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Sensor Board Details

Table 1. Sensor Characteristics

Ref. Design ID	Design Type	Single/ Redundant	Number of Pole Pairs	PCB Size [mm]	Coil Size D_{out} / D_{in} [mm]	Target Size D_{out} / D_{in} [mm]	Air Gap (Nominal) [mm]	Accuracy (Nominal) [deg mech.] / [deg el.]
R_191_V10	Rotary	Redundant	1	100 x 65	31 / 19	27 / 18	1.0	±0.81 / ±0.81
R_191_V10	Rotary	Redundant	16	100 x 65	47 / 34	47 / 33	1.0	±0.02 / ±0.38

1.1 Test Conditions

- Measurements are done in a lab environment at room temperature
- Sensor Board is powered using the IPS communication board
- The supply voltage level is 5V (VDD = 5V)
- The nominal accuracy is measured @ nominal air gap and 1000 RPM
- Inductance and the DC resistance of the transmitter coil is measured using a Smart Tweezer ST5S LCR Meter.

1.2 Tx Coil and Frequency Parameters

Set C_{TX} transmit frequency between 2.2 and 5.6 MHz. To ensure a high quality factor, a C0G capacitor was used. F_{TX} is calculated from the measured inductance and the nominal capacitor values. F_{TX} was measured by the IC itself.

Table 2. Sensor Characteristics

L_{TX}	R_L	C_{TX}	F_{TX} calc.	F_{TX} meas.
1x360: 1.43 µH	1.58 Ω	1300 pF	3.69 MHz	3.28 MHz
16x22.5: 1.72 µH	1.86 Ω	1100 pF	3.66 MHz	3.26MHz

1.3 Calibration Register Settings

The receiver gain (address 0x02) is set to get an output level 1.4V to 2.5V for 5V operation. The sensor signals is calibrated at the nominal air gap without any displacement before the measurement. Amplitude mismatch is calibrated using the receiver fine gain registers (address 0x03 and 0x05), and signal offsets are compensated using the receiver offset registers (address 0x04 and 0x06) of IPS2550.

Table 3. Registers Dump

1x360:

0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08
0x0321	0x0001	0x03C4	0x0000	0x00086	0x0005	0x002F	0x00DF	0x00AF

0x09	0x0A	0x0B	0x0C	0x0D	0x0E	0x12	0x13	
0x0000	0x07FF	0x0000	0x0000	0x0000	0x0000	0x01C4	0x0001	

16x22.5:

0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08
0x0121	0x0001	0x0300	0x0000	0x0007	0x0007	0x0000	0x00DF	0x00AF

0x09	0x0A	0x0B	0x0C	0x0D	0x0E	0x12	0x13	
0x0000	0x07FF	0x0000	0x0000	0x0000	0x0000	0x017F	0x0005	

1.4 Sensor Board

Figure 1. displays the sensor board layout, consisting of one transmit coil, two receive coils, IPS2550 and additional passive components.

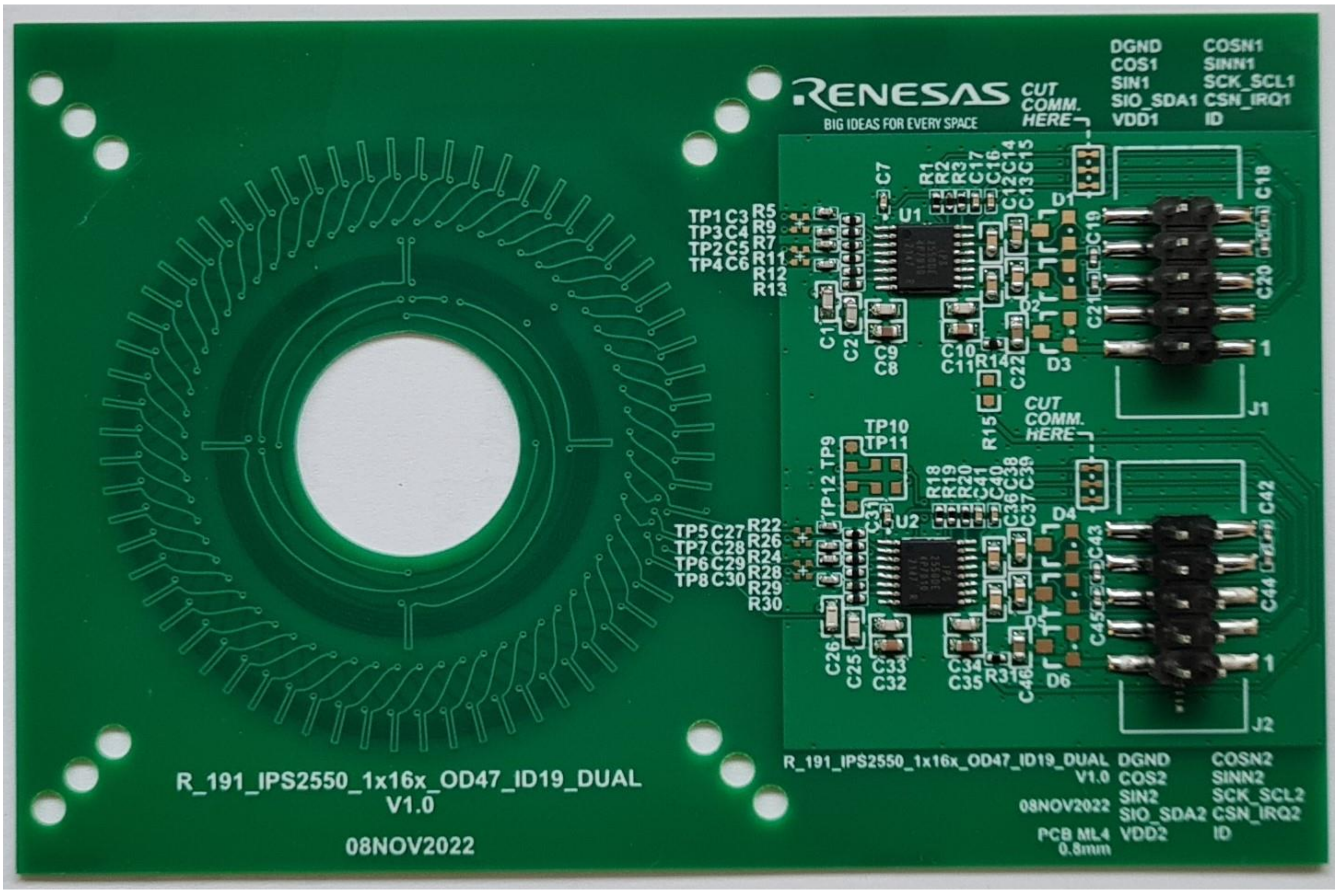

Figure 1. Sensor Board

1.5 Sensor Target

Figure 2. displays the target used during the measurements.

