APPLICATION NOTE

Measurements on TSA5059T/C1 and SP5659 regarding ripple voltage susceptibility

AN99019

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Abstract

This document describes the measurement results of susceptibility on ripple voltage injected on a DC supply voltage. These measurements were performed on a PR39232 demoboard with a PHILIPS TSA5059T/C1 and a pin -and software compatible MITEL SP5659 synthesizer IC. Two measurements were performed and finally compared between:

1. The MITEL SP5659 and the TSA5059T/C1 with external NMOS

2. The TSA5059T/C1 with and without the external NMOS

The results can be useful for customers, for they can derive specifications required for their (Switched Mode) Power Supplies.

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APPLICATION NOTE

Measurements on TSA5059T/C1 and SP5659 regarding ripple voltage susceptibility

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1. INTRODUCTION

This document describes the supply voltage ripple susceptibility of the PHILIPS TSA5059 Low Phase Noise I^2C-controlled Synthesizer IC in a zero-IF QPSK receiver application. Also the pin -and software compatible MITEL SP5659 was measured in the same application and the results are compared.
The measurements described in chapter 3 are performed on the PR39232 Zero-IF demoboard. This board is originally intended to be used with the TSA5059 synthesizer, but is modified for these measurements to operate with the MITEL SP5659 as well, by means of adding an external high voltage transistor.
The measurements are done on the 5V and 28V supply voltages by introducing an AC ripple voltage on the DC and measuring the BER degradation. Further explanation of the setup is done in chapter 3.
From ripple measurements a customer can derive specifications for their (switched mode) power supplies.

2. INSTALLATION AND DESCRIPTION OF THE DEMOBOARD PR39232

The following paragraphs describe step by step the installation of the TDA8060 Zero-IF demoboard PR39232.

2.1 Demoboard PR39232 without external NMOS

In Figure 1 the connectors of PR39232 demoboard are shown:

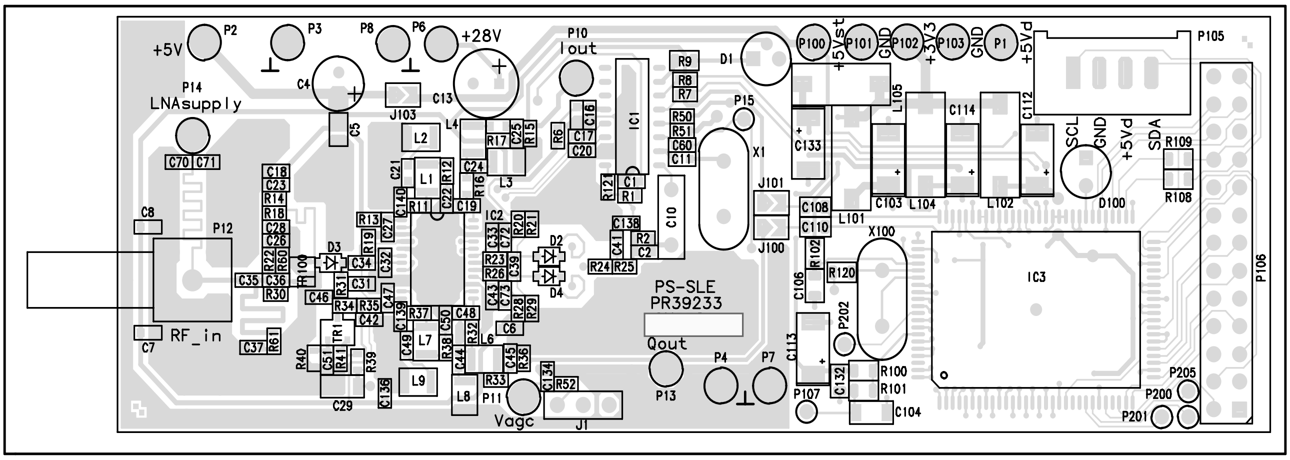

Fig.1 The PCB with the connectors and pins

The voltage supply connectors are:

