Design Note:

HFDN-40.0

Rev. 2; 08/10

Obtaining Larger Output Signals in GPON ONT Video Overlay Applications Using the MAX3654

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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 for the AGC amplifier block; however, depending on the system parameters such as optical modulation index (OMI), average optical power and number of channels, the amplifier might need additional gain. To facilitate various standards such as the one developed by the Multimedia over Coax Alliance (MoCA[SM]), digital signals are injected onto the coaxial cable. This can cause additional loss to be incurred on the video output. The amplifier, therefore, will need additional gain to overcome this loss while still maintaining the required linearity and carrier-to-noise ratio (CNR).

This design note explains the need for increased gain. It illustrates a method that uses a postamplifier to obtain larger output amplitude while maintaining the critical system requirements. Schematics and test data are also provided.

2 Background Information

The MAX3654 CATV transimpedance amplifier delivers 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 uptilt 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, to maintain an equivalent linearity for both the laser transmitter and the AGC amplifier, you must ensure that the total output power does not increase. For the best CNR performance, the OMI will be increased as much as possible for the analog channels, while the linearity of the system is kept 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.

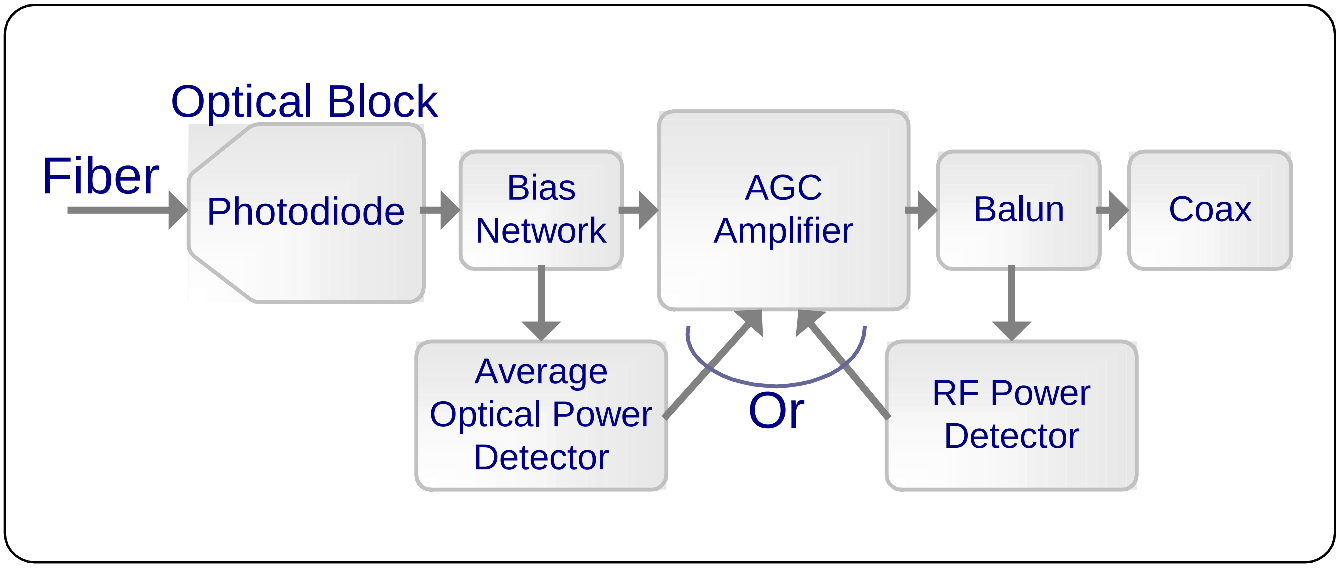

Figure 1. GPON ONT video overlay block diagram.

Channels that use digital modulation are generally much more tolerant of linear distortion and noise than the analog channels. The system performance can thus be optimized by lowering the digital carrier OMI, increasing the analog carrier OMI, and 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 and 12dBmV for the digital channels 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 -6dBm to +2dBm. If the system OMI is lower than this, or if the input power range is larger (e.g., -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 postamplifier, the necessary output amplitude can be met while excellent linearity and CNR are maintained.

