

## 1 Introduction

Many PMR products cover the operating frequency band of 400MHz to 470MHz; an advantage of using the CMX994A/E direct conversion receiver IC over alternative receiver solutions is that this whole band can be covered with a very simple matching circuit.

This application note is based around the CM994A/E evaluation platform (EV9942A/E). The purpose of this document is to provide and verify a 400MHz to 470MHz matching circuit starting with the default values fitted to the EV9942A/E Evaluation Board. The circuit is based on a combination of low and high pass filter elements.

Further investigation has been carried out on the DE9945 which is a PMR/DMR demonstration/evaluation platform that includes the CMX994A/E together with the CMX7341 baseband platform IC.

## 2 History

Version	Changes	Date
1.0	New Issue	27-10-16

### 3 Evaluation Results

#### 3.1 EV9942A/E Default values

An unmodified EV9942A/E, was investigated over a wide input frequency range. The cascaded component chain of the CMX994A/E is shown in Figure 1, all reference designators refer to the EV9942A/E schematic which is available on the CML website.

The results in Figure 2 show the response of the complete Rx chain with the following common CMX994A/E settings:

- Normal IP3 mode,
- LO phase correction ON,
- Freq Cntrl = 300MHz to 700MHz,
- ACR filter at maximum,
- LNA = 50R mode,
- IM reg = 63 dec
- Local Oscillator at  $f_{rf} \times 2$  (external LO).

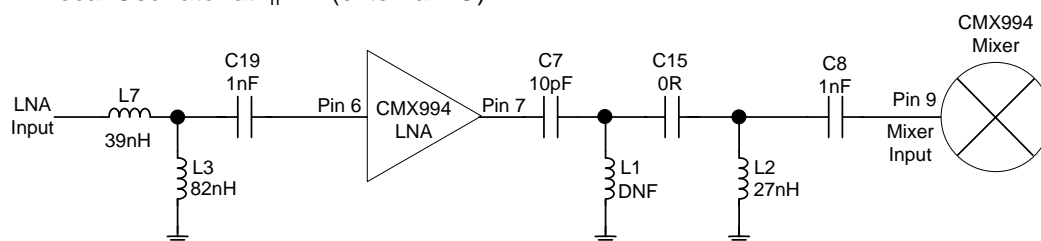


Figure 1 – Default values of the EV9942A/E Rx chain

The gain response in Figure 2 shows that the default matching values can cover the 400MHz to 470MHz band but doesn't provide much out of band filtering. The typical gain variation across the operating band is approximately 1dB.

