Technical Note
Transmitter for Globe6

Edition 2006

Published by Neonseven s.r.l.,
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1 Document Mission/Scope

1.1 Mission

This paper provides an overview for the RF transmitter architecture as implemented on the Globe6 BP30 platform.
The following note describes the components used and the expected performances for the TX side of the RF section in a mobile phone based on Glome3 BP30 platform. By following the application guidelines one should be able to achieve a solid design fully compliant with the GSM specs.

1.2 Scope

This document is useful for customers basing their design on the Globe6 BP30 platform, and provides an overview of the transmit section for the RF part, together with some advices on the critical issues.

2 List of Acronyms

Abbreviation / Term	Explanation / Definition
RF	Radio Frequency
TX	Transmission
PA	Power Amplifier
A/S	Antenna Switch
FEM	Front End Module
PCB	Printed Circuit Board
BP30	Basic Platform Phone

3 Introduction

The Globe6 platform is based on the Infineon EGOLDradio with built in transceiver. Its radio part is based on the well known SMARTi SD2 chip integrated into CMOS die together whit EGOLDlite baseband achieving a high level of integration with the requirement of few external components.

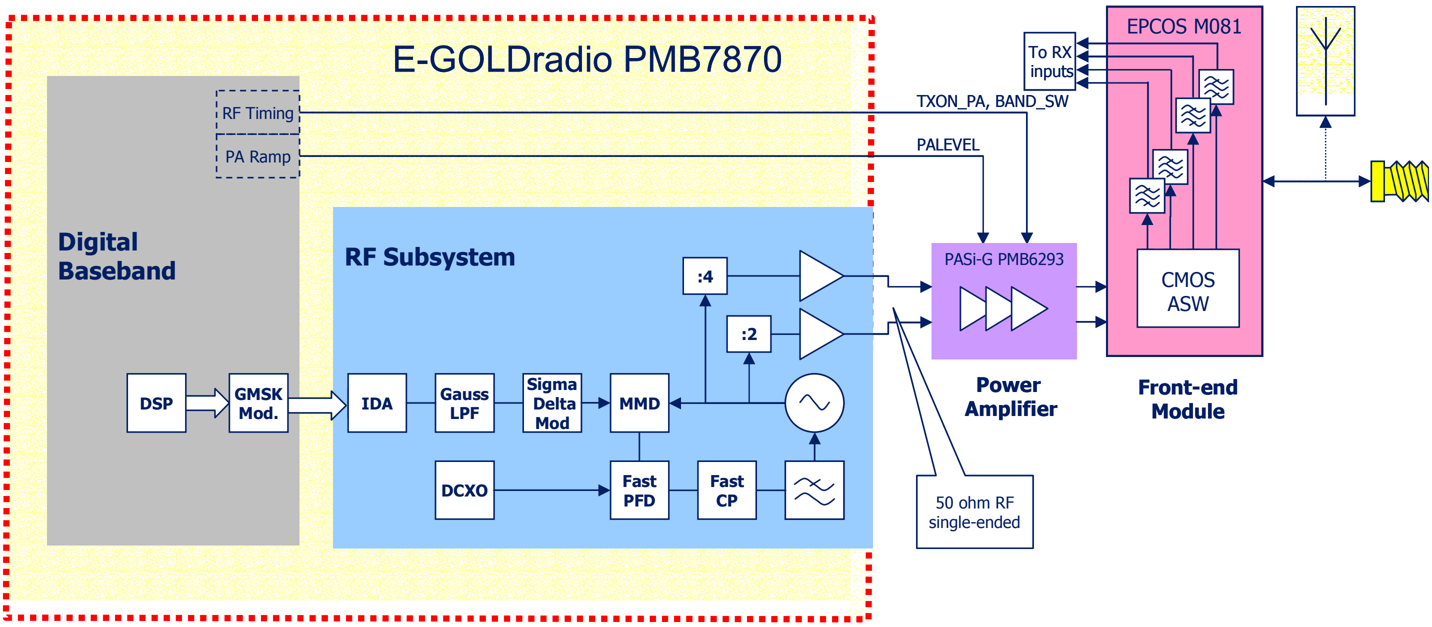
In this note the whole transmit path has been described, together with some hints for achieving the best performances. All the assumptions and calculations are based on actual Globe6 boards and the external components chosen for those boards.

