

## Optimize the MAX2338 Mixer IF SAW Filter Match at 183.6MHz for CDMA Application

*This paper presents the design and simulation of the impedance match between the MAX2338 mixer stage and a 183.6MHz SAW filter in a CDMA application. The SAW filter S-parameter is used to simulate the interface with the mixer. A worked example is provided with a SAWTEK 855893 SAW filter.*

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An optimum impedance matching circuit between the MAX2338 mixer differential IF ports and a 183.6MHz CDMA IF SAW filter is presented in this application note. A practical HP-ADS simulation schematic file along with test measurement results are included. Optimization criteria is based on minimum filter insertion loss, peak-to-peak amplitude ripple, and highest mixer IIP3 performance.

Typically, an IF SAW filter wants to see a source differential impedance in the order of several hundred ohms. The MAX2338 CDMA mixer output transconductance stage's optimum load is in the order of 2 to 3k $\Omega$  as a function of IF frequency. Therefore, a high to low impedance transformation topology is needed for an optimum match.

Initial S-parameter linear simulation is performed based on the mixer differential equivalent circuit at the intended IF frequency of operation and the 4-port S-parameter of the SAW device (without any external matching circuits) supplied by the SAW manufacturer. Actual product platform PCB information such as embedded transmission line lengths, substrate thickness, dielectric material, and vias size characteristics, can all be incorporated in the simulation for accurate modeling. Component values derived from simulation and subsequently implemented on circuit board on the first attempt demonstrated very good correlation between the MAX2338 mixer gain and SAW filter insertion loss. Final circuit implementation may require slight deviation from simulated component values to account for board parasitics that have not been modeled.

A similar approach can be applied to other Maxim LNA/mixer products such as the MAX232X, MAX235X, and family devices. For instance, the simulated internal equivalent circuit of the CDMA mixer IF ports across the MAX2323 IF ports (Pin 19 and 20) at 110 MHz is 12k $\Omega$  in parallel with 0.62pF. An external load resistor of 2.7k $\Omega$  has been chosen for the best gain and IIP3 optimization. Consequently, 2.2k $\Omega$  in parallel with 0.62pF becomes the equivalent differential load presented to the IF SAW filter input, and this load should be applied to source impedance in simulation. Summary of the MAX2323 mixer IF port impedance is shown below:

MAX2323 simulated IF port equivalent circuit	12k $\Omega$    0.62pF
MAX2323 IF external load	2.7k $\Omega$
Equivalent source impedance presented to SAW filter	2.2k $\Omega$    0.62pF

## MAX2338 to CDMA 183.6MHz IF Filter Matching Circuit Simulation Example

A linear RF simulator, such as HP ADS, is used to optimize the matching circuit in this example. Ideal transformers are used to impedance transform from a  $50\Omega$  single-ended environment to the desired differential source/load impedance. Surface mount (SMT) component pads and transmission line board parasitics are represented by an equivalent shunt capacitance of  $8.2\text{pF}$  for simulation. A schematic file for simulation is shown in Appendix A. Forward transfer response is shown in Figure 1. Simulation is based on the following source and load characteristics presented to the SAW filter:

SAW Filter	SAWTEK 855893
MAX2338 IF port differential equivalent circuit	$12\text{k}\Omega \parallel 1.7\text{pF}$
MAX2338 IF external load	$3.3\text{k}\Omega$
Equivalent differential source impedance presented to SAW filter	$2.58\text{k}\Omega \parallel 1.7\text{pF}$
Differential load impedance presented to SAW filter	$604\Omega$
Board parasitics capacitance modeling	$8.2\text{pF}$ shunt (refer to Appendix A)

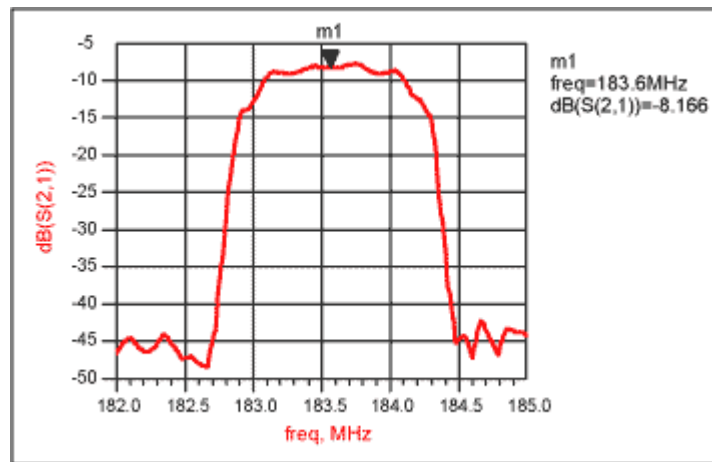


Figure 1. Simulated MAX2338 to 855893 IF filter transfer response

The matching circuit component values shown on schematics were subsequently implemented on Maxim Version 3 CDMA reference design with very favorable results and without much deviation from simulated values.