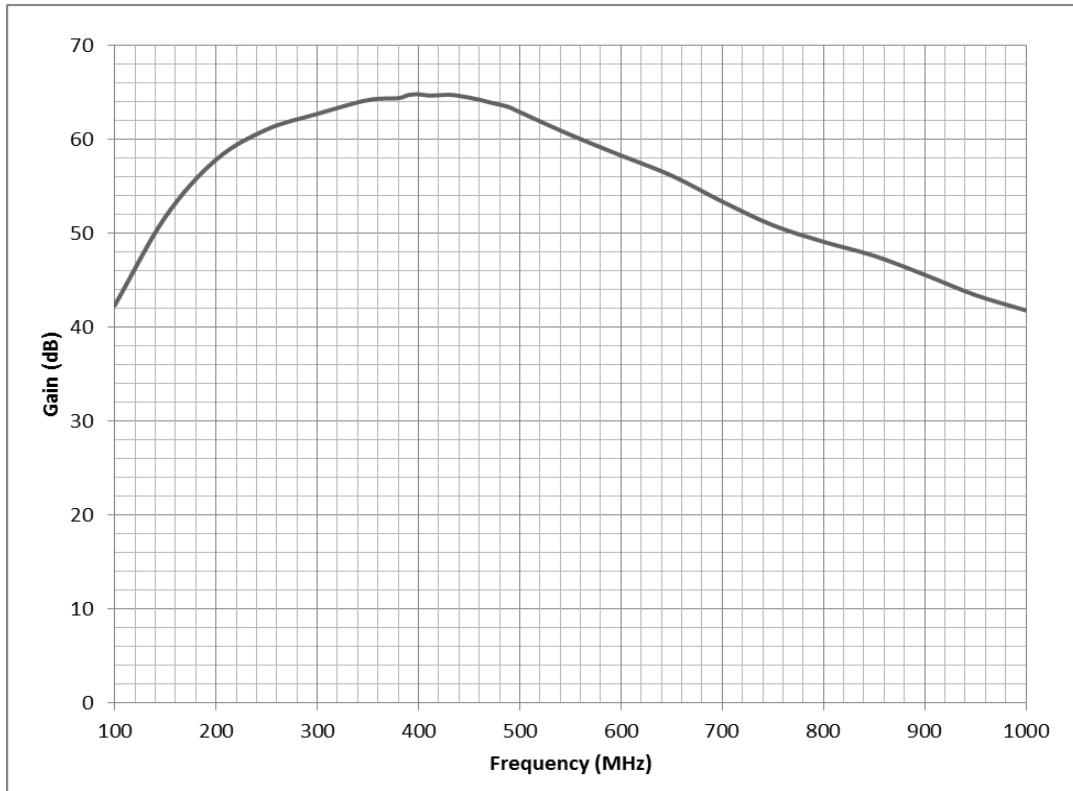


Figure 2 – Gain variation of the default build of EV9942A/E from 100MHz to 1GHz

### 3.2 EV9942A/E New Matching Values

The following results show a new circuit, as shown in Figure 3, implemented on an EV9942E. However the same circuit can be used on the EV9942A. The changes require some slight re-arrangement of components to add in some extra filtering but this is easy to implement, i.e. at position L7 and L3.

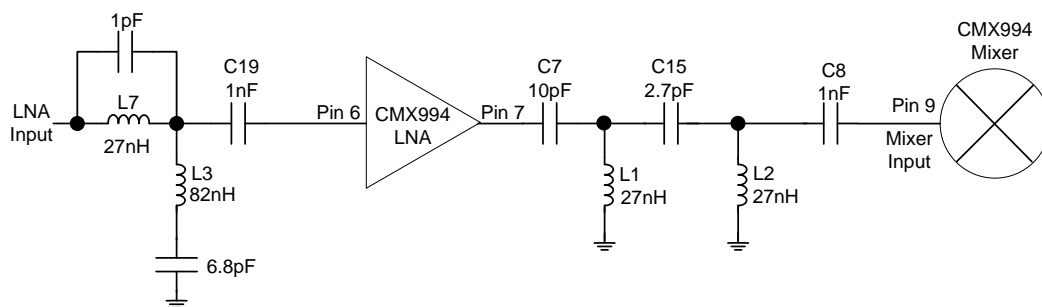


Figure 3 – Modified CMX994A/E matching circuit

The gain response in Figure 4 compares the response of the EV9942E original values to the modified matching circuit. The modified matching circuit provides rejection of the spurious responses within the LO region and also at the  $f_{rf} / 2$  (e.g. 200MHz to 235MHz) which is often a problematic spurious response. A system assumption has been made that there will be a further low pass filter prior to the CMX994A/E receiver input, for example a common Tx/Rx low pass harmonic filter to provide the LO rejection.

The modified matching circuit has a gain variation of approximately 1dB across the 400 to 470 MHz band.

