Frequency Stability

Application note for PPCL600 and PPCL700

The Pure Photonics tunable laser products provide a very low frequency noise, making them very suitable for sensing applications. In that low-noise mode, the Pure Photonics firmware adds frequency flexibility, so that the laser can be quickly moved from one frequency to another.

This application note describes the frequency stability/drift behavior on the PPCL6xx and PPCL7xx product families (micro-ITLA). This will also work on PPCL5xx enclosures with micro ITLA (serial number starting with ‘CRT**M**’ or ‘PP7’).

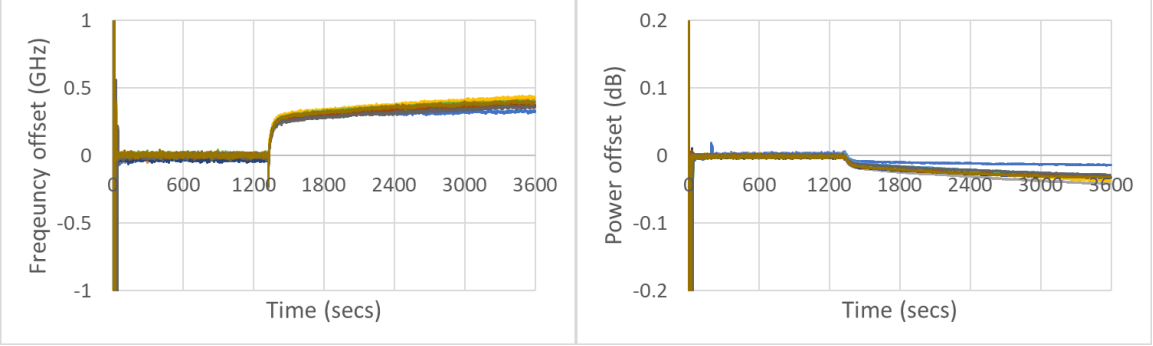
1. PPCL600 / PPCL500 (with serial numbers CRTM…)

The PPCL600 is a telecom grade tunable laser, intended for applications where noise is not the primary concern. It naturally still has the narrow linewidth of the technology base and many features that are suitable for testing and specialty applications.

The whispermode, as implemented on the PPCL600 is fairly bare-bones with the focus on reduces noise from the control loops, but without the auto-correct features that are available on PPCL700. As a result, the whispermode on PPCL600 may show more drift over time and may result in mode-hops. Typical operating time in the whispermode should be limited to minutes to hours. The expectation is that the user will make measurement in the whispermode and then returns to the dither mode.

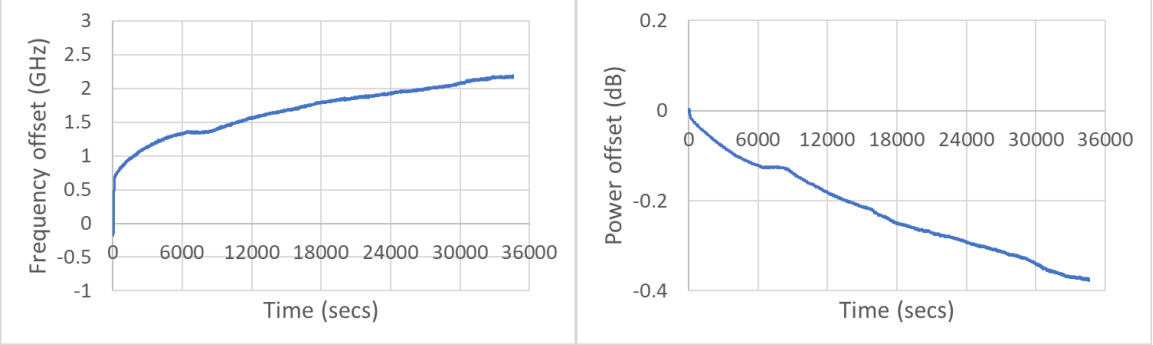
Typical switch to whispermode

We have operated the PPCL600 for 20 minutes in the standard mode before we switched to whispermode and captured another 40 minutes. In the below graph the switching behavior can be seen at 10 wavelenghts.



