Links

Wikipedia GPSDO - https://en.wikipedia.org/wiki/GPS_disciplined_oscillator

Shera's GPSDO - http://www.rt66.com/~shera/index_fs.htm
http://www.rt66.com/~shera/QST_GPS.pdf

Wikipedia PID - https://sv.wikipedia.org/wiki/PID-regulator

Poul Hennings simple description of a PI loop - http://phk.freebsd.dk/time/20141018.html

Pages 14-18 shows control loop of 1PPS locking of PRS10 (similar to the Arduino):
http://www.thinksrs.com/downloads/PDFs/Manuals/PRS10m.pdf

On pages 26-31 you find ADEV and selection of time constants for a modern GPSDO FS740 with different oscillators and similar control loop as in the Arduino:
http://www.thinksrs.com/downloads/PDFs/Manuals/FS740m.pdf

Arduino - https://www.arduino.cc/

ADEV - https://en.wikipedia.org/wiki/Allan_variance

GPSDO simulator - http://www.leapsecond.com/pages/gpsdo-sim/

Timelab - http://www.ke5fx.com/timelab/readme.htm

Time nuts forum - https://www.febo.com/mailman/listinfo/time-nuts

uBlox u-center program - https://www.u-blox.com/en/product/u-center-windows

Lady heather program - http://www.ke5fx.com/heather/readme.htm

PICDIV - http://www.leapsecond.com/pic/picdiv.htm

GPS receiver M12 ADEV-MDEV charts - http://www.leapsecond.com/pages/m12-adev/

GPS receiver M12 sawtooth - http://www.leapsecond.com/pages/m12/sawtooth.htm

GPS receiver uBlox ADEV-MDEV charts - https://www.eevblog.com/forum/projects/ocxo-stable-reference-and-control-voltages/50/

Test of four GPSDO's - http://www.leapsecond.com/pages/gpsdo/

GPSDO HP Z3801 OCXO variations - http://leapsecond.com/pages/z3801a-osc/

FLL versus PLL See ke5fx for example - http://www.ke5fx.com/gpscomp.htm

Appendix:

Arduino GPSDO with 1ns TIC by Lars Walenius					Rev. 3.0 170801 ID:1311										
Type f1 <enter> to get help+info															
time	ns	dac	temp	status	diff_ns	filtX10	tc	filt	timer1	temp1					
0	-390	34221	28.3	WarmUp	62	830	32	1	13838	28.1	Five minute averages: TIC+DAC+temp				
1	-384	34221	28.4	WarmUp	5	890	32	1	25021	28.1	Now acquiring value: 0				
2	-382	34221	28.3	WarmUp	3	920	32	1	25031	28.1					
3	-378	34221	28.3	WarmUp	4	960	32	1	25042	28.1	0	0	0	0	
4	-377	34221	28.3	WarmUp	1	970	32	1	25042	28.1	1	0	0	0	
....															
292	418	34221	28.9	WarmUp	-2	8980	32	1	25046	28.7	1143	4982	34222	33.6	Locked
293	433	34221	29	WarmUp	15	9110	32	1	25046	28.7					
294	431	34221	29	WarmUp	-2	9090	32	1	25046	28.7	TimeConst = 32 sec				
295	426	34221	28.9	WarmUp	-4	9050	32	1	25046	28.7	Prefilter = 1 sec				
296	441	34221	29	WarmUp	15	9180	32	1	25046	28.7	Damping = 3.00 Gain = 80				
297	434	34221	29	WarmUp	-7	9120	32	1	25046	28.7	Type f1<enter> to get help+info				
298	446	34221	28.9	WarmUp	12	9230	32	1	25046	28.7	Rev. 3.0 170801 ID:1311				
299	437	34221	29	WarmUp	-9	9150	32	1	25046	28.7					
300	450	34221	28.9	WarmUp	12	9260	32	1	25046	28.8	Five minute averages: TIC+DAC+temp				
301	441	35276	29	NoLock	-9	9180	32	1	25018	28.8	Now acquiring value: 1				
302	440	35285	29	NoLock	-1	9170	32	1	25018	28.8					
303	439	35293	28.9	NoLock	-1	9160	32	1	25018	28.8	0	5165	34221	28.6	
304	432	35289	29	NoLock	-7	9100	32	1	25018	28.7	1	0	0	0	
305	407	35244	28.9	NoLock	-25	8880	32	1	25018	28.7	2	0	0	0	
....															
523	-21	34418	29.4	NoLock	10	4790	32	1	25016	29.2	1074	4993	34216	33.3	Locked
524	-31	34392	29.4	NoLock	-10	4690	32	1	25016	29.2	1075	4995	34216	31.7	Locked
525	-23	34411	29.4	NoLock	8	4770	32	1	25015	29.2	1076	4995	34216	33.1	Locked
526	-16	34428	29.4	NoLock	7	4840	32	1	25016	29.2	1077	4993	34216	33.8	Locked
527	-30	34393	29.4	NoLock	-14	4700	32	1	25015	29.2	1078	4992	34216	33.2	Locked
528	-24	34393	29.4	Locked	6	4703	32	16	25015	29.2	1079	4994	34216	33.6	Locked
529	-19	34394	29.3	Locked	5	4710	32	16	25016	29.2	1080	4993	34216	33.4	Locked