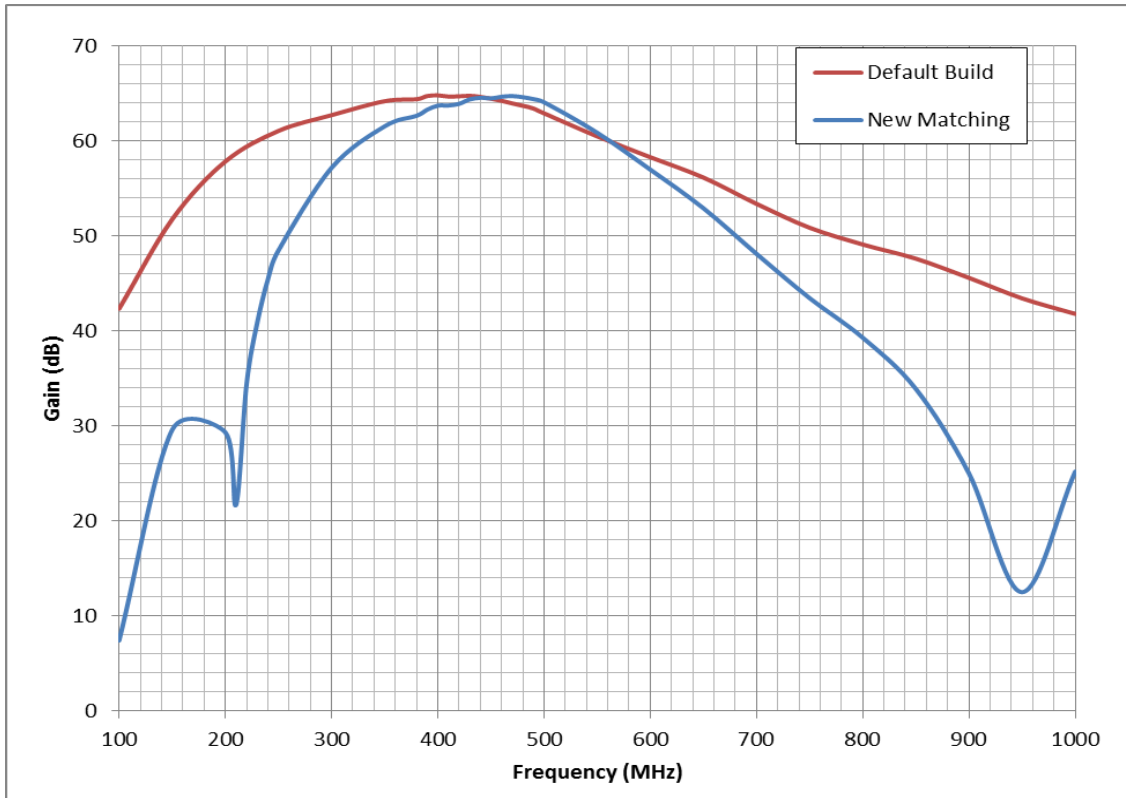


Figure 4 – EV9942E gain response of the default values and the new matching values

### 3.3 DE9945A/E

The default configuration of the DE9945A/E includes a SAW filter between the LNA and mixer, this has a narrow operating bandwidth of 446MHz +/-4MHz. The same matching circuit developed on the EV9942A/E has also been evaluated on the DE9945A/E, see Figure 5 for component values used and the response of the Rx chain is shown in Figure 6 and Figure 7. The response includes the input Tx/Rx harmonic filter and Tx/Rx switch. The receiver system noise figure with the new matching is typically 5.4dB across the band 400MHz to 470MHz.

