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APPLICATION NOTE 3700

Front-end diplex filter for MAX3580

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Abstract: This article presents an optional diplex filter, consisting of only five chip capacitors and two chip inductors, that is designed for use with the MAX3580 direct-conversion DVB-T tuner. The second-order intercept point (IIP2) is improved by at least 25dB at the cost of not more than 0.8dB of noise-figure degradation. To make this improvement, the diplex filter provides typical isolations of 15dB from UHF channels when tuned to a VHF channel, and better than 32dB from VHF channels when tuned to a UHF channel.

Introduction

Click here for an overview of the wireless components used in a typical radio transceiver.

The MAX3580 is an integrated direct-conversion tuner for digital video broadcasting-terrestrial (DVB-T) applications. The IIP2 benefits of adding an optional diplex filter to the MAX3580 input are discussed in this application note. An integrated input switch enables the MAX3580 to select one of the two diplex filter branches to pass the desired band and reject signals in the undesired band. This feature is particularly beneficial for DVB-T applications, in which the assigned frequency range includes two separate bands. The separation of these two bands enables selection of a particular branch of the diplex filter while rejecting the other band. By rejecting signals in the undesired band, the second-order distortion performance is improved, as contributors to second-order distortion are from the undesired band.

Operational overview

The MAX3580 fully integrated direct-conversion tuner is designed for DVB-T applications. The integrated tuner covers an input frequency range of 170MHz to 230MHz (VHF-III) and 470MHz to 878MHz (UHF). The MAX3580 integrates an RF input switch and a multiband tracking filter, allowing low-power tuner-on-board applications without the cost and power dissipation issues of dual-conversion tuner solutions. The zero-IF architecture eliminates all SAW filters by providing baseband I and Q outputs directly to the demodulator.

