TVP5160 IF Compensation Calibration Procedure

1 Introduction

The TVP5160 supports IF compensation. This feature compensates for attenuation at higher frequencies from the transfer characteristics of television tuners or due to channels that are not correctly tuned. This feature can also correct for asymmetrical color subcarrier sidebands resulting in incorrect and uneven UV demodulation.

2 Technology Overview

The television tuner IF stage can attenuate the upper sideband of the chroma, which results in unnatural fringe artifacts in the color boundaries. This block compensates for the resulting crosstalk between the demodulated chroma components u and v and the attenuation of the upper sidebands. A block diagram of the IF compensation is shown in Figure 1. The crosstalk IF compensated or crosstalk plus gain compensated outputs can be selected. Variable gains G_{diffu} and G_{diffv} control the amount of crosstalk compensation that are applied to u and v. Variable gains G_{low_u} and G_{low_v} control the amount of peaking applied to the lower band of frequencies of the compensated u and v, while G_{high_u} and G_{high_v} control the amount of peaking applied to a higher band of frequencies of the uncompensated u and v.

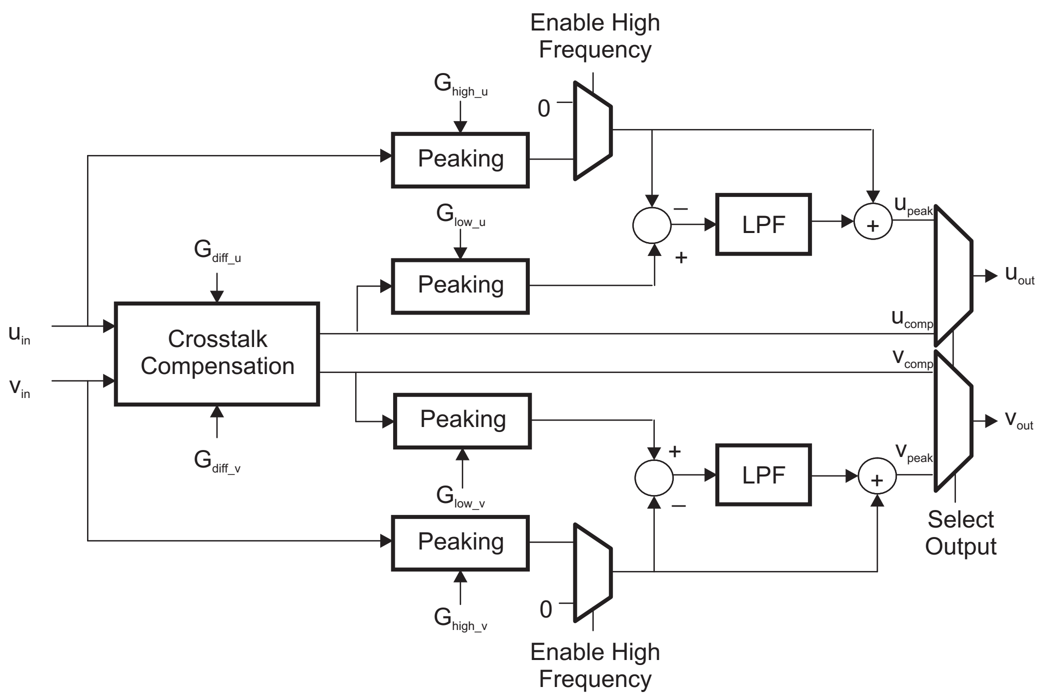


Figure 1. IF Compensation Block Diagram

Figure 2 shows the crosstalk compensation. A differential filter (coefficient weights are 1, 0, -1) outputs pulses corresponding to transitions in its input (first derivative of input). An adjustable gain is applied to the differential filter output and the result is added to the delayed u and subtracted from the delayed v.

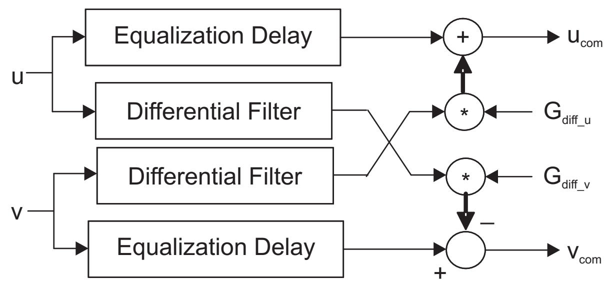
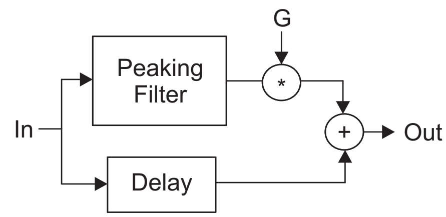


Figure 2. Crosstalk Compensation

Figure 3 shows the peaking block and its frequency characteristics. It amplifies high frequencies by an adjustable gain and then adds the delayed input.