Figure 2. Sensor Target

2. Measurement Setup

2.1 General

All measurements are performed on a 4-axis positioning test bench. During the measurement, the target is rotating continuously. The rotor position is calculated from the sensor output signals and compared to the rotor position measured by high precision reference encoder.

$$f_{mechanical} = real\ sensor\ position - ideal\ position\ value$$

2.2 Design-Specific Test Setup

Figure 3. displays the test setup, the sensor board and target are mounted on the 4 axis positioning test bench.

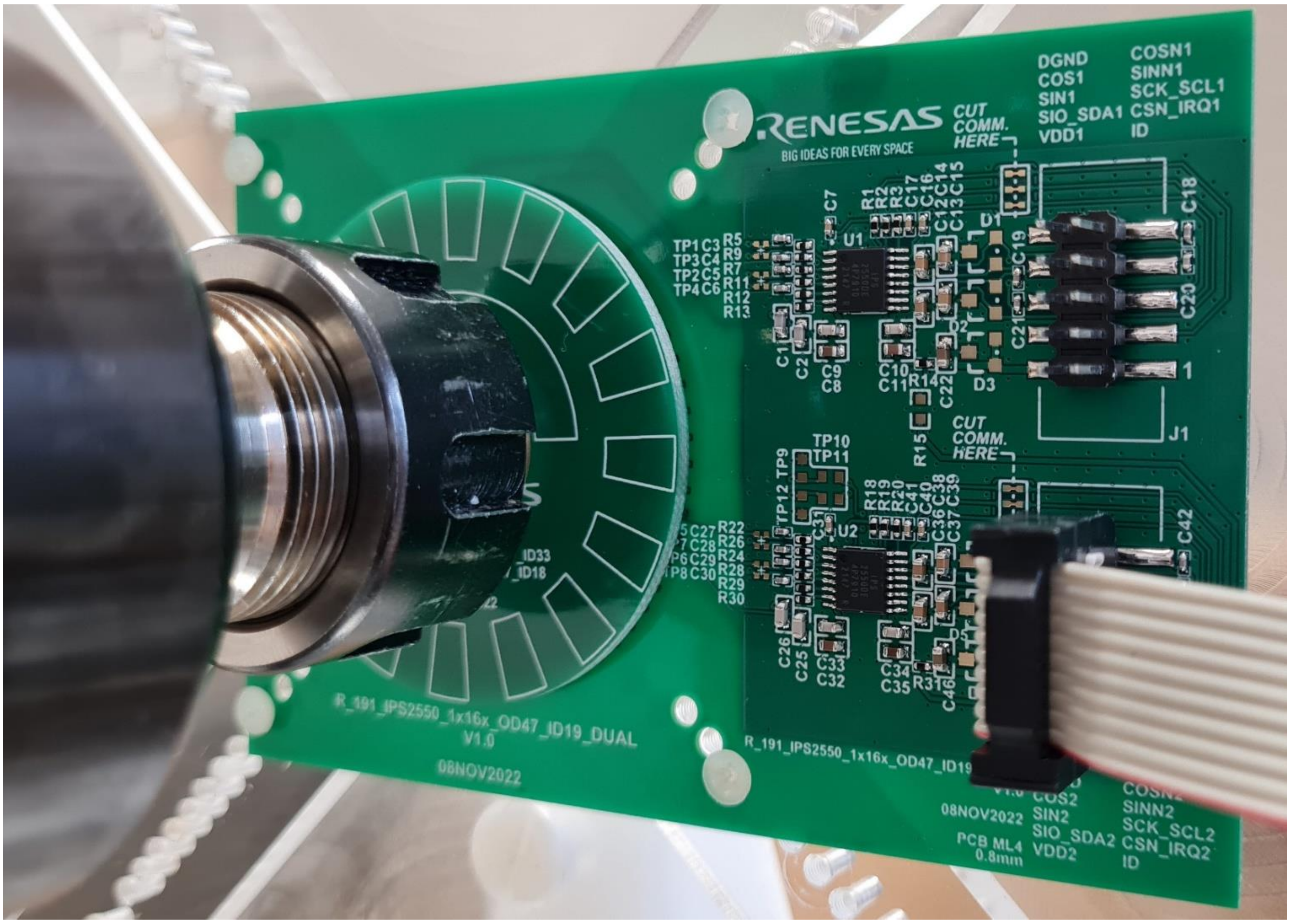

Figure 3. Setup

3. Measurement Results 1x360

3.1 Angle Error at Different Air Gaps

Figure 4. displays a series of data over a rotation of 360 degrees with a variation of air gap with no mechanical x,y displacement. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

Example: X0.000_Y0.000_AG2.000

- Air Gap = 2.00mm
- X radial displacement = 0.00mm
- Y radial displacement = 0.00mm