4 Transmitter for Globe6

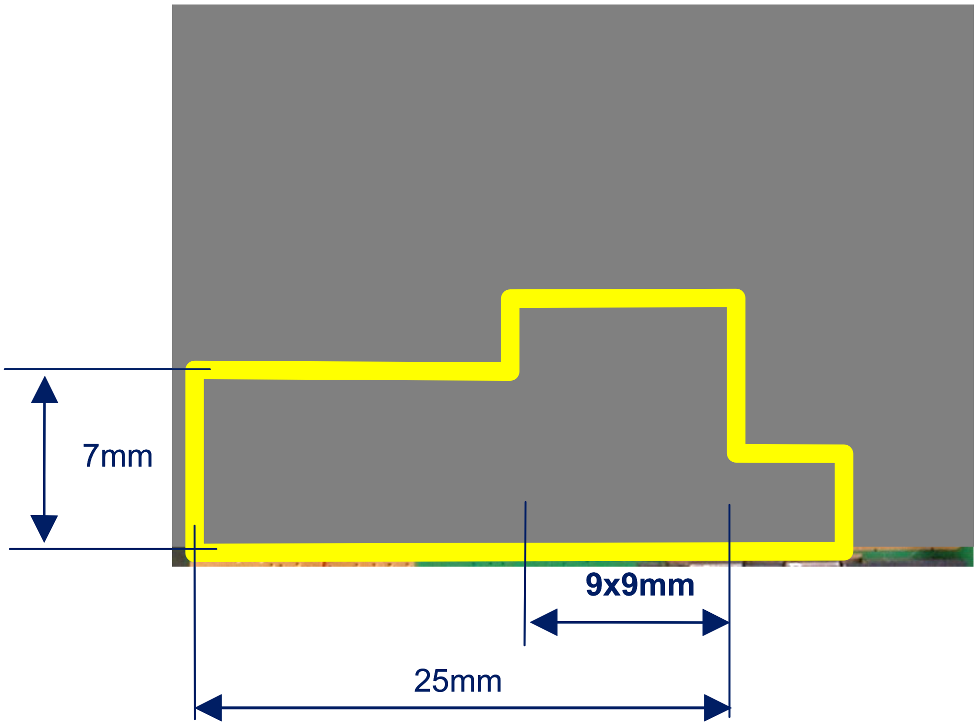
4.1 Brief Overview

The RF transmitting part of the Globe6 platform includes three main components: the transceiver built into Infineon EGOLDradio PMB6870, a Power Amplifier and a Front End Module.
In our case, the chosen PA is the Infineon PMB6293, a quad band 5x5mm CMOS amplifier with integrated power control.
The FEM is the EPCOS M081 which is 4x5.4mm. It includes quad band CMOS antenna switch and it has built-in four pass band saw filter for RX inputs.

This is the block diagram for the TX chain, with the indication of components used



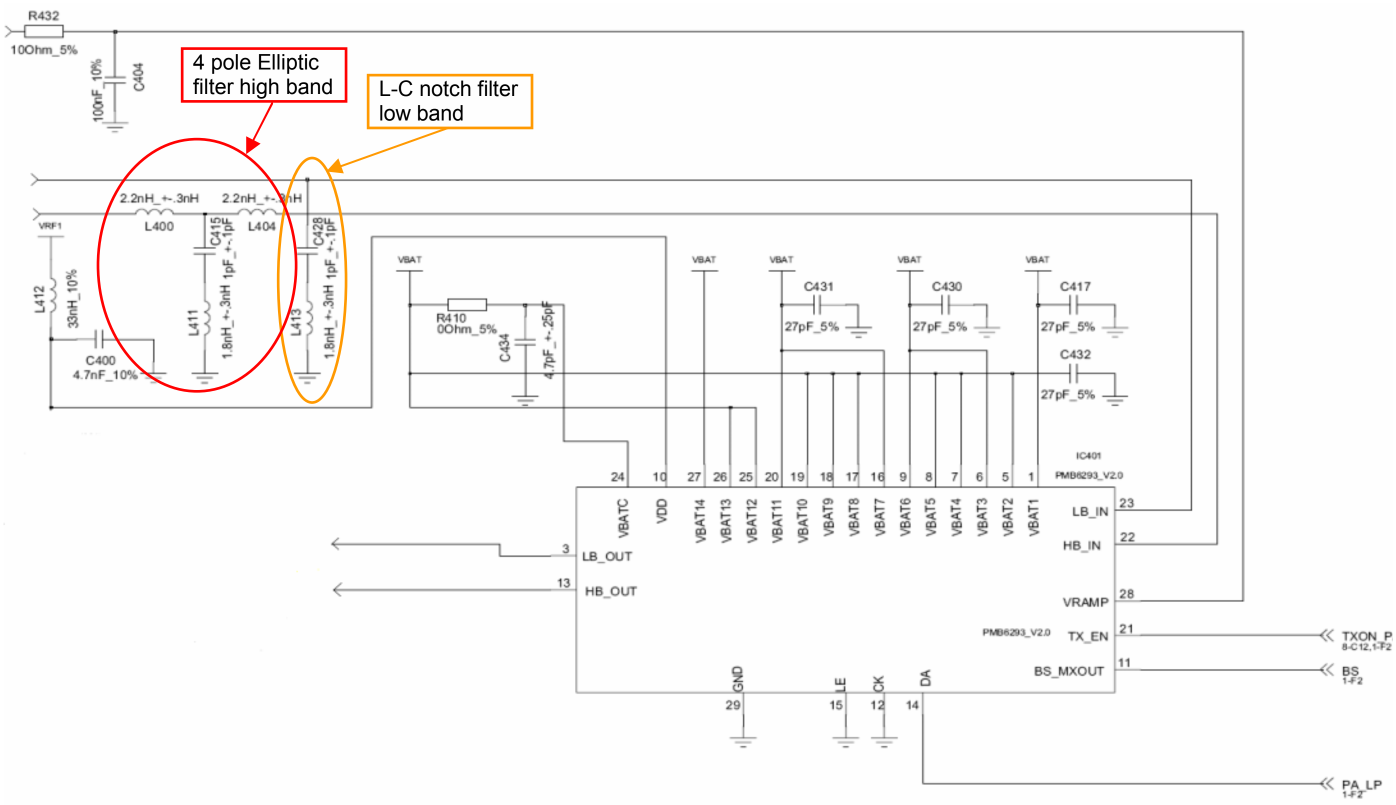
A snapshot of the arrangement is shown here below, taken from Globe6 board