“P1”	+5 Volt I^{2}C supply voltage
“P2”	+5 Volt TDA8060 board supply input
“P3”	ground TDA8060 board supply
“P8”	ground TDA8060 varicap supply
“P6”	+28 Volt TDA8060 varicap supply voltage
“P102”	+3.3V supply voltage TDA8044
“P105”	I^{2}C / 3-WIRE bus interface connector *(SCL, GND, SDA, +5Vd)*
“P12”	RF input connector *(50 Ohm SMA)*
“P4”,“P7”	Extra ground pins for earth connections of probes, etc.
“P11”	AGC voltage input *(0..+4.5V: 0.5V = minimal gain, 4.5V = maximal gain)*

2.1.1 Hardware settings

- Connect the I^{2}C bus connector of the demo board to an I^{2}C interface board. Please check the wiring before power on.
  In the DBUI software “tuner” menu, select the I^{2}C address C2. An easy way to test if the TSA5059 responds, is to enable “output port P3” in the software. The LED “D1” should light up.

2.2 PR39232 with external NMOS

For this measurement, the TSA5059 is placed plus the external NMOS (a BSN20 type), of which the gate is directly soldered to pin 1. Pin 16 is in that case lifted from the PCB (see also below in fig. 2). For more convenient test application, the PLL loop capacitor is changed from a MKT type to SMD, which can be soldered onto the bottom of the PCB.

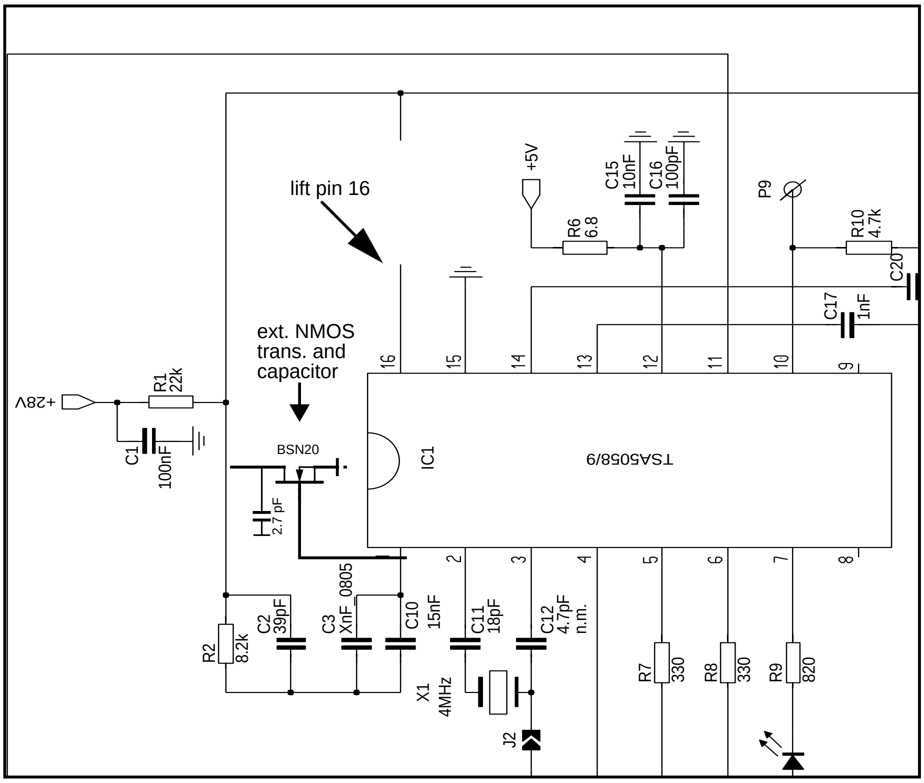

Fig.2 Schematic of TSA5059 with external NMOS

2.2.1 Hardware settings

These settings are the same as described in the previous paragraph.

2.3 SP5659 operation

2.3.1 Hardware settings

The demo board for the use with the SP5659 should be setup the same as for the TSA5059, except for the high voltage transistor application change.

