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## 1. 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_159_V10      | Rotary      | Single           | 10                   | 70 x 70       | 62 / 38                           | 60 / 36                             | 2.5                    | $\pm 0.022$ / $\pm 0.223$                  |

### 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 ( $V_{DD} = 5V$ )
- 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. |
|-------------|---------------|----------|----------------|----------------|
| 1.4 $\mu H$ | 2.26 $\Omega$ | 1100 pF  | 4.06 MHz       | 4.28 MHz       |

### 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 IPS2200.

Table 3. Registers Dump

| 0x00   | 0x01   | 0x02   | 0x03   | 0x04   | 0x05   | 0x06   | 0x07   | 0x08   |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0x0121 | 0x0001 | 0x0300 | 0x0000 | 0x008F | 0x0000 | 0x0018 | 0x00D6 | 0x00AF |

| 0x09   | 0x0A   | 0x0B   | 0x0C   | 0x0D   | 0x0E   | 0x12   | 0x13   |  |
|--------|--------|--------|--------|--------|--------|--------|--------|--|
| 0x0000 | 0x07FF | 0x0000 | 0x0000 | 0x0000 | 0x0000 | 0x0182 | 0x0003 |  |

## 1.4 Sensor Board

Figure 1. displays the sensor board layout, consisting of one transmit coil, two receive coils, IPS2200 and additional passive components.

