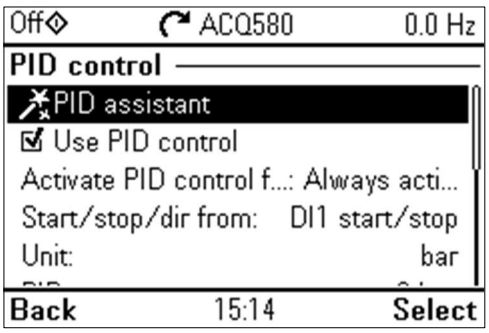
9. Adjust the following PID control settings (Menu → Primary settings → PID control):

PID control → Secondary reference (EXT2)



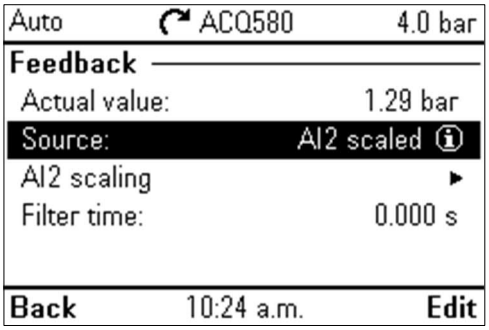
PID assistant
☑ Use PID control

Activate PID control	Always active
Start/stop/dir from	D1 Start/stop
Unit	bar
PID status	0 hex



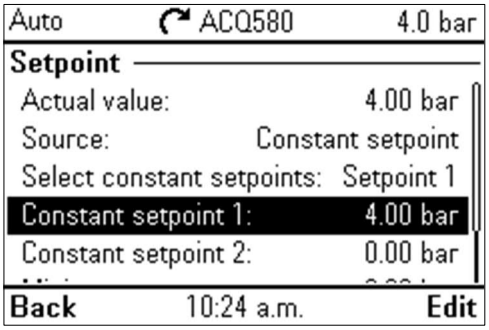
Feedback →

Actual value	0.00 bar
Source	AI2 scaled
AI2 scaling →	
Range	4..20 mA
Scaled min	0.000 bar
Scaled max	6 bar
Filter time	0.000s



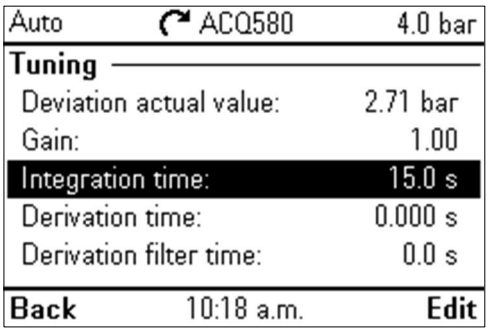
Setpoint →

Actual value	4.00 bar
Source	Constant setpoint
Select constant setpoints	Setpoint 1
Constant setpoint 1	4.00 bar
Constant setpoint 2	0.00 bar
Minimum	0.00 bar
Maximum	6.00 bar



Tuning →

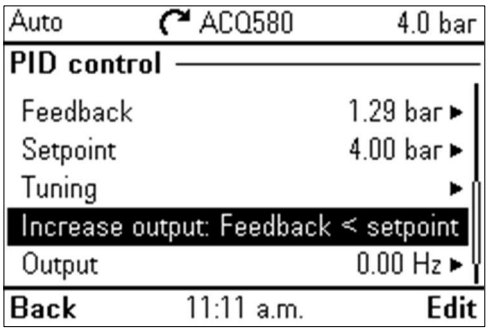
Deviation actual value	0.00 bar
Gain	1.00
Integration time	15.0 s
Derivation time	0.000 s
Derivation filter time	0.0 s