The board is originally intended to be used with the TSA5059 synthesizer, but is for these measurements modified to operate with the MITEL SP5659, by means of adding an external high voltage npn transistor BC847B. Pin 16 of the SP5659 should be lifted from the pcb and connected directly to the base of the external transistor. See Figure 3 on the next page. Please take care that the connections of the transistor to ground and the IC are as short as possible.

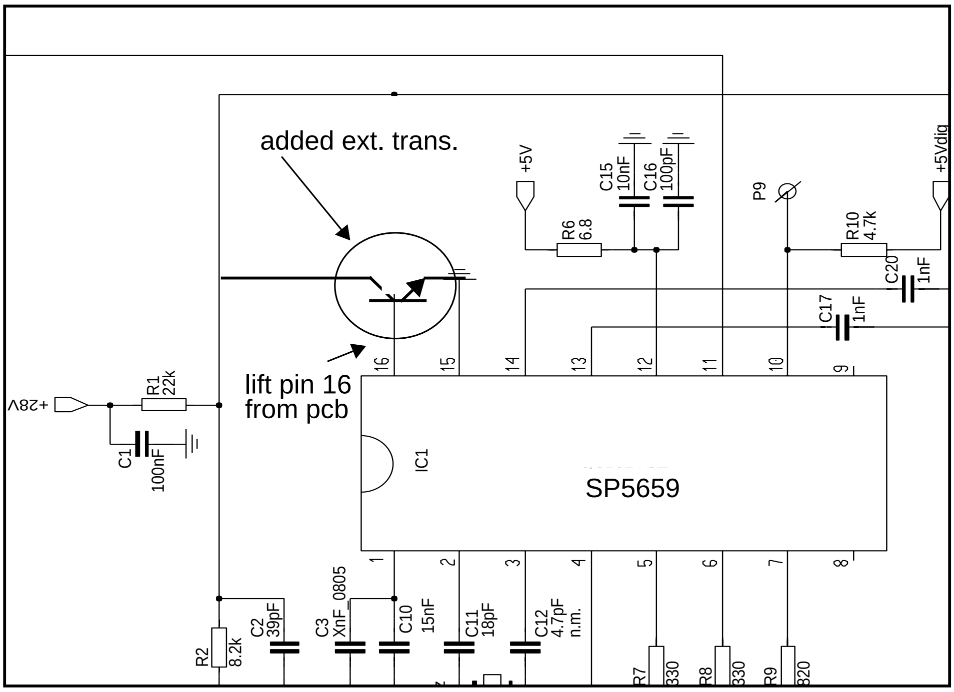

Fig.3 Application change PR39232 for use with MITEL SP5659

3. RIPPLE MEASUREMENTS ON TSA5059T/C1 WITH NMOS AND SP5659

This chapter describes the 5V ripple measurements done on the demoboard. First, measurements on the TSA5059T/C1 with external NMOS are described. Second, the same measurements are carried out with the SP5659. Both measurements are carried out on f_{vco}= 950MHz, 1350MHz and 2150MHz.

3.1 Measurement setup

The measurement setup is shown below in Figure 4.