4 Block Diagram/Schematic

A block diagram for the increased output amplitude solution is shown in Figure 2. The RFMD® CGB-1089Z device was used in these tests; the CXE-1089Z or RF2389 from RFMD could also be used with similar results. See www.rfmd.com for device specifications.

A resistor pad of about 2dB to 4dB between the MAX3654 and the RFMD 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. 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 MAX3654 and RFMD amplifier operate from a single 5V supply. 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.

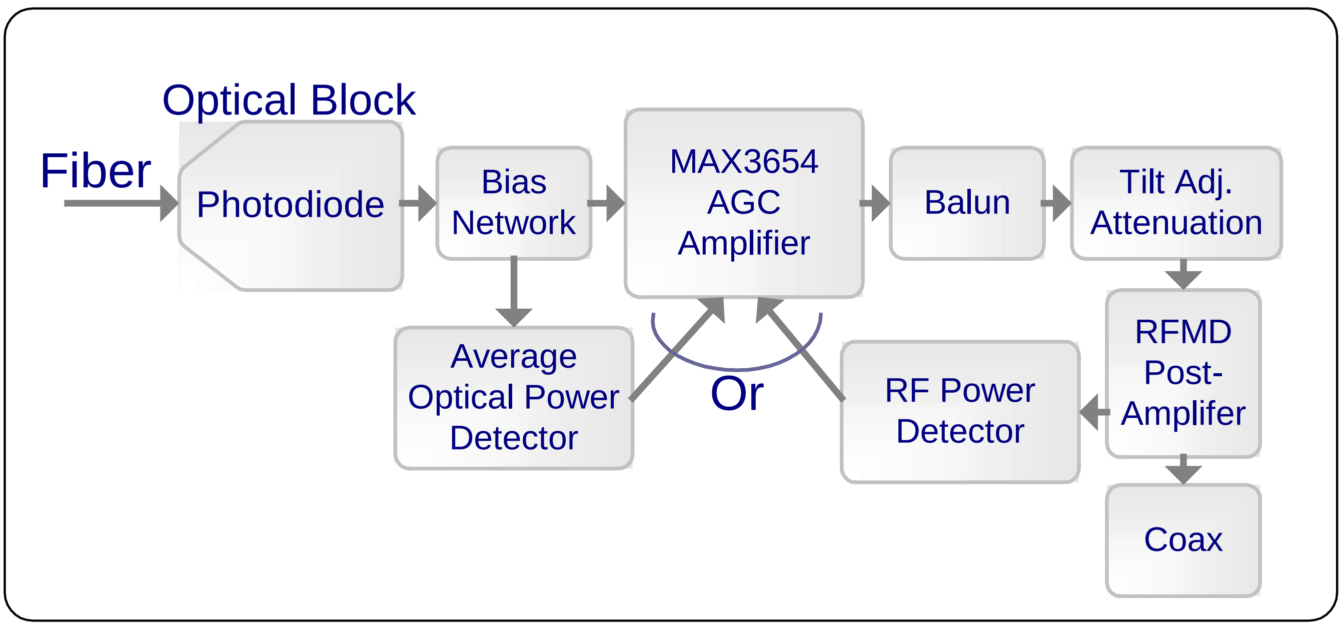

Figure 2. Larger gain block diagram.