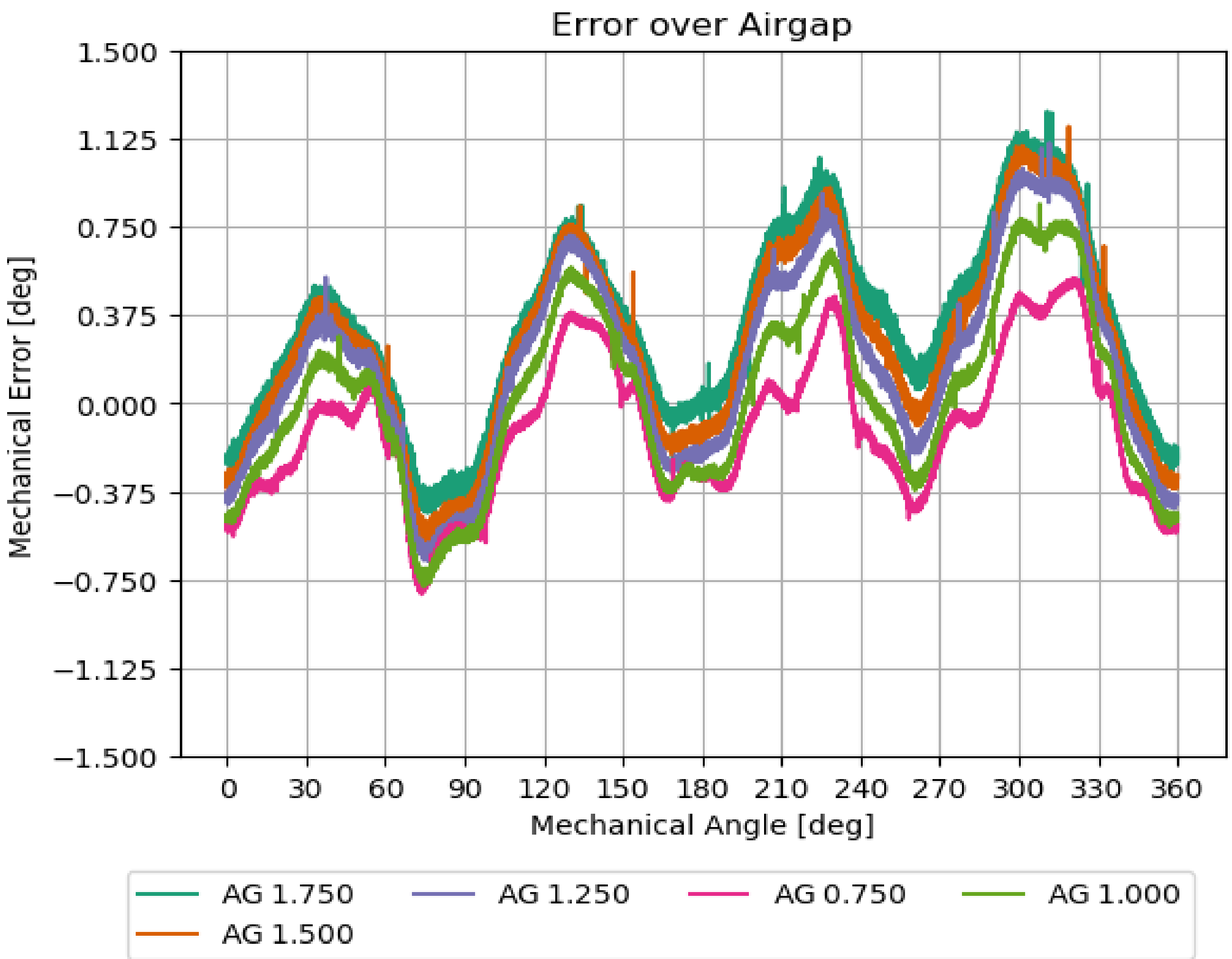

Figure 4. Error over Air Gap

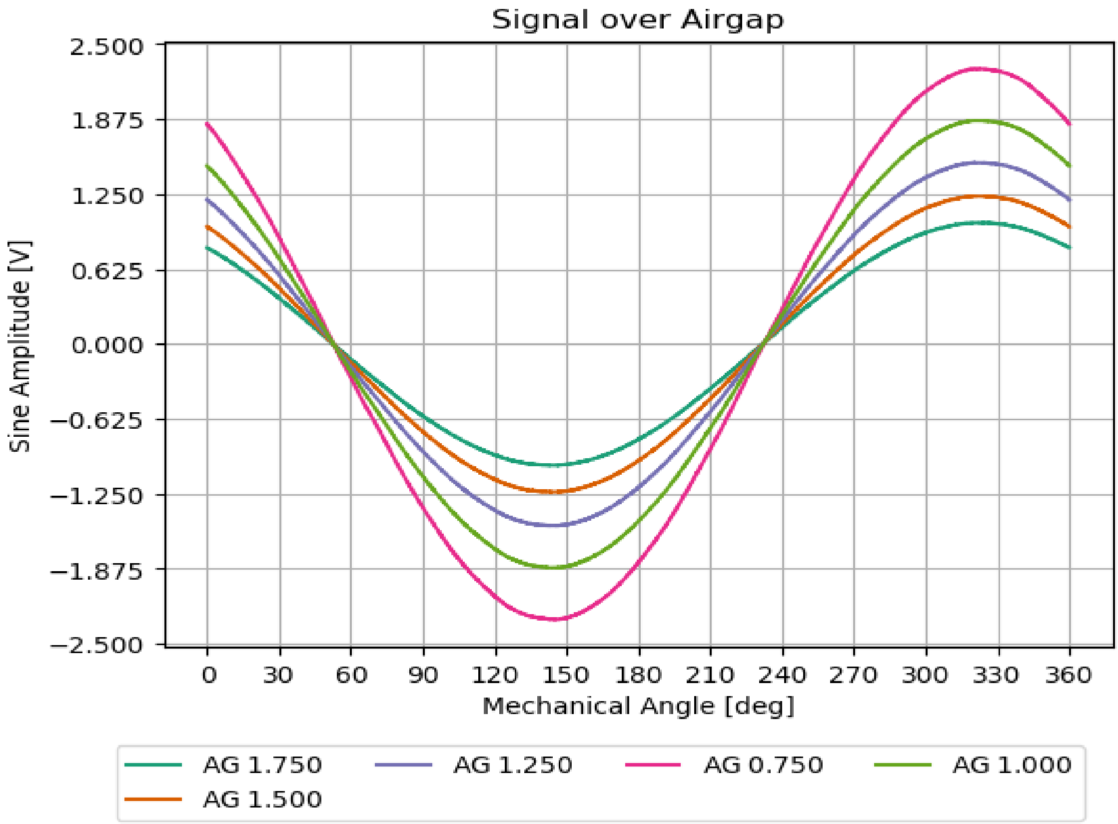

Figure 5. Sine over Air Gap

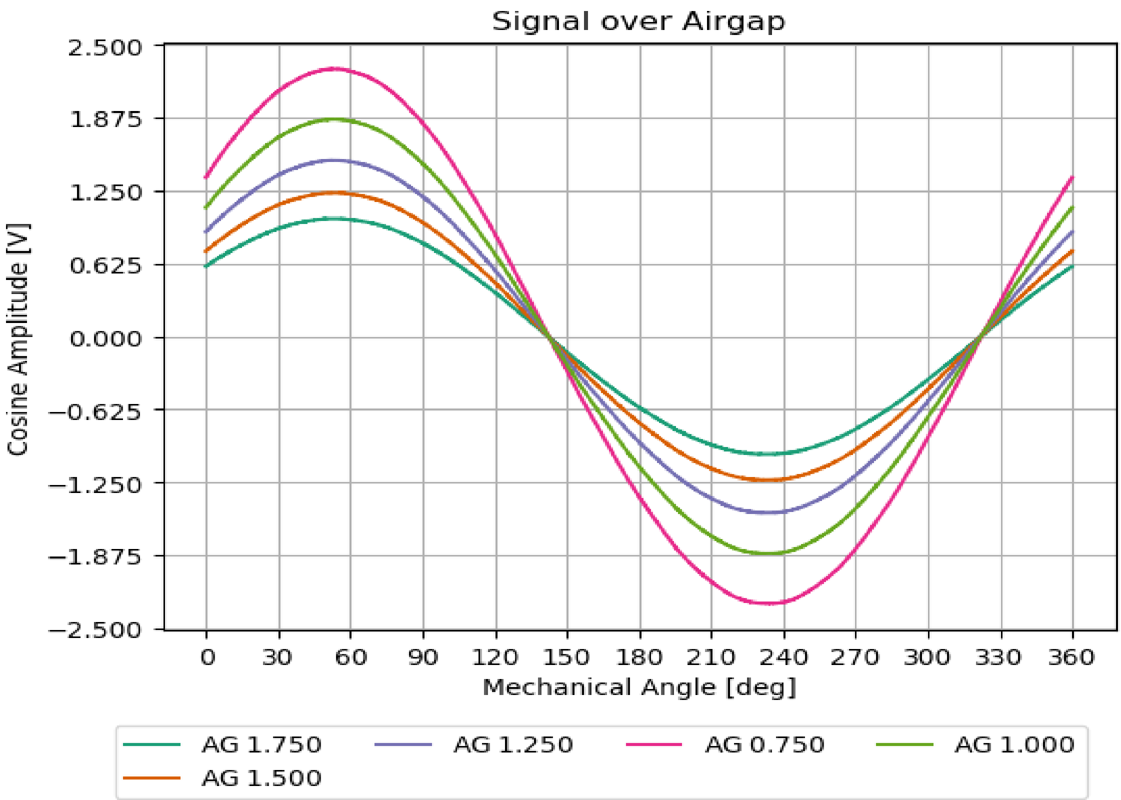

Figure 6. Cosine over Air Gap

3.2 Angle Error at Different Displacements

Figure 7. displays a series of data over a rotation of 360 degrees with no variation of air gap but with mechanical x,y displacement. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

Example: X0.000_Y-0.250_AG2.000

- Air Gap = 2.00mm
- X radial displacement = 0.00mm
- Y radial displacement = -0.25mm