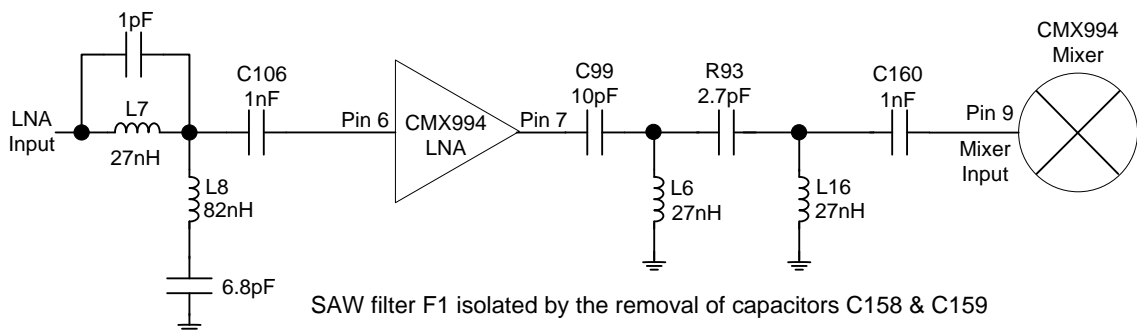
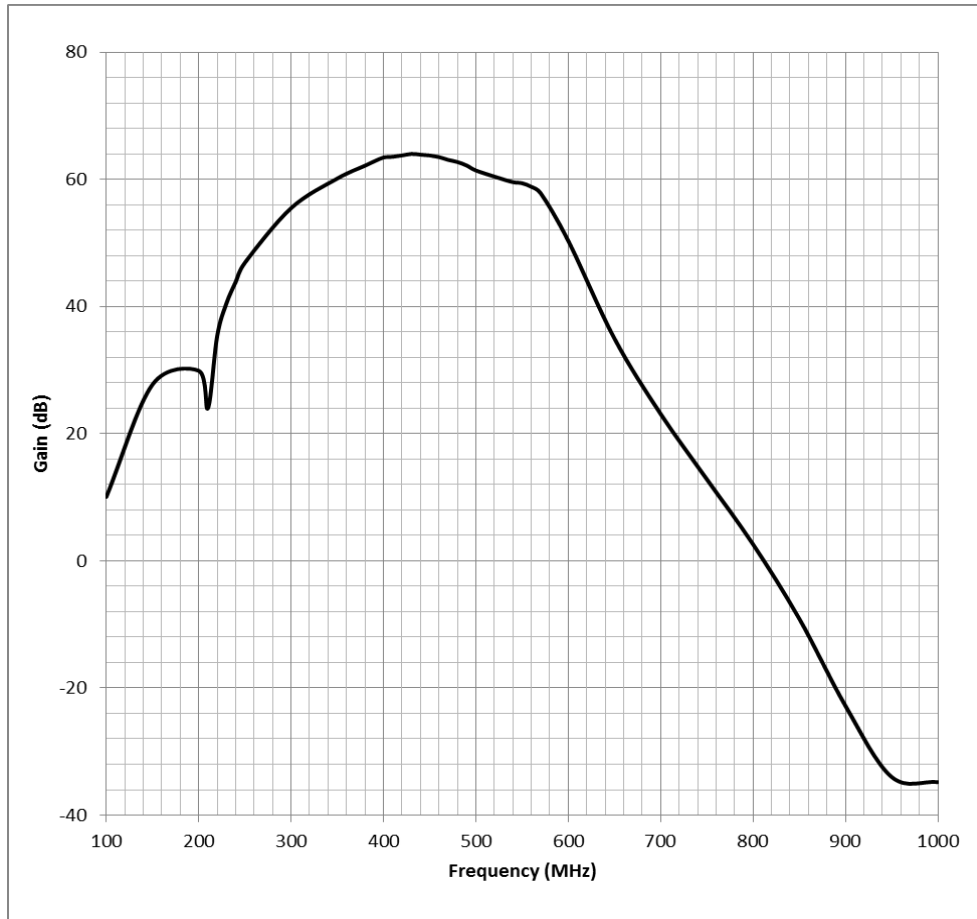
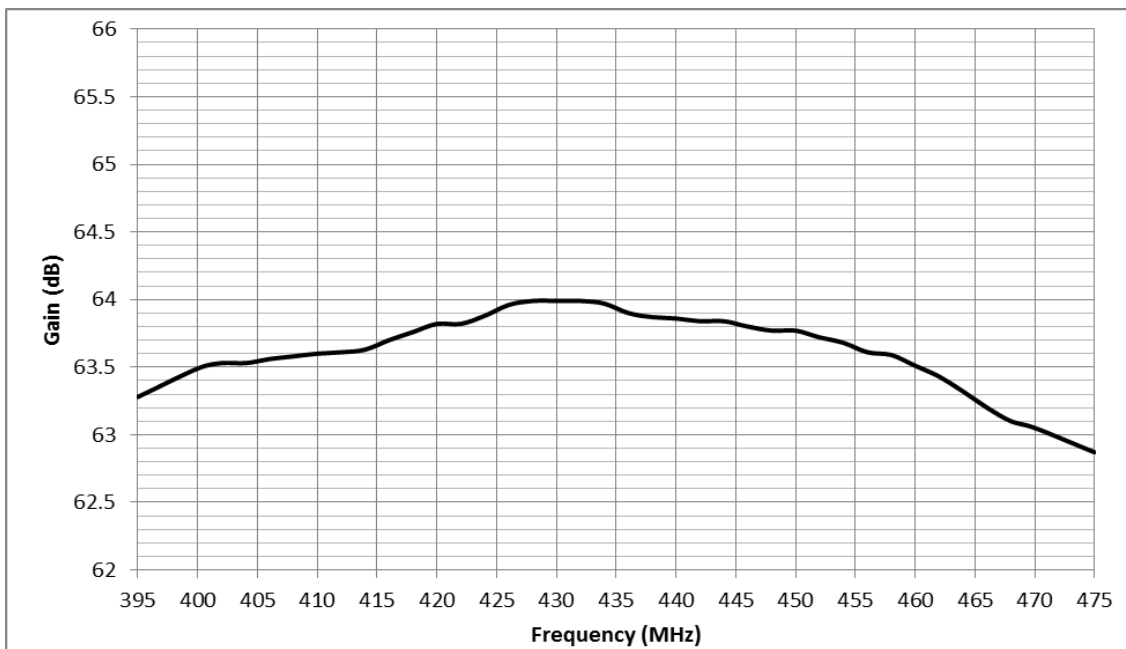


Figure 5 – DE9945A/E New Matching values for 400MHz to 470MHz operation



**Figure 6 – DE9945A/E Gain Response with new matching circuit applied**



**Figure 7 – DE9945A/E New Matching Gain Response of Operating Band**

## 4 Conclusion

The CMX994A/E can easily be configured to cover the 400MHz to 470MHz operating band. As is normal practice customers will need to validate the suggested matching values for a particular PCB layout.

System consideration needs to be given to the total amount of rejection required at certain spurious responses. In the case of the DE9945 this has been considered because the chain also includes a common Tx/Rx harmonic filter.

Further system parameters to consider are that both CMX994A/E LNA modes (50R or 100R) can be used with both the default matching and modified match configuration without having a detrimental effect on the gain response of the cascaded chain. Issues to consider are:

- Using the LNA in 50R mode gives between 1.5dB and 2dB more gain than the 100R mode and therefore the system IIP3 will degrade by the same amount
- The same change in system IIP2 occurs between 50R and 100R mode
- The noise figure of the EV9942A/E Rx chain in all matching cases in 50R mode is typically 4.5dB to 5dB across the band of interest and the noise figure will degrade by approximately 1dB in 100R mode.

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