Figure 1. Example of serial data pasted to Excel

```
Info and help - To get values for gain etc type f2 <enter>, f3 <enter> reads ADC3 and f4 <enter> EEPROM
Arduino GPSDO with 1ns TIC by Lars Walenius     Rev. 3.0 170801  ID:1311

Typing a<value><enter> will set a new damping between between 0.50 and 10.00 set 50 to 1000
Typing b<value><enter> will set a new tempRef between 1 and 1023
Typing c<value><enter> will set a new tempCoeff set between 0 and 10000. Adding 10000 gives negative tc
Typing d<value><enter> will set a new dacValue between 1 and 65535
Typing e<value><enter> will erase the 3 hour storage in EEPROM if value 1 and all EEPROM if 22 (33 sets all EEPROM to FF)
Typing g<value><enter> will set a new gain between 10 and 65535
  gain = (65536/settable VCOrange in ppb) (eg. 100ppb DACrange gives gain=655)
Typing h<value><enter> will set hold mode and the entered dacValue if not h0 that uses the old
Typing i<value><enter> with value 1 will toggle ns decimal point else will toggle amount of information
Typing j<value><enter> Set temp sensor type 0=raw 1=LM35 2=10kNTC+68k 3=10kNTC+47k (second digit=adc1 eg 3x)
Typing l<enter> will set TIC linearization parameters min max square
  values 1-500 sets min to 0.1-50, values 800-1023 sets max, values 1024-1200 sets square to 0.024-0.200
Typing n<value><enter> will set ID number 0-65535 that is displayed
Typing o<value><enter> will set a new TIC_Offset between 200 and 1020 ns
Typing p<value><enter> will set a new prefilter div between 2 and 4
Typing r<enter> will set run mode
Typing s<value><enter> will save gain etc to EEPROM if value 1 and dacvalue if 2
Typing t<value><enter> will set a new time constant between 4 and 32000 seconds
Typing w<value><enter> will set a new warmup time between 2 and 1000 seconds

time    ns      dac     temp    status  diff_ns filtX10 tc      filt    timer1  temp1
3642    -4      34413   32.3    Locked  3       4972    32      16      25016   32.7    39      0       0       0.0
3642    0       34413   32.4    Locked  4       4974    32      16      25016   32.7    40      0       0       0.0
```

Figure 2. f1 info and help

```
Gain            80      Damping         3.00    TimeConst       32      FilterDiv       2       TIC_Offset      500
TempRef         280     TempCoeff       0       TICmin          12.0    TICmax          1012    Square comp     0.100
Warm up time    300     LockPPScounter  3277    MissedPPS       0       TimeSinceMissedPPS  3645
ID_Number       1311    Restarts        19      Total hours     450
```

Figure 3. f2 serial prints some variables

```
EEPROM content:
restarts = 19
totalTime3h = 150
temperature_Sensor_Type =  53
ID_Number = 1311
TICmin = 120
TICmax = 1012
x2 = 100
TIC_Offset = 500
filterDiv = 2
warmUpTime = 300
damping = 300
tempRef = 280
tempCoeff = 0
dacValueOut = 34221
gain = 80
timeConst = 32
k = 6
```