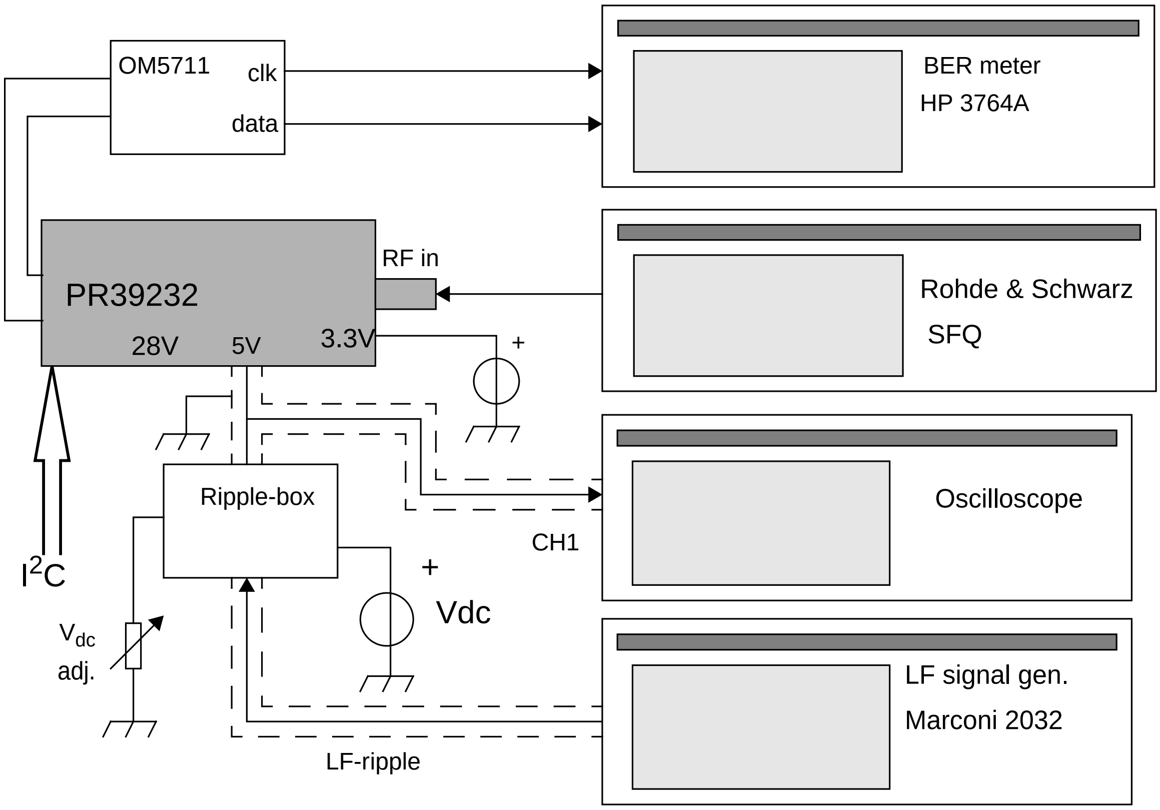

Fig.4 5V ripple measurement setup

The ripple-box consists of a LM317 voltage regulator in which a LF signal is injected. The DC voltage connected is about 12V. Please note the importance of grounding of the demoboard. To minimize the noise caused by grounding loops, the ripple-box is used as a reference star-point from which all grounding-wires run to the demoboard.

3.1.1 Settings

- Set the SFQ to either 950 MHz, 1350 MHz or 2150 MHz.
- Set the symbolrate to 27.5 MSymb/s with a puncturing rate of 5/6 and roll-off factor of 0.35.
- Set the RF output level of the SFQ to -30 dBm.
- Set the VCO frequency in the DBUI software to either 950 MHz, 1500 MHz or 2150 MHz.
- The settings for the TSA5059 synthesizer is as follows:
    - Comp. Freq. 125kHz
    - Charge pump 120µA

- Set the software to ‘Viterbi’ mode
- Get the demoboard in lock and set the C/N value to a $BER_{vit.}$ of $1.0e^{-4}$, which sets the standard value with no ripple influence.
- Increase the C/N value with 0.5dB.
- Introduce ripple with a frequency starting at 1kHz.
- Increase the ripple amplitude until again a $BER_{vit.}$ of 1.0e-4 is reached.
- Read from the oscilloscope the peak-peak ripple voltage for 0.5dB implementation loss for the given frequency.
- Repeat last three steps for other LF frequencies ranging up to 250kHz.
- The settings for the SP5659 operation are the same as for the TSA5059 regarding comparison frequency and charge pump.

3.2 Measurement results

See graphs below.

