RFMD208x Calibration User Guide

Integrated Configurable Components from RFMD Multi-Market Products Group

RFMD Multi-Market Products Group

REVISION HISTORY

Version	Date	Description of change(s)	Author(s)
0.1	26-Sept-11	Review and Revision for external posting	Eric Schonthal
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CONTENTS

1. INTRODUCTION

The RFMD2080 and RFMD2081 are IQ modulators with integrated local oscillator. The RFMD2080 also includes DC offset control circuitry and tunable baseband filters. DC offset calibration is performed using digital-to-analog converters (DACs) to apply a signal to various parts of the circuit to compensate for DC offsets introduced by the internal buffers and the mixer core. The figures below show detailed block diagrams of the RFMD2080 and RFMD2081 modulators.

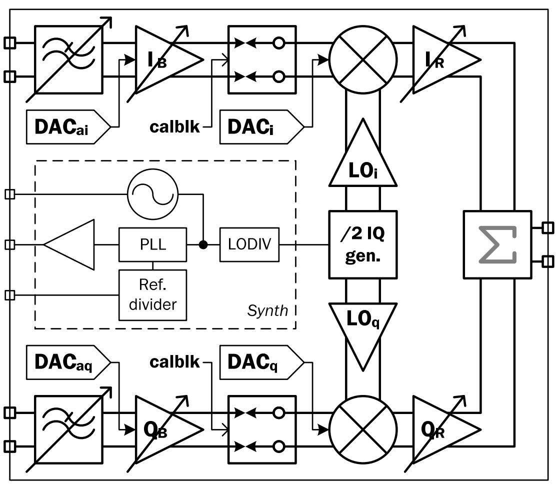

Figure 1. RFMD2080 Block Diagram

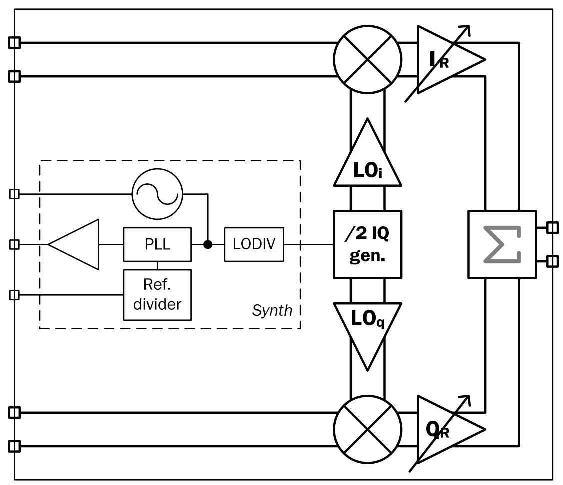

Figure 2. RFMD2081 Block Diagram

The modulators consist of a pair of mixers fed from quadrature local oscillator signals. The local oscillator (LO) signals are generated within an LO divide by two circuits inside the modulator block so as to maintain the best LO stability in terms of both phase and amplitude.

In the RFMD2080 the baseband path consists of a low pass filter with variable bandwidth followed by a variable gain buffer giving 0dB to -20dB gain in 2dB steps. The mixers also have some integral gain control, in this case 0dB to -18dB in 6dB steps.

The variable gain buffer and mixer input both have DACs attached to allow DC offsets within the baseband path to be corrected, reducing LO breakthrough. There is an isolation switch between the variable gain buffer and the mixer input to allow their offsets to be compensated separately. This may be required since the offset within the variable gain buffer will vary with gain and thus its DC compensation may also have to vary for optimum LO cancellation.

The RFMD2081 does not include DC offset calibration, DACs, or baseband low pass filters. The IQ inputs are applied directly to the modulator inputs.

In both modulators the outputs of the in-phase and quadrature path mixers are summed on an internal node and output from the chip.

2. CARRIER SUPPRESSION

Carrier suppression is a function of the DC present on the I and Q inputs, and any offsets within the chip. Carrier signals are undesirable and can be corrected with the internal DACs. As shown in Figure 1, DC offset is applied to a number of locations in the baseband circuitry. The first injection point is the baseband variable gain amplifier and the second is the mixer input. It is possible to isolate the variable gain amplifier output from the mixer input using the switch. This allows the mixer input offset to be corrected independently of the baseband offset. Figure 3 is a flowchart with the steps for performing DC offset correction on the RFMD2080.