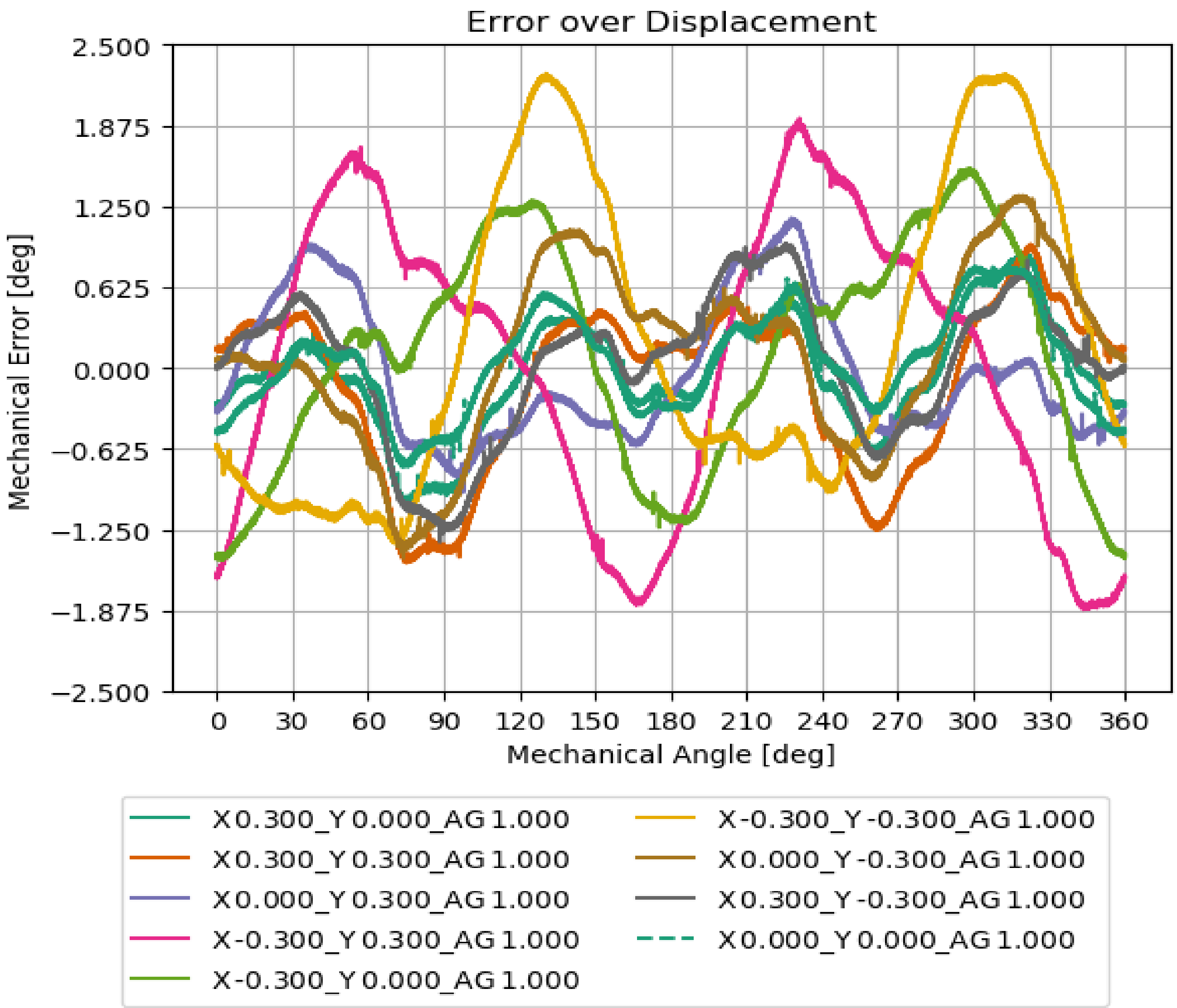

Figure 7. Error over Displacement

3.3 Angle Error at Different Tilt

Figure 8. displays a series of data over a rotation of 360 degrees with neither variation of air gap nor mechanical x,y displacement but with tilt variation. The tilt (φ) is given in degrees. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

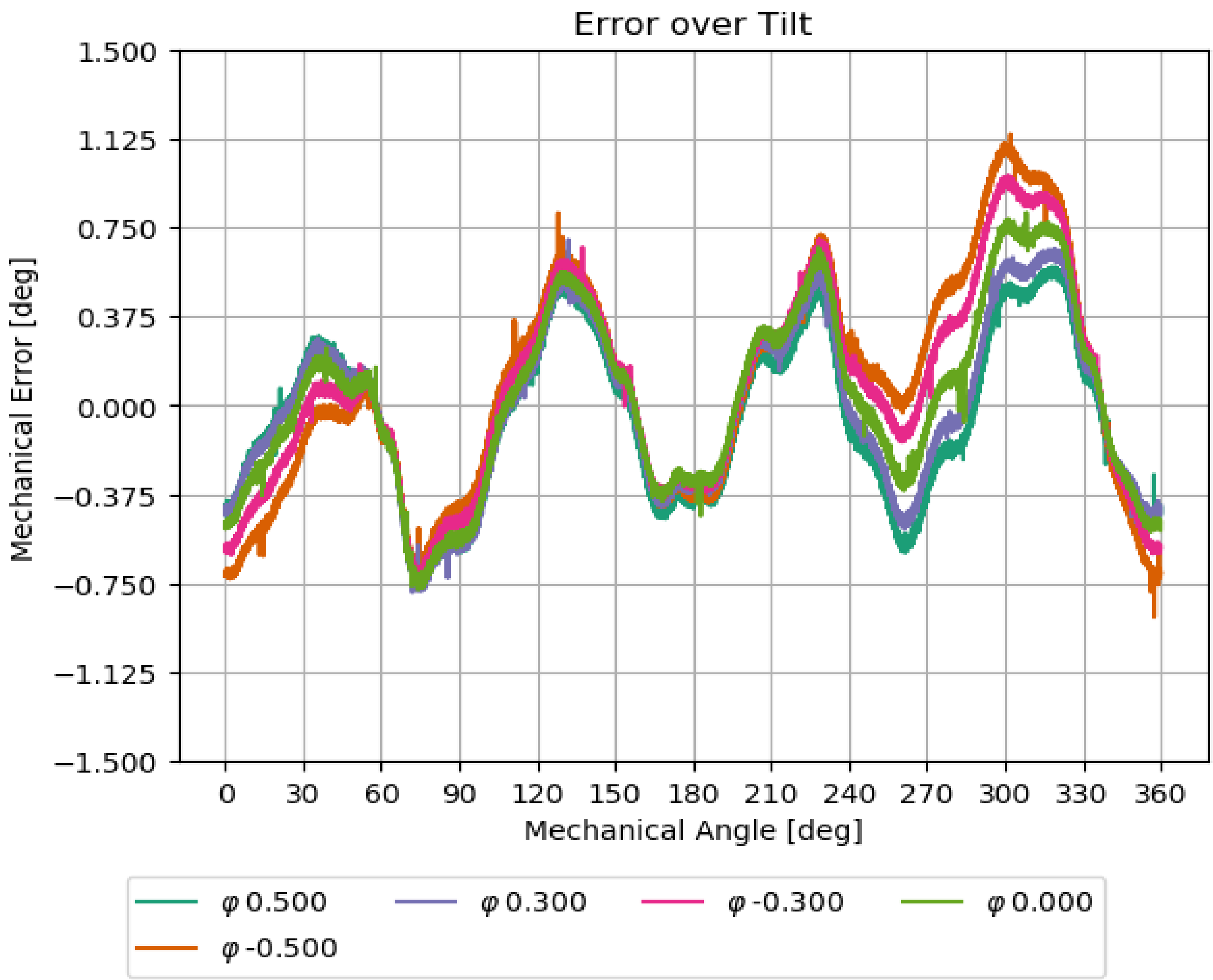

Figure 8. Error over Tilt

4. Measurement Results 16x22.5

4.1 Angle Error at Different Air Gaps

Figure 4. displays a series of data over a rotation of 360 degrees with a variation of air gap with no mechanical x,y displacement. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

Example: X0.000_Y0.000_AG2.000

- Air Gap = 2.00mm
- X radial displacement = 0.00mm
- Y radial displacement = 0.00mm

