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USER DIAGNOSTIC FOR PIP OFFSET WRONG CALIBRATION SITUATIONS

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User Diagnostic for PIP Offset wrong calibration situations

Abstract

Some printers use an ink pressure sensor (PIP), that compares the ink pressure to the air pressure of the Air Pressure System (APS), to control the Ink Delivery System, such as detecting when the Intermediate Tank is full during a refilling process and stopping the ink pump.

Although the PIP sensor is calibrated (Gain and Offset) before its installation into the printer, the Offset suffers a drift during the normal usage of the printer. The recalibration of the Offset is done by comparing the PIP signal with the theoretical ink pressure at a well-known point.

Typically, the recalibration is done after each refill during printing operation, when it is known that the Intermediate Tank is full. Then, PIP sensor is being monitored after each 5cc of ink consumption, which is known as step. During each step, the PIP measurement is read and compared to the previous step, if the slope between the two steps is lower than a certain threshold, it is considered to be in the ***flat zone***.

If this condition is met during five consecutive steps, it is considered that the IT level corresponds to reference point, in which the theoretical ink pressure is well-known, and the Offset is recalibrated accordingly.

However, a considerable number of cases in which the PIP cannot be properly recalibrated have occurred on the field. This may happen for instance if the Offset has drift in the way that the Intermediate Tank is detected as full during an ink refill when it is not and when the recalibration is performed, the value is not the right one. The opposite case is detecting the IT as empty during a printing job and the recalibration is aborted each time that the refill is triggered again.

In both cases, a System Error of *PIP wrong calibration* is reported, and the only solution is to replace the PIP sensor.

This invention describes a User Diagnostic to recover the printer from PIP wrong calibration situations. The solution ensures that PIP Offset value is pre-recalibrated in a correct range allowing its proper recalibration afterwards, avoiding replacing the PIP sensor due to a wrong recalibration.

Invention

If the printer detects that the PIP Offset is not properly recalibrated a System Error is triggered. Then, the customer can execute the User Diagnostic to pre-recalibrate the PIP Offset.

The Diagnostic consists of the following steps:

1. The user selects the PIP sensor that needs to be recalibrated and remove the printheads from the carriage of the affected ink line.
2. The printer checks that there is enough ink in the cartridge to completely refill the Intermediate Tank, considering the case in which the IT is empty.
3. A refill in open loop is triggered during a certain time to ensure that the IT is full.
4. Then, it is required to remove a certain amount of ink through the Fluid Interconnect located in the carriage of the affected ink line to ensure that the Intermediate Tank is not full, thus in the ***flat zone***, not affected by the remaining ink pressure after an ink

refill (exponential pressure profile). Typically, it would require removing around 30ccs of ink.

- Having the APS pressurized, since the PIP is directly connected to the Dugong, the differential pressure (P_s) is 0 and the PIP Offset (O_s) is equal to the voltage measured (V_{oPIP}) by the electronics, allowing to pre-recalibrate the Offset of the sensor accordingly.

$$V_{oPIP} = (P_s [PSI] \cdot G_s) + O_s$$

where:

V_{oPIP} is the differential voltage at the PIP output ports [mV]

P_s is the differential pressure of the sensor [Psi]

G_s is the PIP sensor gain [Psi/mV]

O_s is the PIP sensor offset [mV]

Note: in some printers the PIP is not directly connected to the Dugong (AKA: Intermediate Tank) and the formula would include a parameter related to the relative height of the PIP and the Intermediate Tank.

Figure 1 corresponds to a case of a PIP affected by a *PIP Offset wrong calibration*. It can be seen that the PIP pressure is around -600mPsi when the APS is pressurized, while the expected value should be around 0mPsi since the PIP is directly connected to the Dugong, thus the ink channel and the air channel are at the same pressure.