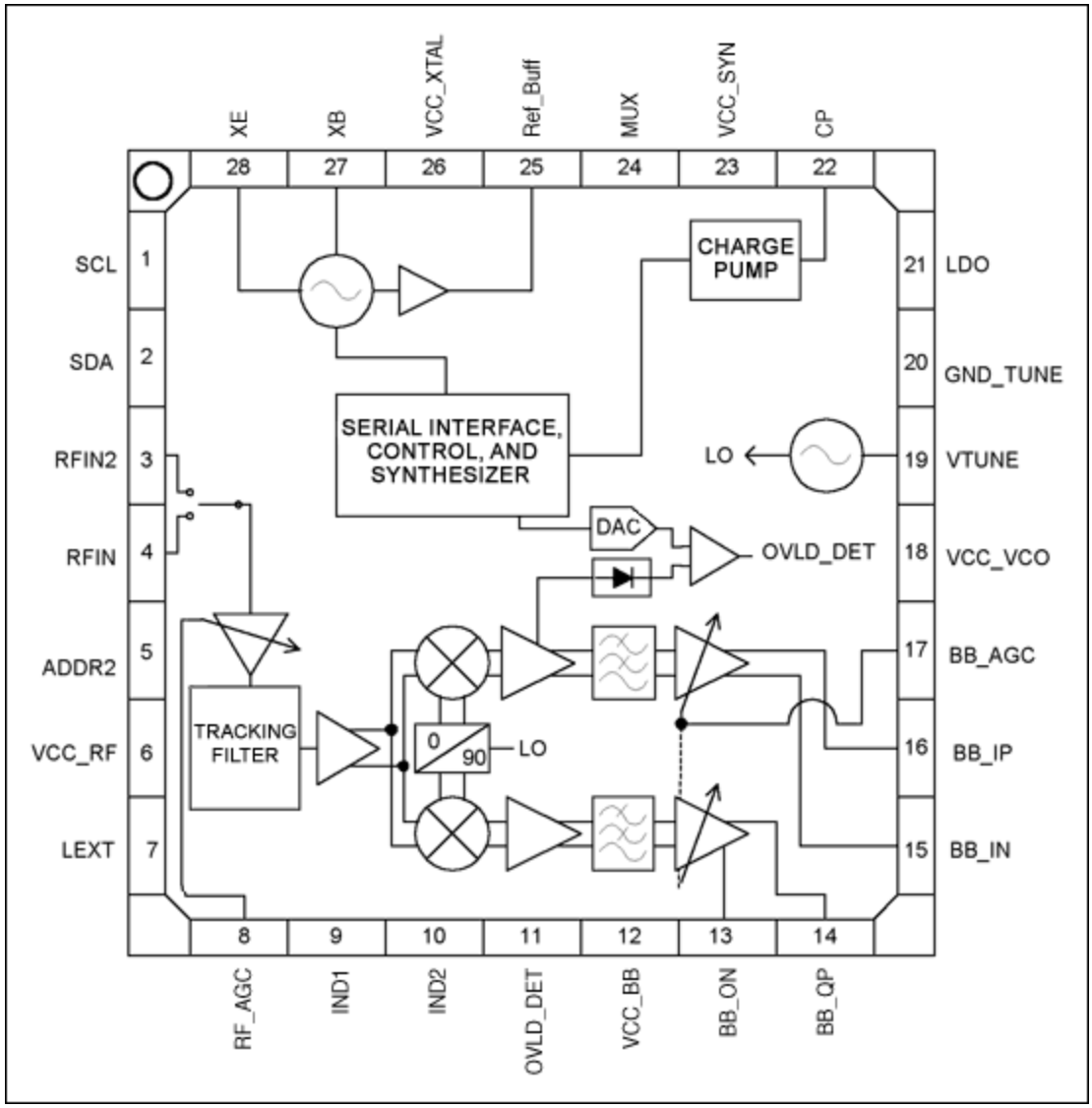

Figure 1. MAX3580 functional block diagram.

Diplex filter

The two separate frequency bands (VHF and UHF) used for DVB-T applications create an opportunity for incorporating a diplex filter with the MAX3580 input switch to improve IIP2 and rejection of strong out-of-band signals. The integrated input switch is illustrated in **Figure 1**. **Figure 2** and **Table 1** show the suggested diplex filter. Both diplexer inputs are connected to the single-connector antenna input, J35. The VHF filter output connects to the RFIN2 pin, and the UHF filter output connects to the RFIN pin on the MAX3580.

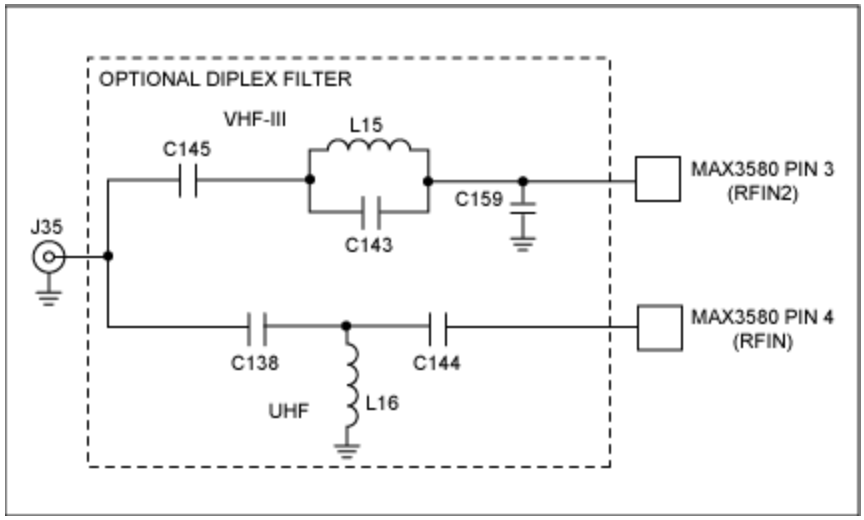

Figure 2. MAX3580 diplex filter schematic.

Table 1. Bill of Materials for MAX3580 Diplex Filter

Reference Designator	Qty	Value	Tolerance	Description	Vendor	Part
C145	1	33pF	5%	0603 capacitor	Murata	GRM1885C1H330J
C143	1	1.2pF	0.1pF	0603 capacitor	Murata	GRM1885C1H1R2B
C159, C138, C144	3	4.7pF	0.25pF	0603 capacitor	Murata	GRM1885C1H4R7C
L15	1	47nH	5%	0603 inductor	Murata	LQW18AN47NJ00
L16	1	18nH	5%	0603 inductor	Murata	LQW18AN18NJ00

When the receiver tunes to a VHF channel, the input switch is set to receive through the lowpass filter, which passes the VHF band and rejects the UHF band. Similarly, when tuning to a UHF channel, the input switch is set to receive through the highpass filter, which passes the UHF band and rejects the VHF band. Termination of the unselected filter occurs within the MAX3580. In the MAX3580 EV kit software, to select the RFIN2 pin for reception of a VHF channel, click on the RF Input Select box to choose RFIN2 while in the Block View window. Similarly, to select the RFIN input for reception of an UHF channel, click on the RF Input Select box to choose RFIN. **Figure 3** shows the frequency responses of these two filters when measured in a MAX3580 EV kit (rev 1).