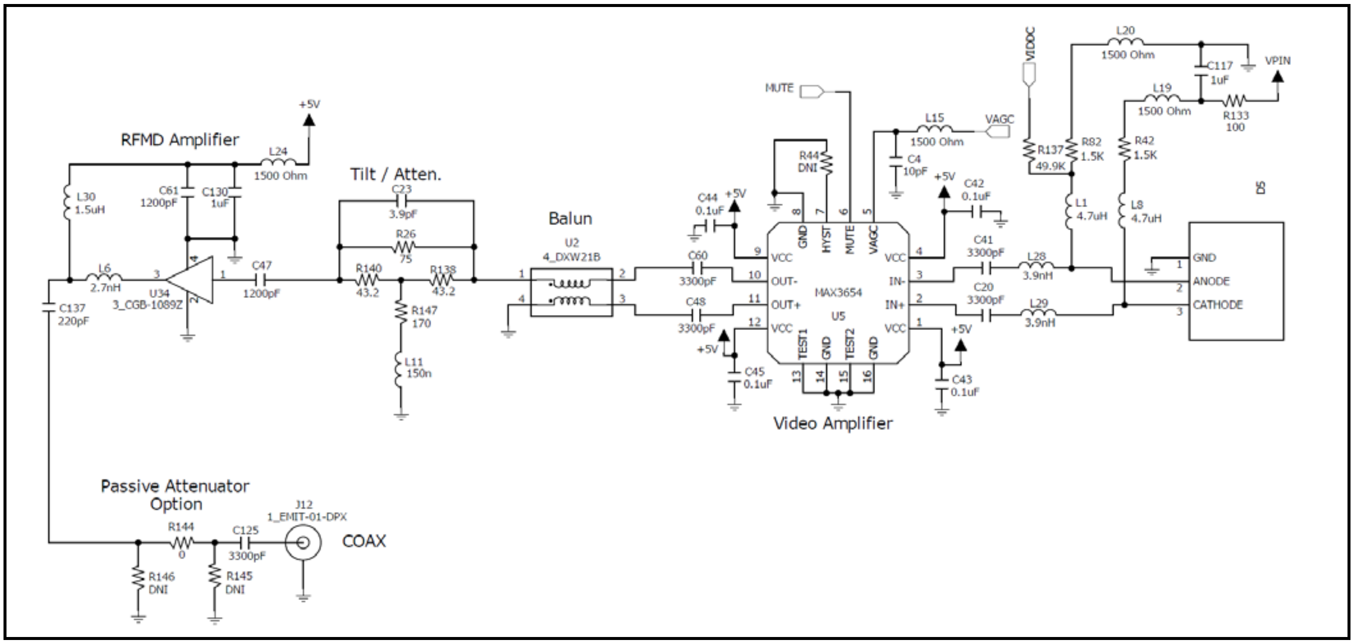

Figure 3. Test circuit schematic.

5 Test Data

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

OMI = 4.2% (analog channels), 2.1% (digital channels)

Number of analog channels: 44
(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. The CNR was better than 47.5dB over the entire -8dBm to +2dBm input power range. The minimum output amplitude was +26dBmV (analog group) per channel. The tilt of the combined parts was approximately 4dB, so this increased output amplitude facilitates simple attenuation methods for tilt adjustment and improvements to S22, if desired.

6 Conclusion

GPON ONT modules that incorporate the MoCA interface may require additional gain to account for system losses. Using an RFMD CGB-1089Z postamplifier 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, July 2005.

