APPLICATION NOTE

Multiple Channel Measurements on TDA8060

AN99017

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Abstract

In the TDA8060 Zero IF QPSK receiver parameters are measured under single signal conditions. From the specifications it can be found that a certain maximum amount of power is allowed to the TDA8060 input. To verify this a measurement set-up is created to avoid the use of more then one signal generator.

In this report used measurement setup is described and also measurement results are included.

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Summary

This report describes a measurement method and setup for evaluating the large signal behaviour of the TDA8060 zero-IF QPSK demodulator. Multiple QPSK signals, which will give increased total input power to the device, are simulated by using a flat wide band noise spectrum to eliminate the need for an expensive measurement set-up.

Also measurement results, for a limited frequency range and symbol rates, are included.

CONTENTS

1. INTRODUCTION

This report describes a measurement method and setup for evaluating the large signal behaviour of the TDA8060 zero-IF QPSK demodulator. Most measurements, to verify specification parameters of the TDA8060, are done with single signal source. It is desired however to verify also these parameters when multiple signals are present at the TDA8060 input. To avoid the use of more then one QPSK signal generator, which is expensive and demands a complicated measuring setup, a work-around is described in this report.

1.1 Technical Background

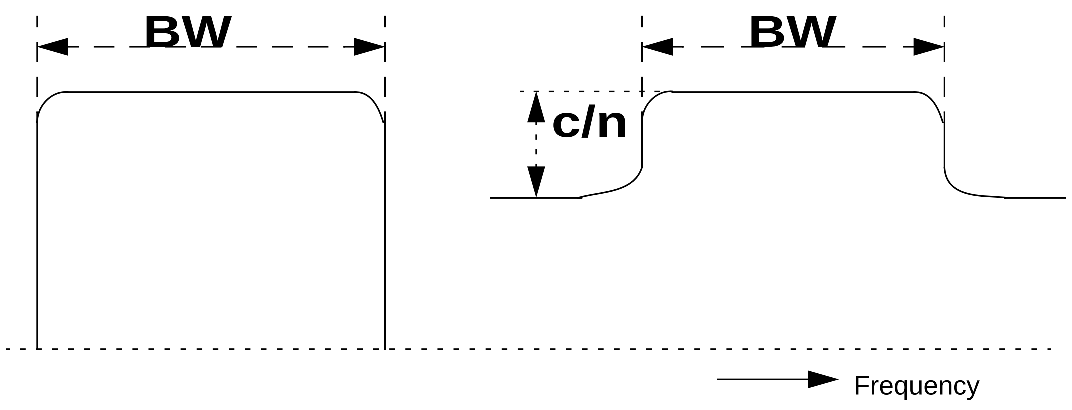
Assume that at the input of the TDA8060 "N" channels, ranging from 950...2150MHz, are present. Due to non-linearity of the first amplifier stage in the TDA8060 these channels produce intermodulation products and, depending on the total input power, the first amplifier stage of the TDA8060 can get into compression. This will lead to unwanted signal distortion.
Depending on the frequency locations and power of all the channels present at the input intermodulation products might fold into the wanted frequency range, which will give similar behaviour as a degraded C/N ratio (additional implementation loss).

2. IMPLEMENTATION OF A MULTIPLE CHANNEL MEASUREMENT

It is very impractical to realise a measurement set-up where 16 QPSK channels can be used simultaneously (with variable frequency allocations and power levels). The number 16 is chosen because it can be found in the TDA8060 specifications under maximum number of channels present at the input.

