V00.0112

Gain and Range Control on the HMC1520

Product Application Note

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Contents

Tables

2 Elizabeth Drive Chelmsford, MA 01824 Phone: 978-250-3343 Fax: 978-250-3373

1 Introduction

The HMCAD1520 has programmable Full Scale input control and well as a coarse and fine programmable gain function. These provide a flexible on-chip signal attenuation system and simplify front end design. The following sections detail the operation of these features.

2 Full Scale Control

For the HMCAD1520, the typical FSR, the Differential input full scale range, is 2 Vpp. This can be adjusted by an internal 6 bit DAC controlled by the *fs_cntrl* register. This adjustment is an analog one to the input of all four converters. The maximum range adjustment is ± 10%. The values for the adjustment range are approximate but the DAC is guaranteed to be monotonic. The 6 bits used in the *fs_cntrl* register are detailed below.

Name	Description	Default	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Hex Address
fs_cntrl <5:0>	Fine adjust ADC full scale range	0% change											X	X	X	X	X	X	0x55

Table 1 Full Scale Control

Table 2 shows how the register settings correspond to the full-scale range. Changing the value by one step adjusts the full-scale input range by approximately 0.3%. The range can be adjusted from approximately 1.8 Vpp to 2.194 Vpp.

fs_cntrl<5:0>	Full-scale range adjustment
111111	9.7 %
111110	9.4 %
.	.
100001	0.3 %
100000	0%
011111	-0.3 %
.	.
000001	−9,7%
000000	−10,0%

Table 2 Full Scale Range Adjustment

3 Programmable Gain Function

The Programmable Gain is a digital function and has both coarse and fine settings. The coarse gain of each channel can be individually set using a 4 bit code, cgain<3:0>, in registers 0x2A and 0x2B as shown below. The gain can be set in dB steps or in gain factor steps (per Table 4) depending upon the setting of register cgain_cfg. When cgain_cfg = 0, a gain in dB steps is enabled. Otherwise, if cgain_cfg =1, a gain factor is enabled.

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Name	Description	Default	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Hex Address
coarse_gain _cfg	Configures the coarse gain setting	x-gain enabled																X	0x33
fine_gain_en	Enable use of fine gain.	Disabled															X		
cgain4_ch1 <3:0>	Programmable coarse gain channel 1 in a Quad Channel setup.	1x gain													X	X	X	X	0x2A
cgain4_ch2 <3:0>	Programmable coarse gain channel 2 in a Quad Channel setup.	1x gain									X	X	X	X					
cgain4_ch3 <3:0>	Programmable coarse gain channel 3 in a Quad Channel setup.	1x gain					X	X	X	X									
cgain4_ch4 <3:0>	Programmable coarse gain channel 4 in a Quad Channel setup.	1x gain	X	X	X	X													
cgain2_ch1 <3:0>	Programmable coarse gain channel 1 in a Dual Channel setup.	1x gain													X	X	X	X	0x2B
cgain2_ch2 <3:0>	Programmable coarse gain channel 2 in a Dual Channel setup.	1x gain									X	X	X	X					
cgain1_ch1 <3:0>	Programmable coarse gain channel 1 in a Single Channel setup.	1x gain					X	X	X	X									

Table 3 Programmable Gain

cgain*<3:0>	cgain_cfg	Implemented gain [dB]	cgain_cfg	Implemented gain factor [x]
0000	0	0	1	1
0001	0	1	1	1.25
0010	0	2	1	2
0011	0	3	1	2.5
0100	0	4	1	4
0101	0	5	1	5
0110	0	6	1	8
0111	0	7	1	10
1000	0	8	1	12.5
1001	0	9	1	16

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1010	0	10	1	20
1011	0	11	1	25
1100	0	12	1	32
1101	0	Not used	1	*50*
1110	0	Not used	1	*Not used*
1111	0	Not used	1	*Not used*

Table 4 Coarse Gain Setting – dB Step & Gain Factor

The fine gain function is implemented for each ADC branch to adjust the fine gain errors between the branches. The gain in implemented by the registers below and is controlled by *fgain_branch* as defined in table 24. For the high speed interleaved modes, there will be no missing codes when using the fine gain control. To enable the fine gain control, the register *fine-gain_en* must be set to '1'.