2. Data sheet: *CGB-1089Z 50MHz to 1000MHz Single Ended InGaP/GaAs HBT MMIC CATV Amplifier*, RFMD, Rev D.

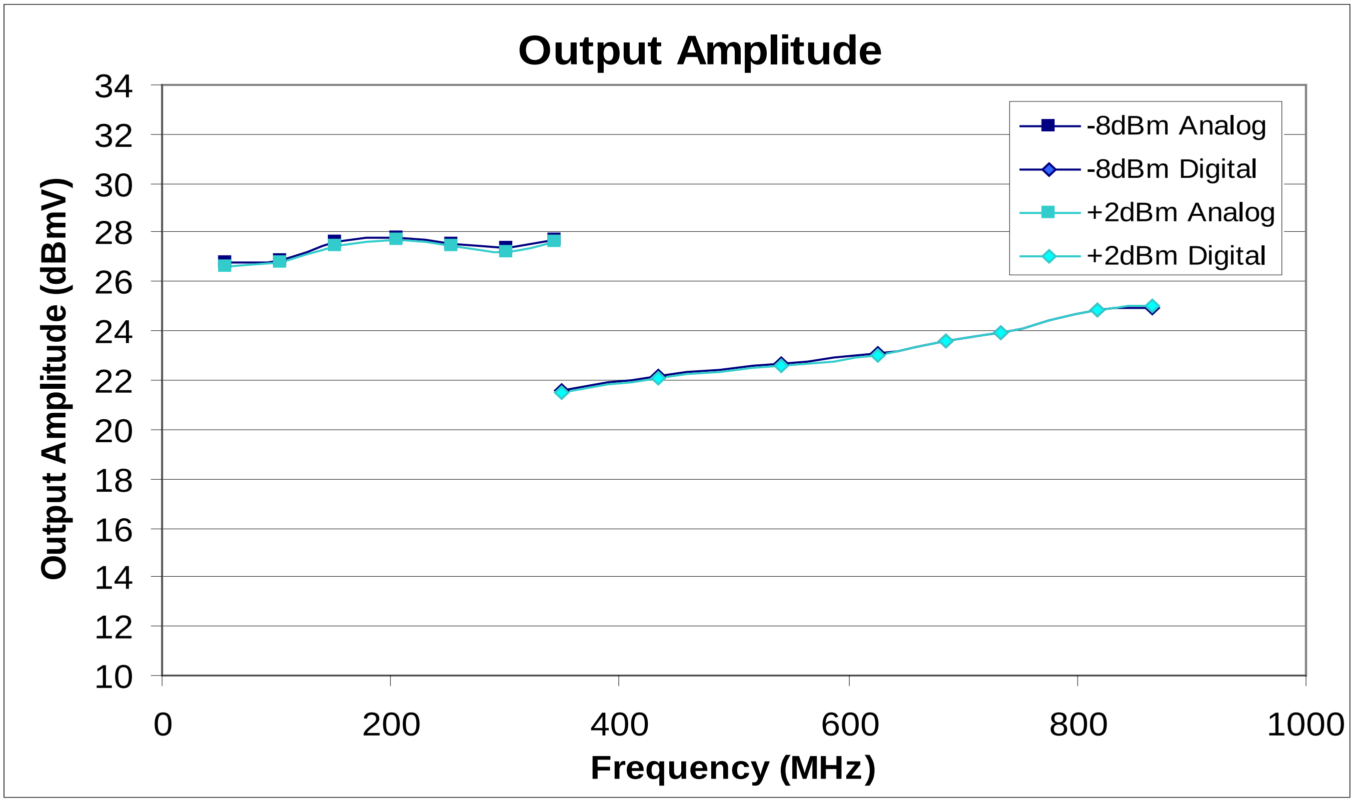

Figure 4. Output amplitude vs. frequency.

