Technical Note
Receiver for Globe6

Edition 2006

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1 Document Mission/Scope

1.1 Mission

This paper provides an overview for the RF receiver architecture as implemented on the BP30 platform.
The purpose is to collect some results following from concept evaluation of Globe6 receiver, performed by mean of simple Excel sheet calculations.

1.2 Scope

The outcome of RX concept analysis might be useful to get insight on the rationale for chosen architecture and also intended as a tool for preliminary investigation regarding the impact on performances that any change might have, following Costumer customization.

2 List of Acronyms

Abbreviation / Term	Explanation / Definition
BP30	Globe6 Platform
RF	Radio Frequency
RX	Receiver
A/S	Antenna Switch
FEM	Front End Module
PCB	Printed Circuit Board
LNA	Low-Noise Amplifier
NF	Noise Figure
ADC	Analog-to-Digital Converter
DSP	Digital Signal Processor
SNR	Signal-to-Noise Ratio
S/(N+I)	Signal-to-Noise and (co-channel) Interference Ratio
SAW	Surface-Acoustic Wave
BPF	Band-Pass Filter
LPF	Low-Pass Filter
GMSK	Gaussian-filtered Minimum Shift Keying
I/Q	In-phase and Quadrature signals
EGR	EGOLDradio

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 BP30 Globe6 receiver architecture is described, with brief outline of transceiver receiver section, by recalling the Infineon application notes contents, and then the other (few) components are described, with reference to their typical performances, listed in the Annex sections.

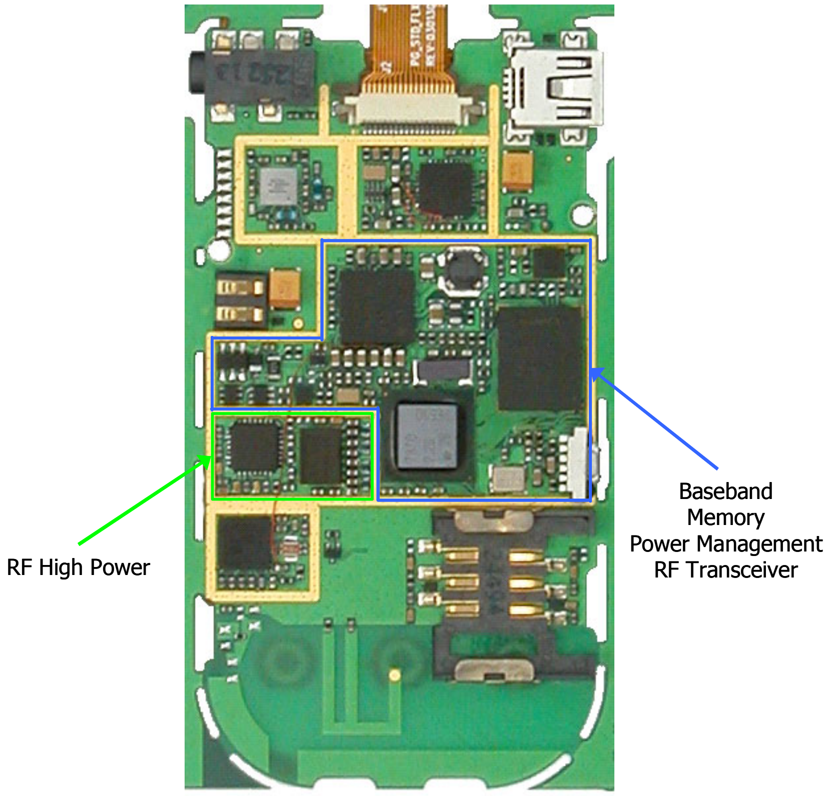
Finally, the receiver link-budget is introduced, with reference to the Excel sheet calculations. Tables of resulting performances are reported in document *"Globe6_RXlinkbudget.xls"* (N7 doc ID: BH02.HW.GW.000002), for the EGSM900, DCS1800, PCS1900 and GSM850 bands, where the architecture is able to operate.

The analysis is based on classical theory for receiver link budget: the first approximation approach cannot give ultimate performances and therefore doesn't fully represent the platform limits, where fully compliant FTA and laboratory measurements should be regarded as reference.