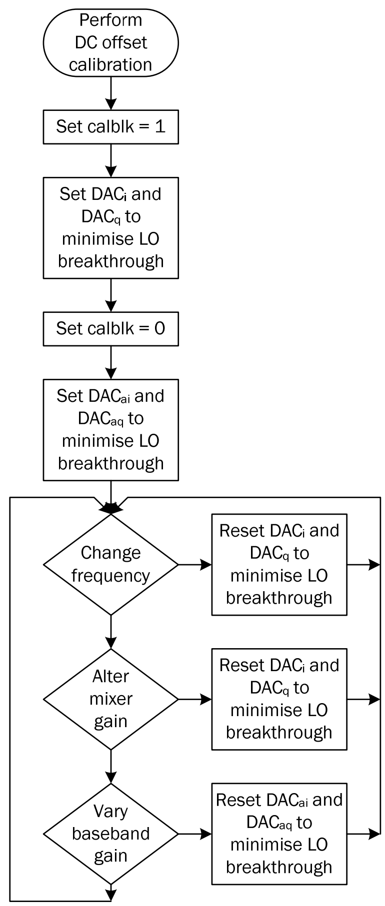

Figure 3. DC Offset Correction Flowchart

It is recommend to begin by isolating the baseband variable gain buffer and use DAC_i and DAC_q to correct for the mixer DC offset, as illustrated in Figure 4.

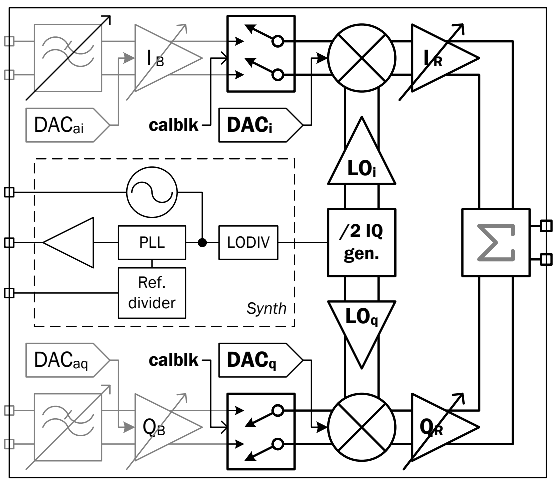

Figure 4. RFMD2080 Mixer DC Offset Correction

After this has been completed, the full path should be restored and the buffer DC offset corrected using DAC_{ai} and DAC_{aq}. The reason for this is because the mixer DC offset is a function of frequency and mixer gain, while the baseband DC offset is a function of baseband buffer gain. Using this approach allows a table to be built for the DC offset values as a function of gain and frequency, if required.

The DC offset control of the mixer is both frequency and gain dependent, as illustrated in Figure 5.

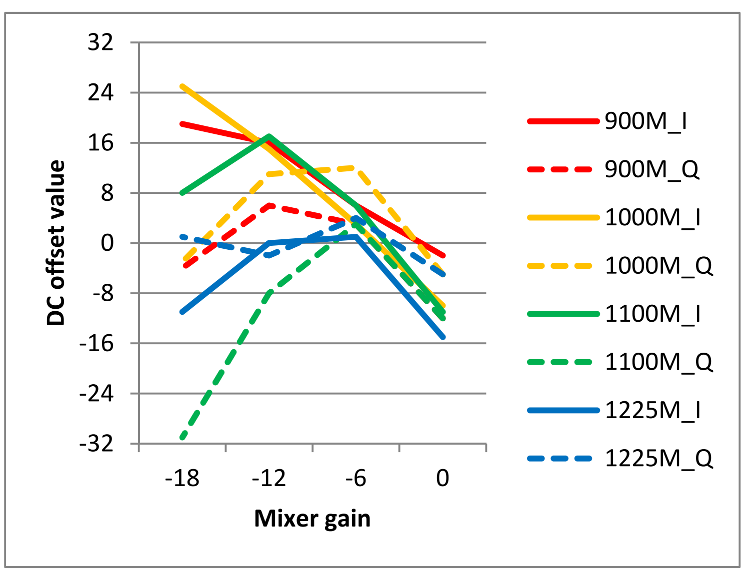

Figure 5. Mixer DC Offset Control

In practice the DC offset in the baseband amplifier is quite small. At maximum gain the baseband DC offset value is close to 0. However, as the gain is reduced, the effect of the applied DC offset is also attenuated and some DC offset manifests in the buffer. The baseband DC offset value can now act as a fine tune of the DC offset, which means that the optimum baseband DC offset increases as the gain is reduced as illustrated in Figure 6.

