Application Note
CMX994 / CMX994A / CMX994E Interference Immunity

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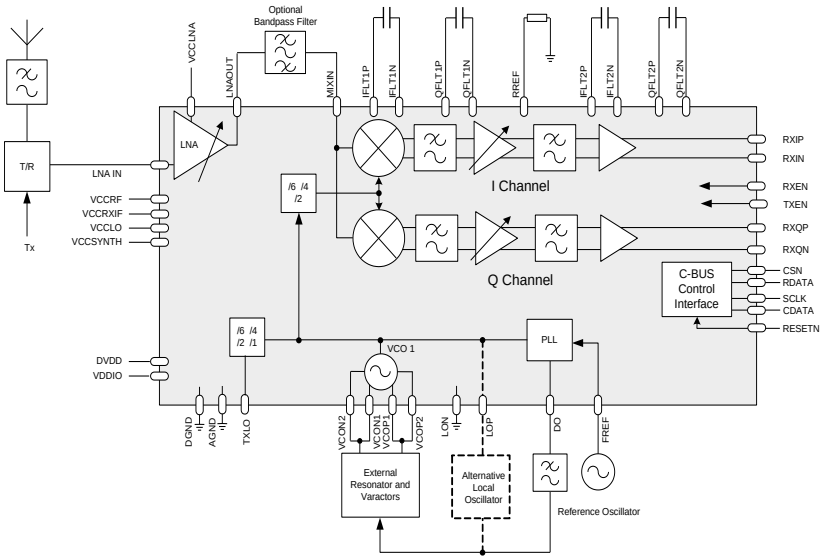

1 Introduction

The specification of the interference immunity of Direct Conversion receivers, such as the CMX994/A/E devices, can be a confusing area. Parameter such as blocking performance and second order intermodulation are often referenced but can have obscure definitions and measurement methods.

ITU-R (SM.322-4) states; “blocking is measured by the level of an unwanted signal on a nearby frequency, e.g., in an adjacent channel, which results in a given change (generally a reduction) e.g., 3 dB, in the output power due to a modulated wanted signal of specified level applied to the receiver input“.

In general, the modern interpretation of “blocking” considers cases of interferers beyond the adjacent channel region, for example in the case of ETSI PMR standards offsets in the range 1 MHz to 10 MHz. It is clear from the ITU-R document that blocking arises from a single interfering (unwanted) signal so it is difficult to see why some manufactures confuse blocking with intermodulation which arises with two interferers (SM.332-4: “intermodulation is measured in terms of the levels of two unwanted signals”.)

CML tends to use terms in our product information that can be traced to relevant technical standards, most commonly ETSI standards as these are publically available free-of-charge; TIA and ARIB standards are also referenced where appropriate. At present no PMR standard from ETSI, TIA or ARIB measures 2nd order intermodulation.

2 History

Version	Changes	Date
1	Initial release	07 April 2016

3 Blocking

The CMX994/A/E offers exceptional blocking performance; typical values are in the range 98 dB to 102 dB depending on the measurement method.

Note: in practical radios performance might be degraded by the applied LO phase noise.

3.1 ETSI Method

Wanted signal: 390 MHz, -107 dBm,
PN weighted SINAD measurement
CMX994 LO at 780 MHz, -10 dBm (HP8642A).

Interferer (SMW200A) at 385 MHz and level adjusted for 14 dB SINAD (PN weighted).

- Blocking is 98 dB

3.2 "TIA-603" Style method

This test uses a "TIA-603" style method, having the wanted signal 3 dB above sensitivity. The sensitivity of the receiver (CMX994+CMX7141) is -120 dBm (12 dB SINAD, unweighted) so for the blocking test the wanted signal level is -117 dBm. The TIA test methods quote performance figures referenced to the sensitivity level.

Interferer (SMW200A) at 385 MHz, level adjusted for 12 dB SINAD unweighted.

- Blocking is 102 dB

4 Second Order Intermodulation

All direct conversion receivers are inherently susceptible to second order intermodulation effects (i.e. $f_1 - f_2 = f_{rx}$). The problem can be mitigated by careful design of the direct conversion mixers to achieve a high "Input Second Order Intermodulation Intercept Point" (IIP2) figure of merit.

