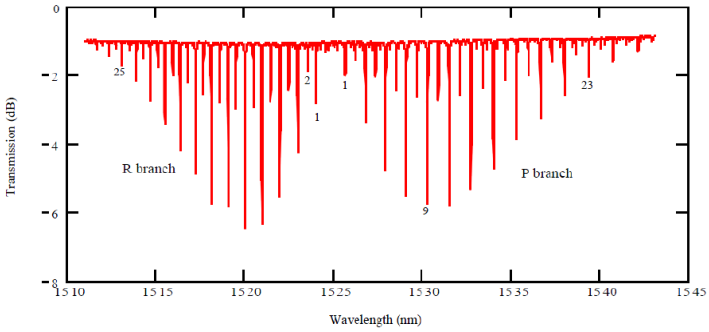
Manual PPCL590 Gas-cell locked tunable laser

Manual

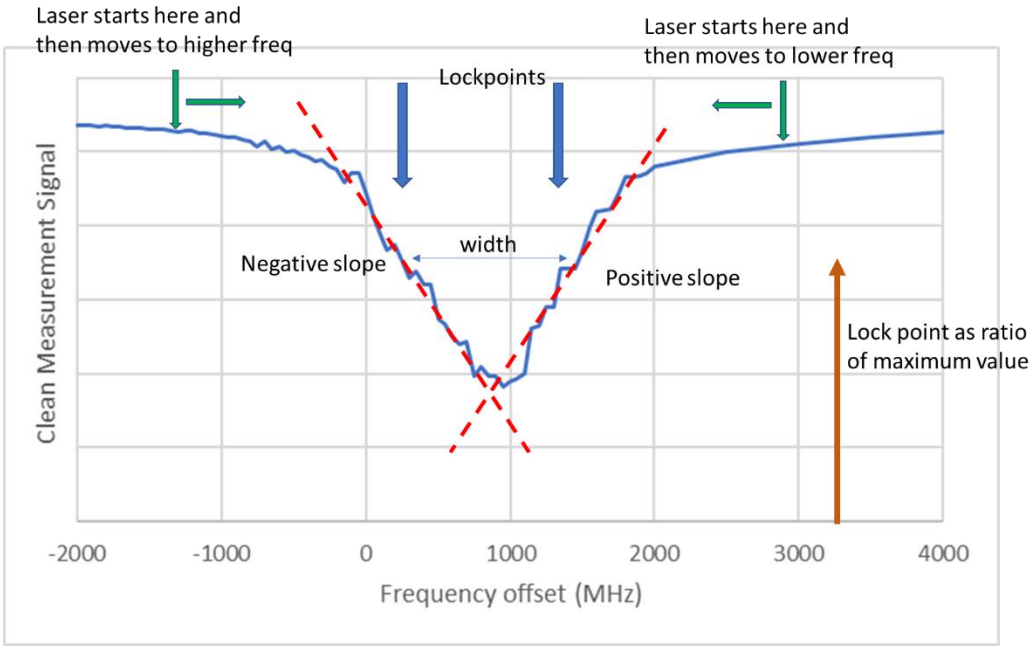
Pure Photonics provides a PPCL590 tunable laser product with an external Acetylene gas-cell integrated within the module. The absorption lines of the gascell serve as reference for a locking mechanism. The laser has a built-in mechanism to enable at any of the absorption peaks of the Acetylene gas cell and lock the frequency on the slope of such a gascell response. No external dither is applied, resulting in a well-controlled and stabilized frequency.

1. Operating Mechanism

The acetylene gas cell has absorption peaks at well-defined frequencies in the lower C-band (up to 1545 nm)



Each peak can be characterized as below.



By guiding the light through such a gascell and measuring the transmitted power, the frequency can be controlled by keeping the power-level consistent with being half down the absorption peak. In the device a PM splitter is used to ensure that the light that is being used for locking is not impacting the light at the output of the device.

For example, starting with a negative offset (left side of the figure), we can move the frequency to higher values, until the power drop is consistent with being half-way down the absorption peak. At this location of maximum slope, the frequency can be controlled in response to the power measurement. If the power is too high, we need to increase the frequency. If the power is too low, we need to lower the frequency.

In this manner we can find two operating points on each absorption line (that is deep enough). We typically have 56-60 operating points in the range up to 197.0THz.

2. Operating sequence

Once the laser is turned on (SENA=1), the laser will automatically go through the following sequences when channel# is larger than 1:

- Turn the laser on in standard dithermode at 2GHz away from the target frequency.
- Lockstate 1: change internal setting until we have a valid measurement of the photodiode current at this setpoint.
- Lockstate 2: adjust internal settings to where we would have a valid photodiode reading when the power has moved down the slope.
- Lockstate 3: Move the frequency (through FTF) towards the lockpoint, until a valid photodiode reading is achieved.
- Lockstate 4: Switch on the whispermode
- Lockstate 5: Wait until whispermode has stabilized
- Lockstate 6: Not used. Skip.
- Lockstate 7: Change frequency offset until the Clean Measurement signal is in locking range
- Lockstate 8: Adjust the internal PZT position to keep the Clean Measurement signal within lock. If the Clean Measurement signal moves out of locking range, the firmware automatically goes back to state 7.