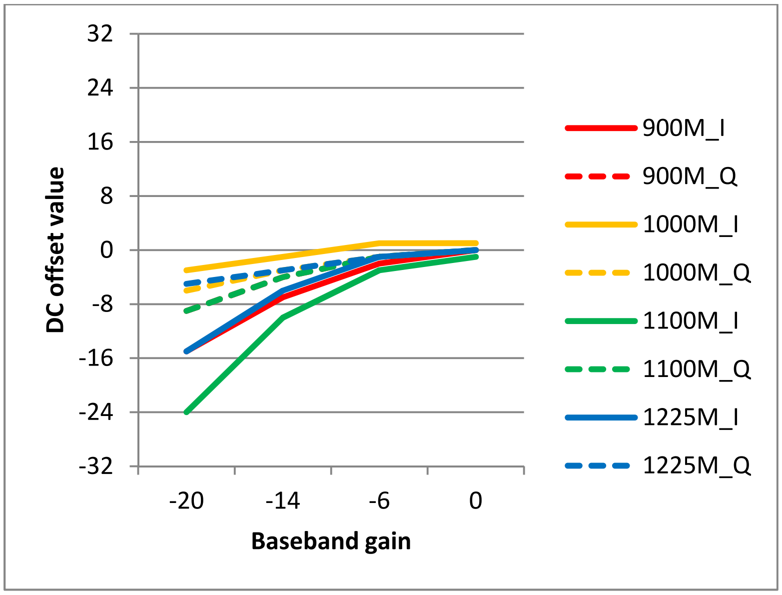

Figure 6. Baseband DC Offset Control

Figure 7 illustrates how the optimum baseband DC offset value varies as the mixer DC offset value is changed. At maximum baseband gain the baseband DC offset resolution is coarser than the mixer DC offset resolution (approximately 0.6:1), whereas at minimum gain the baseband DC offset resolution is finer (approximately 6:1)

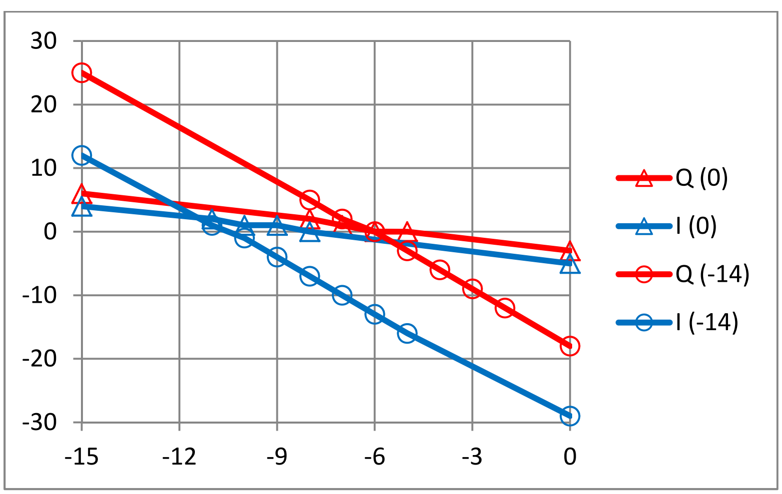

Figure 7. Effect of Baseband Gain on Baseband DC Offset Resolution

3. IMAGE SUPPRESSION

Image suppression within a modulator is related to the accuracy of the phase and amplitude of the local oscillator signals. They should have identical amplitude and phase. An additional factor is the relative gain of the two mixers and the accuracy of the combiner network on the mixer outputs. Figure 8 illustrates the theoretical image rejection as a function of phase and amplitude errors.