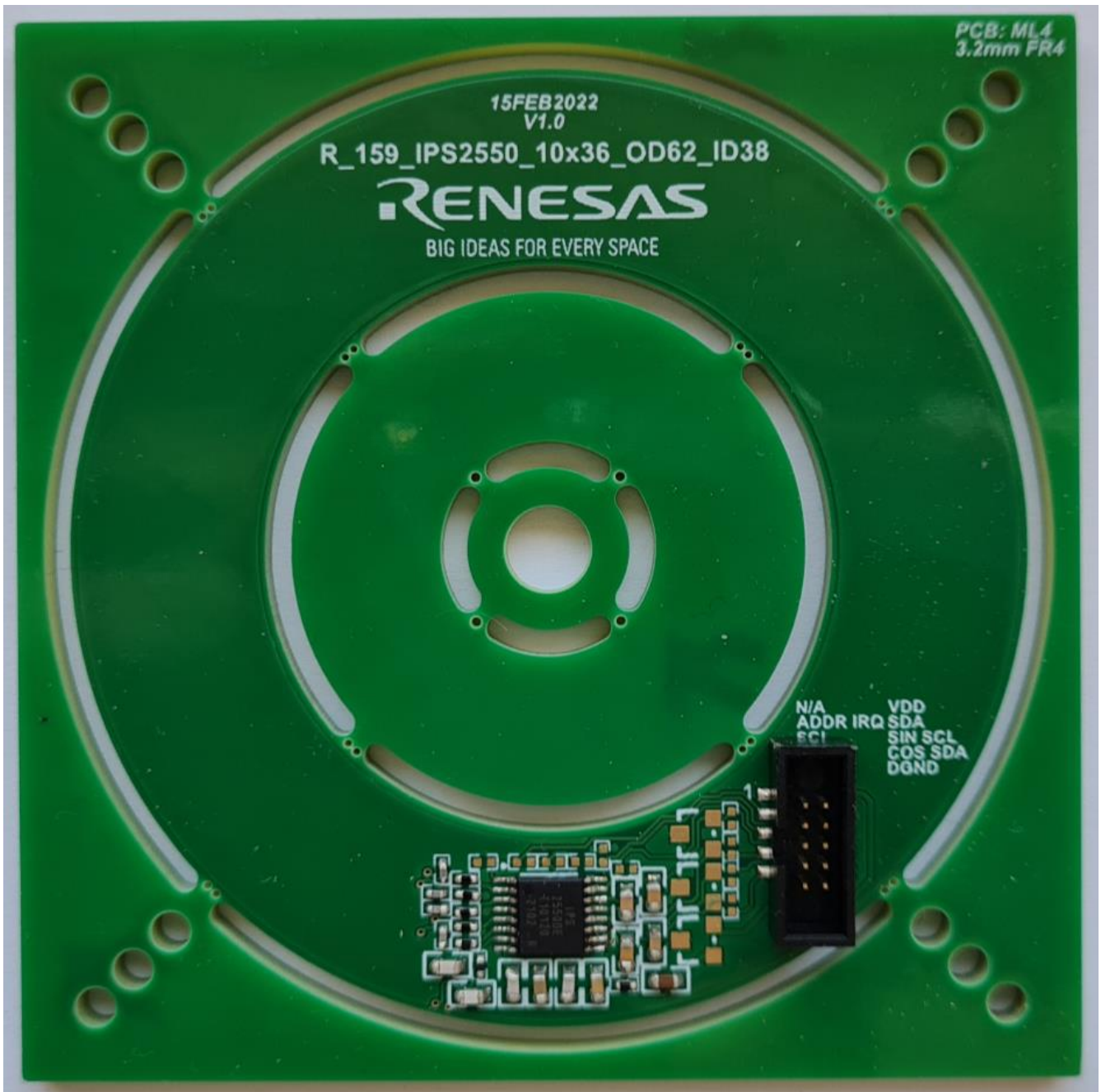


Figure 1. Sensor Board

## 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.

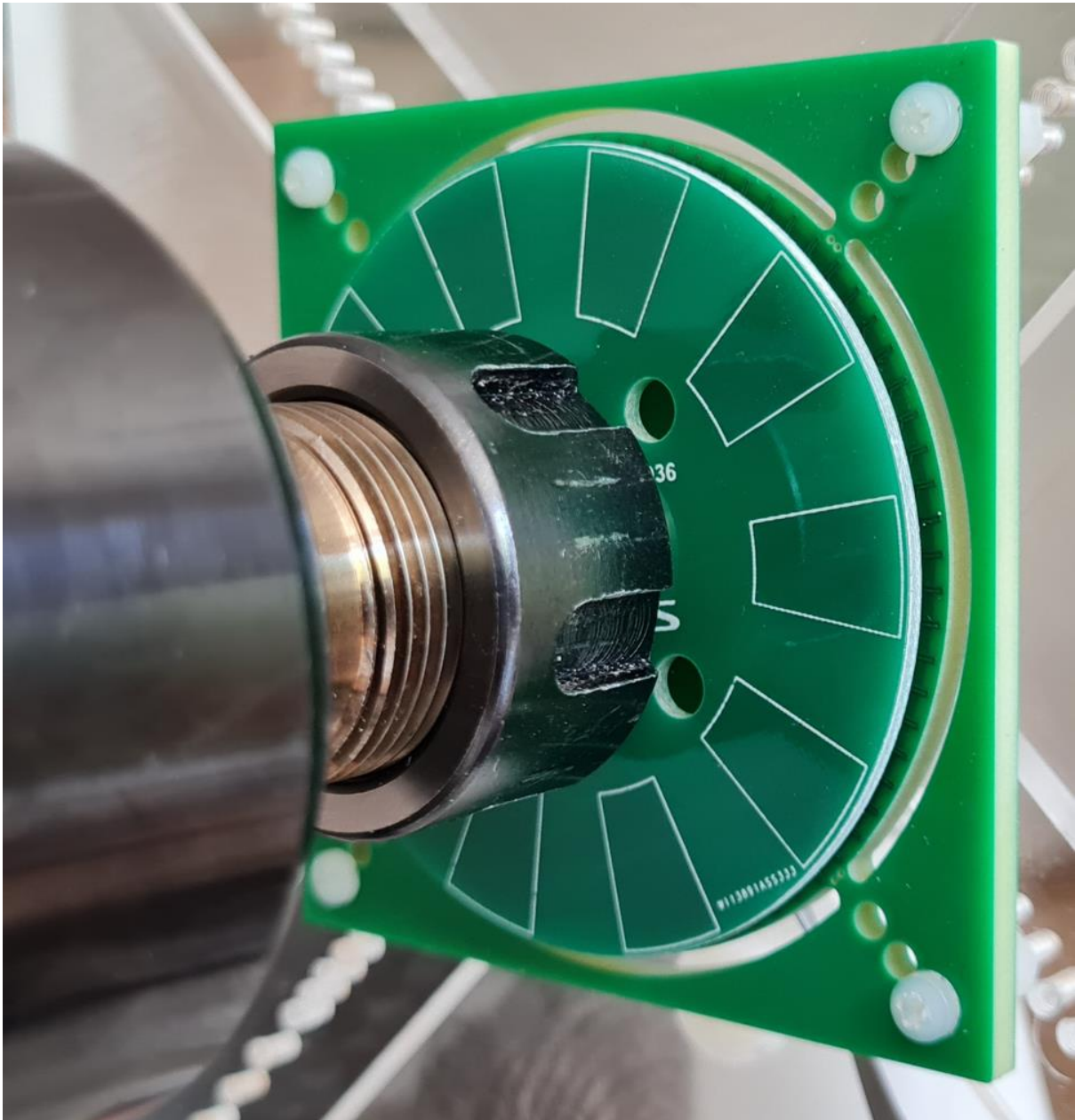


