

HI7190/HI7191 Negative Full Scale Error vs Conversion Frequency

TB348
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Introduction

This technical brief highlights a recently discovered performance anomaly with the HI7190/1. The problem occurs when the digital code for the notch filter is programmed within certain frequencies listed in Table 1 (assuming a 10MHz clock). We believe the error is caused by the calibration logic and the digital notch code NOT the absolute frequency. The error is seen when the user applies mid-scale (0 volt input, Bipolar mode). With this input, the expected digital output should be mid-scale (800000_H). Instead, there is a small probability, of an erroneous negative full scale (000000_H) output.

Experimentation

To characterize the performance anomaly, we tested the device at each of the possible notch frequencies. With an input voltage of mid-scale (0v), 100 hundred conversions were recorded. The frequencies which exhibited at least one negative full scale (NFS) output code are found in table 1. In addition, graph 1 shows the number of erroneous conversions observed at each frequency. Reviewing the graph indicates, the higher the conversion frequency, the lower the probability of observing the NFS error. This is due to the reduced probability of the output code being exactly mid-scale given the noise. For example, with a 10 hertz notch only the lower few data bits are toggling, therefore; there is a high chance (>25%) of hitting exactly mid-scale. With a high conversion rate of 1953 hertz the lower 11 bits are toggling, therefore; there is a very low chance of hitting the exact mid-scale code.

Summary

The present revision of the production silicon operates as designed and meets all other documented specifications. It is highly recommended to avoid the notch frequencies detailed in table 1 based on this limited experimentation. There may be additional notches which exhibit the negative full scale errors which are not identified in table 1. If these frequencies are absolutely needed, the master clock can be increased or decreased slightly ($\pm 10\%$) to accommodate the desired frequency, since the problem is related to the control register programming and not the absolute frequency. In addition, the user may desire to screen the NFS error in software. The user should evaluate their application to determine their sensitivity to this possible anomaly given the likelihood of the input being exactly mid-scale, bad notch frequency and output code hitting exact mid-scale.

TABLE 1. FREQUENCY RANGES WHICH EXHIBITED MID SCALE ERRORS

(Avoid these control register frequencies)

CONVERSION FREQUENCY FNOTCH (HERTZ)		CONVERSION FREQUENCY FNOTCH (HERTZ)	
MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
9.541	9.914	1220.703	1220.703
10.917	11.759	1502.404	1502.404
12.019	12.496	1775.568	1775.568
13.745	14.808	1953.125	1953.125
15.141	15.738		
17.33	18.654		
19.073	19.829		
21.847	23.503		
24.053	24.976		
27.509	29.593		
30.281	31.451		
34.691	46.95		
48.107	49.952		
55.018	59.186		
60.656	62.801		
69.506	74.547		
76.294	79.074		
87.584	93.9		
96.213	99.649		
110.346	125.2		
139.509	157.51		
175.957	199.298		
221.946	250.401		
279.018	398.597		
443.892	465.03		
558.036	630.04		
723.38	723.38		
930.06	930.06		

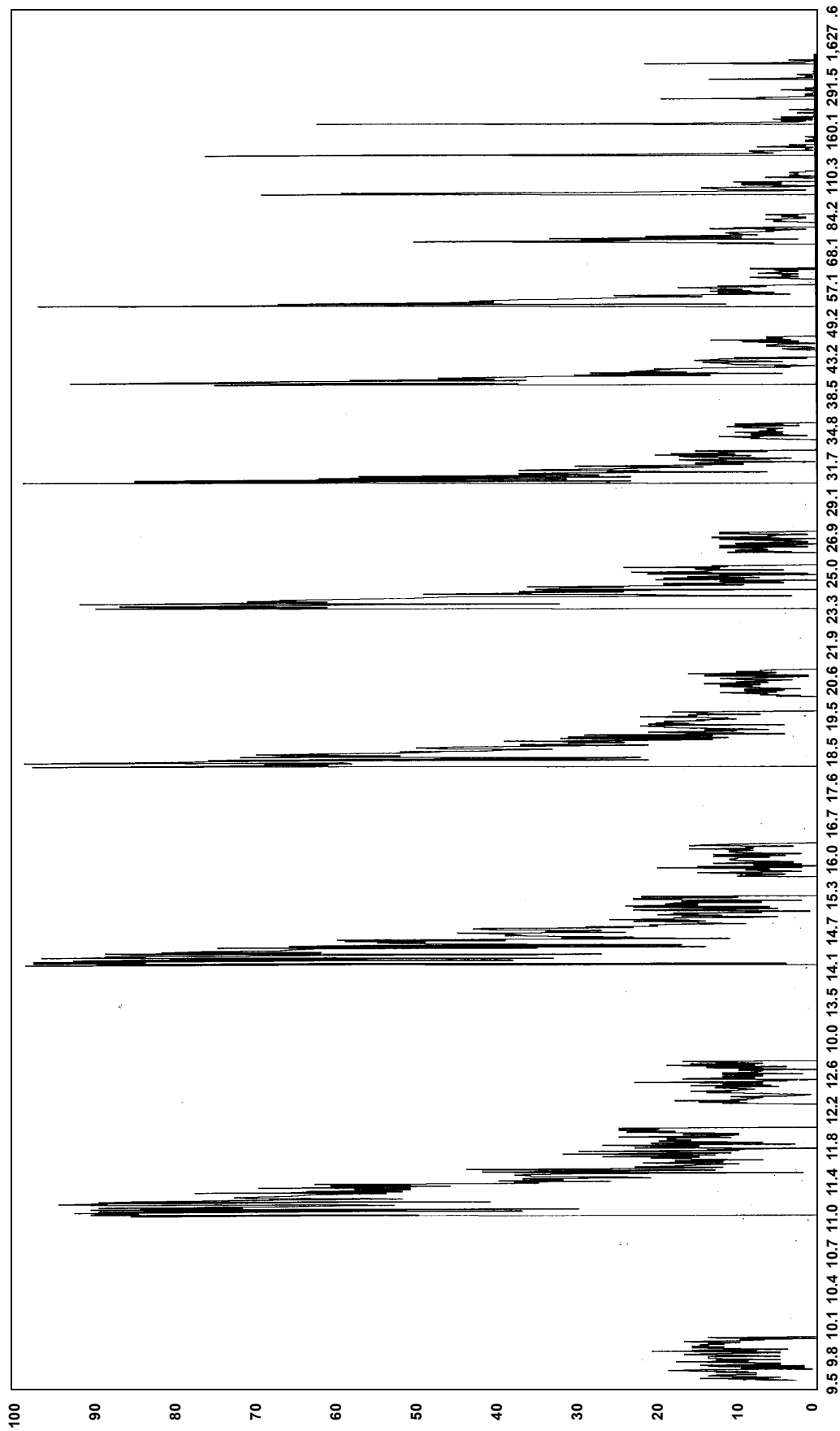


FIGURE 1. NEGATIVE FULL SCALE ERRORS PER 100 COVERSIONS

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