Name	Description	Default	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Hex Address
fgain_branch1<6:0>	Programmable fine gain for branch1.	1x / 0dB gain										X	X	X	X	X	X	X	0x34
fgain_branch2<6:0>	Programmable fine gain for branch 2.	1x / 0dB gain		X	X	X	X	X	X	X									
fgain_branch3<6:0>	Programmable fine gain for branch 3.	1x / 0dB gain										X	X	X	X	X	X	X	0x35
fgain_branch4<6:0>	Programmable fine gain for branch 4.	1x / 0dB gain		X	X	X	X	X	X	X									
fgain_branch5<6:0>	Programmable fine gain for branch 5.	1x / 0dB gain										X	X	X	X	X	X	X	0x36
fgain_branch6<6:0>	Programmable fine gain for branch 6.	1x / 0dB gain		X	X	X	X	X	X	X									
fgain_branch7<6:0>	Programmable fine gain for branch 7.	1x / 0dB gain										X	X	X	X	X	X	X	0x37
fgain_branch8<6:0>	Programmable fine gain for branch 8.	1x / 0dB gain		X	X	X	X	X	X	X									

Table 5 Fine Programmable Gain

2 Elizabeth Drive Chelmsford, MA 01824 Phone: 978-250-3343 Fax: 978-250-3373

fgain_branchx<6:0>							Arithmetic Function	Implemented Gain (x)	Gain (dB)
0	1	1	1	1	1	1	$OUT = (1 + 2^{-8} + 2^{-9} + 2-^{10} + 2^{-11} + 2^{-12} + 2^{-13}) * IN$	1.0077	0.0665
0	1	1	1	1	1	0	$OUT = (1 + 2^{-8} + 2^{-9} + 2^{-10} + 2^{-11} + 2^{-12}) * IN$	1.0076	0.0655
0	1	1	1	1	0	1	$OUT = (1 + 2^{-8} + 2^{-9} + 2^{-10} + 2^{-11} + 2^{-13}) * IN$	1.0074	0.0644
0	1	1	1	1	0	0	$OUT = (1 + 2^{-8} + 2^{-9} + 2^{-10} + 2^{-11}) * IN$	1.0073	0.0634
0	0	0	0	0	1	1	$OUT = (1 + 2^{-12} + 2^{-13}) * IN$	1.0004	0.0031
0	0	0	0	0	1	0	$OUT = (1 + 2^{-12}) * IN$	1.0002	0.0021
0	0	0	0	0	0	1	$OUT = (1 + 2^{-13}) * IN$	1.0001	0.0010
0	0	0	0	0	0	0	$OUT = IN$	1.0000	0.0000
1	1	1	1	1	1	1	$OUT = IN$	1.0000	0.0000
1	1	1	1	1	1	0	$OUT = (1 - 2^{-13}) * IN$	0.9999	-0.0011
1	1	1	1	1	0	1	$OUT = (1 - 2^{-12}) * IN$	0.9998	-0.0021
1	1	1	1	1	0	0	$OUT = (1 - 2^{-12} - 2^{-13}) * IN$	0.9996	-0.0032
1	0	0	0	0	1	1	$OUT = (1 - 2^{-8} - 2^{-9} - 2^{-10} - 2^{-11}) * IN$	0.9927	-0.0639
1	0	0	0	0	1	0	$OUT = (1 - 2^{-8} - 2^{-9} - 2^{-10} - 2^{-11} - 2^{-13}) * IN$	0.9926	-0.0649
1	0	0	0	0	0	1	$OUT = (1 - 2^{-8} - 2^{-9} - 2^{-10} - 2^{-11} - 2^{-12}) * IN$	0.9924	-0.0660
1	0	0	0	0	0	0	$OUT = (1 - 2^{-8} - 2^{-9} - 2^{-10} - 2^{-11} - 2^{-12} - 2^{-13}) * IN$	0.9923	-0.0670

Table 6 Fine Gain Setting

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