Long term stability

The PPCL600 will show worse long term stability in whispermode than the PPCL700. However, in most cases it can operate without modehop over an extended time. In the below graph we show a measurement over 10 hrs. Note that we also measured a second sample, which showed a modehop after about 30 minutes (i.e. there is a strong variation from time to time).



Timing of the switch to whispermode

The telecom grade device has built-in pending flags (accessible through the NOP register) that indicate that the device has locked to the target power and to the target frequency. These flags are however dropped before the device reaches it's long term state (in fact, the frequency lock flag is dropped 5 seconds before the final stage is reached).

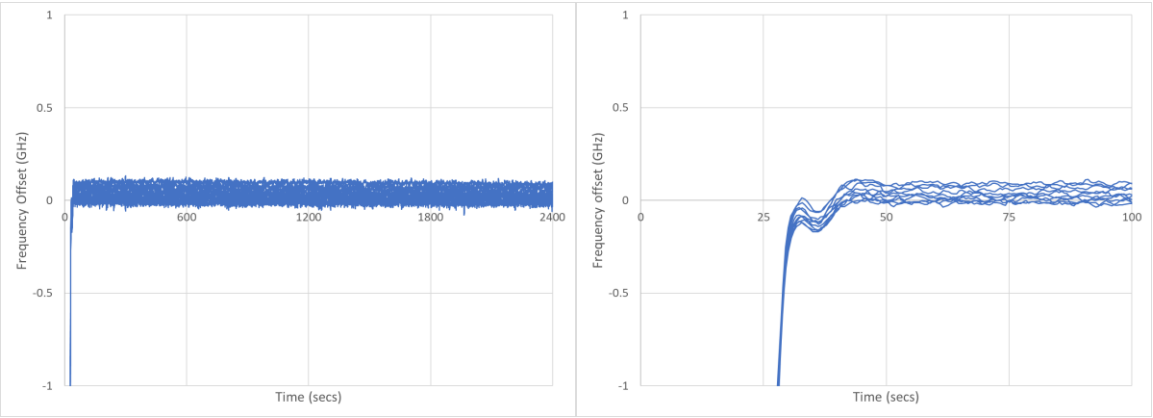
To switch to the whispermode, we would like to see the device in the final stage for a longer period of time (30 secs or longer would be recommended). However, if timing is critical, we recommend to activate the sensor mode operation of the pending flags, which adds a 'stable' pending flag that drops 5 seconds after the final stage is reached.

If the user tries to activate the whispermode before the final stage is reached, the module will trigger an execution error and the command is rejected.

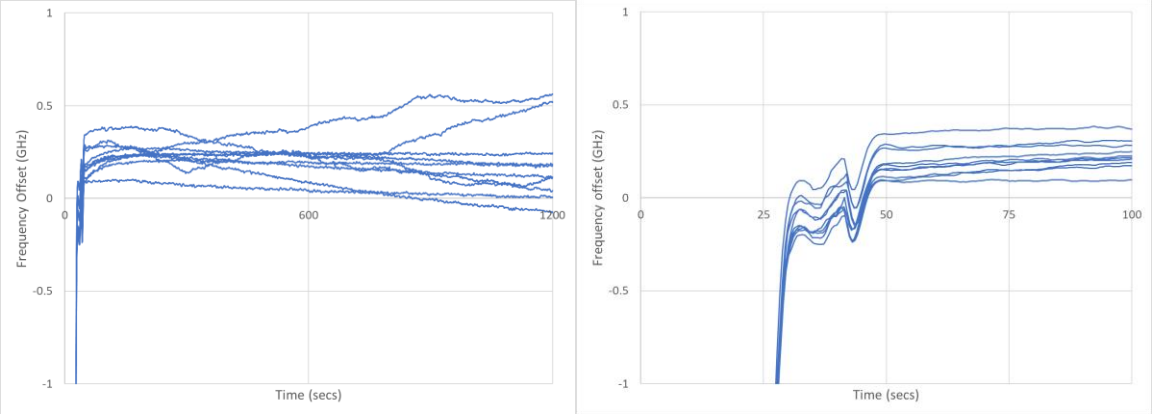
In principle the user can switch to the whispermode 5 seconds after the frequency pending flag is dropped and 5 seconds before the stable pending flag is dropped. However, stability of the whispermode will increase with longer wait time.