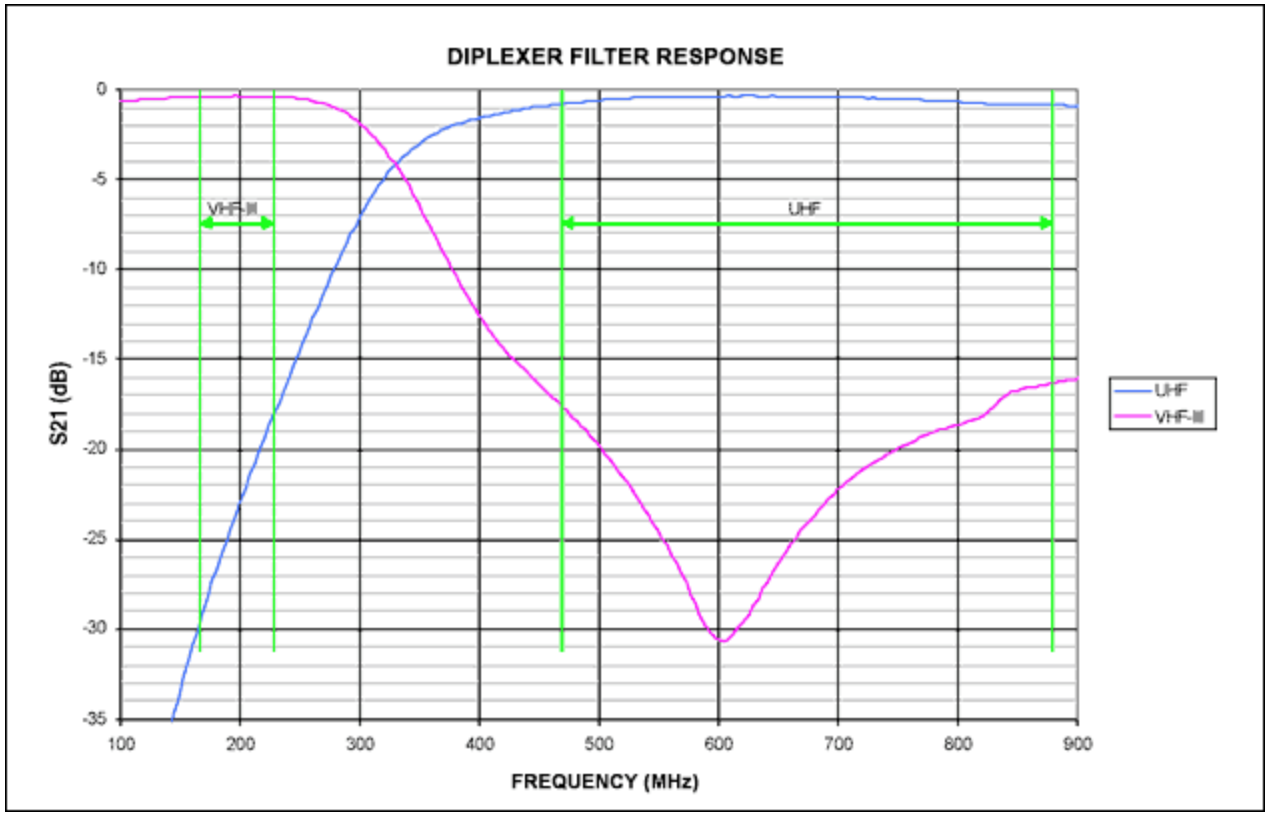

Figure 3. Measured diplex filter rejection and insertion loss.

In the same EV kit, the measured isolation from the undesired band resulting from the diplexer plus MAX3580 combination is shown in **Figure 4**. When tuned to a VHF channel, the undesired UHF channels are attenuated by typically 15dB. Similarly, when tuned to a UHF channel, the undesired VHF channels are attenuated by at least 32dB.