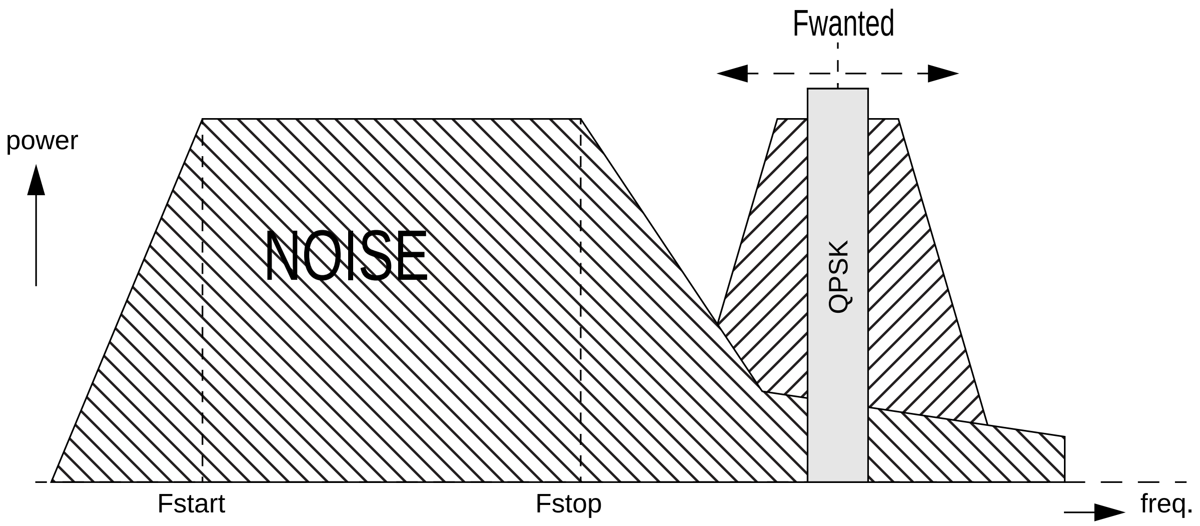
According to the specification of the TDA8060 maximum power handling is -22dBm/channel for 16 channels. From this the total maximum input power can be derived as: -22dBm + 10 log(16) = -10dBm.

If we take a closer look into a QPSK spectrum then we see something similar to a flat noise spectrum within a bandwidth equal to the symbol rate.



The left spectrum is showing a noiseless QPSK signal with BW (=bandwidth) symbol rate. The spectrum at the right hand side shows a real life situation with a certain Carrier to Noise ratio (C/N).

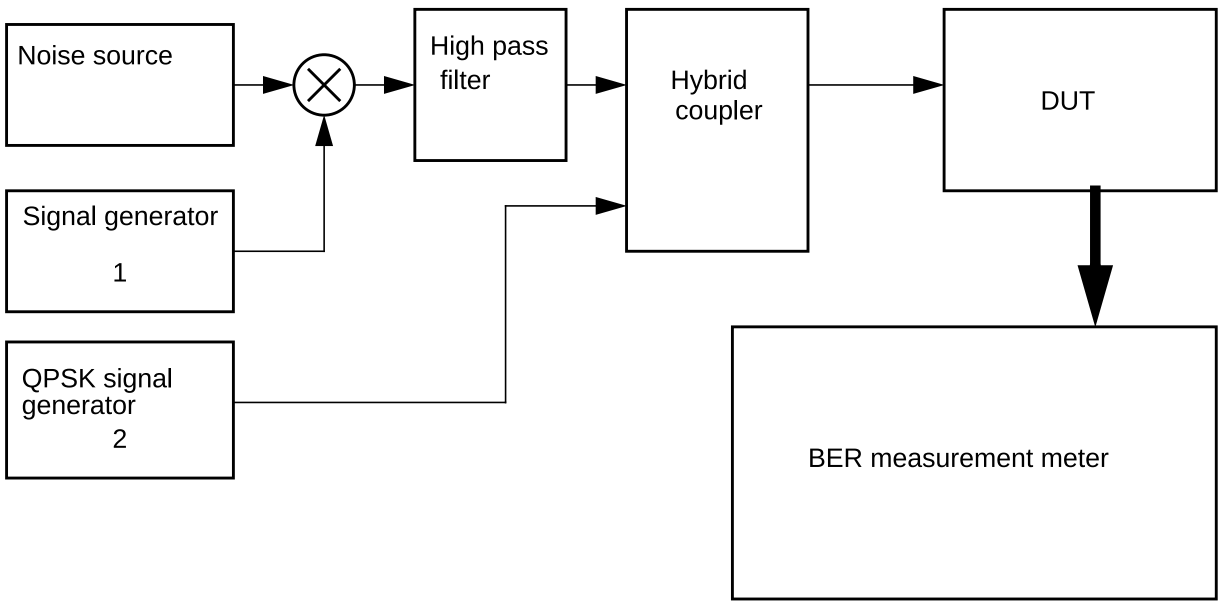
To simulate a spectrum of 15 uncorrelated QPSK transponders of 27.5MSymb/sec each, also a (white) noise spectrum with 412.5MHz bandwidth can be used. Based on this following input spectrum was created to make measurements in the system:



The noise spectrum to simulate 15 QPSK signals ranges from Fstart to Fstop, the wanted QPSK signal (Fwanted) can be set to each wanted frequency (in L-band). Also for the wanted frequency a certain C/N value can be adjusted.