Figure 3. Setup

### 3. Measurement Results

#### 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

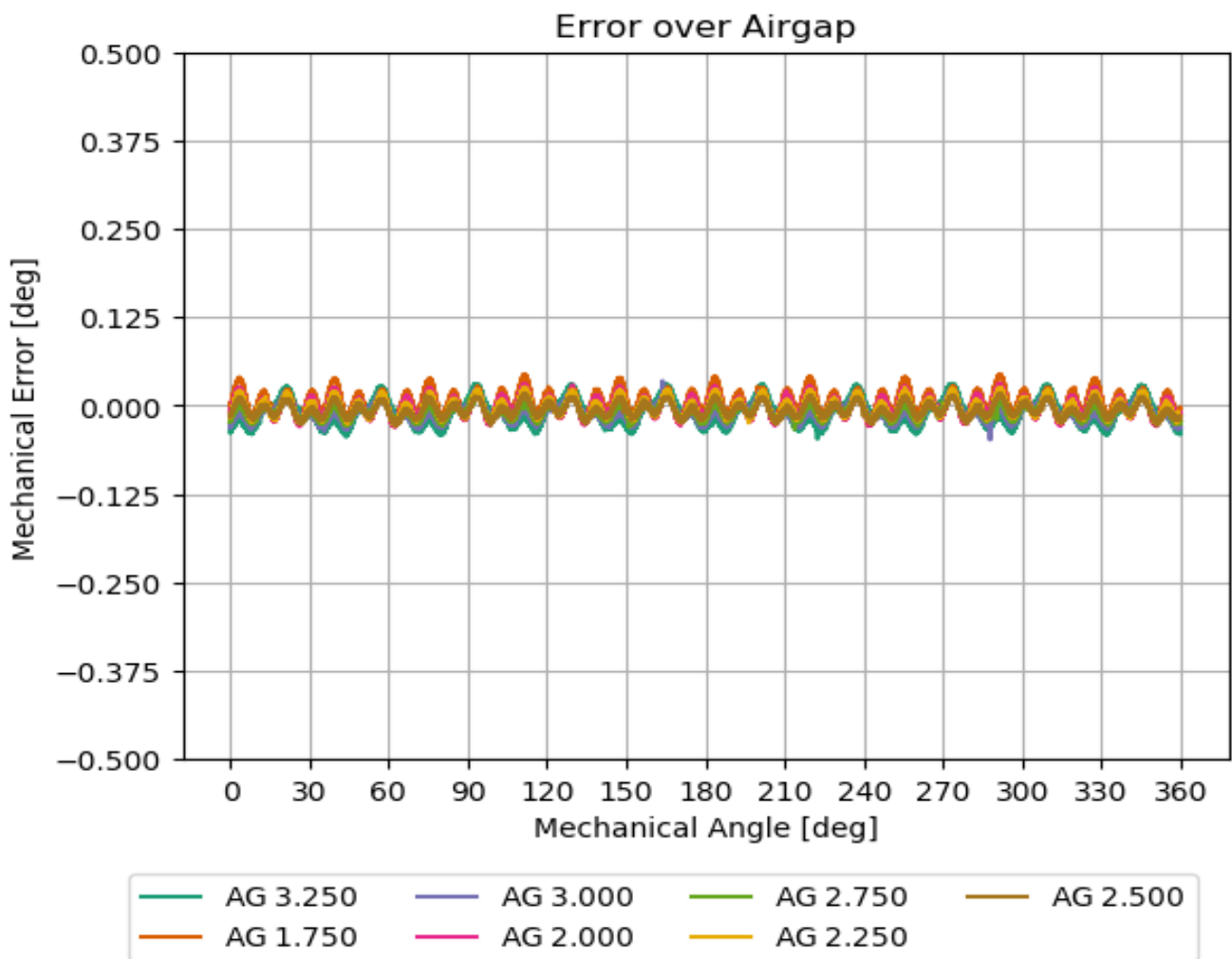