IIP2 performance will vary quite significantly between different devices of the same design and variations are also expected as a function of measurement frequency offset, see Figure 1. In general IIP2 improves as operating frequency reduces. These trends arise because IIP2 performance is closely linked to good balancing of the mixer circuits so the normal random variations in the silicon fabrication process have a significant impact.

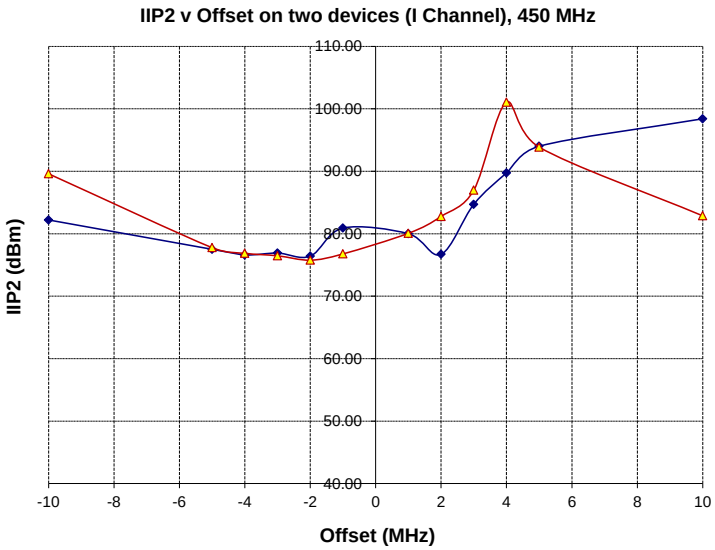

Figure 1

Because of the variable nature of IIP2, CML data sheets quote IIP2 as an average figure. For example:

> "Average value of IIP2 measurements at ±1MHz, ±5MHz and ±10MHz offsets using differential signals on I and Q channels, measurements every 100MHz over the range 100MHz to 600MHz".

An average value of 79 dBm is quoted but individual measurements over 100 dBm are to be expected.

5 Practical Performance

The theoretical interference immunity is one matter but to increase confidence in CML technology a number of field trials have been conducted at the following test locations:

- city centre (Bristol, UK)
- London Heathrow airport
  - one of the most congested RF environments in Europe
  - test route around perimeter road and in central terminal area
- London to Shepton Mallet (107 miles, 172 km)
- radio sites (Dundry Beacon and Beacon Hill, Bulford)

Tests were conducted using three radios connected to a common antenna on a test vehicle (Figure 2), reception is on license exempt frequencies in the European 450 MHz band. Results are summarised in Table 1.

Test Scenario	Number of interference events on test route		
	Low Cost FM Handy	Professional PMR radio (meeting ETSI EN 300 086)	CMX994 radio (CMX7141 baseband)
Heathrow	unusable, continuous interference	1	1
London to Shepton Mallet (including Beacon Hill, Bulford)	25	Not measured	1 (at Beacon Hill)

Table 1

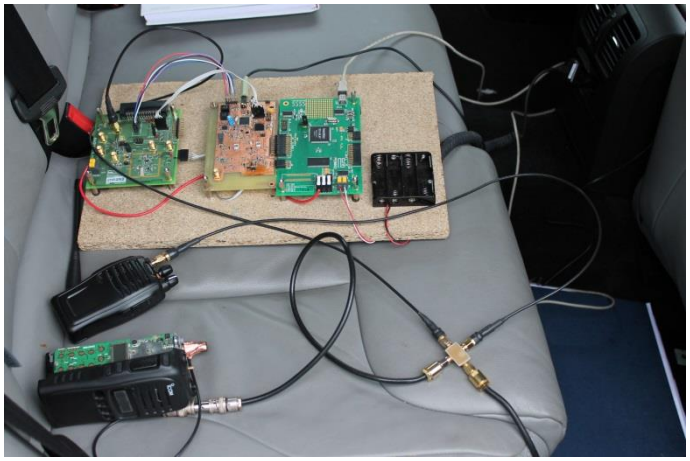

Figure 2 Test Apparatus

6 Conclusion

CMX994 / CMX994A / CMX994E direct conversion receiver ICs provide interference immunity, in terms of second order intermodulation and blocking, that is suitable for professional radio designs.

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