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## 1. Introduction

This document describes how to set up and use the Dynamic Link Library (DLL) combined with a Python® script\* to perform calibration and linearization on the ZMID520x Inductive Position Sensor IC. After running the script successfully, it will produce the new coefficients to write into the memory of the chip.

### **1.1 User Requirements**

- Windows<sup>®</sup> 7 or Windows<sup>®</sup> 10
- Recommended development environment: Anaconda® 5.2.0<sup>†</sup> with Spyder 3.6, 32-bit or 64-bit
- Development environment that supports Python 2.7, 3.4, 3.5, or 3.6

## 2. Getting Started

1. Navigate to the web page for the applicable product:

ZMID5201: <u>www.IDT.com/zmid5201</u> ZMID5202: <u>www.IDT.com/zmid5202</u> ZMID5203: <u>www.IDT.com/zmid5203</u>

- 2. Under "Software and Tools," download the zip files for the DLL and the Python script. Extract the contents of the folder after downloading has completed. The DLL and the script must be in the same folder when the script is running.
- 3. A CSV file containing the spatial angle points or the analog output points is required as an input to run the script. Save the CSV file in the same folder as the Python script and the DLL. Figure 1 shows examples of spatial angle and analog values demonstrating the format that must be used. If the values have decimal points, a period must be used as the decimal separator (not a comma).

