

Design Note:

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OBTAINING LARGER OUTPUT SIGNALS IN GPON ONT VIDEO
APPLICATIONS USING THE MAX3654

MAXIM High-Frequency/Fiber Communications Group



Maxim Integrated Products



Obtaining Large Output Signals in GPON ONT Video Overlay Applications while using the MAX3654

1 Introduction

A block diagram of a typical video overlay in a GPON ONT application is shown in Figure 1. The MAX3654 is an easy to use, low-cost solution to the AGC amplifier block; however depending on the system parameters (Optical modulation Index (OMI), average optical power, number of channels, etc.) additional gain may be needed.

For example, additional loss on the video output could be incurred when injecting digital signals onto the coaxial cable. This may be done to facilitate various standards such as the one developed by the Multimedia over Coax Alliance (MoCA). The amplifier therefore will need additional gain to overcome this loss while still maintaining the required linearity and carrier to noise ratio (CNR).

This application note provides background information on the need for increased gain and illustrates a method for obtaining larger output amplitude, while maintaining the critical system requirements, using a post amplifier. Schematics and test data are also provided.

2 Background Information

The MAX3654 was designed to deliver 15dBmV per channel with 132 channel loading (at approximately 3% OMI and 0.9 A/W responsivity) for a -6dBm to +2dBm average optical power range. The device has an integrated up-tilt feature to account for the loss characteristics of a coaxial cable. The output is therefore nominally 15dBmV at 50MHz and 19dBmV at 870MHz for a typical application.

Increasing the OMI at the transmitter or the responsivity of the photodiode will increase the output amplitude and improve the CNR; however, you must ensure that the total output power does not increase in order to maintain an equivalent linearity for both the laser transmitter and the AGC amplifier. For best CNR performance, the OMI will be increased as much as possible for the analog channels while keeping the linearity of the system within specification. Linearity can be maintained with a large OMI by decreasing the total number of channels or by operating the digital channels at a reduced OMI.

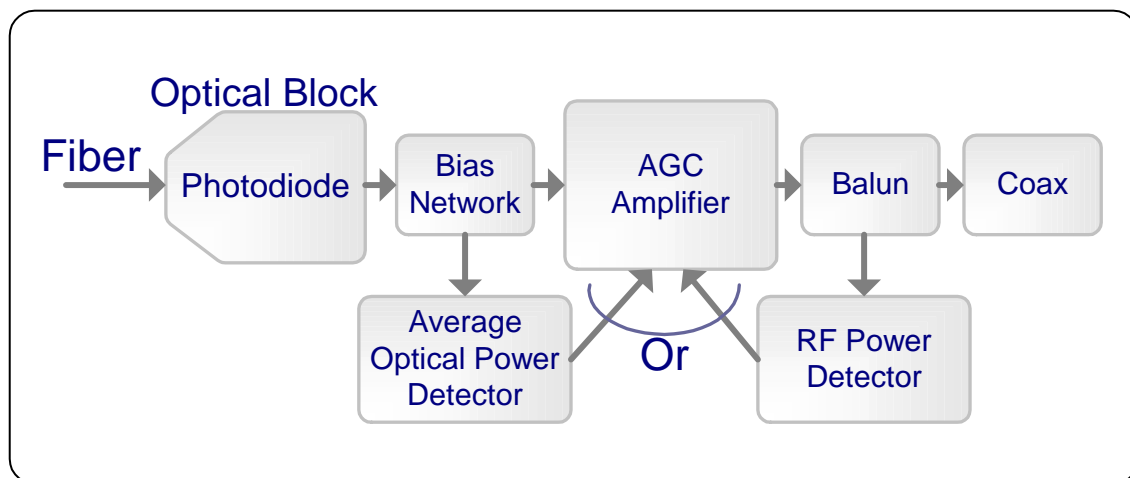


Figure 1. GPON ONT Video Overlay Block Diagram

Channels that use digital modulation are generally much more tolerant of linear distortion and noise than the analog channels. The system performance can then be optimized by lowering the digital carrier OMI and increasing the analog carrier OMI while keeping the total power constant.

3 Need for more gain

Systems that incorporate a MoCA type interface might require 18dBmV or greater output amplitude (for the analog channels only, typically 12dBmV for the digital) from the AGC amplifier. With an OMI of approximately 4.2 to 4.3% the MAX3654 can maintain these levels for average optical power inputs from -6 to +2dBm. If the system OMI is lower than this or if the input power range is larger (for example: -8dBm to +2dBm), then additional gain is needed to meet the 18dBmV requirement.