To evaluate the 16 channel power handling of the TDA8060, the difference is measured between the implementation loss (IL) with only the wanted (QPSK) carrier plus noise (in the same channel BW) and the IL with the broadband noise switched on simultaneously.

2.1 The Measurement Setup



Used equipment:

Noise source: in house made noise source, output frequency range from 8 till 930 MHz, noise shape almost flat over frequency.

Mixer: Anzac MD525-4

Signal generator: Rohde & Schwarz SMH, frequency set to 800 MHz

QPSK signal generator: Rohde & Schwarz SFQ

High pass filter: Mini circuits SHP1000, cut-off frequency 1000 MHz

Hybrid coupler: Anzac H183-4

DUT: demoboard OM5719A (TDA8060/TSA5512/TDA8044), where the input is directly fed (unbalanced) to the input of the TDA8060 and demoboard OM5729 (TDA8060/TSA5059/TDA8083) with normal input used.

BER meter: Hewlett Packard HP3764A

To check the power levels during the measurements also a power meter was used (Hewlett Packard 436A with HP8481A power sensor)

2.2 The Measurement Algorithm

The noise spectrum ranges from 950 till 1700MHz, the power of the total noise spectrum can be adjusted by varying the signal generator 1 power. The total noise power can be calculated by measuring the specific power (with spectrum analyser) in dBm/Hertz and correcting this with 10 log (BW). This will introduce a small error since the power contribution outside the noise BW will not be taken into account. The difference between the calculated noise power and measured noise power with the power meter was 0.4dB.
The purpose of the measurements was to measure the Bit Error Rate (BER) degradation when multiple input signals are present at the TDA8060 input compared to a situation when there is only one (wanted) signal.

Following measurement steps were performed:

A) switch power of signal generator 1 off

B) set signal generator 2 to the wanted frequency, symbol rate, power level etc.

C) tune the ZIF receiver to the wanted frequency, symbol rate etc.

D) adjust the C/N to obtain a BER of 1e-4 after Viterbi, this C/N is called CNref

E) switch power of signal generator 1 on

F) disconnect the input from the DUT and connect it to the power meter

G) adjust the power level of signal generator 1 to get -9.6dBm total input power (a small amount of power is measured outside the L-band, estimated power in L-band -10dBm)

H) re-connect the input signal to the DUT and adjust the C/N of signal generator 2 to obtain a BER of 1e-4, this C/N will be called CNnoise_on

I) the additional implementation loss of the system due to the multiple signals at the input is now CNnoise_on minus CNref

J) verify the C/N with a spectrum analyser as described under measuring the C/N since the noise source also generates noise outside the noise BW.

2.3 Measuring the C/N of a QPSK Signal

This can be used to verify a presetted C/N ratio hence to calibrate a certain signal generator with noise source. Implementation loss measurements normally need high accuracy (0.1dB), calibrating a C/N setting is advised after a certain time interval and/or change of frequency/output power setting/ambient temperature. Below described method is also advised by Rohde & Schwarz when high accuracy implementation loss measurements have to be performed.

Assumptions:
1) the QPSK spectrum has no tilt (is flat over the frequency)
2) the noise spectrum has no tilt (is flat over the frequency)
3) the noise spectrum has a BW of at least the symbol rate +10%

Needed equipment:
1) a spectrum analyser (SA) with the possibility to set the amplitude to 1dB/division
2) a QPSK signal generator were it is possible to switch the signal- and noise power independently on and off

Measurement algorithm:

1) connect the signal to be checked to the SA

2) set the SA to the desired centre frequency

3) set the SA to a span of minimum the wanted symbol rate plus 20%

4) switch off all the noise sources

5) set the SA to 1dB/division, adjust the reference level so that the QPSK level is almost at the top of the display

6) put a display line at the average QPSK power level

7) switch the QPSK power off (set generator 2 to external QPSK, external inputs terminated with 50 Ohms), and switch the total noise power on

8) the difference between the display line and the noise level (within the channel BW) is the C/N ratio.