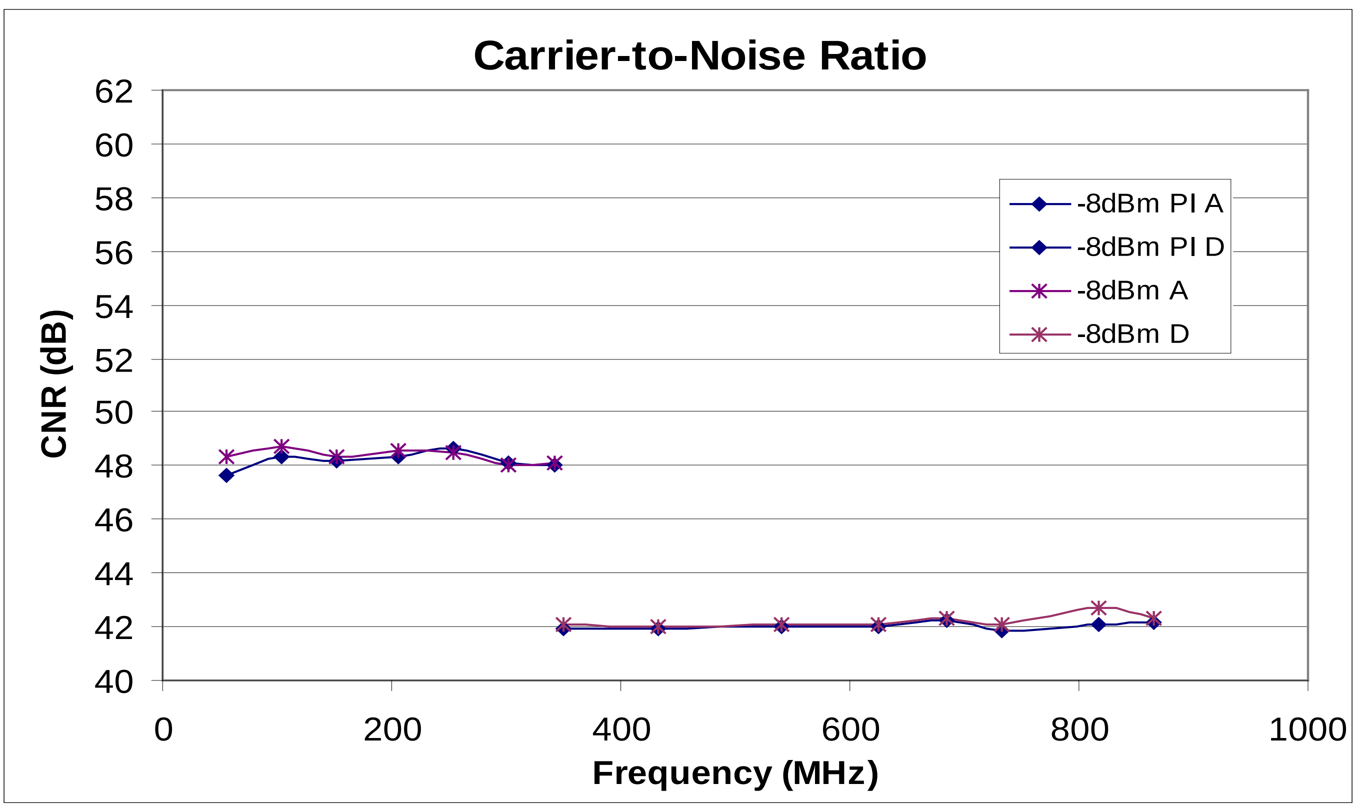

Figure 5. Carrier-to-noise ratio.

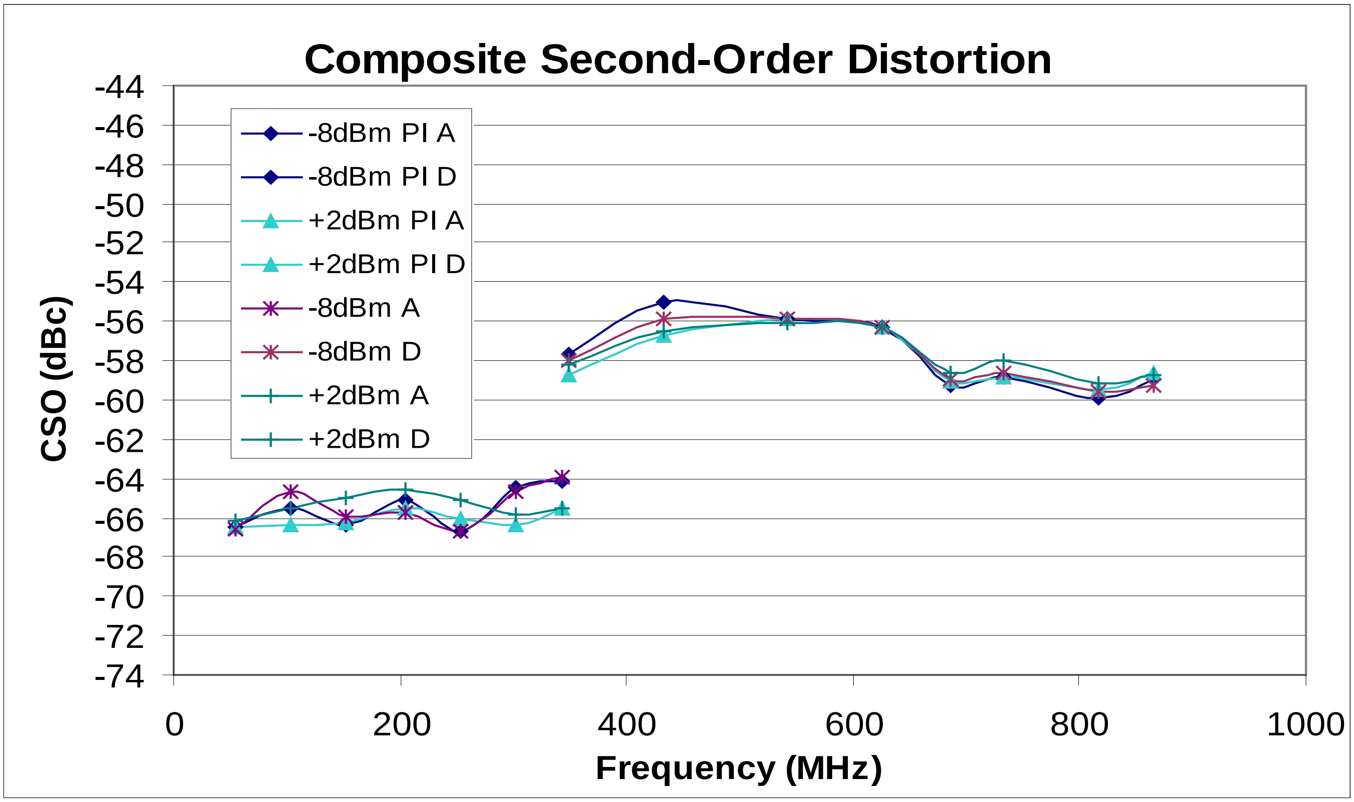

Figure 6. Composite second-order (CSO) distortion.

