Exercise Report
(Lab2-M9)

|  |  |
| --- | --- |
| **Subject of this exercise:** | Study of Analog Phase-Locked Loop (APLL) |
| **Students – Student code:** | <me>-student code<myself> -student code<I> -student code |
| **Course/code:** | <course>, <group> |
| **Date & time:** | 20<YY>. <MM>. <DD>. |
| **Lecturer today:** |  |

Equipment in use, device under test

|  |  |
| --- | --- |
| Oszcilloscope | Agilent 54622A |
| Power supply | Agilent E3630 |
| Synchronizable function generators | Agilent 33220A-Option 001 |
| Digital multimeter (6½ digit) | Agilent 33401A |
| Digital multimeter (3½ digit) | Metex ME-22T |

Exercises



Test panel Fig.9‑.

1. Measuring of the loop elements of the APLL

Obtaining the PD curve

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **θ2** [o] | **ud** [V] | **θe** [o] |  | **θ2** [o] | **ud** [V] | **θe** [o] |
| 180 |  | -180 |  | 0 |  | 0 |
| 170 |  | -170 |  | -10 |  | 10 |
| 160 |  | -160 |  | -20 |  | 20 |
| 150 |  | -150 |  | -30 |  | 30 |
| 140 |  | -140 |  | -40 |  | 40 |
| 130 |  | -130 |  | -50 |  | 50 |
| 120 |  | -120 |  | -60 |  | 60 |
| 110 |  | -110 |  | -70 |  | 70 |
| 100 |  | -100 |  | -80 |  | 80 |
| 90 |  | -90 |  | -90 |  | 90 |
| 80 |  | -80 |  | -100 |  | 100 |
| 70 |  | -70 |  | -110 |  | 110 |
| 60 |  | -60 |  | -120 |  | 120 |
| 50 |  | -50 |  | -130 |  | 130 |
| 40 |  | -40 |  | -140 |  | 140 |
| 30 |  | -30 |  | -150 |  | 150 |
| 20 |  | -20 |  | -160 |  | 160 |
| 10 |  | -10 |  | -170 |  | 170 |
| 0 |  | 0 |  | -180 |  | 180 |

When *θe* is small (|*θe*| < 45 o)

 ***ud*(*t*)** = ***Kd θe***

*ud1* = V

*ud2* = V

*θe1* = o

*θe2* = o

Kd’= [V/o]

**Kd = [V/rad]**

**Matlab code:**

<PD curve - plot>

<Experience collected during the completion of the measurement>

Obtaining VCO curve

|  |  |
| --- | --- |
| **uf** [V] | **f2** [kHz] |
|  |  |
|  |  |
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|  |  |
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|  |  |

**Matlab code:**

<VCO curve - plot>

*uf1* = V

*uf2* = V

*f1* = kHz

*f2* = kHz

Kv’= [kHz/V]

**Kv= [k rad/Vs]**

<Experience collected during the completion of the measurement>

Calculating the free-running frequency of the VCO

 f0 = kHz; ω0 = *k*

<Experience collected during the completion of the measurement>

VCO operation formula:

 ω2 = [rad/s].

Obtaining the locking- and tracking ranges of the APLL

Obtaining the locking range

1. method

*f1* = kHz

*f2* = kHz

2ΔfP= kHz

< ábra>

2. Lissajous’s method (Lissajou curve)

<Plot>

<Experience collected during the completion of the measurement>

Obtaining tracking range

*f1* = kHz

*f2* = kHz

2ΔfH= kHz

<Experience collected during the completion of the measurement>

Implementation of analog FM demodulator and obtaining its curve

Obtain the curve of FM demodulator

**ζ=1** Reference signal: 100 Hz → 0 dB

|  |  |
| --- | --- |
| **f** [Hz] | **uf** [dB] |
| **100** |  |
| 300 |  |
| 500 |  |
| 700 |  |
| 900 |  |
| 1100 |  |
| 1300 |  |
| 1500 |  |
| 1700 |  |
| 1900 |  |
| 2100 |  |
| 2300 |  |
| 2500 |  |
| 2700 |  |
| 2900 |  |
| 3100 |  |
| 3300 |  |
| 3500 |  |
| 3700 |  |
| 3900 |  |
| 4100 |  |
| 4300 |  |
| 4500 |  |
| 4700 |  |
| 4900 |  |
| 5100 |  |
| 5300 |  |
| 5500 |  |
| 5700 |  |
| 5900 |  |
| 6100 |  |

**Matlab code:**

<FM demodulator curve - plot>

<Experience collected during the completion of the measurement>

Implementation and measurement of digital FSK demodulator

Measurement in case of FSK with small deviation

 Settings:

 Frequency: 90 kHz

 Frequency hopping: 92 kHz

 Modulation frequency: 200 Hz

**ζ=1**

<plot>

<Experience collected during the completion of the measurement>

Measurement of FSK with big deviation (collapsing the locked state, generating locking transient)

 Settings:

 Frequency: 90 kHz

 Frequency hopping: 97 kHz

 Modulation frequency: 200 Hz

**ζ=1**

< plot>

<Experience collected during the completion of the measurement>