## MAX2338 and CDMA IF Filter Matching Circuit Measurement Example

In this example, similar simulation methodology is applied to determine matching circuit components. SAWTEK 855871 SAW filter is used in this example. Cascaded response in  $50\Omega$  environment correlates well with the MAX2338 mixer gain and the SAW manufacturer's specs given the filter insertion loss and implementation PCB loss. Mixer gain, IIP3, and filter selectivity have all met specifications. The circuit diagram used for this measurement is shown in Figure 2.

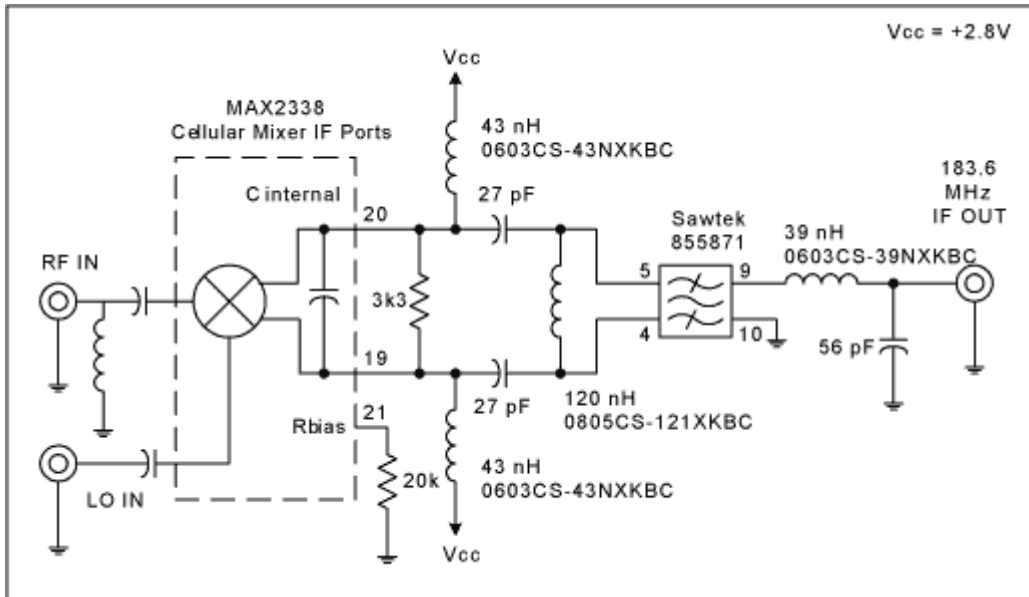


Figure 2. MAX2338 to SAWTEK 855871 circuit diagram

### CDMA IF Filter Test Condition:

- Testing conducted at +25°C
- RF in = 881MHz  $\pm$ 5 MHz at -30.5dBm for swept response measurement
- RF in = 880.96MHz and 881.04MHz at  $\pm$ 25dBm each tone for IIP3 measurement
- LO in = 1064.6MHz at -7dBm

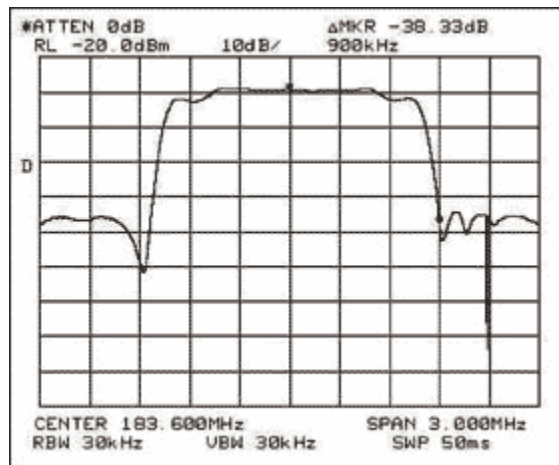


Figure 3.

