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APPLICATION NOTE

ST7 10-BIT A/D CONVERTER NON-LINEARITY AT CENTER OF RANGE

by MCD Application team

INTRODUCTION

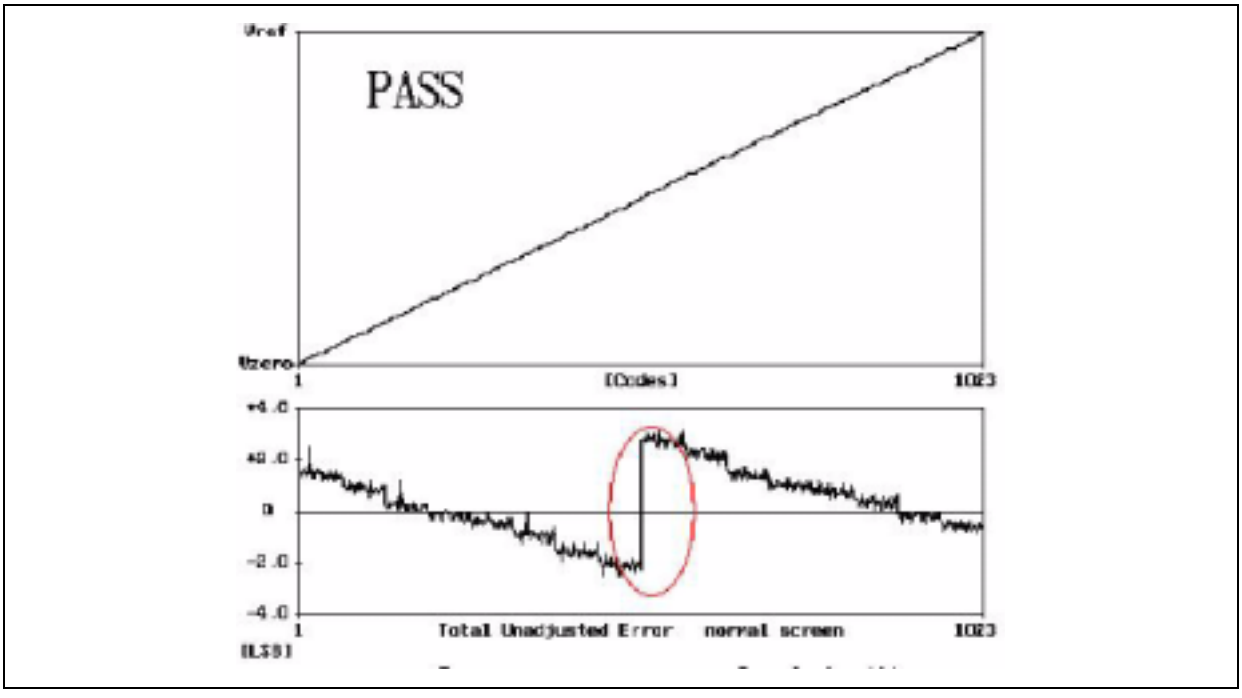
The digital output of the 10-bit A/D Controller is not always linear when compared to the analog input voltage.

This application note explains in brief the non-linearity effect around the center of the analog input range and its impact on applications.

1 ERROR DISTRIBUTION

The errors are not evenly distributed on entire voltage range.

Figure 1. Diagram for error recorded Vs analog voltage range

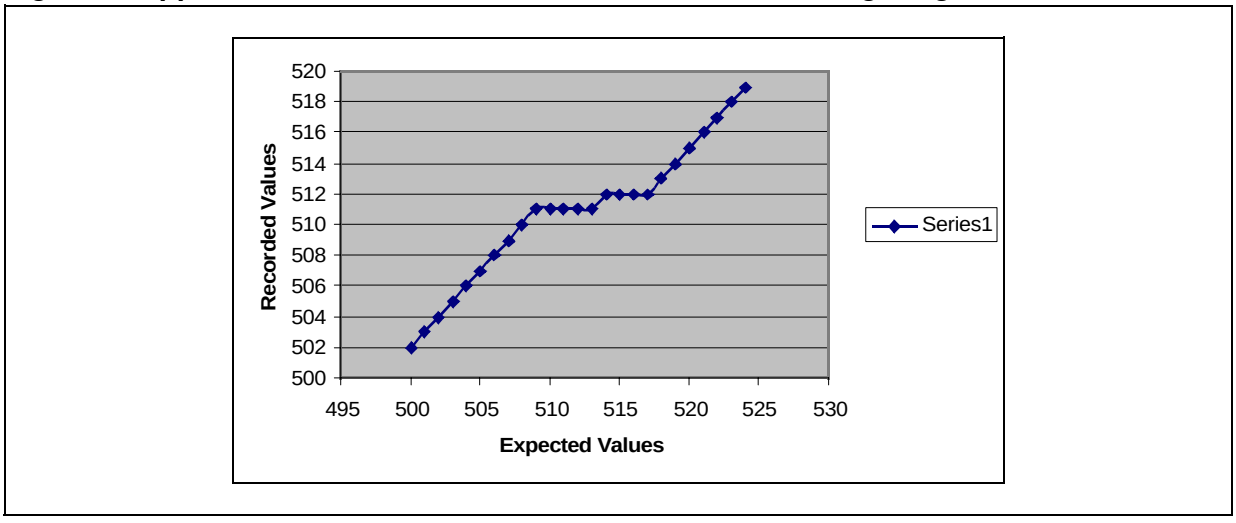


There can be cross-over points where, the error changes from positive polarity to negative or vice versa.

1.1 TRANSFER CURVE

In ideal case, if we draw a transfer curve between the analog input and digital expected values, there is a linearity and one-to-one correspondence.

Figure 2. Approximate transfer curve around center of analog range



In practice, the curve between analog input and digital recorded value is not perfectly linear. There is a potential non-linearity at the center of analog input range i.e around digital code of 512.

1.2 AFFECTED VOLTAGE RANGE

(approximate, only for reference) for V_{AREF} = 5V

Table 1. Affected voltage range

	Minimum	Maximum
Analog Voltage	$V_{AREF}/2$ - 20mV	$V_{AREF}/2$ + 25mV
Digital code corresponding to analog voltage	509	517

The behavior described above is less than the typical accuracy error specified in the ST7 datasheets (typical TUE, DLE), but there is a possible impact if the user does not consider the strong non-linearity in transfer curve and change in polarity of errors of digital values for increasing analog input between 509 to 516.

1.3 WORKAROUND

To handle this non-linearity the user has to take care in the software depending on the application.

Please note that the digital codes are linear below and above the 512. For majority of the applications this behavior will have no impact. But for sensitive applications related to process control there is a possible impact if not taken care.

2 REFERENCES

AN1636: Understanding and minimizing ADC conversion errors.

AN1711: Software techniques for compensating ADC errors.