Figure 4. Error over Air Gap

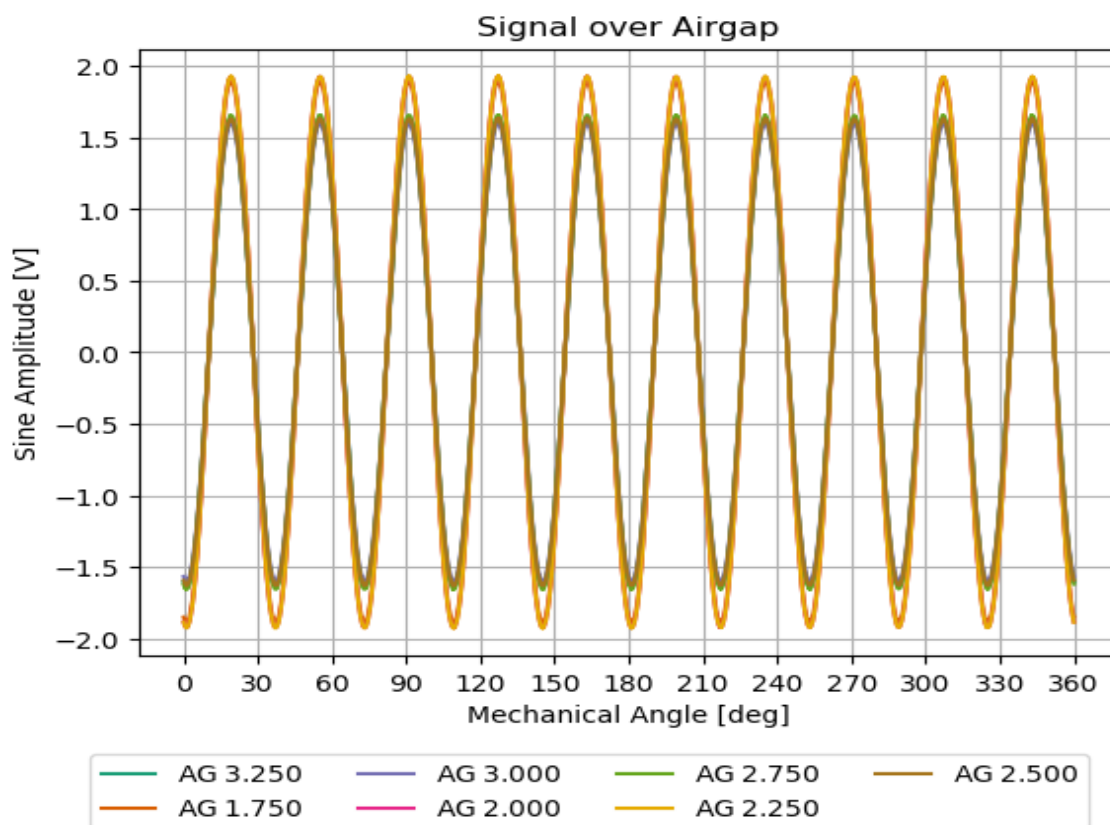


Figure 5. Sine over Air Gap

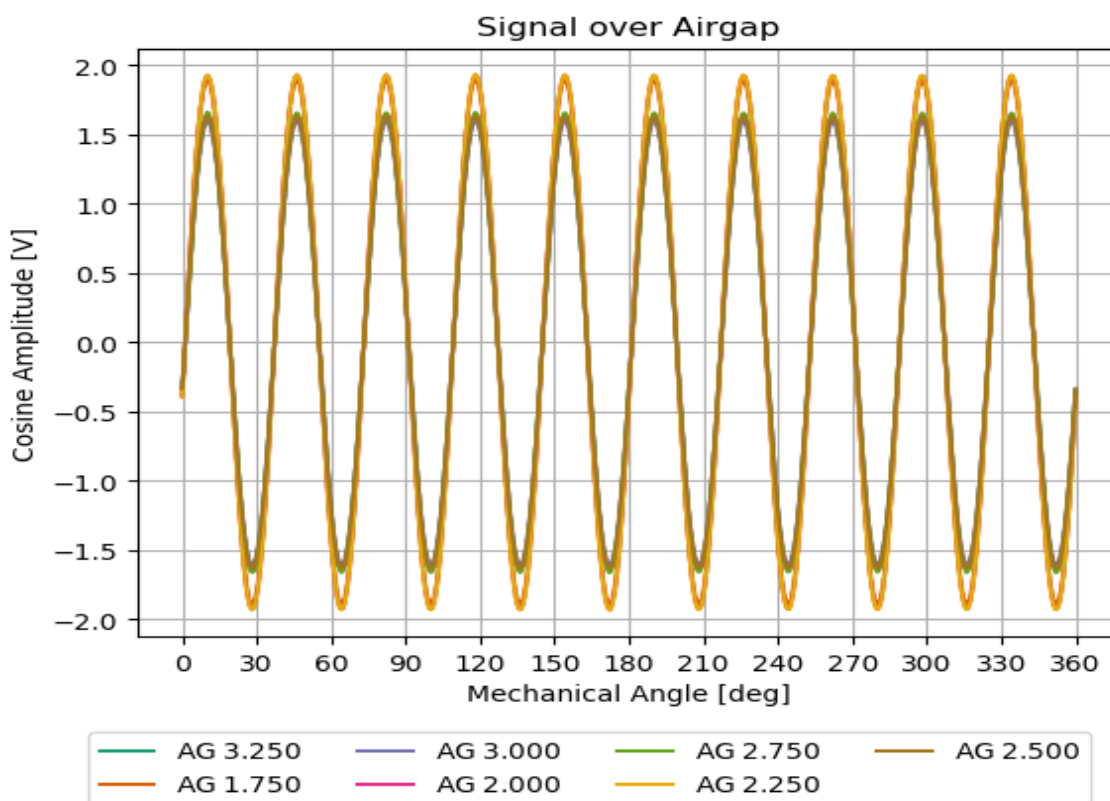