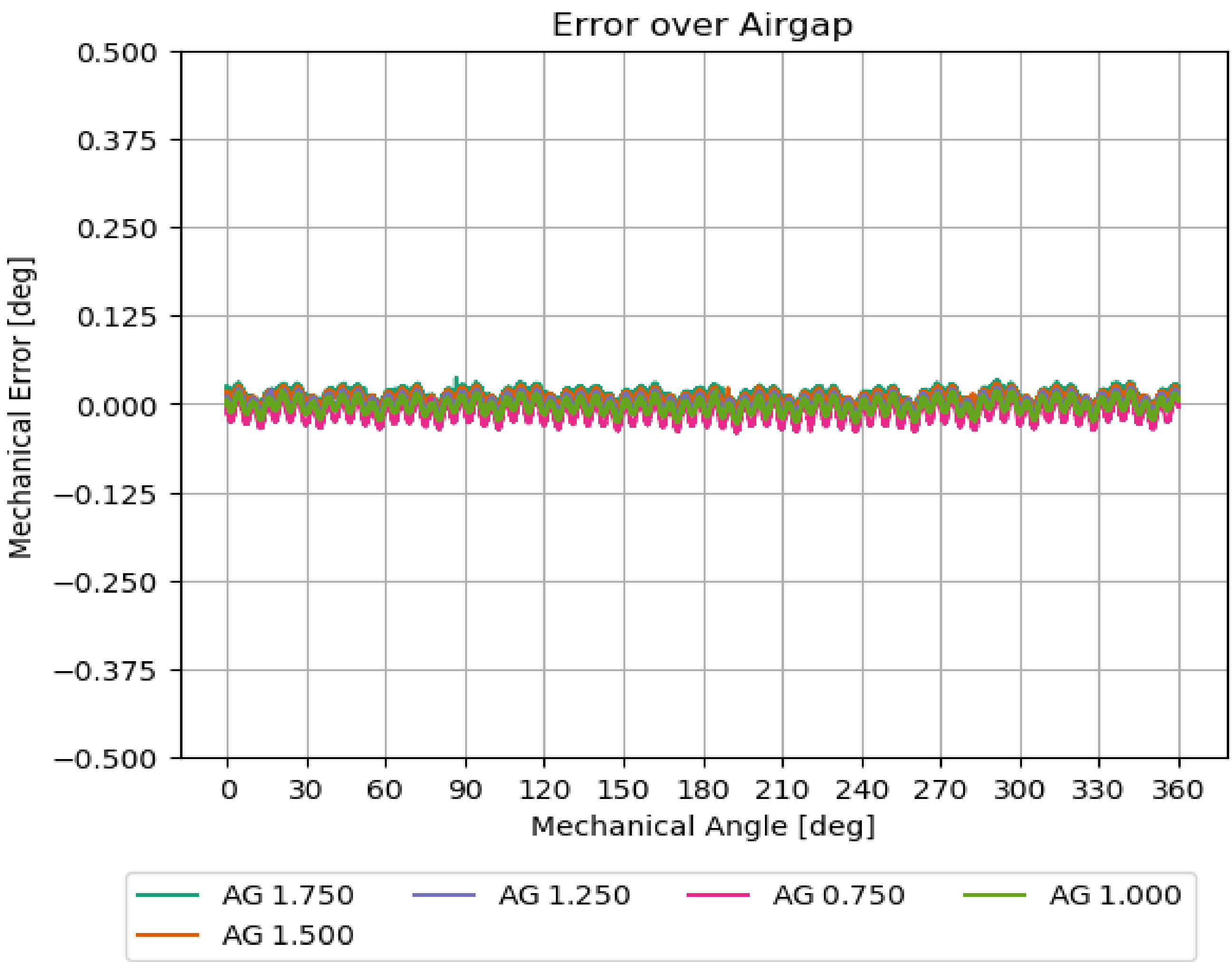

Figure 9. Error over Air Gap

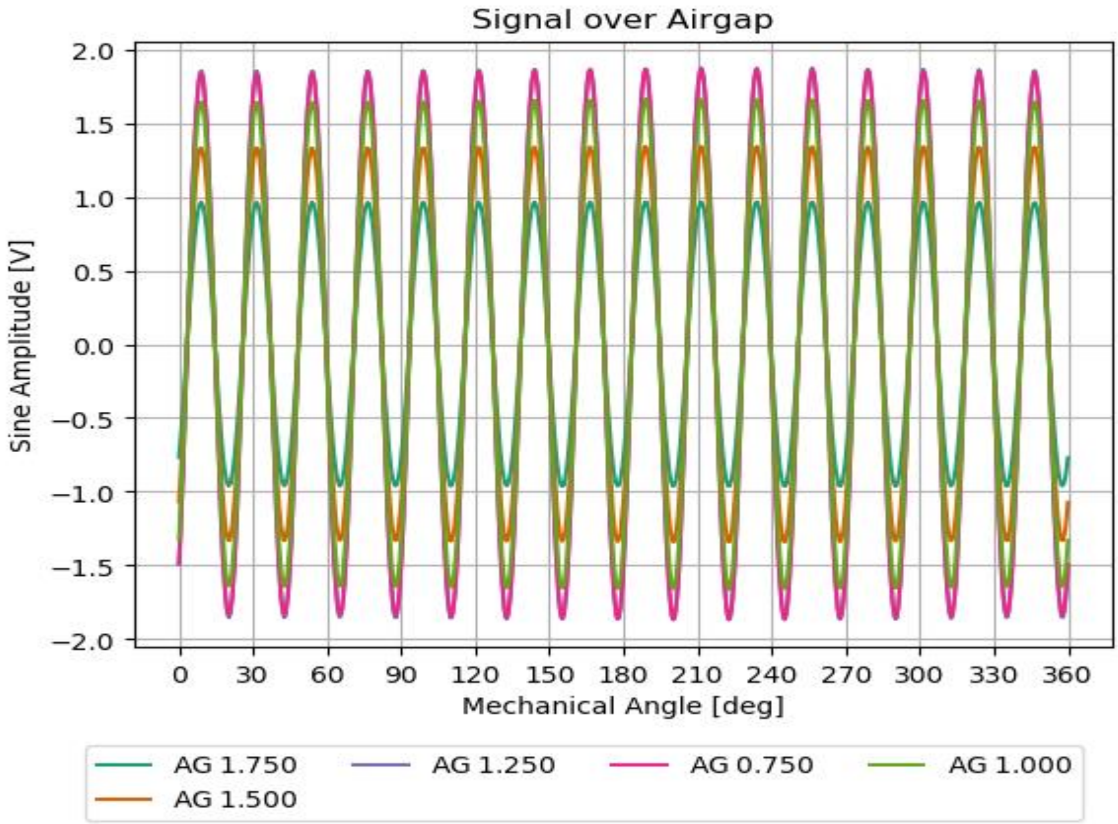

Figure 10. Sine over Air Gap

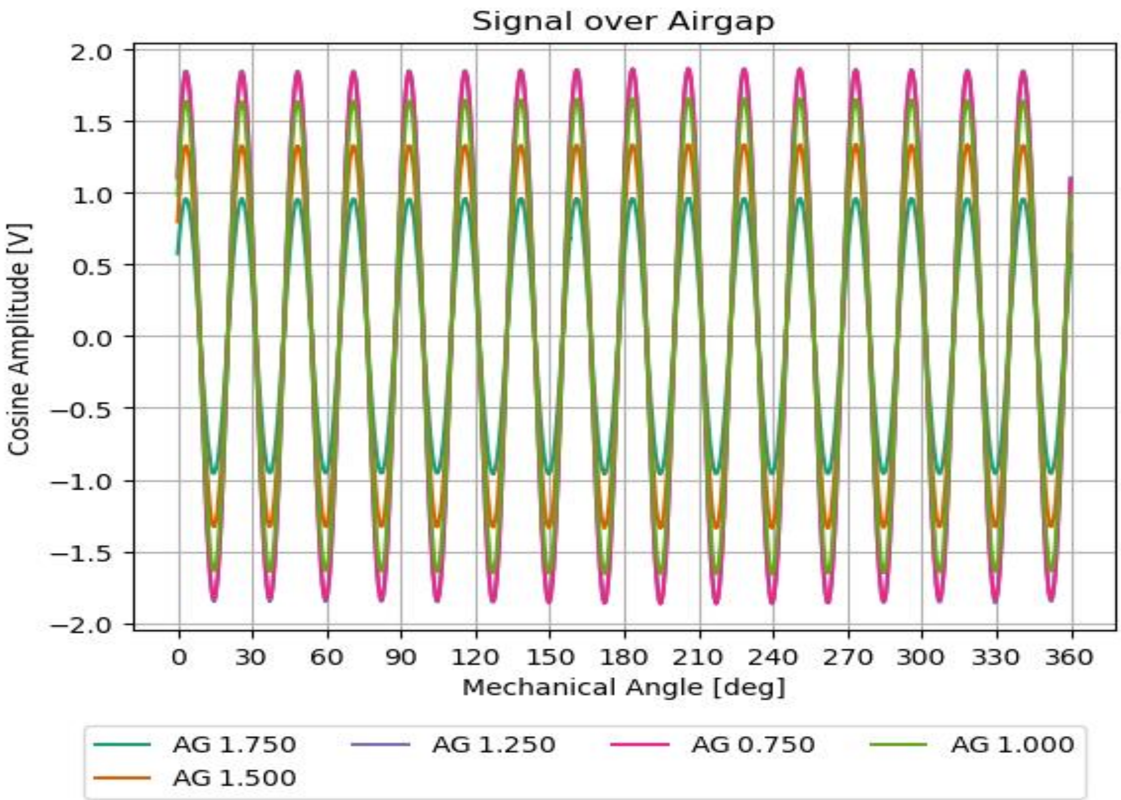

Figure 11. Cosine over Air Gap

4.2 Angle Error at Different Displacements

Figure 7. displays a series of data over a rotation of 360 degrees with no variation of air gap but with mechanical x,y displacement. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

Example: X0.000_Y-0.250_AG2.000

- Air Gap = 2.00mm
- X radial displacement = 0.00mm
- Y radial displacement = -0.25mm