4 BP30 RF Modem

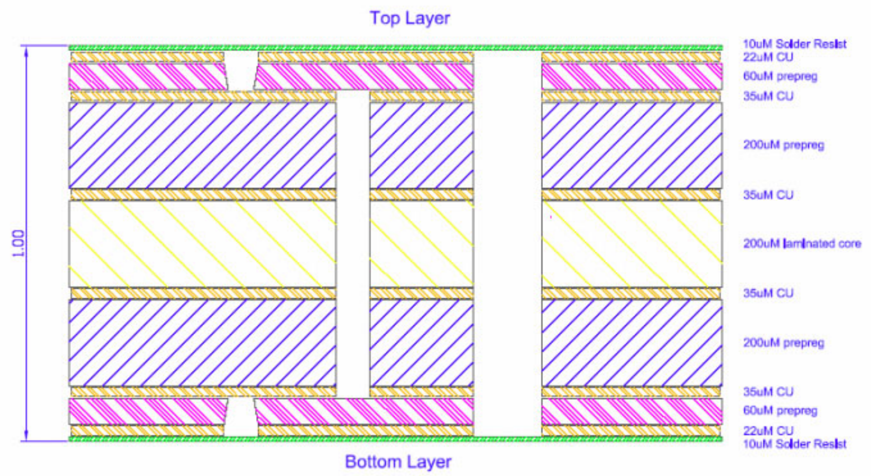
The Globe6 GSM/GPRS modem is based on the following main components:
- Infineon E-GOLDradio PMB7870 GSM/GPRS Single Chip Solution that integrates Baseband System and Quad-Band GSM850/E-GSM/DCS/PCS RF Transceiver for voice and data applications
- Infineon PMB6293 Quad-Band GSM850/E-GSM/DCS/PCS Power Amplifier Module based on 0.13µm CMOS technology, with integrated power controller.
- Epcos DGM081 Quad-Band Antenna Switch Module with integrated SAW filters and external RX matching components for GSM850/E-GSM/DCS/PCS Receiver.
- Infineon E-POWERlite PMB6814 Power and Battery Management IC
- Intel Multi-Chip Memory that integrates 128Mbits 1.8V Wireless Flash and 32Mbits 1.8V PSRAM

The modem is divided in two separated areas surrounded by traces on which metal boxes can be soldered. The first area encloses the RF high power components (PA, antenna switch) and the remaining passive components of the transceiver; the second area groups baseband processor, memory, crystals and power management unit. The shield height can be limited to 2 mm external.



The placement and routing is arranged on a single face of 6 layers build up printed circuit board. Electronics parts are placed on both sides. The RF connections traces dimensions are calculated to achieve the wanted characteristic impedance and are placed on Layer4. Layer 3 is full ground. Layer5 is also mostly RF ground under sensible RF parts, with suitable clearance over components pads. The VBATT track is routed on Layer2 and Layer5. Quad band printed antenna elements are on Layer6 and Layer1.

The following picture shows the lay-up main dimensions.



Surface Finishing: Chemical Gold Plate Ni 5 uM / Au 0.1 uM

PCB design rules are also reported in the following tables.