Increase output Feedback < Setpoint

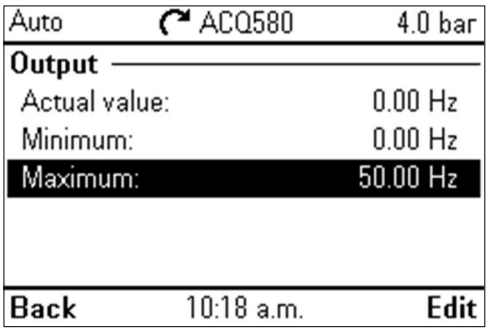
Selects whether deviation means "feedback minus setpoint" or "setpoint minus feedback":

- Feedback < Setpoint: Drive increases motor speed when feedback signal is below setpoint. Example: booster pump.
- Feedback > Setpoint: Drive increases motor speed when feedback signal is greater than setpoint. Example: Cooling tower.



Output →

	0.00
Actual value	0.00
Minimum	0.00
Maximum	50.0 Hz or 100.0 %



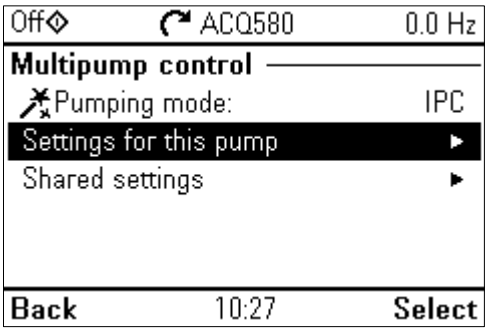
Sleep function Off

How to set up IPC in the rest of the drives

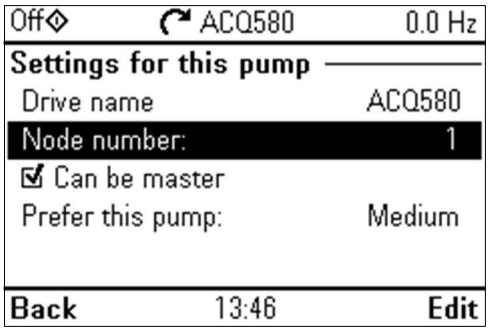
After commissioning the first drive in the system, the follower drives can be configured. The motor values and localization need to be done separately for all the drives. These instructions will finalize the multipump configuration.

1. Select Primary settings → Multipump control → IPC (Intelligent Pump Control)

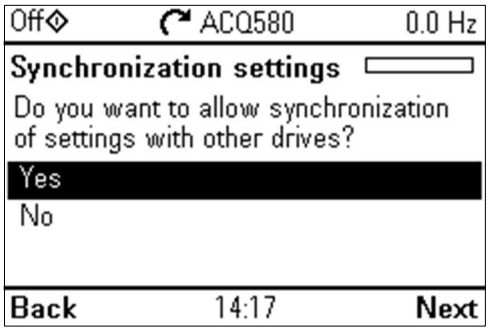
   Select Settings for this pump and adjust the following settings:



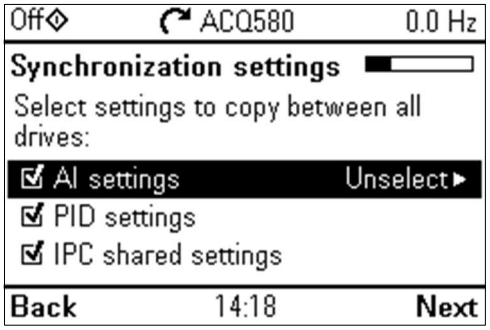
   Node number: 2…8 (depending on number of drives in the system)
   Can be master: ☑ (Selected)
   Prefer this pump: Medium



   Select Shared settings → Synchronization settings → Yes



   Enable the synchronization of settings for:
   - ☑ AI settings
   - ☑ PID settings
   - ☑ IPC shared settings



   Now all the above parameter settings are copied to this drive.

   Please note: PID unit is not copied through the synchronization and needs to be set for all drives.

   Hint: A simple confirmation that all applicable parameters are synchronized, check that *p76.105 IPC synchronization checksum* is the same value in all drives.

Related settings

This chapter provides examples for configuring related functions: setting of limits and resetting of pump run times.