3. Selection of operating frequency

With the channel register set to 1, the laser operates like a normal tunable laser and the FCF setting can be changed to get to any frequency (not a locked mode). When the channel is set to a value higher than 1, a calibrated frequency is selected (as per the datasheet that comes with each module). The actual frequency can be read through the FCF register and thought the LF register.

The laser is enabled by writing SENA to the Resena register (value of 8 to register 0x32). After the laser is enabled in the dither mode (NOP register reads without pending flags), the module can be switched to whispermode (value of 2 to register 0x90). After this the operating sequence is executed.

Below an example datasheet is shown:

			12dBm		10dBm		7dBm	
Channel	frequency	Depth of peak (dB)	Locktime (s)	RMS frequency offset (kHz)	Locktime (s)	RMS frequency offset (kHz)	Locktime (s)	RMS frequency offset (kHz)
2	194.5635	0.27	69	543	66	825	61	1394
3	194.5681	0.27	83	526	79	765	70	1381
4	194.7402	0.41	88	455	65	581	60	937
5	194.7448	0.41	78	440	77	539	73	974
6	194.9138	0.56	99	613	85	513	63	841
7	194.9185	0.56	79	443	78	466	74	780
8	194.9994	0.27	80	605	65	834	62	1516
9	195.0041	0.27	81	564	75	856		
10	195.0845	0.76	89	358	96	522	61	642
11	195.0891	0.76	79	327	77	422	73	591
12	195.1688	0.36	85	569	65	748	61	1427
13	195.1736	0.36	82	477	78	681	74	1349
14	195.2521	1.02	117	335	97	425	64	582
15	195.2568	1.02	76	338	77	382	75	585
16	195.3349	0.41	104	471	63	621	60	1114
17	195.3397	0.41	83	449	75	582	73	1078
18	195.4169	1.25	120	429	71	414	64	532
19	195.4217	1.25	75	352	78	338	74	469
20	195.4981	0.51	82	391	69	482	61	903
21	195.5028	0.51	84	428	78	495	72	863
22	195.5786	1.43	132	415	100	427	58	521
23	195.5833	1.43	76	411	74	368	75	475
24	195.6583	0.60	88	431	81	508	59	747

4. Useful registers

Lock state

Read register 0xFD with datavalue 0x9000. This will return the lock state of the module as per the information in section 2

Frequency error

Read register 0x96 to obtain the RMS frequency error. If the datavalue is 0, this is averaged over 1 second. If the datavalue is 1 it is averaged over 20 seconds.

Control/feedback signals

Read register 0x93 for the signal from the photodiode. In locked condition the photodiode value is controlled to then center 0x8000.

Read register 0xFD with the datavalue 0x9001 for the control signal applied to the PZT (fast frequency adjustment). This value is kept around 0x8000 value to provide as big a range as possible to respond to perturbations. The FTF value (register 0x62) is adjusted when the value deviates too much from the target.

5. Command Line Interface

The Command Line Interface (CLI) has implemented several PPCL590 commands starting in version 3.2.7 (release 28 August 2024).

The PPCL590 commands are enabled by typing it.setPPCL590(True).

The following PPLC590 commands are available:

PPCL590 Registers (activate with it.setPPCL590(True))	
PPCL590RMSValue(longterm=False)	Reads register 0x96 for the RMS frequency offset value; False for integration over 1 second; True for integration over 20 seconds
PPCL590Lockstate()	Reads register 0xfd with value 0x9000; provides the lockstate of the PPCL590 lock
PPCL590PZTsignal()	Reads register 0xfd with value 0x9001; provides the DAC value to the PZT which controls the fast frequency correction; should be around 0x8000 when locked.
PPCL590Locksignal()	Reads register 0x93; provides the feedback signal received from the photodiode. Target is 0x8000 in the PPCL590 and could be a specified value in the external lock situation
PPCL590Outputsignal()	Not applicable for PPCL590 users
PPCL590Setfeedback(value=50)	Not applicable for PPCL590 users

6. Appendix

The following firmware timestamps are suitable for PPCL590. A higher timestamp indicates that the firmware is compiled later, which makes it likely that the firmware is more mature or has more functionality. Note that not every firmware version supports PPCL590 functionality.

The timestamp can be obtained from the release register. This returns a string with at the end TX xxx.yyy.000. The timestamp is xxx*256+yyyy.

- 28316 (a previous version; do not use anymore)
- 30765 older version
- 33581 released version for PPCL590