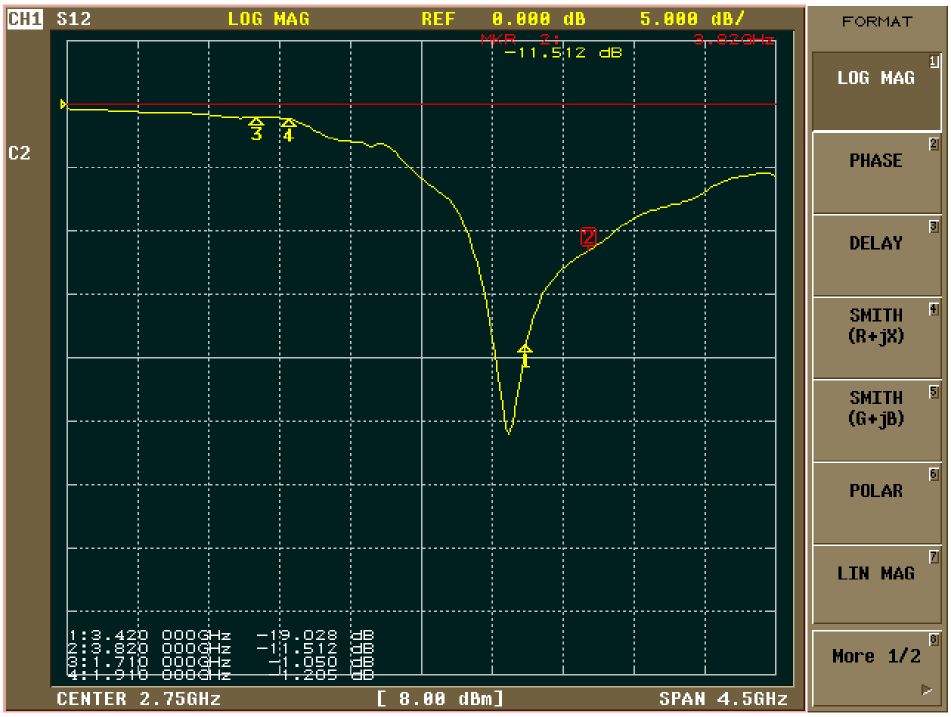
4.2 RF connection between PA and EGOLDradio

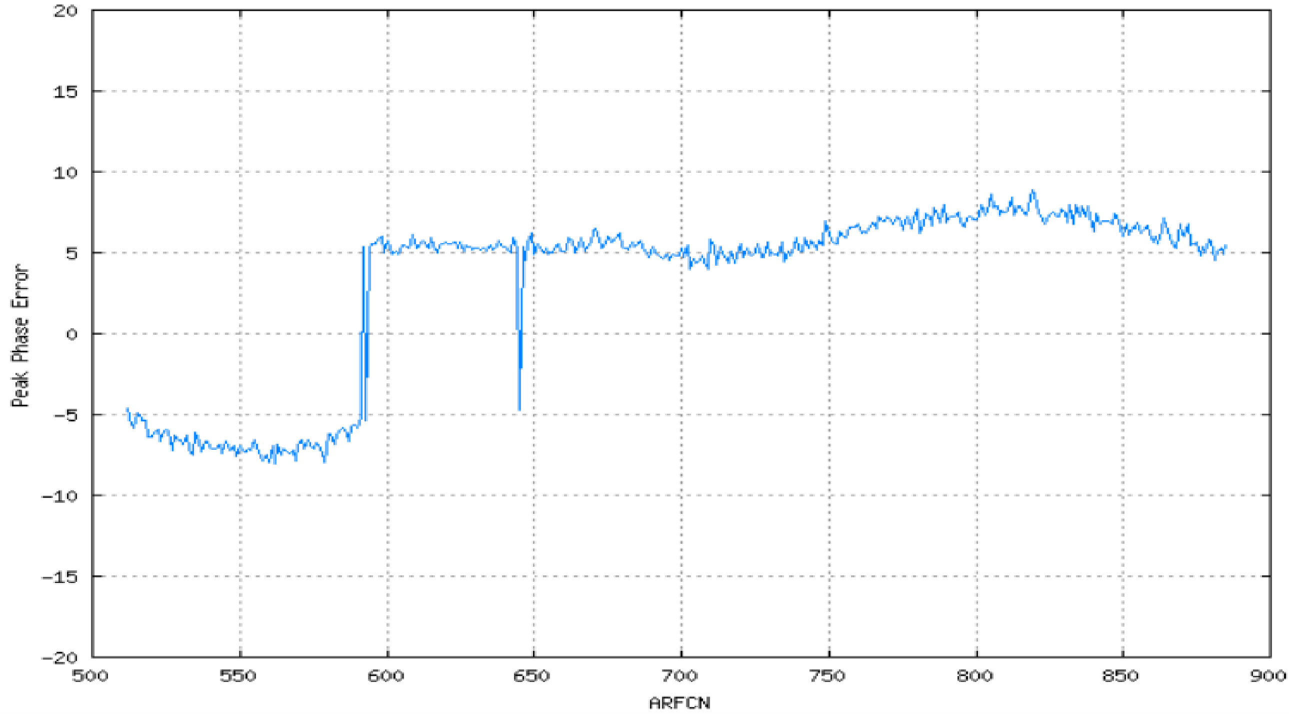
The PMB7870 EGOLDradio has two 50 ohm TX outputs, one for low band 824-915 Mhz and one for the high band 1710-1910 Mhz. Unfortunately these outputs are high sensitive respect the harmonics spurs reflected back from the PA inputs. These spurs impact to the built-in VCO into EGOLDradio transceiver which operates at the 4 times of the output frequency in low band and 2 times of the frequency in the high band.
Due on this is necessary to add filters between EGOLDradio TX outputs and the PA's inputs, which cut the spurs around the 3600 Mhz frequency.
Without these filters the TX signal at the output of the PA may be affected by a high phase error exceeding the ETSI limit value or close to it. This phenomenon is in particular evidence in high band.