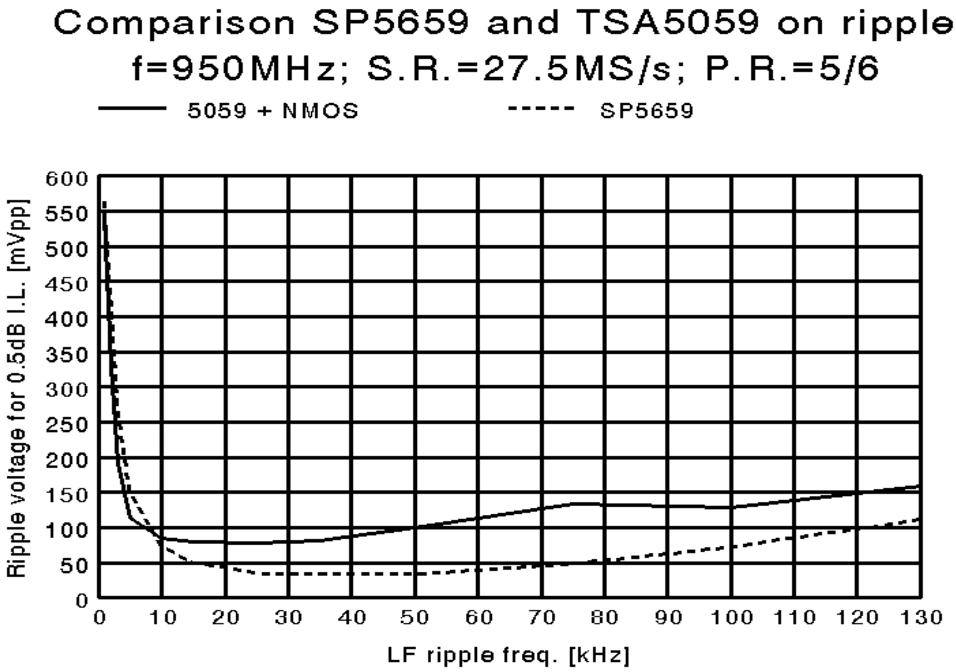

Fig.5 Measurement ripple between TSA5059T/C1 with external NMOS and MITEL SP5659 at f=950MHz

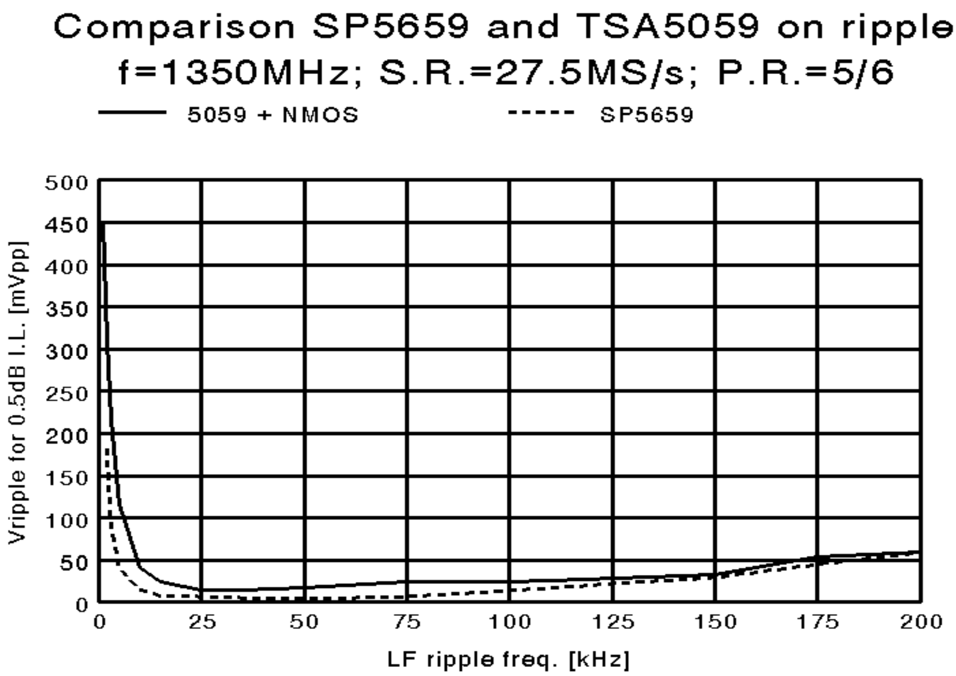

Fig.6 Measurement ripple between TSA5059T/C1 with external NMOS and MITEL SP5659 at f=1350MHz