Figure 6. Cosine over Air Gap

### 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

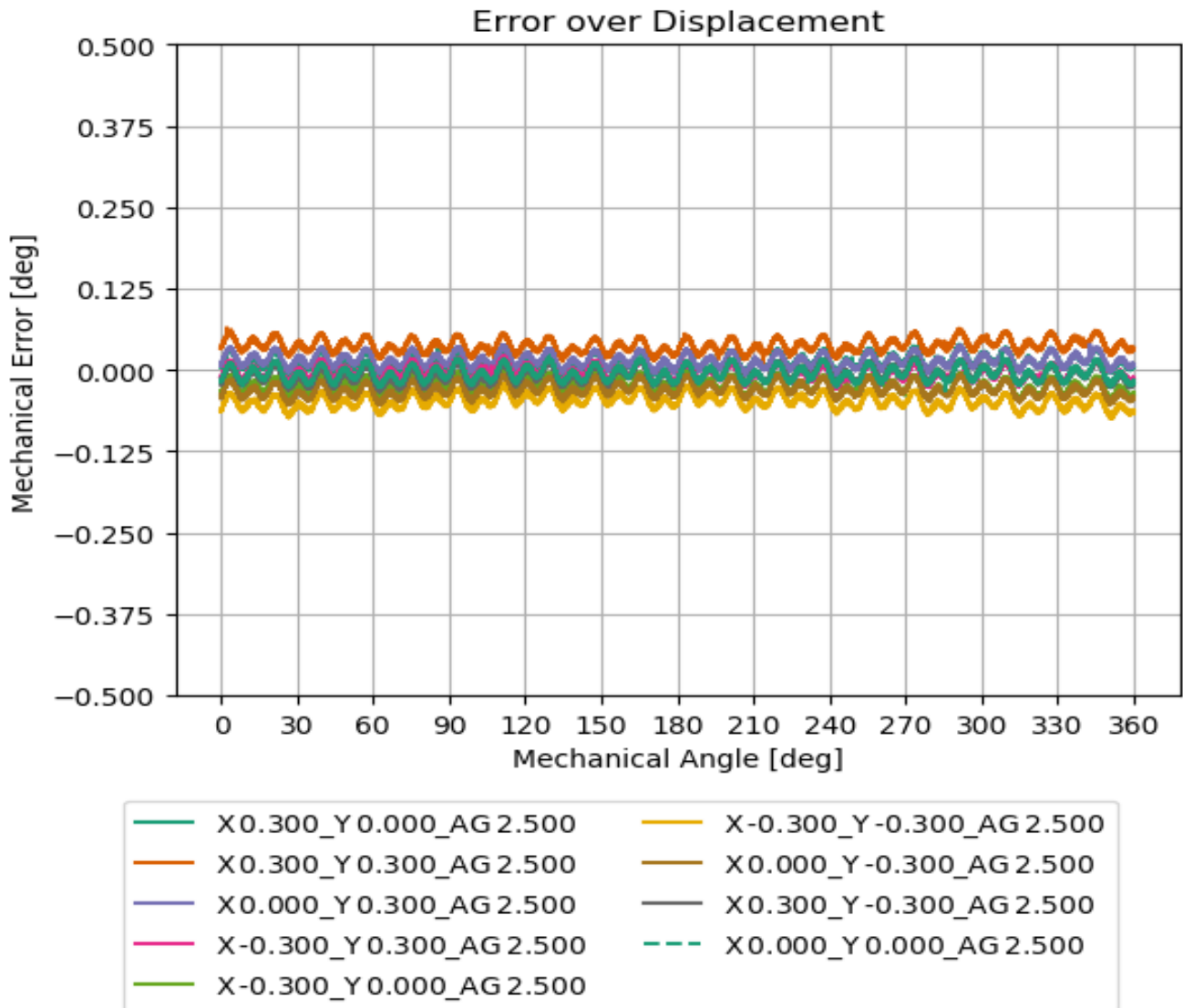


Figure 7. Error over Displacement

### 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 ( $\phi$ ) 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.