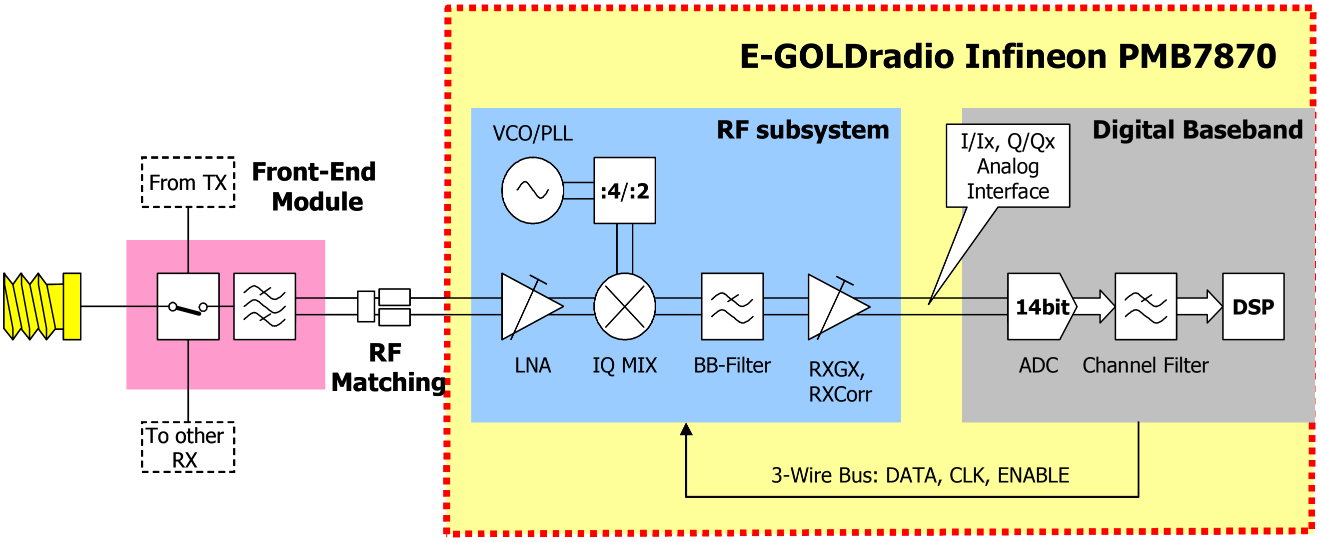
Design Clearance										
	Trace to Trace	Trace to Pad	Trace to Via	Via to Via	Via to Pad	Pad to Pad	Plane to Trace	Plane to Pad	Plane to Via	Plane to Plane
Layer 1	100um	100um	100um	100um	100um	200um	125um	150um	125um	150um
Layer 2	100um	100um	100um	100um	100um	200um	125um	150um	125um	150um
Layer 3	100um	100um	100um	100um	100um	200um	125um	150um	125um	150um
Layer 4	100um	100um	100um	100um	100um	200um	125um	150um	125um	150um
Layer 5	**75um**	**75um**	**75um**	100um	100um	200um	125um	150um	125um	150um
Layer 6	**75um**	**75um**	**75um**	100um	100um	200um	125um	150um	125um	150um

(*) 75um apply under 0.5mm pitch BGA, otherwise 100um

Design Rules				
	Trace Width	Laser Via Pad	Buried Via Pad	
Layer 1	100um	250um		
Layer 2	75um	275um	550um	
Layer 3	100um		550um	
Layer 4	75um		550um	
Layer 5	75um	250um	550um	
Layer 6	75um	275um		

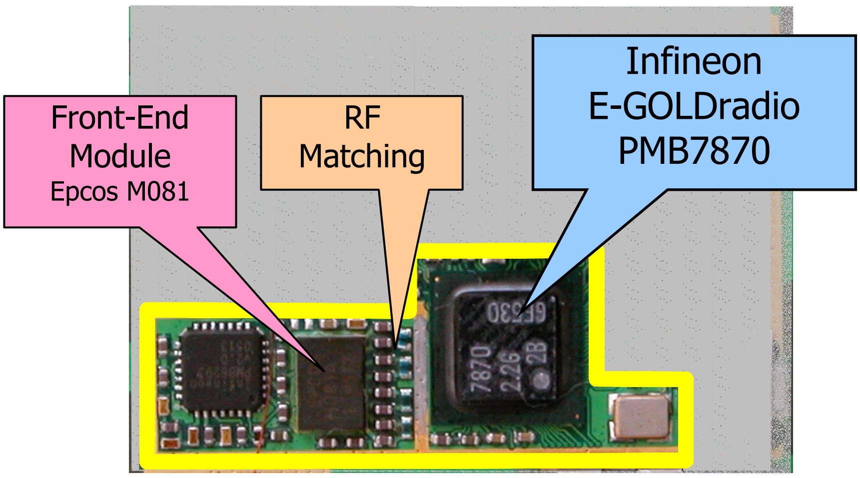
5 Receiver for BP30

The architecture for the BP30 Globe6 receiver might be outlined as the following figure:



For each of the 4-band (GSM900, DCS1800, PCS1900 and GSM850), the RX path is mainly composed by similar functional blocks, namely:

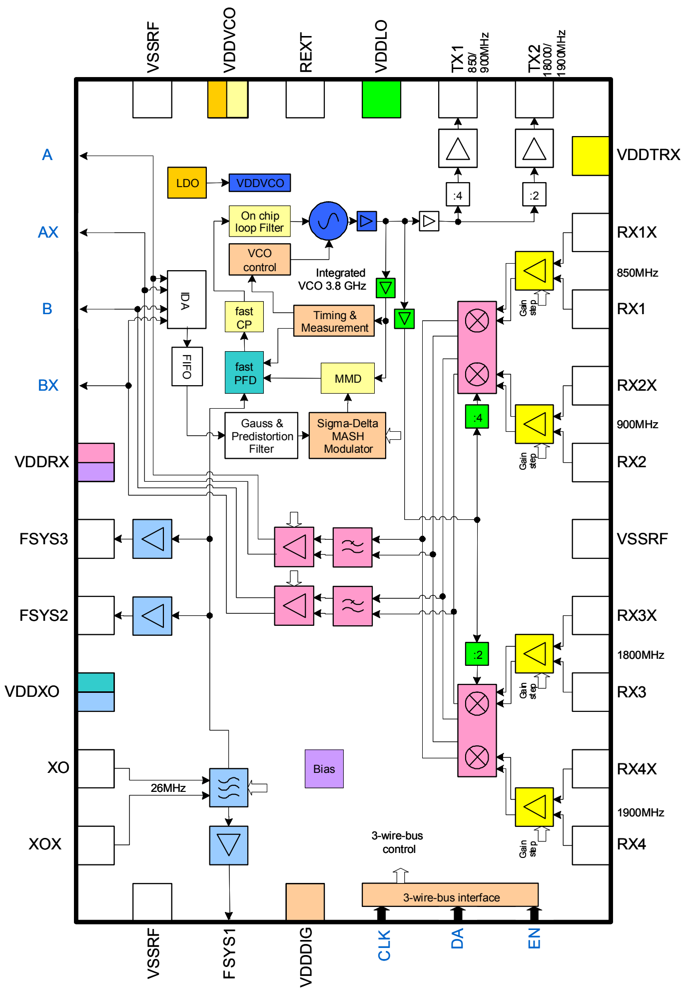
- Epcos DGM081 Quad-Band Antenna Switch Module with integrated SAW filters. It connects the antenna port to suitable output pin according to control signals coming from baseband timer unit. The switching matrix is implemented by SP4T MMIC switch PIN diodes, and it directly connected to EGOLDradio TOUTs. Two 2in1 RF SAW provide the out of band filtering and acts as Bal-Un, therefore each RX output is balanced.
- Discrete RX matching components for GSM850/E-GSM/DCS/PCS Receiver. Three components per band are required.
- **Infineon E-GOLDradio PMB7870** GSM/GPRS Single Chip Solution with integrated Quad-Band GSM850/EGSM/DCS/PCS RF Transceiver



5.1 EGOLDradio RF Transceiver

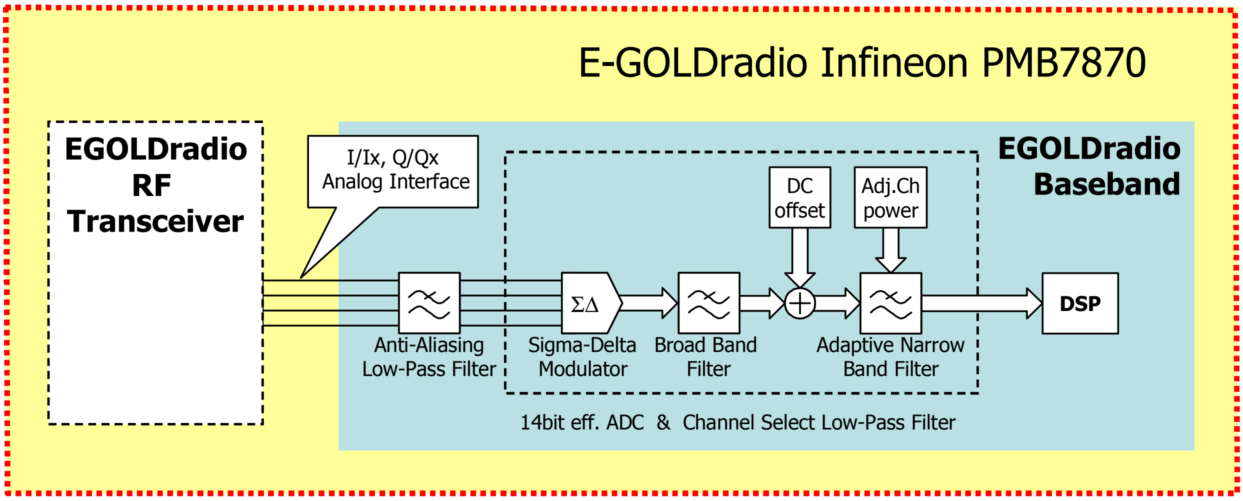
The EGOLDradio RF Transceiver is based on proven SMARTi-SD2 architecture, briefly outlined here; please refer to Infineon documentation for complete reference.