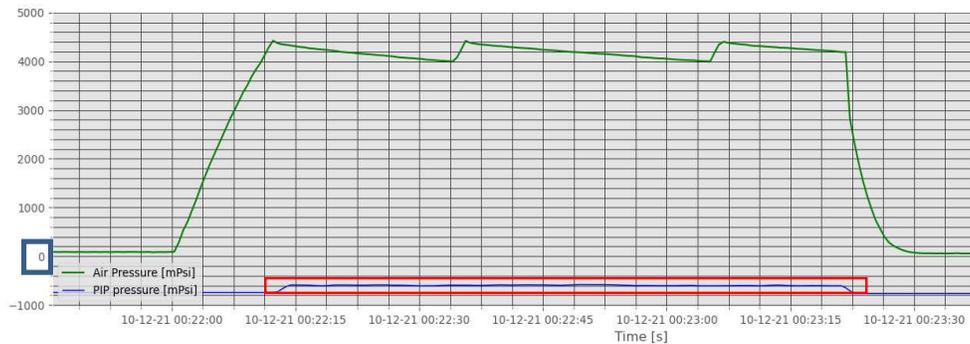


Figure 1. PIP affected by a PIP Offset wrong calibration

Figure 2 corresponds to a PIP Offset properly calibrated. It can be seen that the PIP pressure read is around 0mPsi when the APS is pressurized.

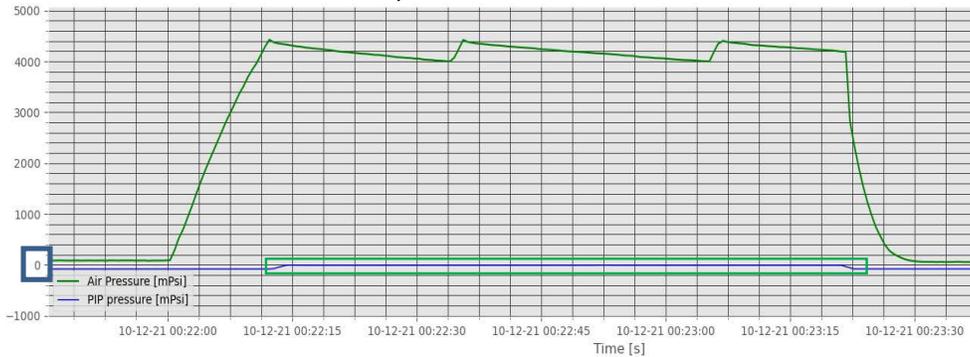


Figure 2. PIP offset properly calibrated

6. After having perform this pre-recalibration, a refill is triggered to have the Intermediate Tank full. Afterwards, an area fills of the ink color for the PIP sensor that has been pre-recalibrated is sent to print that consumes enough to trigger the PIP recalibration.
7. During the print job, the PIP recalibration works as normal.
 - If the recalibration performed by the algorithm matches the pre-recalibration (with a certain margin) the PIP sensor is marked as good.
 - However, if the recalibration drastically differs from the pre-calibration, the PIP sensor is marked as faulty, and it is required to be replaced.

The advantages that provide the invention are:

- Printer down: reduces the total time in which the printer is not operative since it does not require a Service Visit to repair the printer if the root-cause of the issue is a PIP wrong calibration.
- Repair cost: avoids replacing the PIP sensor due to a PIP wrong calibration.
- Service Intervention: the customer has the proper tools to recalibrate the PIP Offset, reducing the Service Visit to troubleshooting the issue.
- Customer experience: giving the proper tools to the customer to self-repair the printer improves the experience of using the printer.
- Printer malfunction: not properly detecting the End of Refill may impact on overstressing some components, such as the Intermediate Tank bag, ink pumps, cancelling print jobs, etc. and for Recirculation IDS, it may impact on recirculation errors.
- Robustness: the PIP Offset could be verified during Idle time, increasing the robustness of the current recalibration process.
- Printing conditions: the calibration is not affected by the printing conditions since there is no pressure loss due to the ink flow.
- Flexible solution: the solution does not depend on the ink type and cartridge types and can be adapted to different IT geometries.
- Cost: It reuses the current hardware of the printer and no additional electronic element (EE board, cables, ...) or mechanical parts are required.

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