Application Note 1012: May 01, 2002

EURO-DOCSIS CATV Upstream Amplifier Saves Space (MAX3507)

This application note describes the cause of "alias" spurious signals in a CATV upstream amplifier. The MAX3507 has on-chip filters to prevent these spurious signals. Measured data show the MAX3507 has IP2 spurious levels approximately -68dBc and IP3 levels approximately -85dBc.

Additional Information: Wireless Product Line Page
Quick View Data Sheet for the MAX3507
Applications Technical Support

Introduction

The MAX3507 is a unique upstream amplifier which incorporates an anti-aliasing filter to eliminate spurs produced by the upstream modulator DAC. The on-chip filter, along with the MAX3507's small 28-pin QFN package, create a compact DOCSIS compliant solution for both DOCSIS and EURO-DOCSIS applications.

Description of Transmit Spur Generation

A typical cable modem (Figure 1) requires a complex, differential, low-pass filter before the upstream amplifier to eliminate spurs produced when converting the modulated signal from a digital bit-stream to an analog waveform. These alias spurs are produced at a frequency that is equal to the sampling clock frequency minus the desired output frequency and can be as high as -10dBc relative to the desired output signal. If not filtered, these spurs can mix with the desired signal producing 2^{nd} and 3^{rd} order products that will fail the spurious emissions requirements defined in the DOCSIS specification.

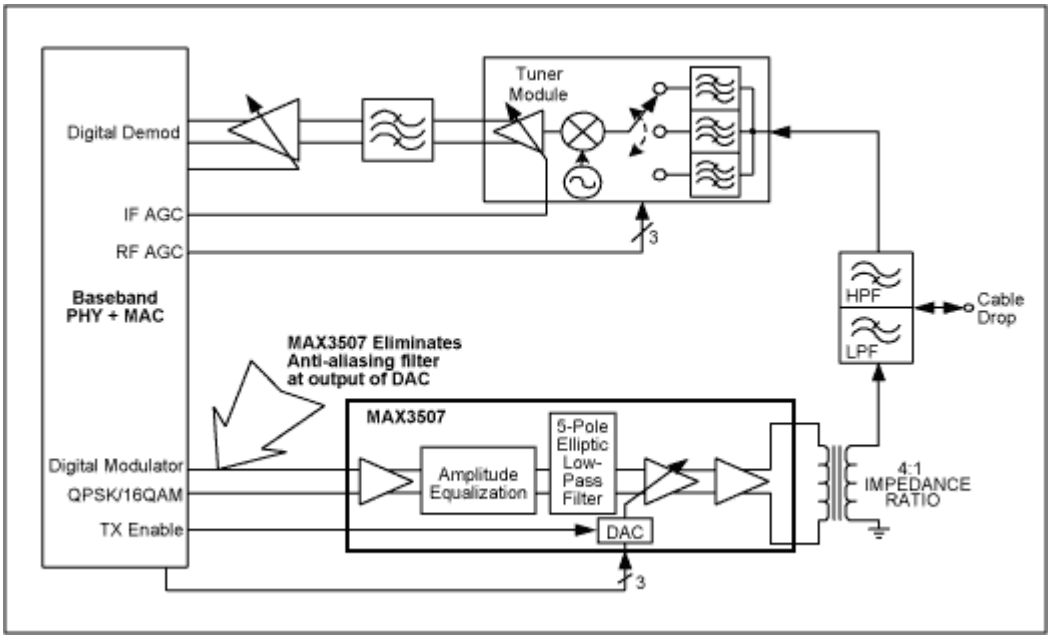

Figure 1. DOCSIS cable modem

A standard rule of thumb in performing digital-to-analog conversion is that the minimum clock frequency should be 2.5 times higher than the highest analog output frequency. Most cable PHY/MAC ICs use a clock frequency that is approximately 3x the highest required output frequency. Figure 2 shows the spurious products that the cable modem designer must consider when determining the attenuation required in the anti-aliasing filter. In this example, the clock frequency is held constant at 184MHz. The desired signal is produced at 3 different frequencies: a) 5MHz b) 35MHz c) 65MHz.