The receiver **RF front-end** contains all active circuits for a complete receiver chain. The GSM850/900 and GSM1800/1900 LNAs with balanced inputs are fully integrated. No interstage filtering is needed. A programmable gain step is implemented.
The amplified RF-signal is **direct converted to baseband frequency** (Zero-IF) final output signals by quadrature demodulators. The RX local oscillator is provided by **fully integrated internal fractional-N sigma-delta synthesizer with integrated VCO** running at 3.8GHz, and the orthogonal signals for downconversion mixer are generated by a divider by four for GSM850/900 band and a divider by two for the GSM1800/1900 band.
The resulting in-phase and quadrature signals are fed into the **baseband low pass filters** and a programmable gain correction stage.
Even with almost **constant gain receiver** architecture, the baseband filters provide sufficient suppression of blocking signals and adjacent channel interferers to fit into EGOLDradio Mixed-Signal ADC, which exhibits 82dB dynamic range. The ADC's anti-aliasing requirements are fulfilled for sampling rates from 6.5MHz on.
The **RXCORR** provides a gain correction range from -6dB..+6dB in 1dB steps. An additional gain step (**RXGS1**) is recommended to minimize the baseband ADC noise contribution for wanted signal levels Pw<-90dBm at the antenna input. All the receive path is fully differential.



5.2 EGOLDradio Baseband Receiver

The Infineon EGOLDradio baseband receive unit is composed by the following main blocks:



Analog Pre-Filters
Both the in-phase and quadrature components of the baseband signal from the RF demodulator circuit are delivered to EGOLDradio Mixed-Signal unit as differential analog signals (IR/IRX and QR/QRX). Each of them will pass a 1st order RC low pass filter which acts as an anti-aliasing pre-filter with a typical 3 dB attenuation @400 kHz (standard mode) or @6MHz (enhanced mode).
Note that the signals I/IX and Q/QX of the receive path are multiplexed together with the according signals of the transmit path to the same balls, I/IX and Q/QX.

The ΣΔ Analog-to-Digital Converter and baseband filter
The 2-channel analog-to-digital conversion of the pre-filtered baseband signal is performed using for each component I and Q a suitable combination of a Sigma-Delta (ΣΔ) modulator and a subsequent digital decimating low pass filter. The modulator shapes the noise spectrum such that the main noise energy is shifted to higher frequencies (maximum at half of the sampling frequency). The samples are then processed by a multi-stage low-pass filter for channel filtering.

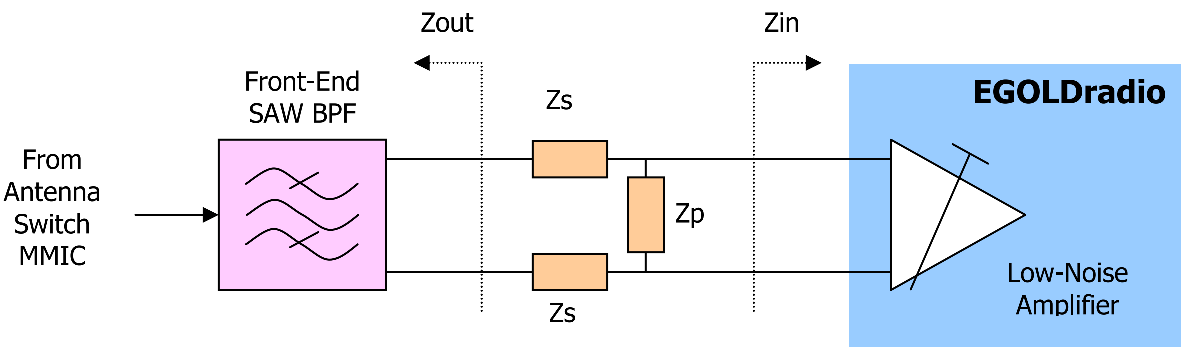
The complete receive chain consists of the ΣΔ ADC converters, the low pass filters, a DC compensation stage and the frequency rotator processor. The last filter stage is an adaptive switchable linear-phase FIR filter. Depending on the level of adjacent channel interference it selects a filter with appropriate frequency transfer characteristic. The decision is made burst by burst.