File Edit Format View Help           10873           10873           11125           11181           11321           11484           11547           11896           11284           11284           11284           11284           11284           11280           11280           11282           12825           12826           12826           12827           12828           12829           12834           12835           12836           12832           12832           12832           13833           13843           13844 <td< th=""><th>-</th><th></th></td<>	-	
0.28551208       0.301719257         11125       0.301719257         11321       0.331628738         11484       0.34546269         11487       0.36460298         11708       0.372265797         11800       0.395511758         11800       0.39551258         11895       0.399516397         12058       0.410932521         12170       0.426646298         12180       0.436636678         12234       0.436636678         12394       0.436636678         12394       0.45038652         12394       0.45038652         12394       0.45038652         12394       0.45038652         12394       0.45038652         12394       0.45038652         12394       0.531169036         12313       0.5387386         1232       0.5387386         12392       0.5387386         13193       0.531169036         13193       0.558517344         13232       0.538198647         13447       0.5389786         13552       0.58198647         13677       0.58198647         13677 <td< td=""><td></td><td></td></td<>		
1125       0.301719257         1181       0.31711027         1321       0.31628738         1484       0.345436269         1547       0.3506460298         1548       0.35251758         1890       0.35551758         1895       0.40932521         2058       0.43633652         2170       0.436636678         2294       0.436636678         2394       0.436636578         2394       0.436636678         2394       0.43663678         2394       0.43663678         2394       0.43638652         2496       0.446497451         2538       0.546172573         2832       0.50387386         2992       0.50387386         3103       0.534125273         3123       0.546172573         3123       0.53817844         326       0.570124779         3552       0.58519344         3677       0.613679372         3677       0.613679372         3900       0.624699691         4018       0.644189623		
1181       0.317111027         1321       0.331628738         1844       0.345436269         1547       0.360460298         1708       0.372265797         1800       0.372265797         1801       0.39516397         2058       0.410935211         2170       0.42821432         2294       0.436636678         2394       0.43693652         2496       0.464697451         2534       0.47933766         2922       0.50387366         2922       0.5038736         3103       0.55817344         3123       0.55817344         3246       0.45038673         3252       0.51387134         3263       0.570124779         3552       0.58517344         3426       0.570124779         3552       0.51389647         3677       0.61369944         9809       0.613697372         3900       0.624699691         4018       0.649189623		
1321       0.331628738         1484       0.33636269         1547       0.360460298         1708       0.372265797         1809       0.372265797         2058       0.41932521         2058       0.42821432         2024       0.436536678         2394       0.436536678         2394       0.478494516         2654       0.478494516         2761       0.478494516         2761       0.5983736         2392       0.5983736         2393       0.5948735         2394       0.5984736         2761       0.478494516         2761       0.5918143         3103       0.55417573         3193       0.55417573         3193       0.55417573         3193       0.55817344         3426       0.55817344         3426       0.55817344         3426       0.55817344         3426       0.55817344         3426       0.51369747         3577       0.601307904         3607       0.613697372         3807       0.624690691         3807       0.636593778		
11484       0.345436269         11547       0.360460298         11708       0.372265797         11800       0.385571758         11895       0.399516397         12058       0.410932521         12170       0.410932521         12170       0.436536678         12394       0.436536678         12394       0.45636678         12394       0.45636678         12394       0.45636678         12394       0.45636678         12394       0.45636678         12394       0.45636678         12394       0.45636678         12394       0.456378         12394       0.456378         12394       0.456378         12394       0.456378         12394       0.456378         12395       0.519188143         12392       0.519188143         13133       0.534105036         13133       0.55817344         13146       0.5581784         13146       0.5581784         13143       0.5581784         13143       0.613697372         13154       0.613697372         13164       0.63593778 <td></td> <td></td>		
1547       0.360460298         1708       0.372265797         1800       0.3722571758         1895       0.399516397         2658       0.410932521         2170       0.4426314322         2294       0.436636678         2394       0.45636678         2496       0.446697451         2534       0.4494516         2701       0.436373786         2992       0.5387386         2992       0.5387386         2992       0.5387386         2992       0.5387386         2992       0.5387386         3103       0.55817344         3123       0.55817344         3246       0.55817384         3252       0.58518647         3263       0.58518647         3274       0.6613697372         3287       0.613697372         3390       0.613693778         3404       0.63593778         3404       0.63593778		
1708       0.372265797         1800       0.385571758         1895       0.399516397         2658       0.430932521         2700       0.422821432         294       0.436636678         2934       0.45636652         2946       0.4508652         2947       0.44697451         2638       0.49467633         2832       0.491467633         2832       0.59387386         2992       0.519188143         3103       0.534172633         3123       0.55817344         3246       0.570124779         3552       0.585198647         3677       0.6359378         3900       0.636593778         3900       0.63593778         4174       0.63498623		
1800       0.385571758         1895       0.399516397         2058       0.410932521         2170       0.410932521         2294       0.436636678         2394       0.45638652         2496       0.45638652         2496       0.478494516         2634       0.478494516         2761       0.491467633         2832       0.59387386         2992       0.519188143         3103       0.534105036         3193       0.534105036         3193       0.55817344         3246       0.570124779         3552       0.58198647         3677       0.681307904         3807       0.613697372         3900       0.613693778         4174       0.6498653		
1895       0.399516397         2058       0.410932521         2170       0.4208214322         2294       0.436636678         2394       0.45638652         2496       0.456938652         2537       0.446497451         2634       0.478494516         2761       0.491467633         2832       0.5087386         2992       0.519188143         3103       0.534105036         3193       0.558517344         3226       0.558517344         3223       0.558517344         3234       0.558198647         3525       0.661307904         3807       0.613697372         3900       0.624699691         4018       0.63593778         4174       0.636198623		
2058       0.410932521         2170       0.42821432         2294       0.436636678         2394       0.45938652         2496       0.464697451         2634       0.478494516         2771       0.59387386         2832       0.59387386         2932       0.519188143         3103       0.534105036         3193       0.534105036         3193       0.558517344         3246       0.579124779         3552       0.585198647         3557       0.61369732         3567       0.613697372         3900       0.624699591         4174       0.649189623		
2170       0.422821432         2294       0.43636678         2394       0.45636678         2394       0.45636678         2496       0.45038652         2634       0.478494516         2761       0.491467633         2832       0.59387386         2992       0.519188143         3103       0.534105036         3193       0.55817344         3246       0.579124779         3552       0.585198647         3677       0.681307904         3887       0.613697372         3900       0.63593778         4174       0.6499623		
12294       0.43636678         12394       0.456397451         12634       0.478494516         12634       0.478494516         12751       0.491467633         12832       0.59387386         12992       0.531988143         13193       0.534165036         13133       0.558517344         13426       0.558517344         13426       0.5585185477         13522       0.585185477         13677       0.6613697372         13807       0.613697372         13807       0.613697372         1390       0.624699691         14018       0.63593778         1474       0.649189623		
12394       0.45038652         12496       0.464697451         12634       0.478494516         12761       0.491467633         12832       0.50387386         12992       0.534105036         13103       0.534105036         13193       0.554172573         13323       0.558517344         13426       0.55198647         13552       0.561198794         13677       0.661367372         13677       0.613697372         13677       0.621593778         13900       0.621693778         1394       0.631697372         13900       0.634593778         14174       0.649189623		
2496       0.464697451         2634       0.478494516         2761       0.491467633         2832       0.59387386         2992       0.519188143         3103       0.534105036         3193       0.534105036         3232       0.558517344         3426       0.570124779         3552       0.585198647         3677       0.6613697372         3900       0.613697372         3900       0.624599591         4174       0.649189623		
2634       0.478494516         2761       0.491467633         2832       0.59387386         2992       0.519188143         3103       0.534105036         3193       0.534105036         3233       0.558517344         3426       0.55918647         3677       0.661307904         3807       0.613697372         3900       0.624699691         4174       0.66939778		
12761       0.491467633         12832       0.59387386         12992       0.519188143         13103       0.534165036         13193       0.546172573         13323       0.558517344         13426       0.570124779         13552       0.561308647         13552       0.561308704         13677       0.601307904         13807       0.613697372         13900       0.624699691         14018       0.63693778         14174       0.649189623		
12832       0.50387386         12992       0.519188143         13103       0.534105036         13193       0.546172573         13233       0.558517344         13426       0.579124779         13552       0.585198647         13677       0.661367944         13897       0.613697322         13900       0.624699691         14018       0.63653778         14174       0.649189623		
12992     0.519188143       13103     0.534165036       13133     0.53417573       13232     0.558517344       13426     0.579124779       13552     0.585198647       13677     0.681307904       13807     0.613697372       13900     0.624699691       14174     0.66933778		
13103       0.534105036         13193       0.546172573         13323       0.558517344         13426       0.570124779         13552       0.58198647         13677       0.601307904         13690       0.613697372         13900       0.624699691         14174       0.649189623		
3193       0.546172573         3323       0.558517344         3426       0.570124779         3552       0.58198647         3677       0.601307904         3807       0.613697372         3900       0.624699691         4018       0.63653778         4174       0.649189623		
3323       0.558517344         3426       0.570124779         3552       0.585198647         3677       0.681307904         3887       0.613697372         3900       0.624699691         4018       0.63593778         4174       0.649189623		
3426     0.570124779       3552     0.585198647       3677     0.601307904       3807     0.613697372       3900     0.624699691       4018     0.63593778       4174     0.649189623		
3552     0.585198647       3677     0.601307904       3807     0.613697372       3900     0.624699691       4018     0.636593778       4174     0.649189623		
3677     0.601307904       3807     0.613697372       3900     0.624699691       4018     0.635593778       4174     0.649189623		
3807     0.613697372       3900     0.624699691       4818     0.636593778       4174     0.649189623		
3900     0.624699691       4018     0.636593778       4174     0.649189623		
14018 0.636593778 14174 0.649189623		
44174 0.649189623		
4291		
0.0051278		