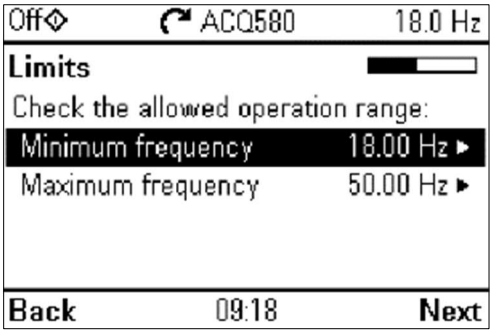
Limits

It is possible to set the drive to start from a minimum speed or to not exceed a maximum speed. By setting a minimum frequency of 18 Hz can help to decrease vibrations in pumps and motors.

Menu → Primary settings → Limits:
Minimum frequency: 18.00 Hz
Maximum frequency: 50.00 Hz
Maximum current: 3.24 A (The operation can be limited based on the maximum consumption current to protect the motor or drive)

Please note: The limits must be applied to each drive separately; they are not part of the synchronized parameters.

Also note: The limits cannot be lower or higher than those set in Start/Stop speeds.

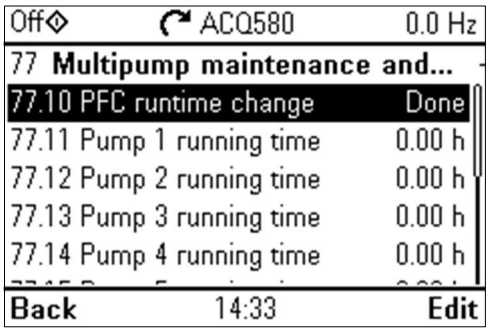


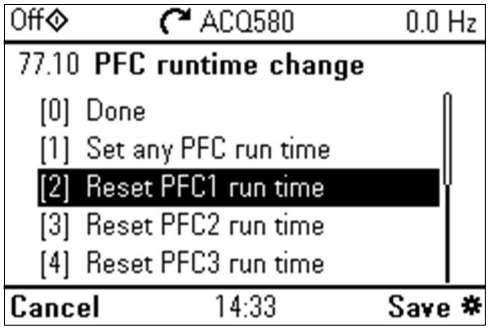
Reset pump run times

In case of a pump replacement, the working times of the pumps can be reset. This will be synchronized automatically in all drives.

Menu → Parameters → Complete list → 77 Multipump maintenance and monitoring → 77.10 PFC runtime change → Edit
[2] Reset PFC1 run time
[3] Reset PFC2 run time
[4] Reset PFC3 run time
→ Press Save

Please note: If single pump's running time is set to zero, the default IPC configuration will aim to balance the operating times between all the pumps in the system and thus prioritize the pump with least running hours.





Additional notes (Hints)

- There are additional application guides that may be quite beneficial in setting up a multipump system:
  - Quick ramps configuration guide, pdf (abb.com)
  - Communication fail functionality configuration guide, pdf (abb.com)
  - ACQ580 Pump cleaning function configuration guide, pdf (abb.com)

- The IPC system requires that all the drives have same IPC version; different version causes an IPC version error (visible in *p76.02 Multipump system status*) because the internal checksums (*p76.105 IPC synchronization checksum)* will have a mismatch. The IPC version does not necessarily differ for each FW version; however, it is generally the case. The table below shows the IPC version that each FW version contains:

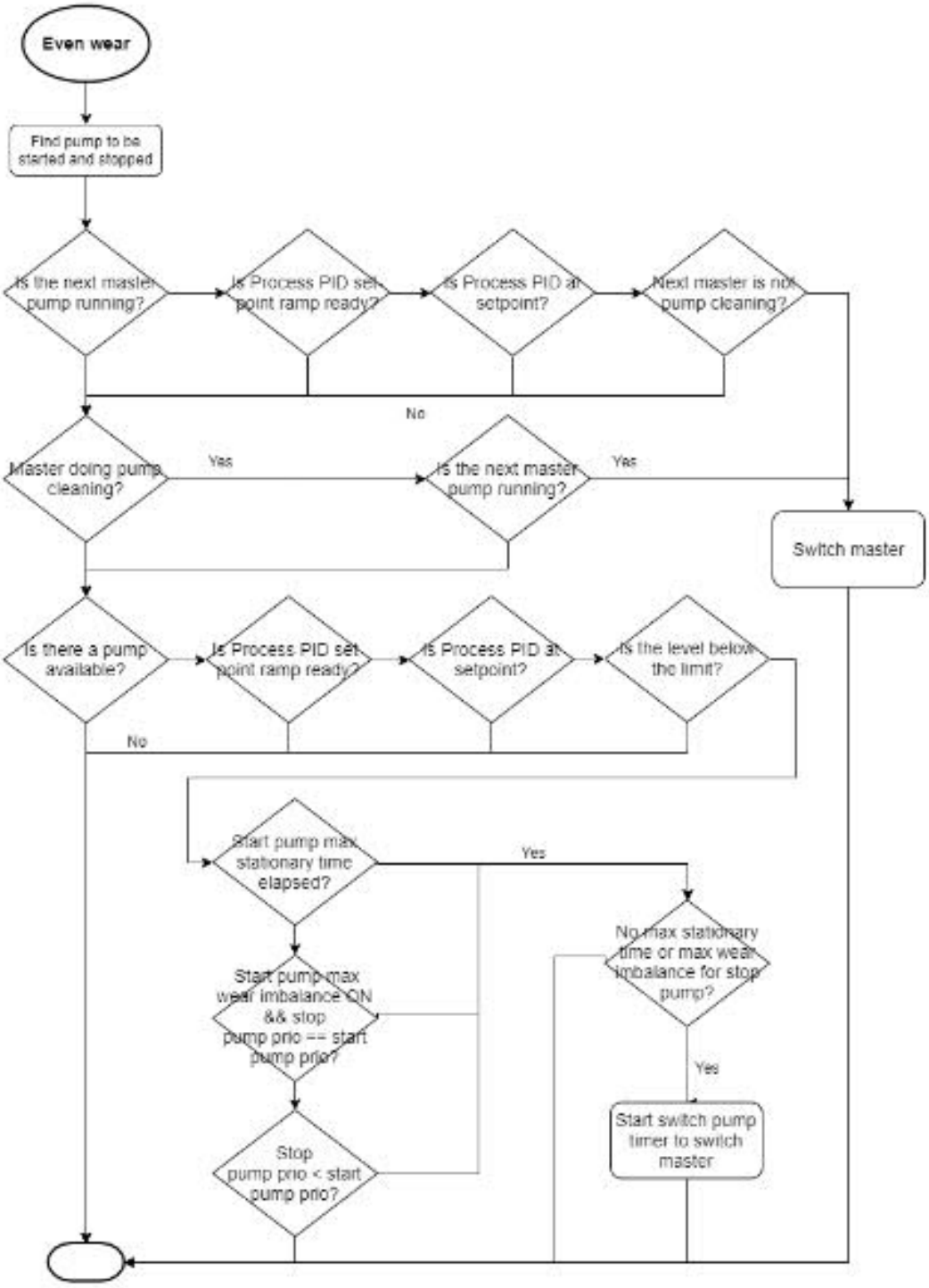
Internal IPC version	Compatible FW version*
1	v2.01, v2.02
2	v2.03
4	v2.04, v2.05, v2.06
5	v2.07, v2.08, v2.10
6	v2.09, v2.11
7	v2.12, v2.13
8	v2.14, v2.15
9	v2.16