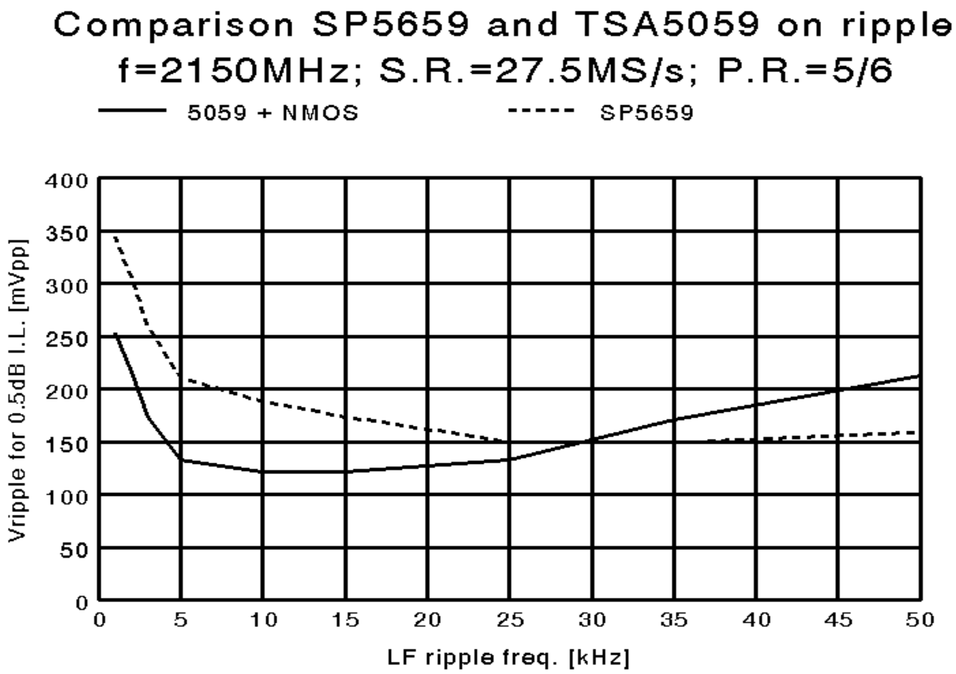

Fig.7 Measurement ripple between TSA5059T/C1 with external NMOS and MITEL SP5659 at f=2150MHz

3.3 Conclusions

The measurement results show that on 950MHz the TSA5059 performs better in ripple than the SP5659. The most sensitive region here is between 10kHz and 50kHz for both IC's.
The most sensitive frequency for ripple is 1350MHz, where the K_{vco} is the highest. Here a very small ripple voltage around 50kHz introduces a big insertion loss. Therefore, specifications on power supply ripple performance should be derived at from this data.
On 2150MHz the tolerable ripple voltage for a given insertion loss is not important anymore; Although the SP5659 performs better than the TSA5059 below approx. 30kHz, the voltages measured for 0.5dB insertion loss are that high that in practice they never occur.

4. RIPPLE MEASUREMENTS ON TSA5059T/C1 WITH AND WITHOUT NMOS

4.1 Measurement setup

The measurement setup is equal to the previous measurement, except the measurements are only carried out on the TSA5059T/C1.

4.1.1 Settings

The settings are the same as described in paragraph 3.1.1

4.2 Measurement results

See graphs below.