Filter selectivity at  $F_c \pm 900\text{kHz} = -38\text{dBc}$ .

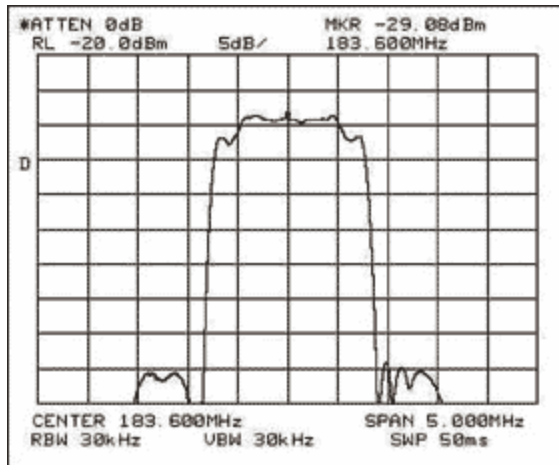


Figure 4.

Filter I.L. = Pin + Mixer Gain (typ.) - Pout = -30.5dBm + 13.3dB - (-29dBm) = 11.8dB (included PCB loss)\*

\*Note that 855871 typical insertion loss is 10dB.

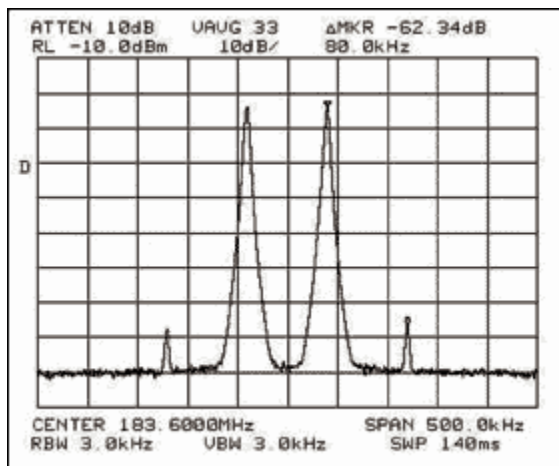


Figure 5.

IIP3 = (62/2) + (-25dBm) = +6dBm.

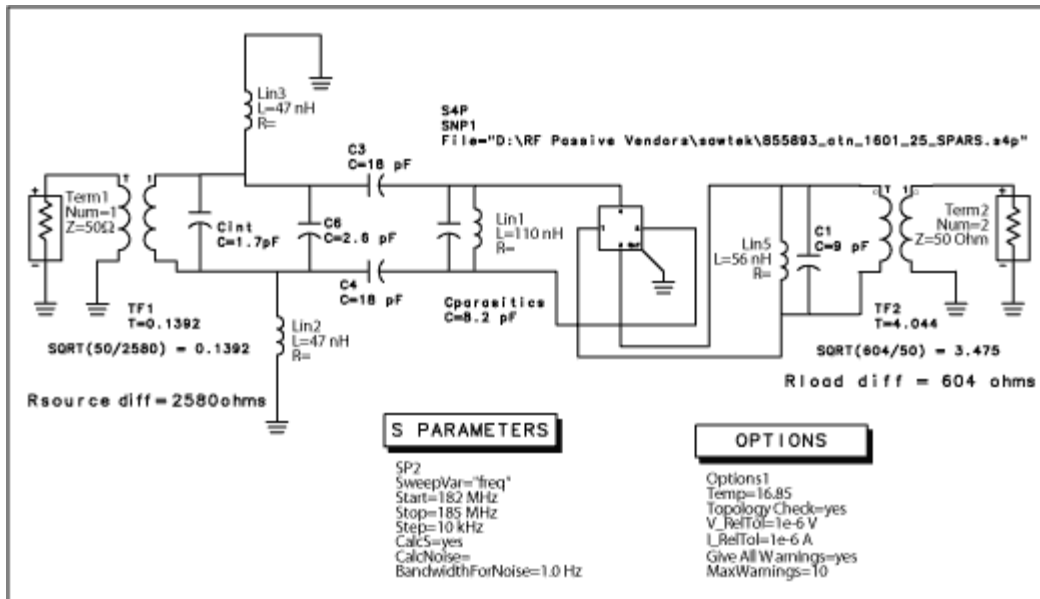


Figure 6. Appendix A: HP ADS simulation schematic diagram

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