  * Official FW releases in bold

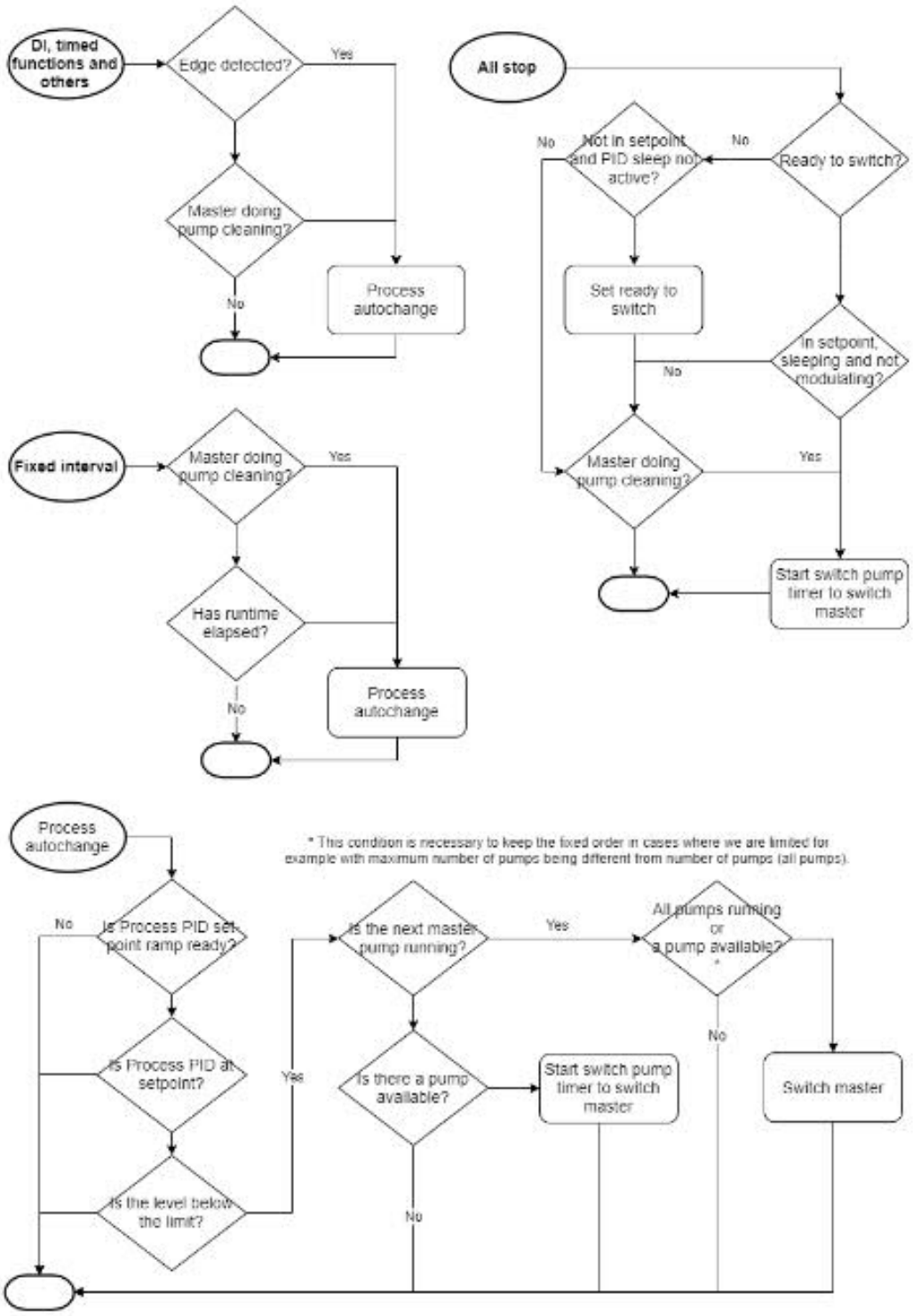
- For FW versions prior to v2.12.0.0: When the start signal is given simultaneously to all the drives in the system, it will start all the pumps for a short time to in order to define master and followers and then continue operation with only the required amount of pumps.

- For FW versions prior to v2.12.0.0: The autochange was defaulted for Even wear, no other options existed.