In Globe6 platform design the TX path filter are implement with a 4 pole elliptic filter for high band and a simple L-C notch filter for the low band.
The following is the schematic implementation:

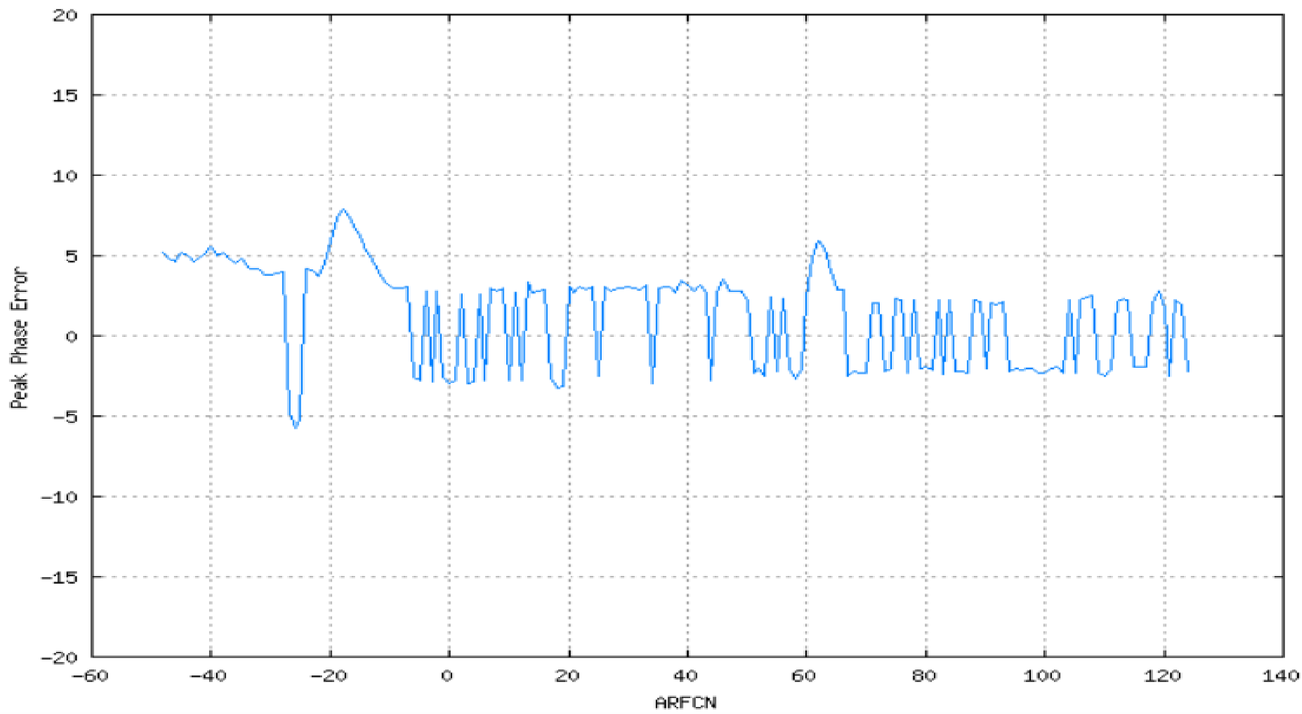


Obviously designer have to take into account the in band attenuation of the filters in order to respect the requirement of the PA input power. The following picture shows the measured response of the high band elliptic filter:





Example of peak phase error measured on DCS1800 band



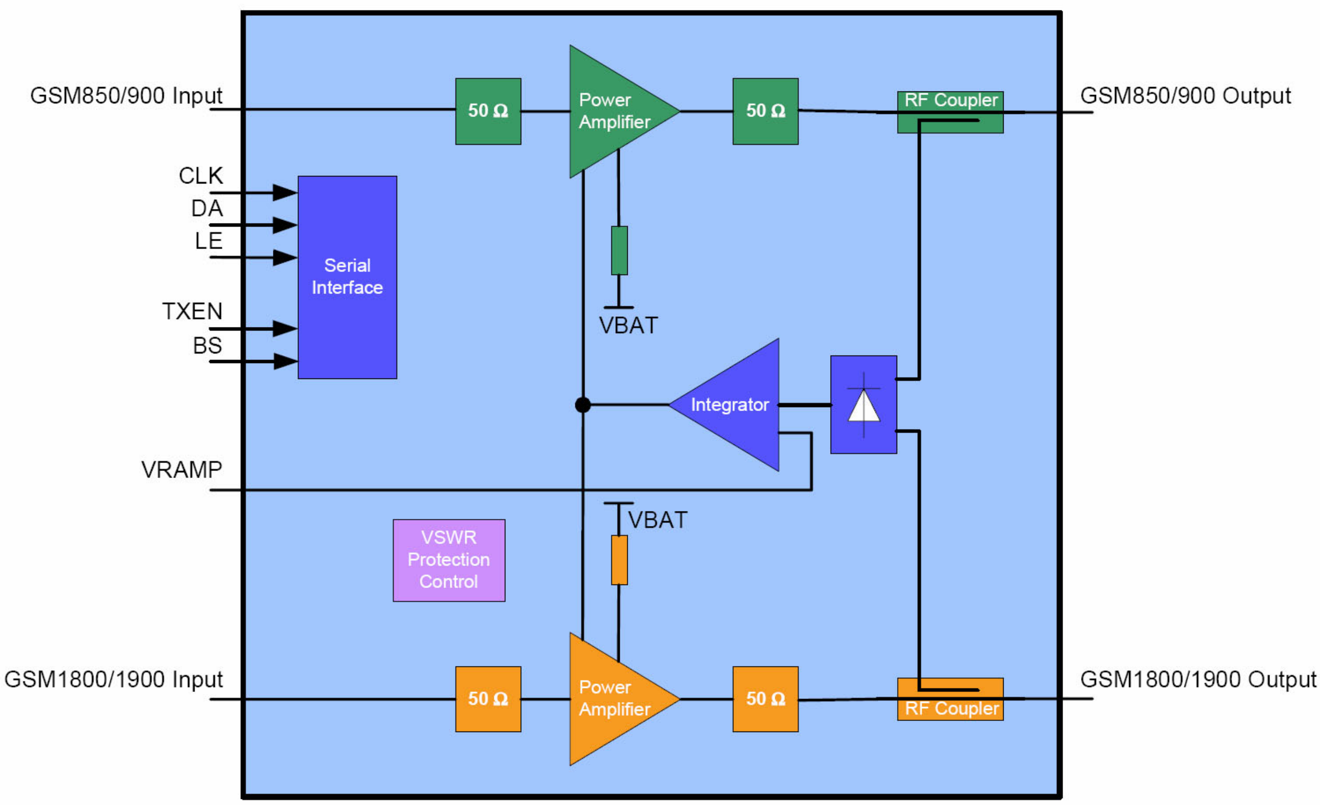
Example of peak phase error measured on GSM900 band

4.3 RF Power control path

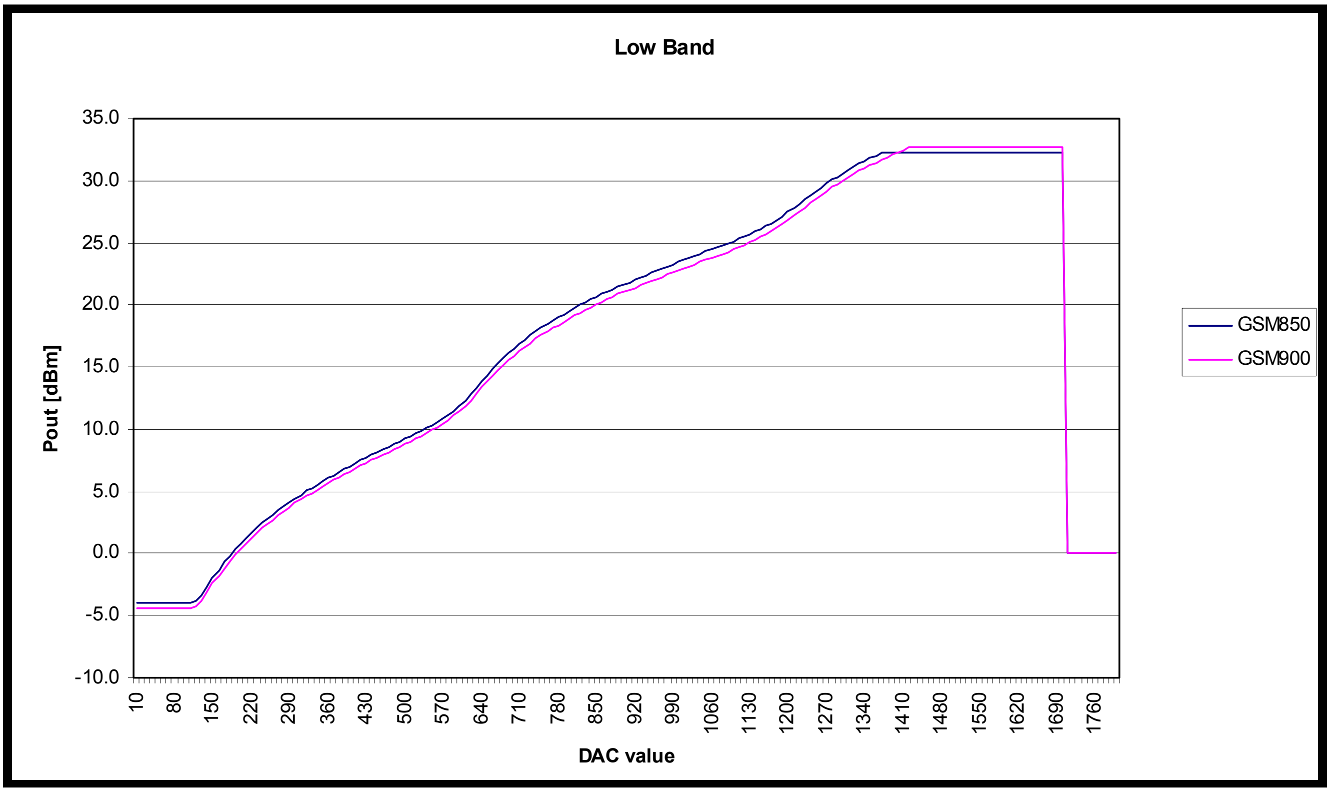
The PA chosen into Globe6 has a fully integrated closed-loop power control. This eliminates the need for additional external components like directional couplers, detector diodes and operational amplifiers to set the dedicated output power level. The output power of the PA module is set directly by applying a control voltage from the base band's DAC to the VRAMP input of the module.