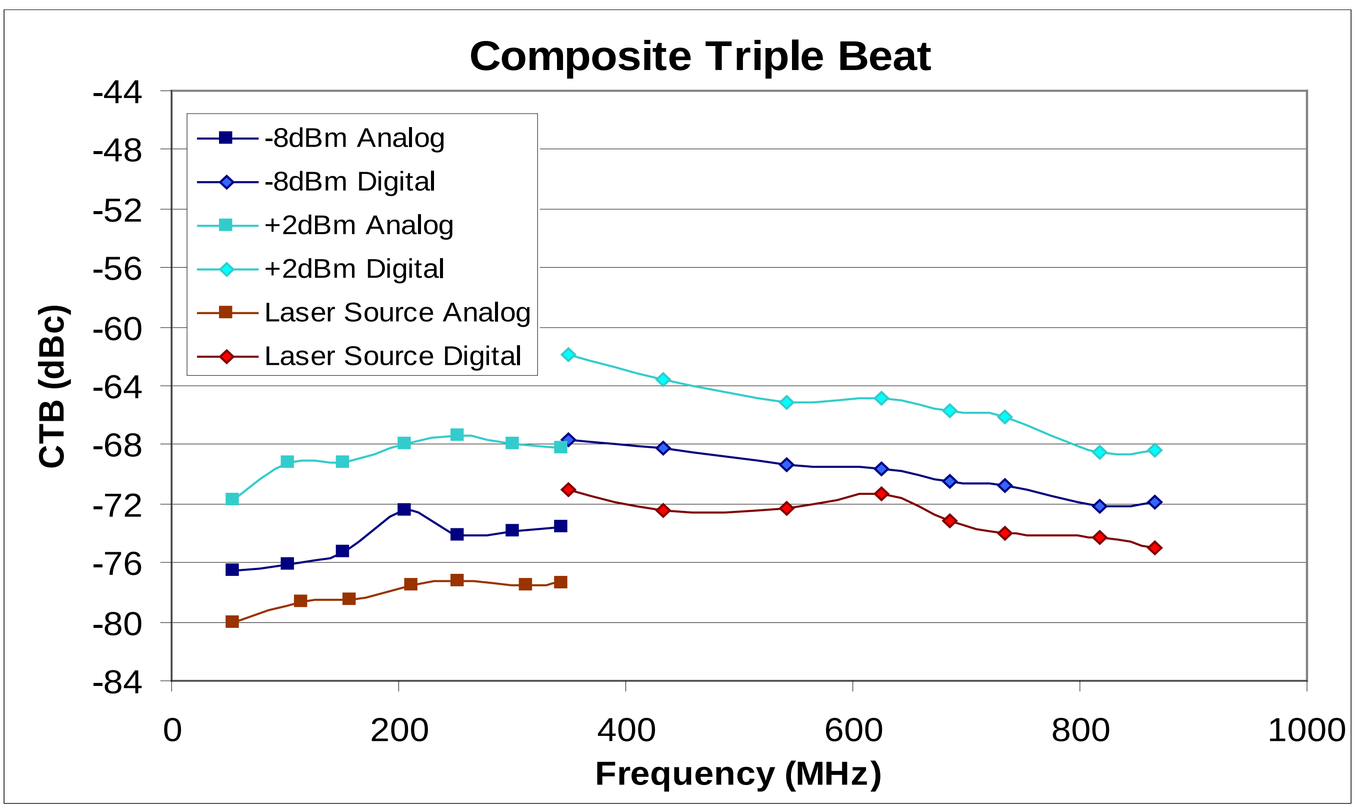

Figure 7. Composite triple beat (CTB).