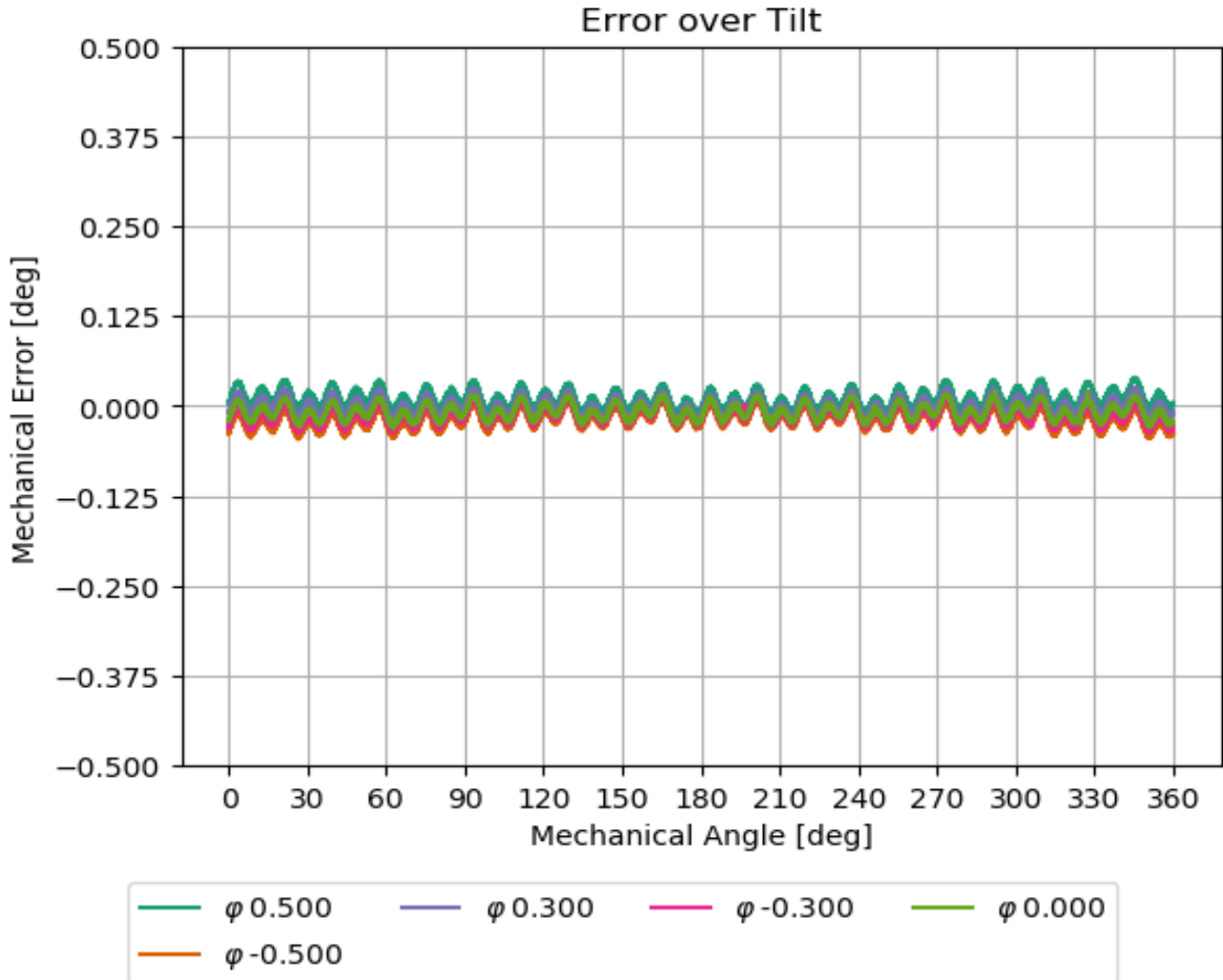


Figure 8. Error over Tilt

#### 4. Revision History

| Revision | Date        | Description      |
|----------|-------------|------------------|
|          | May. 23, 22 | Initial release. |