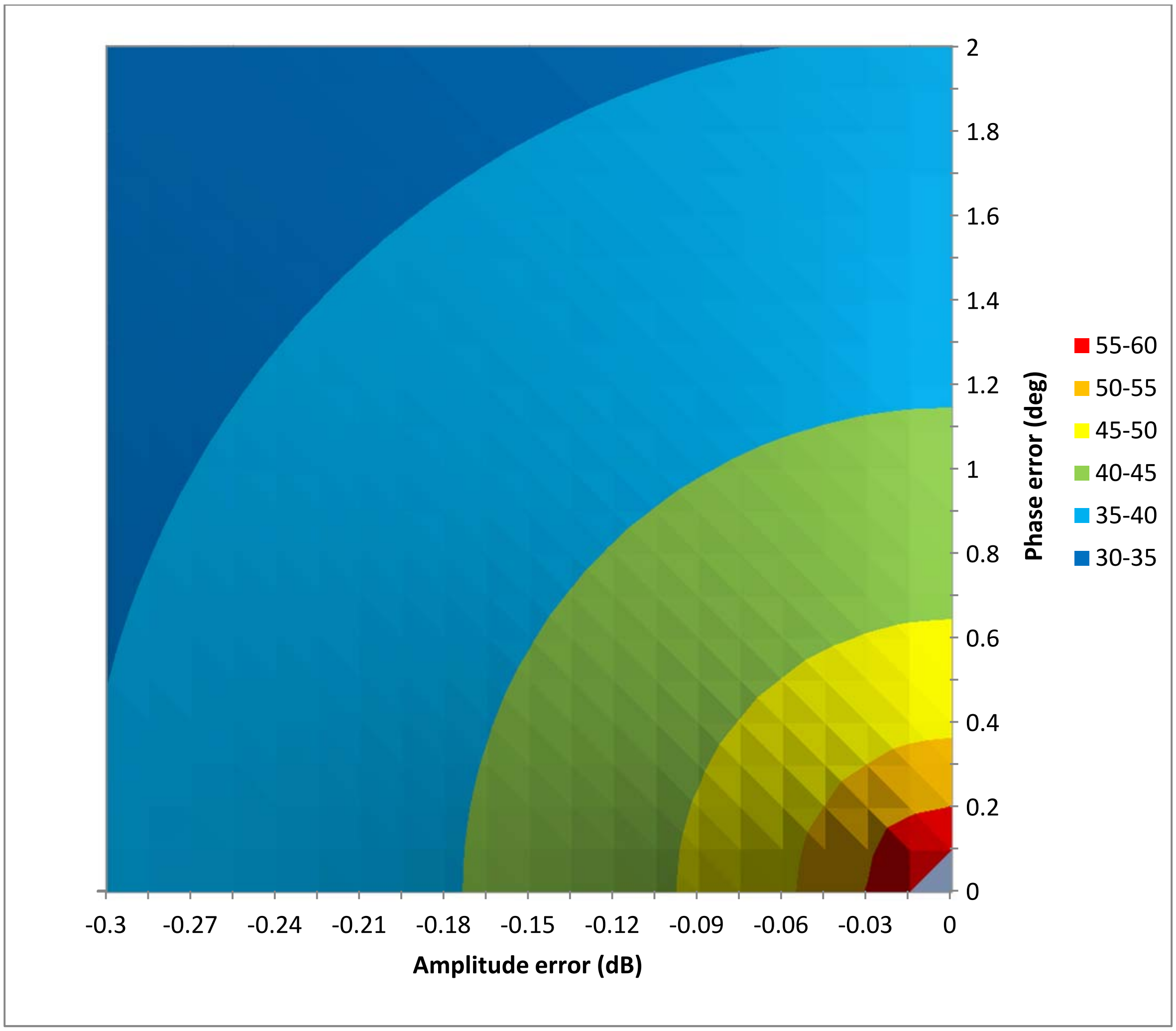

Figure 8. Modulator image rejection as a function of I and Q amplitude and phase errors

Figure 8 illustrates that achieving an image rejection of >35dB requires an amplitude error of better than 0.25dB and a phase error of better than 1.5°. The RFMD208x parts typically have an image rejection of around 40dB, implying an amplitude accuracy of better than 0.15dB and a phase accuracy of better than 1°.

There is no functionality on the chip to correct for these errors. If required, they must be corrected in the baseband processor when applying the signals to the I and Q inputs.