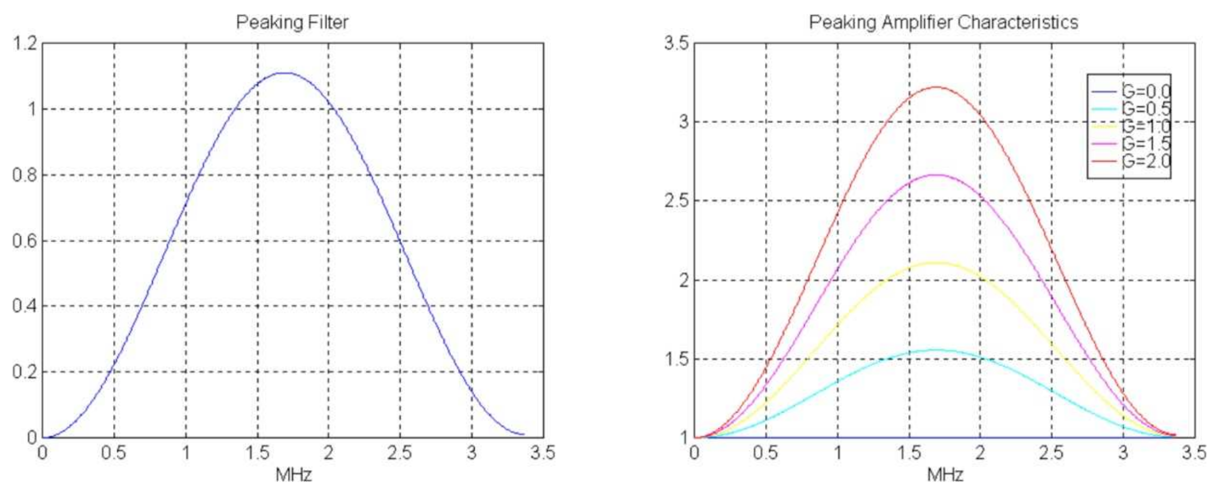


Figure 3. Peaking Amplifier

Figure 4 shows the frequency characteristics of the low pass filter (LPF). It limits the bandwidth of the u and v to 1 MHz and establishes the low-frequency and high-frequency bands.

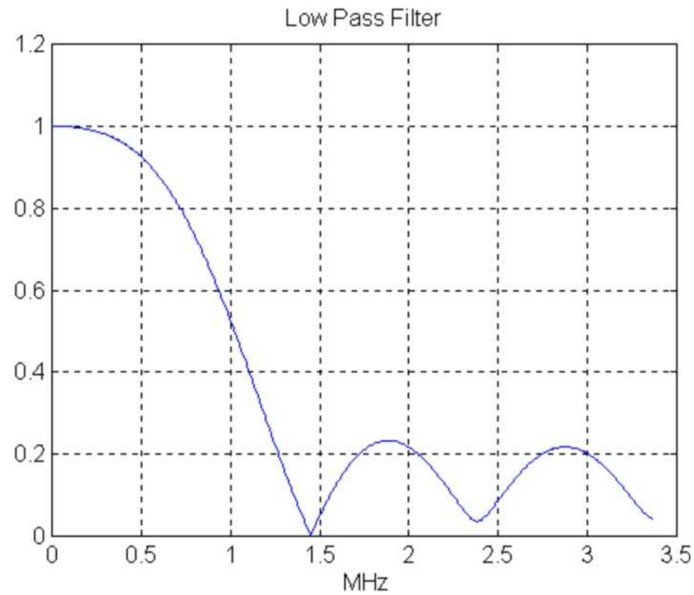


Figure 4. Low-Pass Filter

With reference to Figure 1, equations for u_{peak} and v_{peak} in Equation 1 show the low and high frequencies can be amplified by the gains.

$$u_{peak} = LPF \times (G_{low\_u} \times u_{comp} - G_{high\_u} \times u_{in}) + G_{high\_u} \times u_{in}$$
$$= \underbrace{LPF \times G_{low\_u} \times u_{comp}}_{\text{low frequency}} + \underbrace{(1 - LPF) \times G_{high\_u} \times u_{in}}_{\text{high frequency}}$$

$$v_{peak} = LPF \times (G_{low\_v} \times v_{comp} - G_{high\_v} \times v_{in}) + G_{high\_v} \times v_{in}$$
$$= \underbrace{LPF \times G_{low\_v} \times v_{comp}}_{\text{low frequency}} + \underbrace{(1 - LPF) \times G_{high\_v} \times v_{in}}_{\text{high frequency}} \quad (1)$$

This is an important feature that applies when u and v do not have the same bandwidth. If u and v have the same bandwidth, then both have the same crosstalk and gain attenuation. Therefore, the same differential gains and the low-frequency and high-frequency gains are applied to u and v. If u and v have different bandwidths, then the symmetry of the IF compensation changes. Figure 5 shows an example where u has a greater bandwidth than v.

