GC5016 Application Note:
Automatic Gain Control Settings

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Setting Up the GC5016's BackEnd AGC mode

The objective of the back end AGC is to drive the RMS output level to be a specified number of dB below full scale. This is commonly called the crest factor (CF). The back end AGC is used after the DDC has isolated the desired carrier from all adjacent interference. The typical output crest factor is between 6 and 8 dB and the typical output word size is 4 to 8 bits.

The user controls the AGC through the cmd5016 program by specifying the desired output crest factor (*agc_cf* specified in dB), the desired agc time constant (*agc_tc* specified in microseconds) and the desired AGC mode (*agc_mode*). The AGC can operate in three modes, one optimized for CDMA signals (*agc_mode*=0 for WCDMA, UMTS, CDMA2000 signals), one for narrowband signals (*agc_mode*=1 for tones or GSM signals), and one for mixed signals (*agc_mode*=2 for CDMA with narrowband interference). The cmd5016 program then initializes all of the AGC parameters, but leaves the agc turned off. The user can turn on the AGC by setting *agc_freeze* and *gain_sync* to "0". Note, *gain_sync* both loads the default gain values and clears the AGC adjustments, so it must be active during initialization, but must be off while AGC is active.

The GC5016's standard AGC range can add 0 to 42 dB of gain to the signal over the desired gain set by the *overall_gain* keyword (see the "DDC Mode Gain Settings" app-note). This range can be increased in 6dB increments by increasing the desired crest factor in 6dB increments, while simultaneously clipping one bit off of the output data's MSBs for each additional 6dB of range. For example, to extend the range to 60 dB by adding an additional 18dB of range, one would add 18dB to the desired crest factor, and externally clip the three MSBs off of the output samples. To clip the three MSBs, one would check for overflow in those bits and if overflow is found to saturate the remaining bits to full scale.

How CMD5016 Calculates the AGC settings

Definitions:

NOTE: All variables in italics are key words for the cmd5016 program
agc_cf: The desired output crest factor in dB (default = 10).
agc_tc: The desired AGC time constant in microseconds (default = 1000)
agc_mode: The AGC mode:
0 for guassian signals (CDMA), 1 for tones, 2 for mixed signal (default=2)
agc_freeze: Freezes the AGC adaption loop (default = 1)
gain_sync: Selects the sync event that loads the initial gain value and clears the AGC loop
(default=7 for forced active)
agc_min: Set by cmd5016 to prevent underflow in the AGC loop
agc_max: Set by cmd5016 to prevent overflow in the AGC loop
agc_thresh: Set by cmd5016 to give the desired output threshold
agc_Dzro: Set by cmd5016 to give the step size when the output is close to zero
agc_Dsat: Set by cmd5016 to give the step size when the output is clipping too much
agc_Dabv: Set by cmd5016 to give the step size when the output is above threshold
agc_Dblw: Set by cmd5016 to give the step size when the output is below threshold
agc_zmag: Set by cmd5016 to give the step size when the output is above threshold
agc_zero_cnt: Set by cmd5016 to give the step size when the output is below threshold
agc_sat_cnt: Set by cmd5016 to give the step size when the output is above threshold

overall_gain: User's desired overall gain for each channel.
G: 19 bit unsigned front end gain word, manually set using *gain*, *gain_lsb* or *gain_msb*
gain: Keyword for gain, *gain* = G/4096 = (*gain_msb*$*2^{16}$ + *gain_lsb*)/4096
gain_msb: 3 MSBs of G

gain_lsb: 16 LSBs of G
fck: The GC5016 chip clock rate in MHz, used to set the adaption time constant
fir_dec: FIR decimation, used to set the adaption time constant
cic_dec: CIC decimation, used to set the adaption time constant

TC_SAMPLES: The number of output samples in the desired agc_tc time period.
TC: the actual time constant closest to TC_SAMPLES
D: the desired step size
RMS: the desired RMS threshold based upon *agc_cf*

The user is required to set *agc_mode, agc_cf,* and *agc_tc*. The cmd5016 program will use these keywords to calculate the gain settings.

The AGC controls are set by cmd5016 using the following algorithm:

1) The gain, G, *gain_lsb* and *gain_msb* values are determined by cmd5016 as normal
2) The step sizes D, *Dabv*, *Dblw, Dsat* and *Dzro* are determined from *agc_tc* by:
    a. Set TC_SAMPLES = *agc_tc***fck*/(*fir_dec***cic_dec*)
    b. Set D = floor(log2(TC_SAMPLES)-1.25)
    c. Limit D <=15
    d. Set TC = $2^{(D+1.75)}$
    e. Set *Dblw* = D
    f. Set *Dabv* = D for *agc_mode*=0 or 1, if *agc_mode*=2 set *Dabv*=D-2
    g. Set *Dzro* = *Dblw*-4, but not less than 0
    h. Set *Dsat* = *Dabv*-4, but not less than 0
3) Set *agc_min* = G/8 - 2
4) Set *agc_max* = $65536/(1+2^{-(Dzro+2)}) - G/8$
5) Set *agc_sat_cnt* = *agc_zero_cnt* = 6, set *agc_zmag* = 15
6) Set *agc_thresh* based upon *agc_cf* and *agc_mode*
    a. Set RMS = $256*10^{-agc\_cf/20}$
    b. If *agc_mode* = 0, set *agc_thresh* = 0.6745*RMS
    c. If *agc_mode* = 1, set *agc_thresh* = RMS
    d. If *agc_mode* = 2, set *agc_thresh* = 1.28*RMS

Cmd5016 should report in the analysis file the time constant used (TC), the step size (D), and the *agc_thresh* used.

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