Figure 4. f4 serial prints EEPROM contents

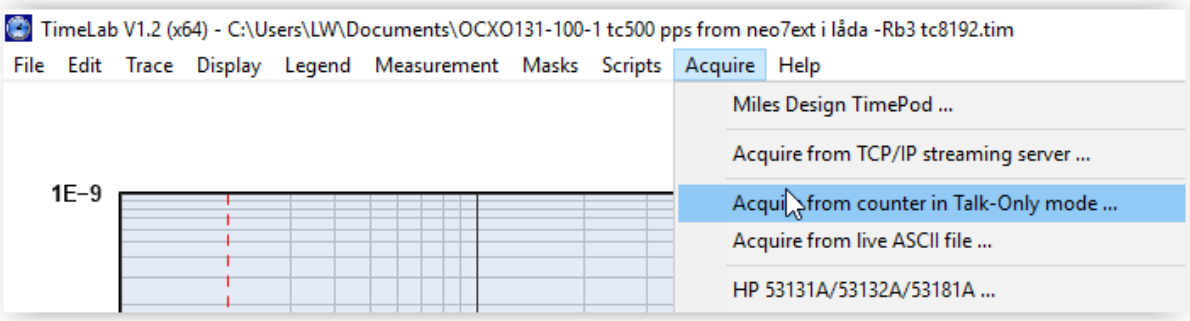

Figure 5. Acquire from Arduino serial port

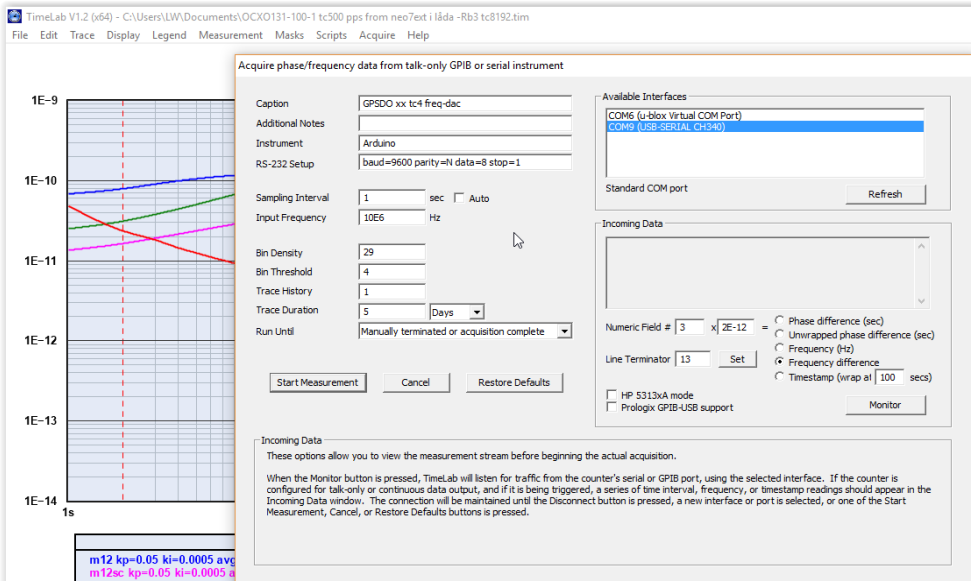

Figure 6. Acquire DAC value from Arduino serial port

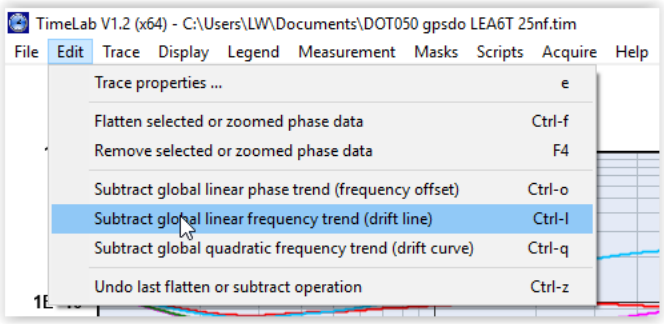

Figure 7. Subtract linear drift in Timelab