#### Figure 1. Example Content for Spatial Angle and Analog Output Values in CSV Files

<sup>\*</sup> Python<sup>™</sup> is a trademark of the Python Software Foundation.

<sup>&</sup>lt;sup>†</sup> Anaconda® is a trademark of Anaconda, Inc.

### 3. Parameters

- 1. From the development environment, open ZMID520x\_calibration\_and\_linearization.py.
- 2. There are ten parameters found at the beginning of the script, which are the user inputs as illustrated in the example given in Figure 2. Table 1 defines the parameters to set.
- 3. Run the script after the parameters have been set correctly. The result will appear in the console window.
- 4. Write the new coefficients in the respective memory in the chip. One method is via the ZMID520x EVK Application Software, which is a graphical user interface (GUI) provided on the IDT website.

#### Figure 2. Example of the Python Script

```
21
22
23 DLL = ctypes.WinDLL (r'C:\OneStepDLL\ZMID520X_OneStepCalibration_32.dll')
24 filename = 'spatialangle.csv'
25 spa_or_analog_input = 0
26 zmid_type = 1
27 position_slope = 0
28 reverse_slope = 0
29 out_mod = 0
30 clamping_percent_low = 5
31 clamping_percent_high = 95
32 Vdd_value = 4.994
33
34
```