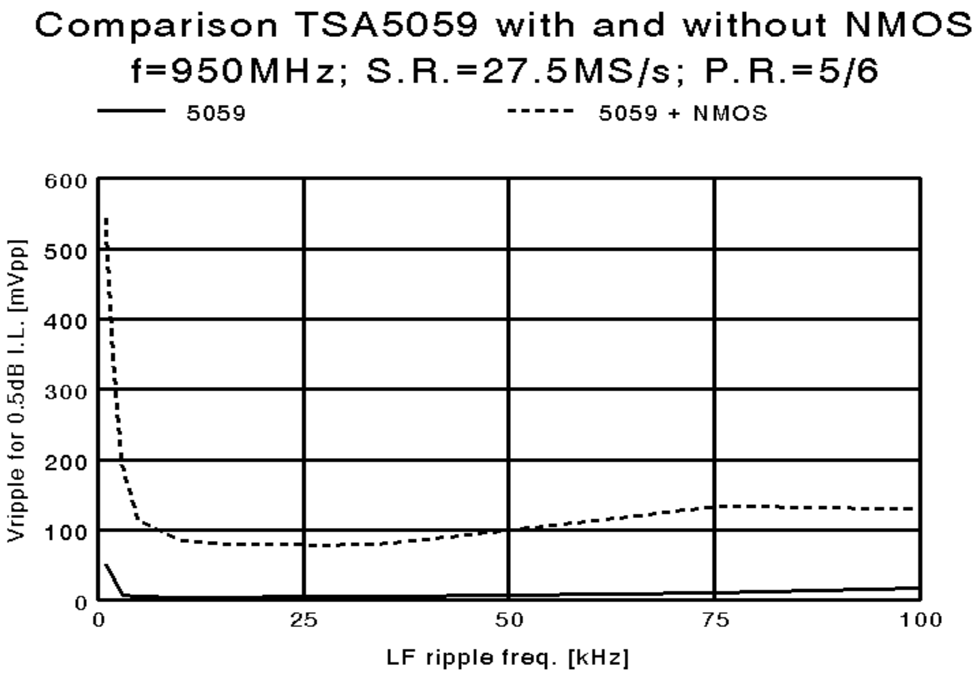

Fig.8 Measurement ripple between TSA5059T/C1 with and without external NMOS f=950MHz

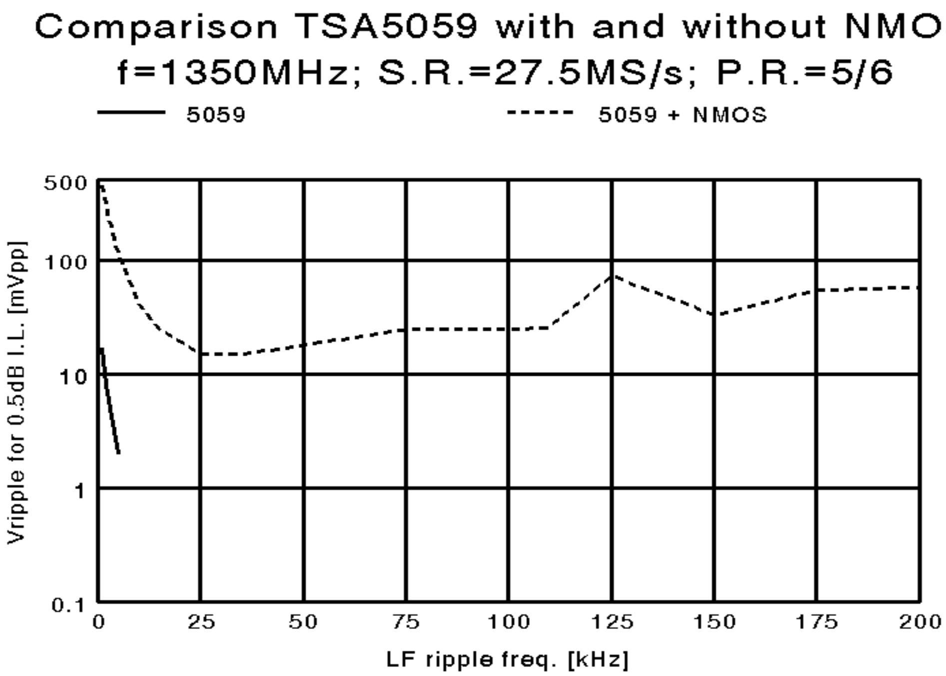

Fig.9 Measurement ripple between TSA5059T/C1 with and without external NMOS at f=1350MHz. (Y-axis log scale)