Additional gain is a challenge as the stringent linearity, noise, power consumption and cost targets must still be met. Using a low-cost, low noise, high linearity and low current post amplifier from Watkins Johnson (AG606-G), the necessary output amplitude can be met while maintaining excellent linearity and CNR.

4 Block Diagram / Schematic

A block diagram for the increased output amplitude solution is shown in figure 2. A resistor pad of about 2 to 4dB between the MAX3654 and the Watkins Johnson amplifier is recommended to maintain linearity. A pad on the output can also be used to adjust the tilt, output amplitude and S22 as desired. However for this demonstration an output pad is not included so the total power available for various options on the output can be measured.

The test schematic for this configuration is shown in figure 3. The AG606-G is biased at approximately 5.2V using an active bias circuit with a 5.4V supply voltage. Depending on the available supply voltage, various biasing techniques are possible. Please see the Watkins Johnson website (www.wj.com) and the AG606-G data sheet for details.

To reduce the 5.4V supply voltage, a 2.0Ω resistor is added between Vcc and the MAX3654 keeping its supply at no greater than 5.2V. For testing, a feed-forward monitor of the average optical input power is used to control the AGC gain (18dB electrical gain range) over the input power range of -8dBm to +2dBm.

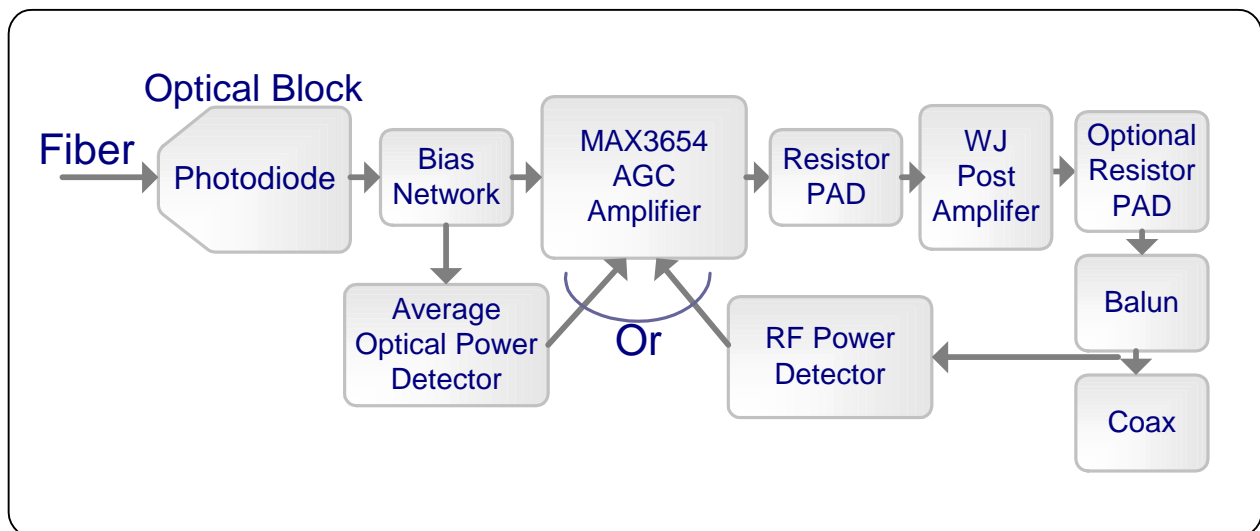


Figure 2. Larger Gain Block Diagram

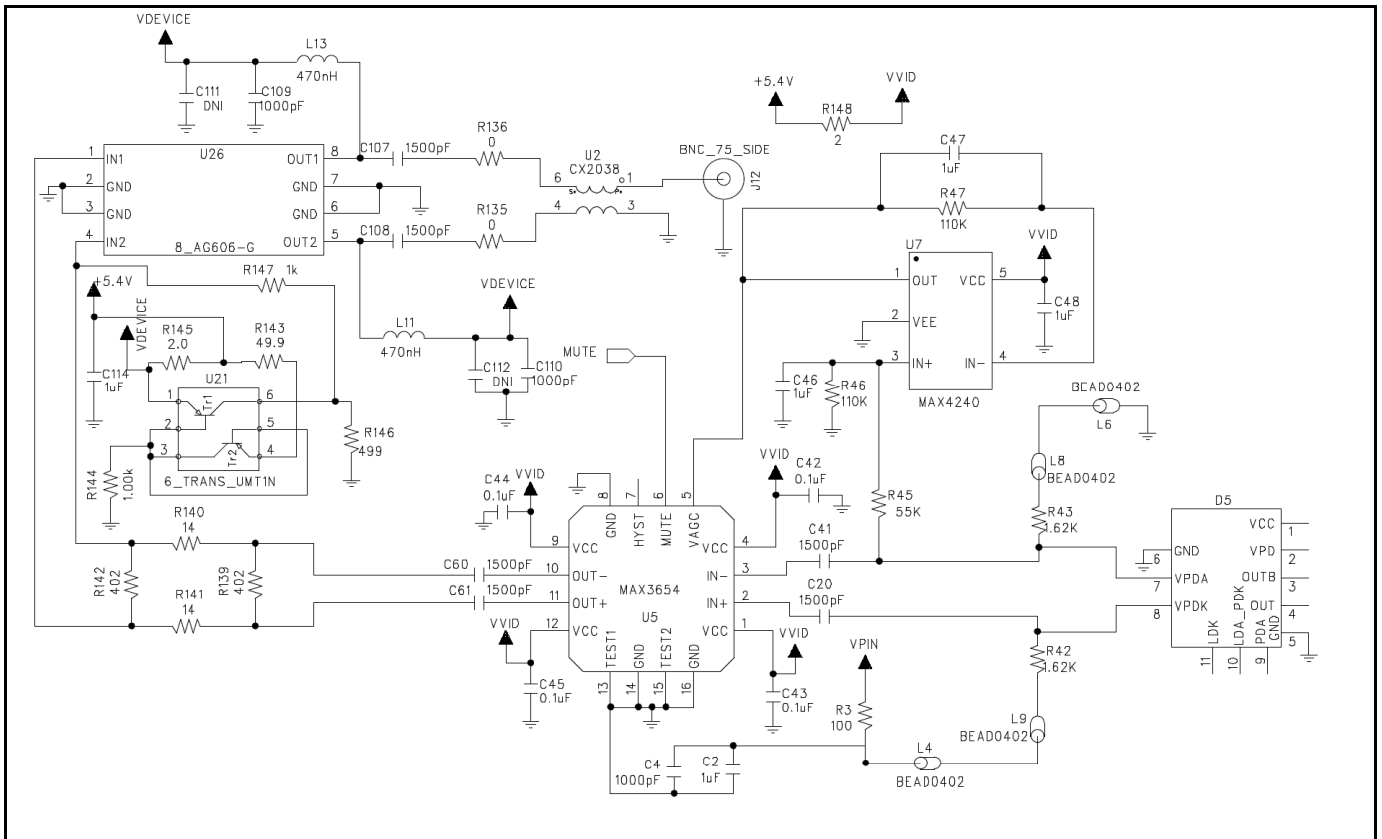


Figure 3. Test circuit schematic

5 Test Data

The test data shown in figures 4 to 7 were obtained with the following setup conditions:

OMI = 4.0% (Analog Channels), 2.0% (Digital Channels)

**Number of Analog Channels: 48
(55.25MHz to 343.25MHz)**

**Number of Digital Channels: 66
(349.25MHz to 865.25MHz)**

The measured CSO and CTB were better than 64dBc for the analog channels and the CNR was better than 47dB over the entire -8 to +2dBm input power range. The minimum output amplitude was +24dBmV per channel. Given that the tilt of the combined parts was approximately 2dB this increased output amplitude facilitates simple attenuation methods for tilt adjustment and improvements to S22 if desired.