#### Table 1.Parameters

Parameter	Description
DLL	Full path of the location of the DLL, including the filename with ".dll" at the end.
	Note: Write the path inside the parentheses. Keep "ctypes.WinDLL" as it is.
filename	Name of the file containing the spatial angle/analog values, including .csv at the end.
spa_or_analog_input	This parameter specifies which values the input file contains:
	0 = Input file with spatial angle values
	1 = Input file with analog values
zmid_type	Select the product:
	1 = ZMID5201; analog output
	2 = ZMID5202; PWM output
	3 = ZMID5203; SENT output
position_slope	Position_slope defines the slope of the spatial angle values:
	0 = Positive
	1 = Negative
reverse_slope	This applies to the intended output of Position0 where
	0 = Keep the slope
	1 = Invert the slope

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Parameter	Description
out_mod	Output mode of the chip:
	0 = Linear Output Mode
	1 = Modulo360 Output Mode
percent_input_low	Lower clamping in percentage. 5 = no clamping.
percent_input_high	Upper clamping in percentage. 95 = no clamping.
Vdd_value	Supply voltage when using analog output.

## 4. Example of Usage

The following lines are an example of completing the parameters using a ZMID5201 (analog output) and a positive spatial angle as input. In this example, the output mode is set to linear, the slope is not inverted, and clamping is set to 10% and 90%. The supply voltage is set to 5V; however in this example, it will not affect the calculation because the input file is the spatial angle. For all parameters used in this document, refer to the user guide for calibration and linearization.

```
DLL = ctypes.WinDLL(r'C:\Users\Desktop\OneStepDLL\ZMID520X_OneStepCalibration_32.dll')
filename = 'spatialangle.csv'
spa_or_analog_input = 0
zmid_type = 1
position_slope = 0
reverse_slope = 0
out_mod = 0
clamping_percent_low = 10
clamping_percent_high = 90
Vdd_value = 5
```

After the parameters are entered and the script has run without errors, the new coefficients for the memory will appear in the Python console. The following lines are an example of what the output can look like when the script has run successfully.

Write to EEPROM: Address 0x00: 234D Address 0x01: 050A Address 0x02: 0505 Address 0x03: 0200 Address 0x04: 9391 Address 0x05: A9A1 Address 0x06: 8A94 Address 0x07: 000C

The new coefficients can be written in the entry fields provided on the "MEMORY EDIT" tab in the GUI and saved in the ZMID520x memory by clicking the "Write EEPROM" button.

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E SETTINGS TOOLS F	HELP									
MID5201										www.IDT.co
CONNECTION	MAIN CO	NFIGURE	CALIBRATIC	N COMM	MAND CONS	OLE ME	MORY EDIT			ACTIVE DEVICES
Disconnect	EEPROM	0	1	2	3	4	5	6	7	Refresh
	0h	234D	050A	0505	0200	9391	A9A1	8A94	000C	Device: D:
IC STATUS	8h	E226	010D	0802	8117	083B	0255	BFFF	0000	Name: ZMID5201
Powered	10h	0000	00C2							FW: 00.05.1000 Device: COM7
Busy APP mode										Name: ZMID5201 FW: 00.05.1000
CMD mode	SWR	0	1	2	3	4	5	6	7	11110000511000
SW parity error	0h	2400	0400	0000	0000	0000	0000	0000	0000	
Read Status	8h	E226	010D	0802	8117	083B	0255	BFFF		
	10h		00C2		03B1	0005	0002	6571	0014	
I/O FUNCTIONS	18h	4D47	4D47	4D47	0001					
Read EEPROM										
Write EEPROM										
Copy SWR To EEPROM										
Reset IC										
	Register values in	n red are diffe	rent than actual v	alues in chip m	emory. You nee	d to write them	to chip memory	in order to tak	e effect.	

### Figure 3. Example of Writing Coefficients Using the "MEMORY EDIT" Tab

### 5. Error Codes

Table 2 describes possible DLL error codes. A code of 0 indicates that the run was successful.

#### Table 2. Error Codes

Error Code	Error Name	Description
Error code -1	ERR_INVALID_INPUT	One or more of the inputs are invalid.
Error code -2	ERR_SLOPE	The calculated slope is out of range.
Error code -3	ERR_OFFSET	The calculated offset is out of range.
Error code -4	ERR_CORR	One or more of the calculated correction values are out of range.
Error code -5	ERR_POS0	One or more of the calculated Pos0 values are out of range.
Error code -6	ERR_POS1	One or more of the calculated Pos1 values are out of range.

# 6. Revision History

Revision Date	Description of Change
August 1, 2018	Initial release

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