A little bit critical issue is the connection of the power control signal VRAMP between EGOLDradio and the PA. Routing have to be carefully made to avoid interference with other signals and spurs, and a R-C low pass filter (see R432 and C404 into Globe6 schematic) have to be implemented on VRAMP path.

Following picture shows the PMB6293 block diagram:



The control characteristic of the output power (in dBm) has a quite linear relationship with Vramp voltage (minus a voltage threshold). This simplifies the power control algorithm.
Nevertheless designer have to take into account the drift of Vramp DAC in EGOLDradio due to temperature-aging-supply (±5mV ±1%) and the PA itself output power variations in temperature-aging-supply.



Measured output power in low band respect the DAC control value

4.4 PA's digital controls

The major goal of the PMB6293 is the development of a complete quad band GSM RF amplifier on a silicon die with CMOS technology. Due on this PMB6293 implements a complex control circuit which con be programmed with a digital serial interface. In Globe6 this feature in not used but the DA pin of the PMB6293 has an alternate function: it can set the PA into low power mode where at middle-low output power levels PA efficiency is incremented.
Designer have to take care that in low power mode the maximum output power of the PMB6293 doesn't reach the ETSI specified target, so this mode have to be dynamically disable at the highest output power level.

4.5 TX Noise in the RX Band

Due to its internal structure the major source of the noise in the RX bands is the transceiver integrated into EGOLDradio.
The spurious emission depends on modulator concept and can be divided in the following types:

Alpha spurs:

- Spurious sidebands on the TX output signals when TX frequency is close to a multiple of the reference frequency (26 MHz) :
  foffset= ± (fTX - (n * 26MHz))

- It can be seen that with PRBS modulation the spurious sideband which is at a multiple of 26 MHz still is a single line while the sideband on the opposite side of the TX carrier is spread.
- Typically the critical item is the 400kHz modulation spectrum at ± 2 ARFCN from 26MHz multiple,
  - GSM900.... 26MHz*36 = 910MHz = ch100 → check ch98 and ch102
  - DCS1800... 26MHz*66 = 1716MHz = ch541 → check ch539 and ch 543

Beta spurs:

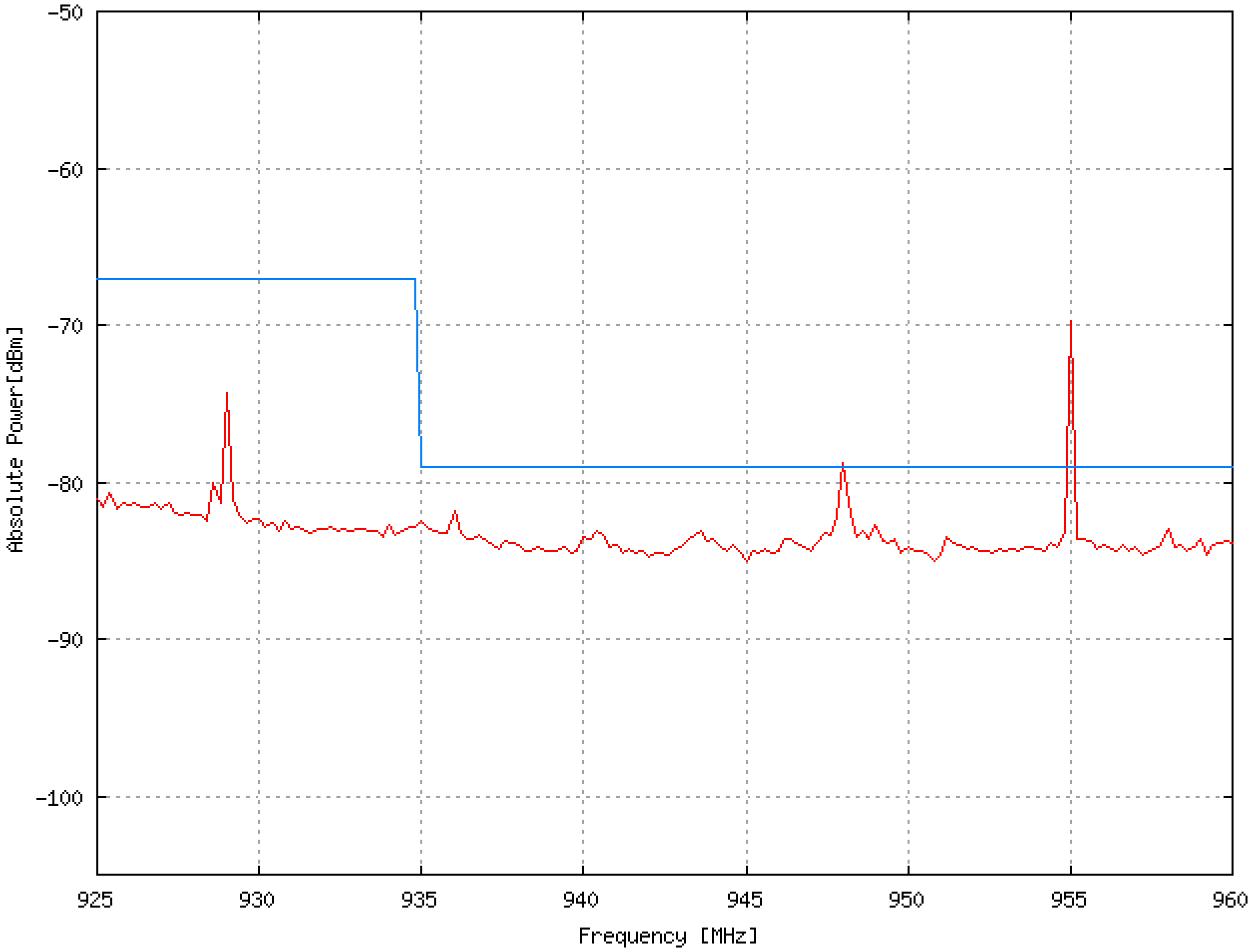
- Spurious sidebands on the TX output signals when VCO frequency is close to a multiple of 13 MHz spurious
- The offset frequency of these sidebands is the frequency difference between the VCO/LO signal and a harmonic of half of the reference frequency.
  foffset= ± (4 fTX - (n * 13MHz)) for GSM850 / GSM900
  foffset= ± (2 fTX - (n * 13MHz)) for DCS1800 / PCS1900