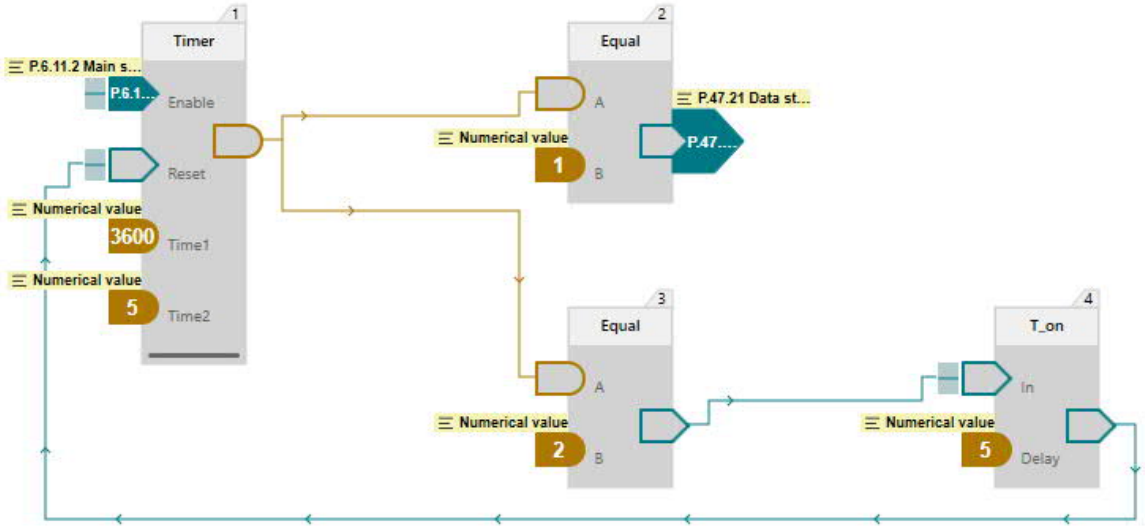
- The following diagrams try to show the decision tree for autochange:



- Start pump and stop pump refer to pumps to be started or stopped next. Those are sorted before running this logic.
- Prio equals parameter p76.77 pump priority.
- Pumps are available when number of running pumps is smaller than maximum number of pumps and there is a pump at standby (not interlocked).
- Max stationary time is specified with p76.76.
- Limit used for comparing the level refers to the p76.73 Autochange level.
- Max wear imbalance is specified with p76.72 Maximum wear imbalance.


DI, timed functions and others
Edge detected?
Yes
Master doing pump cleaning?
No
Process autochange
All stop
Not in setpoint and PID sleep not active?
No
Ready to switch?
No
Set ready to switch
In setpoint, sleeping and not modulating?
No
Master doing pump cleaning?
Yes
Start switch pump timer to switch master
Fixed interval
Master doing pump cleaning?
Yes
Has runtime elapsed?
No
Process autochange
Process autochange
* This condition is necessary to keep the fixed order in cases where we are limited for example with maximum number of pumps being different from number of pumps (all pumps).
No
Is Process PID set-point ramp ready?
Is Process PID at setpoint?
Is the level below the limit?
Yes
Is the next master pump running?
Yes
All pumps running or a pump available? *
No
Is there a pump available?
Start switch pump timer to switch master
Switch master
No

- Currently, in order to maintain the setpoint, autochange ramps up the new master before stopping the current master; this means that even though you may have “Never run more than: 1 pump” the system will run two pumps during autochange. If this is unacceptable for the specific application, an AP is most likely required. The simplest way to inhibit the current master from running when the autochange is needed is to remove its Run permissive; it will stop and the next master will start. Please note: This will cause a variance in the system (actual value controlling to will change) until the new master is up to speed. The following AP example is to autochange every hour (*p20.40 Run permissive* is set to “Other” which is pointing to *p47.21b00 Data storage 1 int16*)



This guide is designed to help assist with using the Intelligent Pump Control function available in the ACQ580 and ACH580 drives. Please consult your local ABB for additional assistance.