3. MEASUREMENT RESULTS

Due to the unavailability of desired high- and low pass filters the noise spectrum could only be set from 947 till 1700 MHz. For this reason the desired channels were measured from 1800 till 2150 MHz, with 50 MHz increment.

3.1 OM5719A Measurements

Settings wanted QPSK channel: symbol rate 27.5Msymbs/sec, P.R. 5/6, power -22dBm, roll off 0.35

Total power to TDA8060 in multiple channel mode: -9.6dBm

TABLE 1

Freq.(MHz)	**1800**	**1850**	**1900**	**1950**	**2000**	**2050**	**2100**	**2150**
C/N for 1e-4 BER single channel (dB)	7.7	7.8	7.9	7.8	7.8	7.8	7.7	7.8
C/N for 1e-4 BER multiple channel(dB)	7.7	7.7	7.7	7.8	7.8	8.0	7.7	7.9

Same measurements were performed with a lower symbol rate:

Settings wanted QPSK channel: symbol rate 15Msymbs/sec, P.R. 5/6, power -22dBm, roll off 0.35

Total power to TDA8060 in multiple channel mode: -9.6dBm

TABLE 2

Freq.(MHz)	**1800**	**1850**	**1900**	**1950**	**2000**	**2050**	**2100**	**2150**
C/N for 1e-4 BER single channel (dB)	7.9*)	7.2*)		7.5*)		7.4*)		7.0
C/N for 1e-4 BER multiple channel(dB)	*2)	7.7*)		7.4*)		7.7*)		7.0

*) Remark: system occansionally get’s out of lock, due to pulling/defective QPSK signal generator?

*2) Could not get the system into lock.

WARNING: all measurement results are for comparative use only, a precise IL figure cannot be derived from it.

3.2 OM5729 Measurements

Settings wanted QPSK channel: symbol rate 30.0Msymbs/sec, P.R. 5/6, power -22dBm, roll off 0.35

Total power to OM5729 demoboard in multiple channel mode: -9.6dBm

TABLE 3

Freq.(MHz)	1750	1850	1900	1950	2000	2050	2100	2150
C/N for 1e-4 BER single channel (dB)	6.1	6.2		6.5		6.3		6.2
C/N for 1e-4 BER multiple channel(dB)	6.0	6.4		6.7		6.5		6.2

Settings wanted QPSK channel: symbol rate 15Msymbs/sec, P.R. 5/6, power -22dBm, roll off 0.35

Total power to OM5729 demoboard in multiple channel mode: -9.6dBm

TABLE 4

Freq.(MHz)	1750	1850	1900	1950	2000	2050	2100	2150
C/N for 1e-4 BER single channel (dB)	6.2	6.1		5.5		6.4		6.4
C/N for 1e-4 BER multiple channel(dB)	6.2	6.2		5.7		6.6		6.5

4. CONCLUSIONS

From above measurement results it can be concluded that:

Additional implementation loss due to multiple signal input can hardly be seen, differences between +0.2 till -0.5dB were measured;

Due to the fact that the noise spectrum, which consists of the one generated by the QPSK signal generator combined with a part generated by the noise source, is not fully flat over the frequency range the accuracy of these measurements will exceed 0.1dB;

At lower symbol rates measurements are less reliable because of problems with the measurement set-up and/or pulling phenomenon (input signal was -22dBm and directly connected to the input of the TDA8060)

4.1 Recommendations

The own made noise spectrum is located at the lower side of the L-band hence only measurements were performed with the wanted frequencies at the higher side. Special high- and lowpass filters are ordered to be able to inverse the wanted and unwanted (noise) spectrum.

It can be useful to measure till which level the noise spectrum can be raised until serious performance degradation can be observed.

This was impossible due to:
- unavailability of a 1700MHz LPF to eliminate the (unwanted) noise contribution in the wanted frequency band;
- limited output power of the signal generator 1 (additional amplifier is also needed).