- Again, the critical item is the 400kHz modulation spectrum

Gamma spurs:

- Spurious sidebands on the TX output signals which have an offset of multiples of the reference frequency to the LO frequency.
  foffset= ± (n * 26MHz)

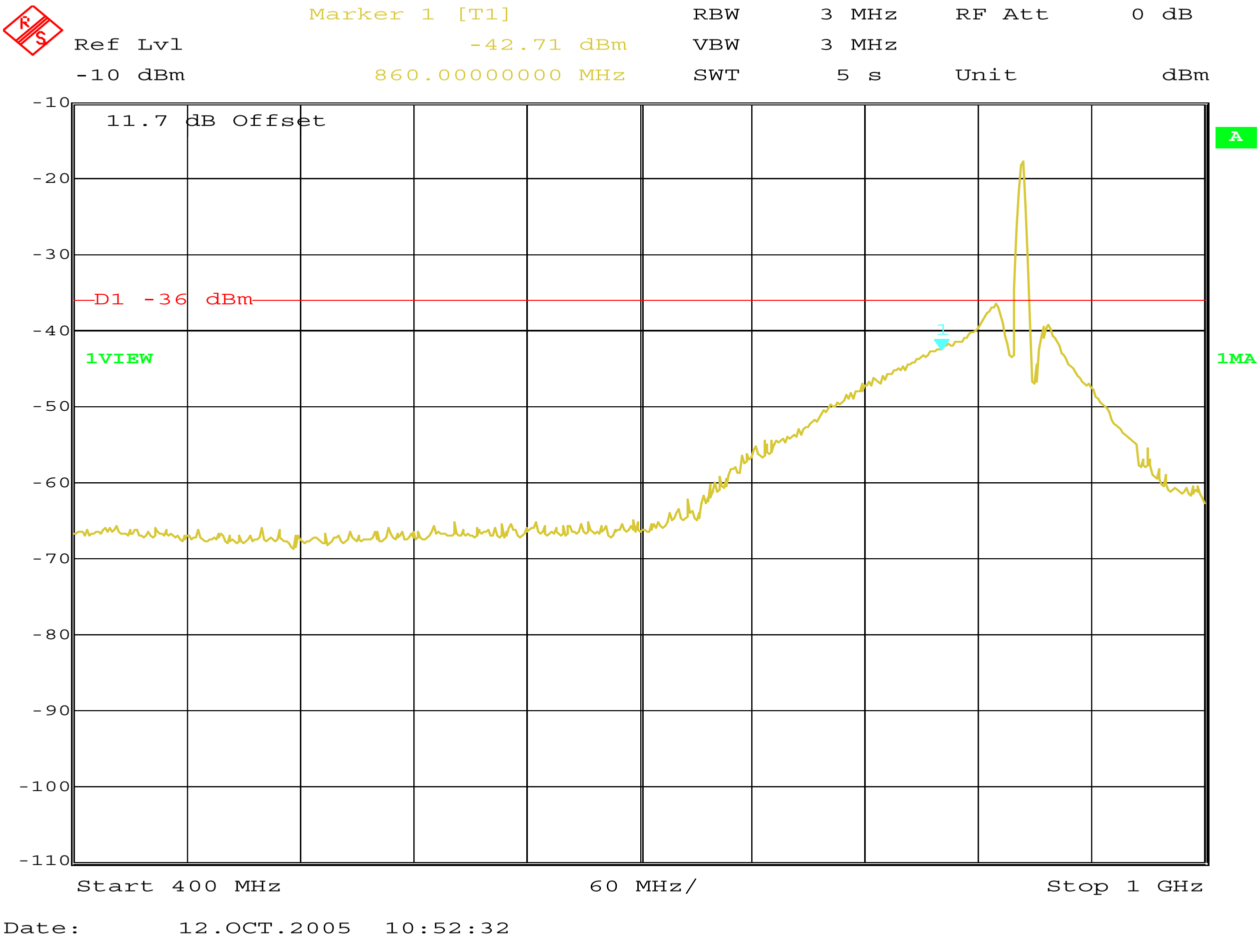
- The internal digital noise of EGOLDradio is the main spurious source
- They cause TX spurious in RX band