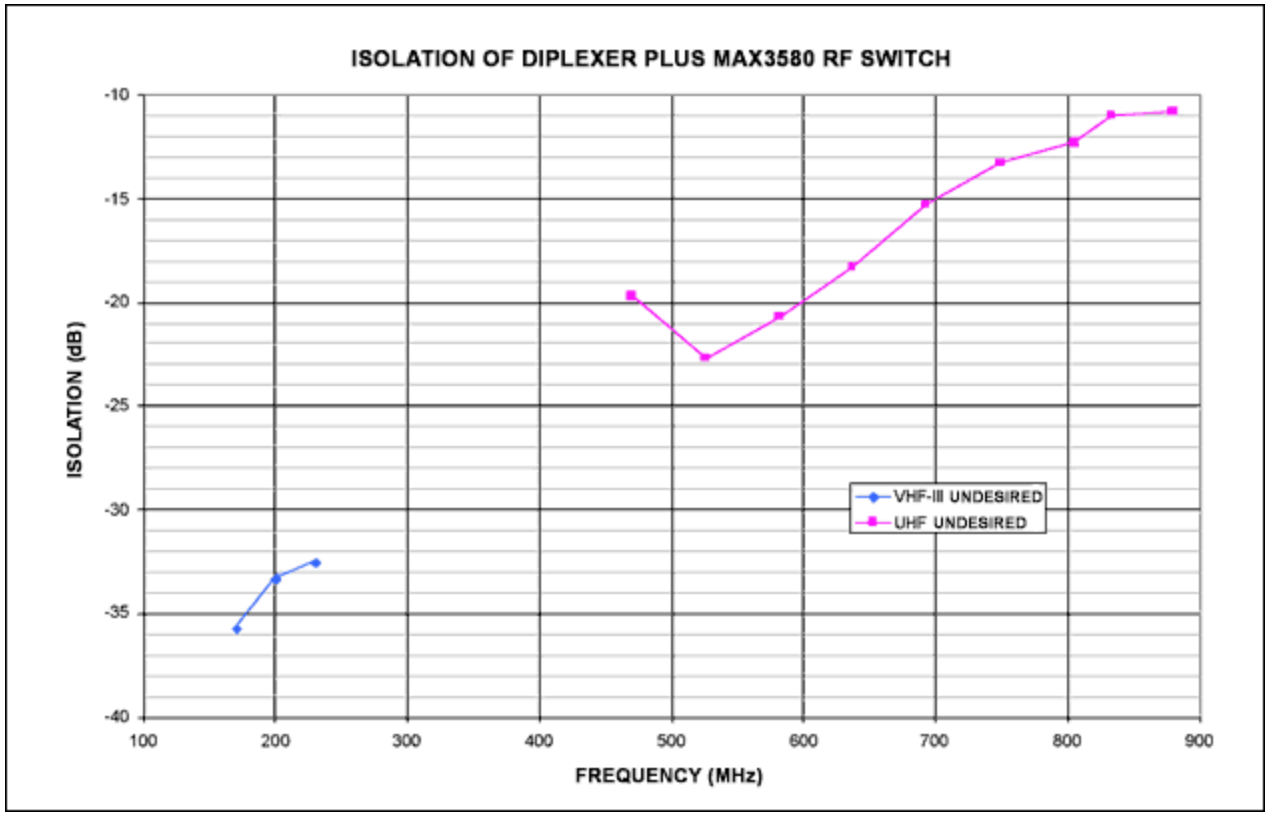

Figure 4. Isolation from unselected path for diplexer solution with the MAX3580.

This unique solution increases IIP2, yet has minimal impact on overall noise figure. IIP2 increases in the VHF band due to attenuation of UHF channels, which create A-B distortion products in the VHF band. Similarly, IIP2 increases in the UHF band due to attenuation of the VHF channels, which contribute to A+B and A-B distortion products in the UHF band.

Table 2 shows that the diplexer solution improves IIP2 by more than 30dB for selected input frequency and LO combinations. NF degradation is not more than 0.8dB for the Table 2 scenarios. IIP2 improvement for other scenarios is predicted by Figure 4. The IIP2 improves by the isolation of the out-of-band input frequency. When both input frequencies are out of band, the sum of both isolations predicts the IIP2 improvement. Consequently, the expected worst-case IIP2 improvement is 25dB when the input frequencies are 707.5MHz and 878MHz for a LO of 170MHz.

Table 2. Measured MAX3580 IIP2 Improvement and NF Degradation with Diplex Filter

LO (MHz)	F1 (MHz)	F2 (MHz)	IIP2 (dBm)	IIP2 Improvement (dB)	NF Degradation (dB)
200	470	670.5	49.6	35	0.2
470	230	700.5	46.3	31	0.8
700	230	470.5	56.1	38	0.2

Conclusion

An optional discrete diplex filter is incorporated with the MAX3580 DVB-T integrated tuner IC to improve IIP2 by at least 25dB and to enhance rejection of large out-of-band signals. These benefits are realized at the cost of not more than 0.8dB degradation in noise figure.

Related Parts		
MAX3580	Direct-Conversion TV Tuner	Free Samples

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