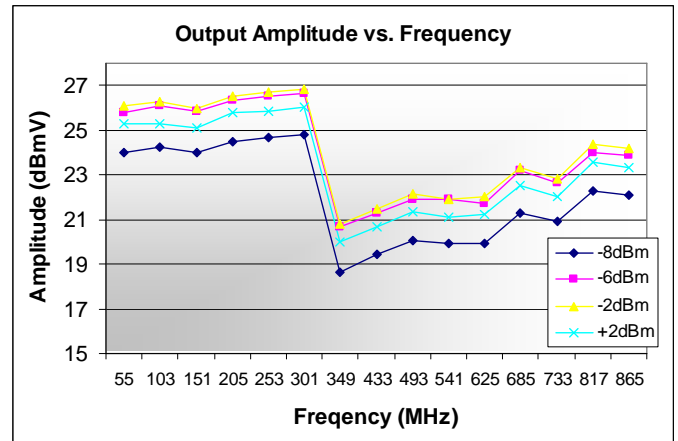


Figure 4. Output Amplitude vs. Frequency

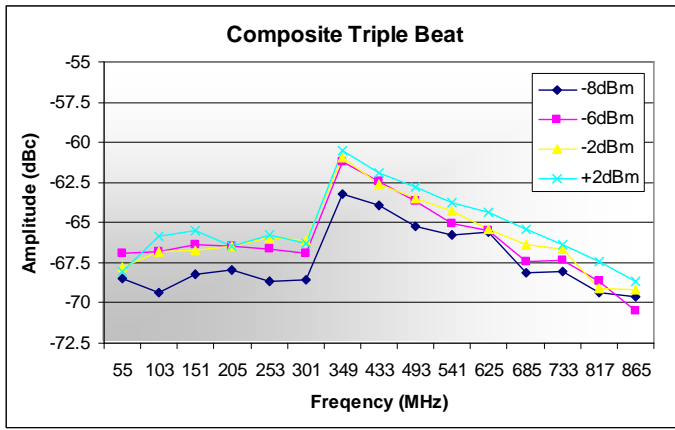


Figure 5. Composite Triple Beat (CTB)

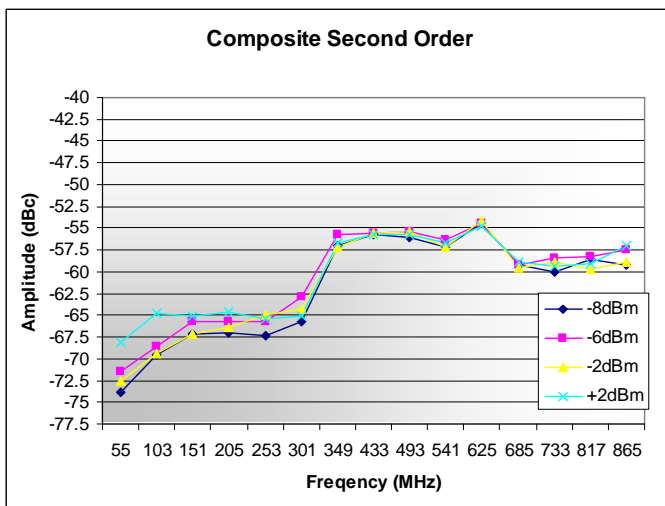


Figure 6. Composite Second Order (CSO)

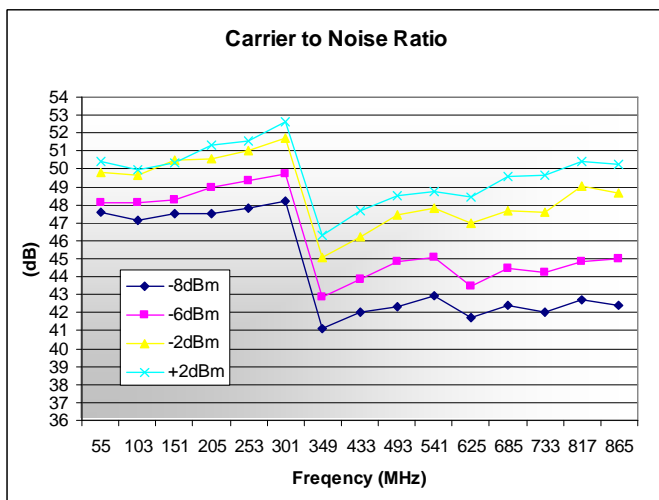


Figure 7. Carrier to Noise Ratio

6 Conclusion

GPON ONT modules that incorporate the MoCA interface may require additional gain to account for system losses. Using a Watkins Johnson AG606-G post amplifier after the MAX3654 provides a low-cost, highly linear and low noise solution for these applications.

References:

1. Data Sheet: “MAX3654: 47MHz to 870MHz Analog CATV Transimpedance Amplifier” - Maxim Integrated Products, May 2003.
2. Data Sheet: “AG606: Push-Pull CATV Amplifier” – Watkins Johnson, April 2006.