The ADC offers two operating modes, a standard mode and an enhanced mode. The enhanced mode is activated by default since the RF transceiver provides anti-aliasing filtering only (as for Infineon SMARTi-SD2). In standard mode a 3rd-order ΣΔ-modulator performs the A/D conversion at a sampling rate of 13 MHz with very low power consumption. In enhanced mode a 4th-order ΣΔ-modulator that performs the A/D conversion at a sampling rate of 26 MHz offers the required effective 14-bit resolution for the filtered 16-bit samples that are delivered to DSP.

5.3 Receiver RF Matching

The RF matching should transform the output impedance of SAW Band-Pass Filter Zout=150ohm to the complex conjugate of the EGOLDradio impute impedance Zin, both differential. Target is to achieve minimum mismatch loss, which maximize the overall receiver sensitivity. As second goal, the RX matching offers some filtering for out-of-band interferers, therefore also impacts the RX blocking performances.

Three passive components are needed for the balanced matching per band, 12 total components. Inductors are highQ type to minimize the resistive loss. For each RX path the topology is as follows:



RF matching components might be either calculate by analytical/simulation approach or by trial-and-error.

Simulation starts from the complex parameter measurement of EGOLDradio LNA input impedance and Front-End Module output impedance. These data should be available in s2p format or might be given as single point for specified frequency, assuming that value almost constant among the RX band.

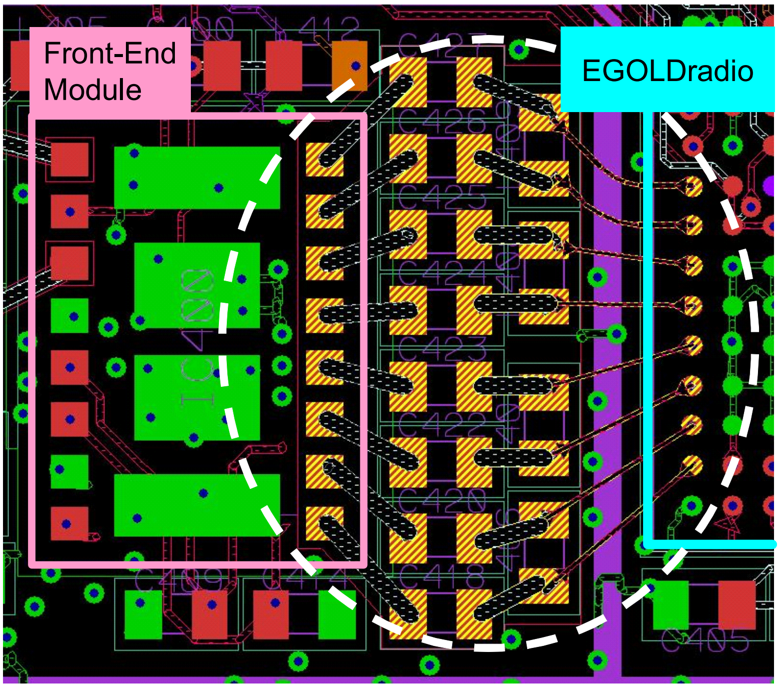
The simulation should model accurately the PCB layout, since this usually plays relevant role for matching calculation: the characteristic impedance for the transmission line should be available and their electrical length as starting point. Then the passive component will be introduced including their parasitic effects, better if using the simulation model offered by component's manufacturer. Please note that usually the inductors have different parasitic depending on their technology, often the same nominal value for different producer's result in different performances. Therefore the final matching configuration should be specified including manufacturer and type fro the used inductors.

The reliability of the simulation depends on the accuracy of the system model: very often the PCB layout introduces parasitic effect quite difficult to estimate, so typically the simulation offers the first guess for RF matching that must be confirmed by system sensitivity or SNR measurements.