The sensor mode operation of the pending flag is activated through the MCB register 0x33 (bit 3, value 0x0008). This setting can be saved to permanent memory through the genCfg command.

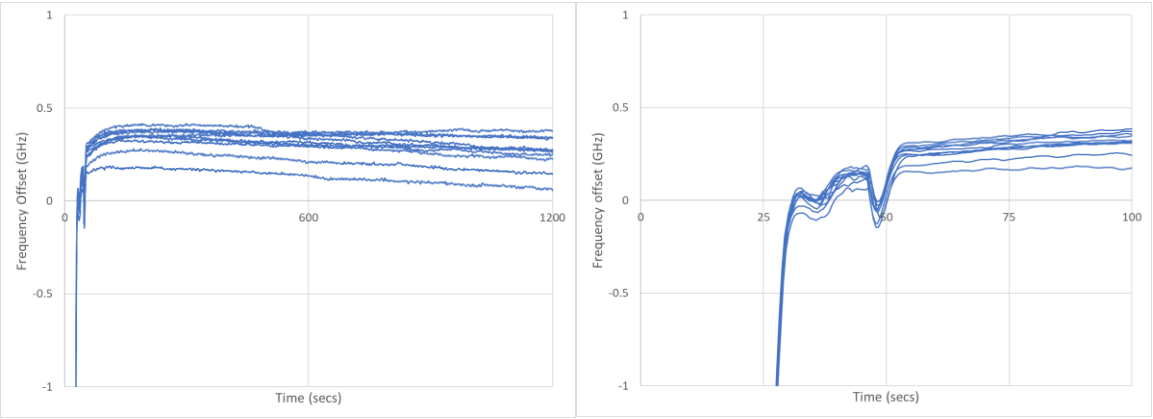
The below figure shows the frequency change versus time in the dither mode (10 individual measurements/traces).



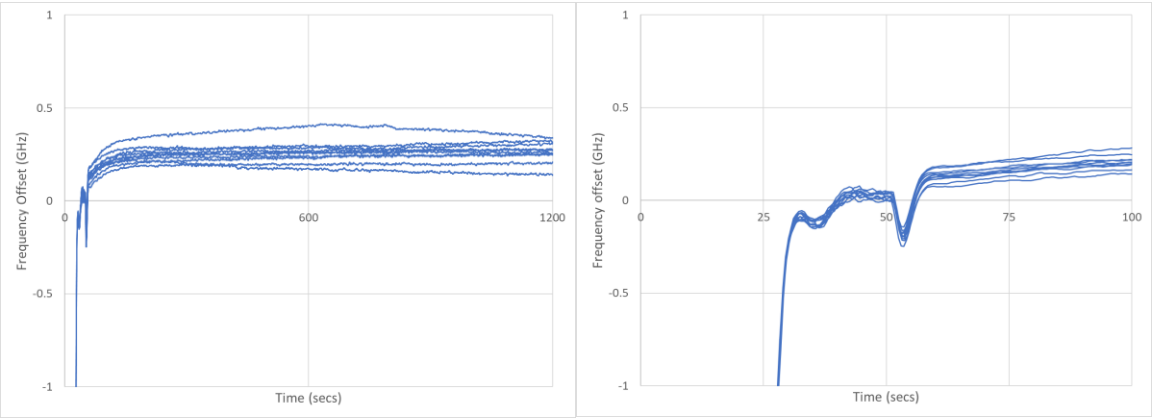
The below figures shows the frequency change versus time when switching to whispermode 5secs after the pending flag is dropped (i.e. almost directly after the device enters the final stage, activation before this time will result in an execution error).