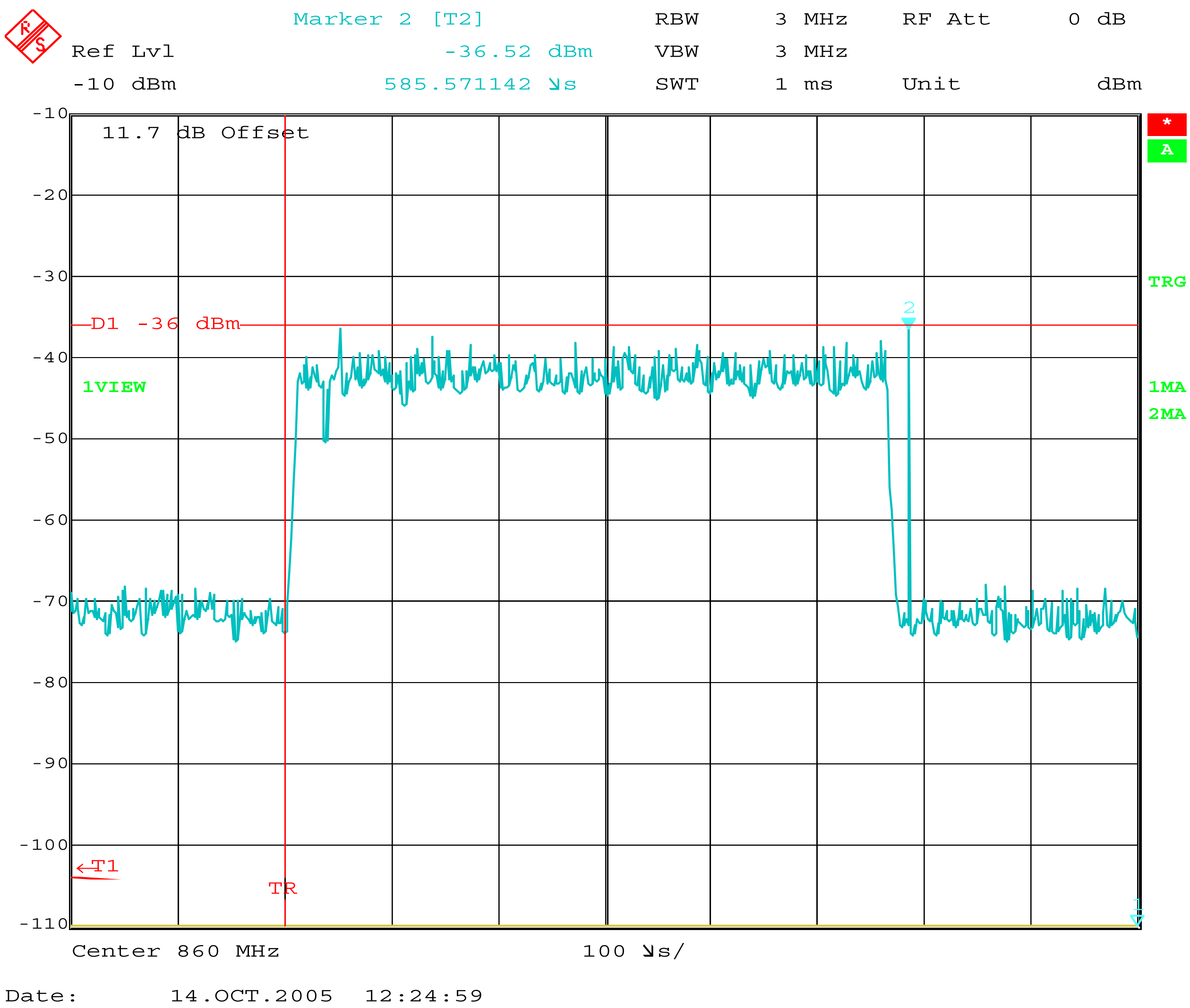
The previous picture shows the TX noise in GSM900 RX band measured on a Globe6 board. The transmit channel is set to 65 (Mid ARFCN). The noise floor is approximately -84dBm while the spike is a spur at 2*26MHz offset from the carrier: 955 – 903 = 52MHz.
ETSI standard specify that five exceptions above the limit are allowed.

4.6 Wide Band Noise

Measures on Globe6 evidence a noise level around main TX frequency close to the limit both in high and low bands. Example is shown in the following pictures, measured according to 12.1.1 ETSI specification:



This behavior comes from the PMB6296 PA which generates a peak of noise in correspondence with the falling edge of the TX_ON control signal, as shown in the following pictures where the peak of noise is clearly at the end of the TX burst:



This problem will be solved in the PMB6293 versions successive to the 2.2 one.

5 Conclusions

The main critical issues was been verified for the TX part of the Globe6.
Due to its complexity Globe6 platform isn't optimized for the RF performance, but have to be considered as a demonstration of the real possibility to develop a GSM phone staring by Infineon EGOLDradio chipset.

6 Document change report

	Change Reference		Record of changes made to previous released version	
Rev	**Date**	**CR**	**Section**	**Comment**
1.0	13/01/2006	N.A.		First release

7 Approval

Revision	Approver(s)	Date	Source/signature
1.0	Massimo Vlacci	30/01/2005	Document stored on N7 server