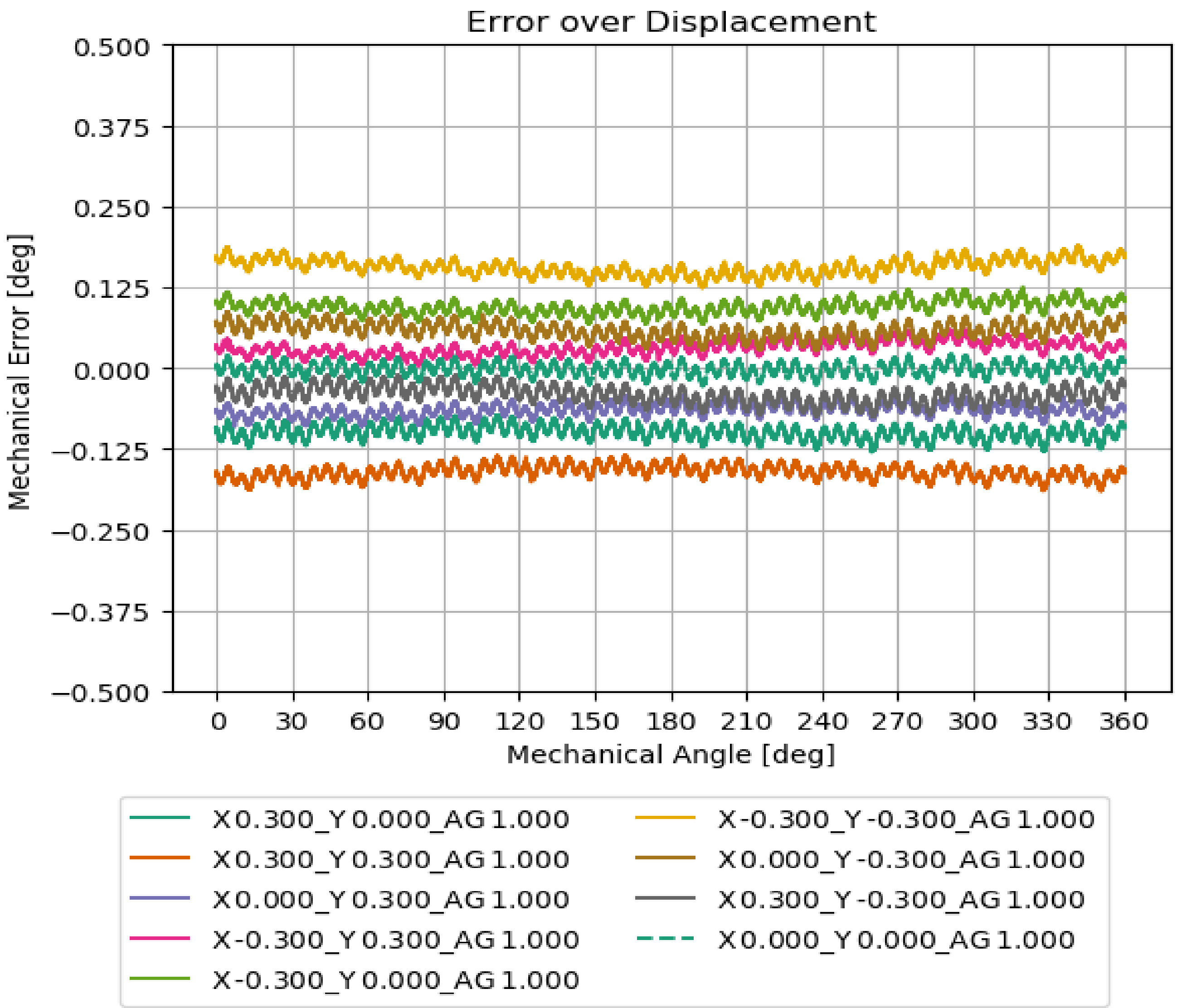

Figure 12. Error over Displacement

4.3 Angle Error at Different Tilt

Figure 8. displays a series of data over a rotation of 360 degrees with neither variation of air gap nor mechanical x,y displacement but with tilt variation. The tilt (φ) is given in degrees. Measurements are taken with the original memory settings, as shown in Table 3. No further offset cancelation and gain mismatch compensation is performed.

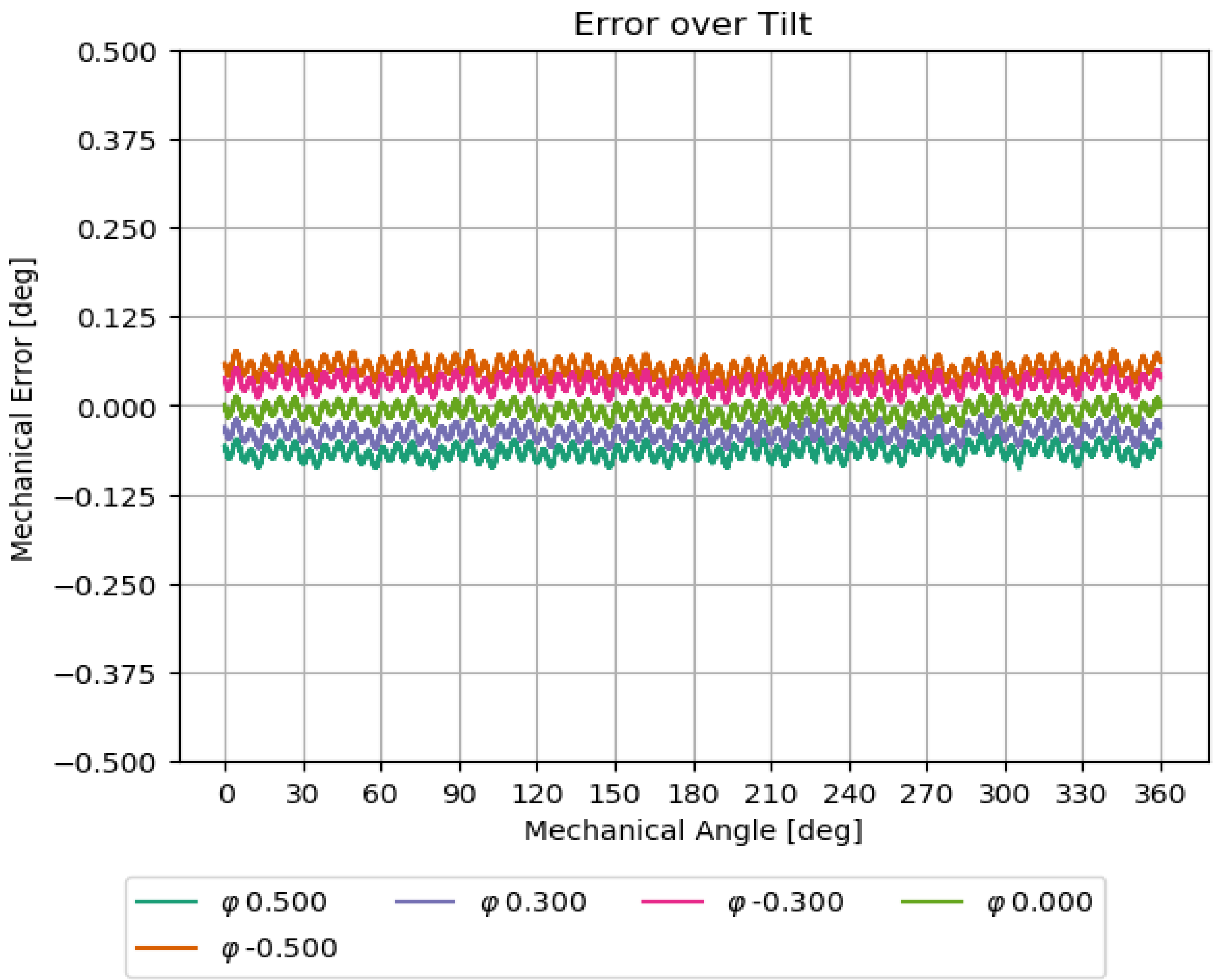

Figure 13. Error over Tilt

5. Revision History

Revision	Date	Description
	Dec. 1, 22	Initial release.