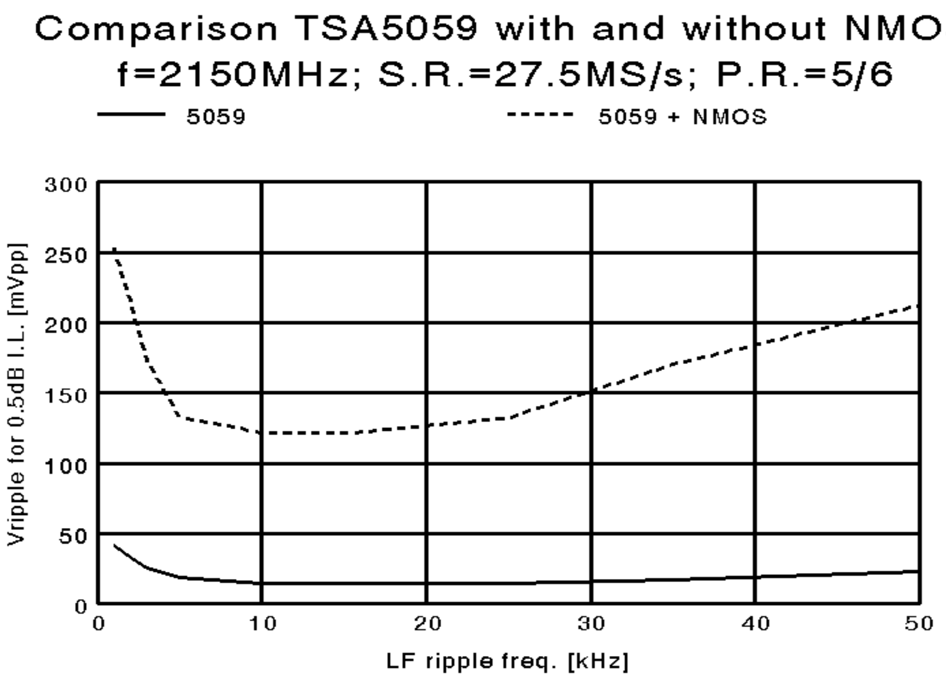

Fig.10 Measurement ripple between TSA5059T/C1 with and without external NMOS at f=2150MHz.

4.3 Conclusions

From the graphs can be concluded that on all frequencies measured the TSA5059 with external NMOS greatly improves on ripple sensitivity. On 1350MHz, without the NMOS, the ripple voltage could not be measured anymore above 5kHz, because of noise present on the DC voltage, also due to the high K_{vco}. For convenience, the scale of the Y-axis is logarithmic.
The LF frequency-range where the measurements have taken place are not the same for all three RF frequencies; Due to noise present on the supply voltage or unlocking of the SDD because of the high ripple amplitude, no further measurements were performed for higher LF frequencies.

5. CONCLUSIONS

It seems that the TSA5059 application with the external NMOS transistor is a good application solution to improve ripple performance, compared to operation without the external NMOS.
Second, with this NMOS-application the overall performance of the TSA5059 seems to be better on ripple for frequencies ranging 950MHz to about 1500MHz compared to the SP5659 of MITEL.
Note that only the ripple sensitivity on the 5V supply voltage has been investigated. The 28V supply needed for the tuning showed no degradation in BER when injected, only at high ripple voltages (in the range > $500mV_{pp}$), but then the normal operation failed (no SDD lock). It seemed that the 28V was not susceptible to ripple. Therefore, no measurement results were performed and included on the 28V supply.

APPENDIX 1 Board Schematic