ANALOG DEVICES

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APPLICATION NOTE

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Modifying the Range of the ADXRS150 and ADXRS300 Rate Gyros

by Harvey Weinberg

INTRODUCTION

The ADXRS150 and ADXRS300 rate gyros have a dynamic range of ±150°/s and ±300°/s, respectively. In some cases a user may wish to have a dynamic range or scale factor other than what is offered. This application note will discuss three techniques that can be used to modify the dynamic range to provide about one third the rated dynamic range to several thousand degrees per second.

INCREASING THE SCALE FACTOR

If the goal is to increase the scale factor (e.g., give an ADXRS150 a ±100°/s range), then one could easily add a simple amplifier circuit, as shown in Figure 1. The only drawback to this technique is that several external components are required.

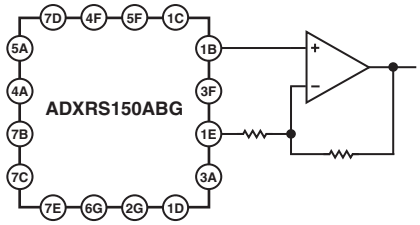

Figure 1. Amplifier Circuit to Increase Scale Factor

Alternatively, a resistor could be placed between the CMID and SUMJ terminals. This raises the gain of the output amplifier by reducing the value of R_{SEN2}. For the ADXRS150, the modified dynamic range is roughly described by the following equation:

$$RANGE_{NEW} = 75 \times \left(1 + \left(2R_{EXT} / \left(2R_{EXT} + 18\right)\right)\right)$$

where R_{EXT} is the external resistor between CMID and SUMJ in kΩ.

The modified scale factor is roughly described by the following equation:

$$SCALE_{NEW} = \left[\left(18 + 2R_{EXT}\right) / \left(9 + R_{EXT}\right)\right] \times 12.5$$

These equations are approximate because R_{SEN2} has a value that varies ±35%. So it is likely that anyone using this technique will have to adjust the external resistor value somewhat for each part in order to arrive at an accurate sensitivity value.

A low tempco resistor is recommended because the external resistor's temperature coefficient will affect the gyro's sensitivity tempco. In general, one can increase the scale factor of a given part by a factor of approximately 1.5 without difficulty.

DECREASING THE SCALE FACTOR BY LESS THAN A FACTOR OF FOUR

If moderate extension of the dynamic range is required (an increase by a factor of 4 or less), the recommended method of modifying the dynamic range is by adding a resistor (R_{EXT}) across the SUMJ and RATEOUT pins. This reduces the gain of the final amplifier. Table I outlines various ranges and their appropriate resistor values. Note that since the internal resistor (R_{OUT}) between the SUMJ and RATEOUT pins is factory trimmed to be accurate to ±1%, these values can be well predicted.

There are two possible drawbacks to this technique:

- Reducing the feedback resistance across the output amplifier will result in a change in the null drift performance of the gyro (by as much as 2°/s over the –40°C to +85°C range).
- The initial null output may shift somewhat. This can be readjusted by the user, employing null adjustment techniques outlined in the gyro data sheet.

Table I. Scale Factor for Various Values of R_{EXT}

	ADXRS150		ADXRS300	
R_{EXT} (kΩ)	Range (°/s)	Scale (mV/°/s)	Range (°/s)	Scale (mV/°/s)
536	200	9.4	400	3.7
267	250	7.5	500	3.0
178	300	6.2	600	2.5
133	350	5.3	700	2.1
107	400	4.7	800	1.9
88.7	450	4.1	900	1.7
76.8	500	3.7	1000	1.5
66.5	550	3.4	1100	1.4
60.4	600	3.1	1200	1.3

DECREASING THE SCALE FACTOR BY MORE THAN A FACTOR OF FOUR

If very wide dynamic range is required, the motion of the gyro's resonator must be attenuated. This is done by eliminating the capacitors at CP1/CP2 and CP3/CP4 and applying a fixed voltage at CP5 (V_{CP5}). Any voltage below approximately 12 V will result in a reduction of the scale factor. Table II shows some experimental results using this technique with the ADXRS150.

Table II. Scale Factor for Various Values of V_{CP5}

V_{CP5}	Scale (mV/°/s)	Range (°/s)
5	0.27	5500
6	0.56	2600
7	1.02	1400
8	1.72	900

Some care must be taken to ensure that the voltage used is very stable because any change to the CP5 voltage will cause a change in the scale factor. Since even small variances in CP5 voltage result in large changes in scale factor, the user must calibrate both the null and sensitivity of each unit if this technique is used.

If one requires a dynamic range greater than ~5000°/s, a combination of techniques may be used, such as adding an external resistor and reducing the voltage at CP5. Using an ADXRS300 with an external resistor of ~60 kΩ and a V_{CP5} of 5 V, a dynamic range of roughly 50,000°/s can theoretically be achieved. Such extreme measures must be thoroughly characterized for performance by the user to ensure suitable operation in the application.

CONCLUSION

The ADXRS150 and ADXRS300 output structure flexibility can be exploited to deliver virtually any scale factor that the user requires. In general, adding external passives or modifying V_{CP5} requires that the user recalibrate the null and sensitivity.

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