The below figure shows the frequency change versus time when switching to whispermode 10secs after the pending flag is dropped (i.e. almost same time when the stable flag is dropped in sensing mode).



The below figure shows the frequency change versus time when switching to whispermode 15secs after the pending flag is dropped.



From the above figures it can be seen that a 10-15 sec wait time is recommended as a minimum.

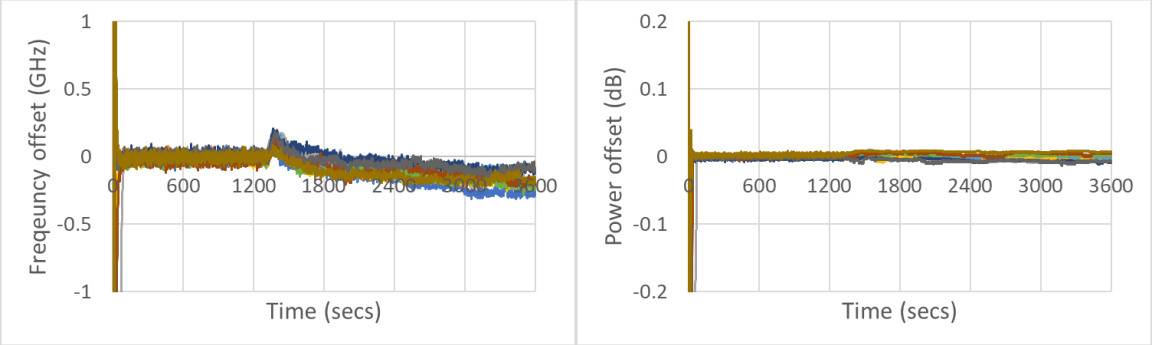
2. PPCL700 / PPCL550 (with serial numbers PP7…)

The PPCL700 is a sensor grade tunable laser, intended for applications where noise is critical. It has the narrow linewidth of the technology base and many features that are suitable for sensing applications (such as modulation etc).

The whispermode, as implemented on the PPCL700 is includes auto-correct features while stabilizing all the control loops. The feature is explicitly under constant development to get the best possible performance. Typical operating time in the whispermode should be limited to hours and days. The expectation is that the user will make measurement in the whispermode and then returns to the dither mode.

Typical switch to whispermode

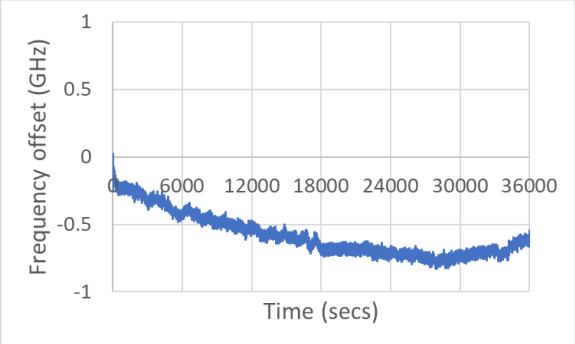
We have operated the PPCL700 for 20 minutes in the standard mode before we switched to whispermode and captured another 40 minutes. In the below graph the switching behavior can be seen at 10 wavelenghts.

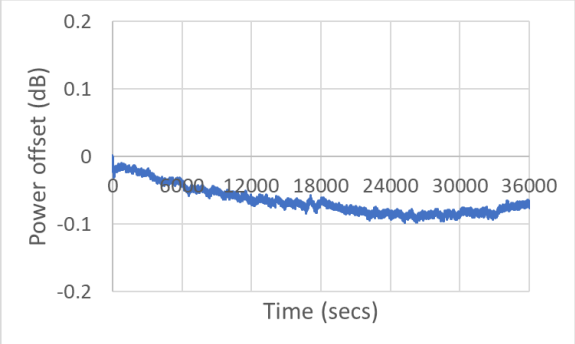


Long term stability

Below graphs show the frequency and power drift on two units over a period of 10hrs. It can be seen that the movement is gradual and no mode hops occur.

First unit





Second unit