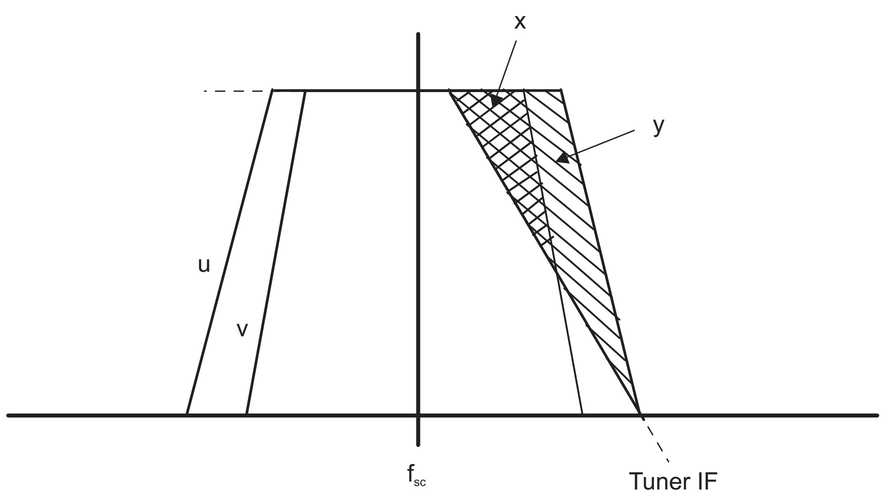


Figure 5. UV Frequency Spectrum (u Bandwidth Greater Than v)

The frequency attenuation of the tuner IF stage on the baseband chroma is also shown. There is more crosstalk from u into v and less crosstalk from v into u. The differential gains G_{diff_u} and G_{diff_v} are first adjusted to eliminate the crosstalk. The low frequency gains G_{low_u} and G_{low_v} are then adjusted to compensate for the attenuation of the crosstalk compensated u_{comp} and v_{comp} in the region x. Then frequency region y of the uncompensated u can be boosted by the gain G_{high_u}. The controls that enable high-frequency gain of u is set to 1 and enable high-frequency gain of v is set to 0. Table 1 shows the different possible control settings.

Table 1. Control for Different UV Bandwidth Combinations

uv Bandwidth	Enable High-Frequency Gain of u	Enable High-Frequency Gain of v
Same	0	0
u greater than v	1	0
v greater than u	0	1
u equal to v	0	0

3 Programmable I²C Control Registers

Table 2. IF Compensation Control (subaddress = 8Dh)

Bits	Description	Default	Recommendation
0	Enable IF compensation	0	
1	Select crosstalk and gain compensated outputs 0 = crosstalk compensated outputs only 1 = crosstalk and gain compensated outputs	0	For SAW IF stage, set to 0. For non SAW IF stage, set to 1.
2	Enable high-frequency gain of v	0	
3	Enable high-frequency gain of u	0	

Table 3. Differential Gain (subaddress = 8Eh)

Bits	Description	Label	Default	Comment	Recommendation	
					IF Stage Distortion	Setting
7-4	u differential gain	G_{diff_u}	2	Actual gain = n/4 as n varies from 0 to 8	Low	1
3-0	v differential gain	G_{diff_v}	2		Medium	2
					High	3-4

Table 4. Low Frequency Gain (subaddress = 8Fh)

Bits	Description	Label	Default	Comment
7-4	u low frequency gain	G_{low_u}	4	Actual gain = n/4 as n varies from 0 to 8
3-0	v low frequency gain	G_{low_v}	4	

Table 5. High Frequency Gain (subaddress = 90h)

Bits	Description	Label	Default	Comment
7-4	u high-frequency gain	G_{high_u}	0	Actual gain = n/4 as n varies from 0 to 8
3-0	v high-frequency gain	G_{high_v}	0	

4 Calibration Procedure

Perform these steps to perform IF compensation calibration.

1. Enable IF compensation.
2. Select crosstalk compensated outputs only and set differential gains to 0.
3. For color bar test pattern determine whether or not u and v bandwidths are same by looking at crosstalk pulses around color bar transitions (undershoots and overshoots).
4. Adjust differential gains to eliminate crosstalk pulses (default is 2).
5. Select crosstalk and gain compensated outputs and set low and high-frequency gains to 0.
6. Adjust low frequency gains for optimum picture (sharper edges in color transitions); if the gain is too high undershoots and overshoot will reappear (default is 4).
7. Set enable high frequency controls based on Table 1 (default is 0).
8. Adjust high-frequency gains for optimum picture (sharper edges in color transitions); too high a gain may distort edges.
9. CTI can also be used to sharpen edges.

IMPORTANT NOTICE