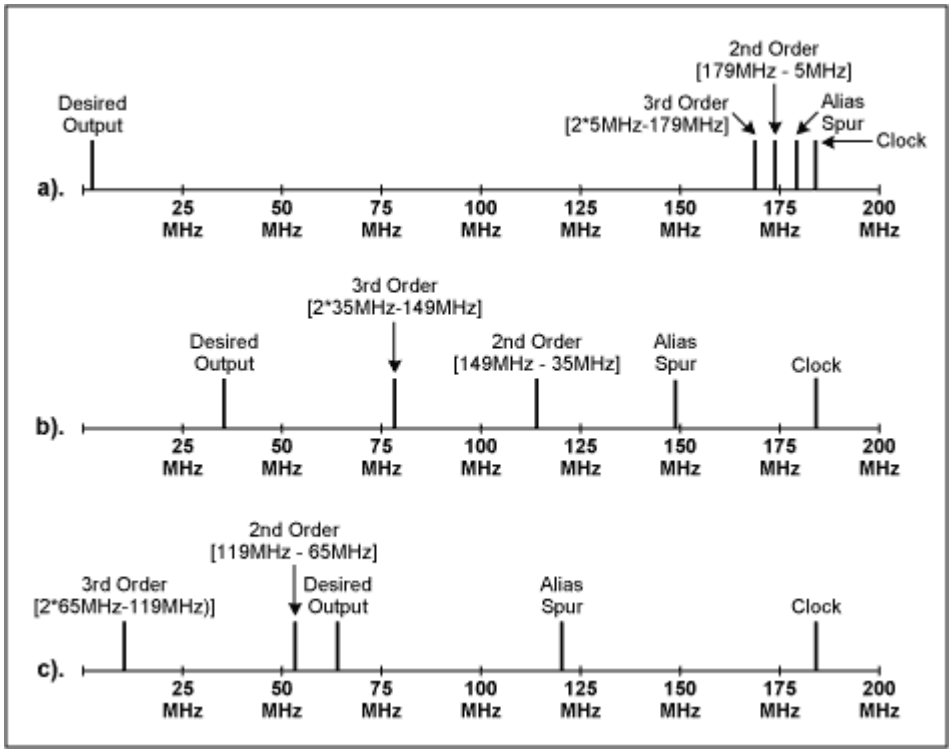

Figure 2. Spurious products

Example a) is an uninteresting case where all of the spurious products fall well out of band. Example b) shows that as the desired signal gets higher in frequency, the spurious products get closer to the transmit band. Finally, example c) demonstrates in band 2nd and 3rd order spurs that must be less than -53dBc in order to satisfy the EURO-DOCSIS requirements.

Performance of the MAX3507

Measurements were taken on the MAX3507 EV kit using the test set-up shown in Figure 3. The MAX3507 is designed for a nominal input voltage of +34dBmV; this input corresponds to the "desired signal" of Figure 2. In addition to the desired signal, an alias spur was injected into the MAX3507 at -10dBc relative to the desired signal and the magnitude of the spurious products was recorded. Performance across various gains and both high power and low gain transmit modes is tabulated in Table 1.

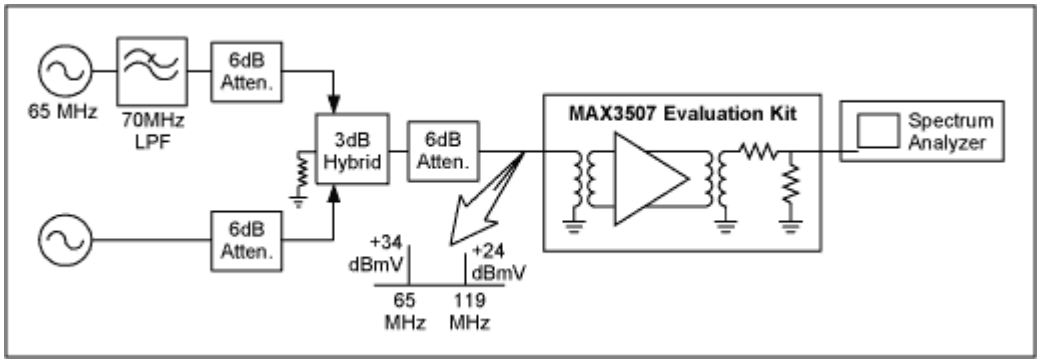

Figure 3. Test set-up

Table 1. Measurement Results

FIN1 = 65MHz at+34dBmV (CW input)
FIN2 = 119MHz at +24dBmV (CW input)
IP2 spur measured at 54MHz
IP3 spur measured at 11MHz

GCW	Transmit Mode	IP2 Spur Relative to Desired Signal (dBc)	IP3 Spur Relative to Desired Signal (dBc)
127	High Power	-67.3	-83.2
119	High Power	-67.6	< -85
104	High Power	-68.3	< -85
84	High Power	-69.5	< -85
64	High Power	-69.0	< -85
74	Low Noise	-69.5	< -85
54	Low Noise	-70.6	< -85
42	Low Noise	-69.2	< -78

Conclusion

The typical cable modem uses 12 components (Ls and Cs) to implement the anti-aliasing filter that follows the PHY/MAC IC. This filter is eliminated by using the MAX3507; saving space and cost while providing a DOCSIS compliant upstream driver amplifier solution.

MORE INFORMATION

MAX3507: QuickView -- Full (PDF) Data Sheet (368k) -- Free Sample