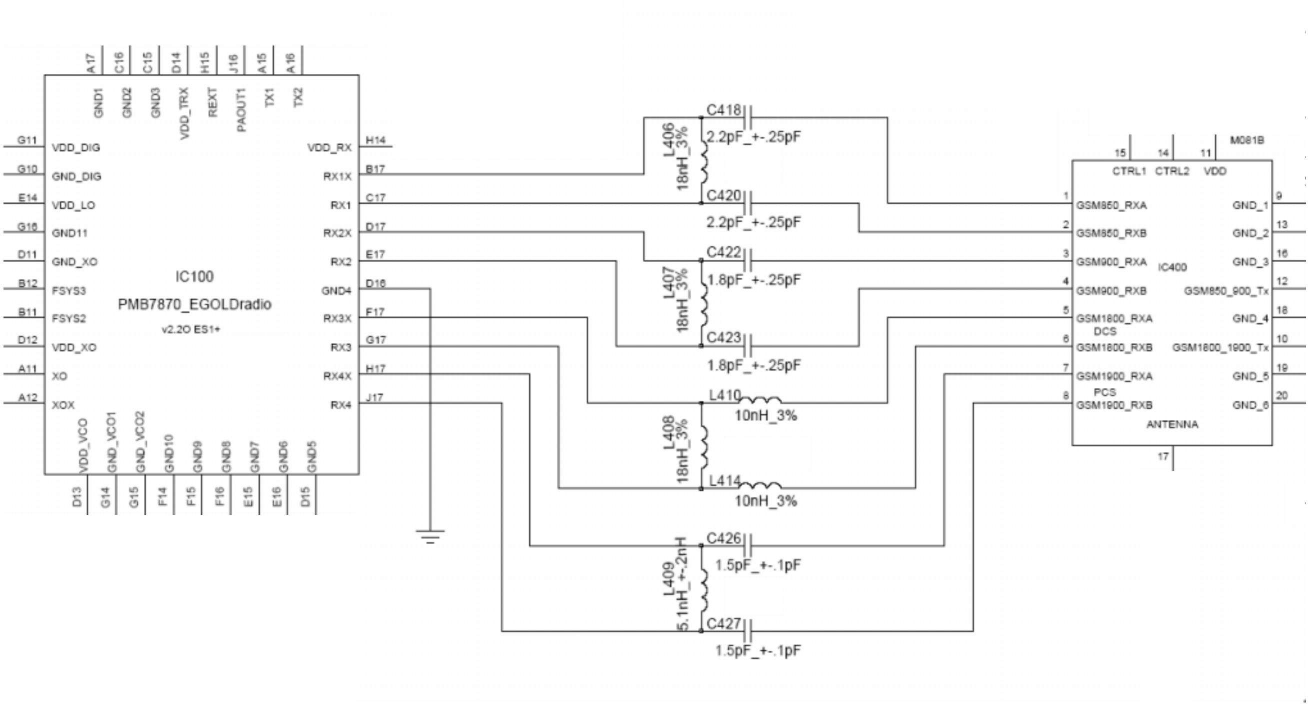
With other approach the complex differential impedance might be measured on the real layout board by Network Analyzer and used instead of FEM and EGR data as input to simulation. In this way the uncertainty of PCB layout model might be avoided. Nevertheless this approach is also leading to possible errors introduced by delicate RF measurement setup for differential impedance.

In conclusion, final configuration is again confirmed and fine tuned by measurements on finalized board.

In the following figure, the layout fro the RF matching PCB is highlighted: EGOLDradio fan-out is done by stripline on layer 5 with minimum line width, then matching component and final connection to Front-End Module is implemented by short stripline on layer 6. Lines are kept as differential as possible, but physical dimension of 0402 components doesn't allow to implement perfect symmetry.



Finally the following figure shows the schematic fro RX matching implemented on Globe6.



6 Specification Test Cases

The receiver performances should fulfill specification *3GPP TS 05.05: "Radio transmission and reception"* Detailed testing procedure can be found in *3GPP TS 51.010-1: "Mobile Station (MS) conformance specification; Part 1: Conformance specification"* therefore the test cases applicable to the receiver refers to the latest document, with explicit link to subsection where the test is defined and described.

The rationale behind the concept-level verification of the receiver compliance with the standard requirement is briefly outlined here for each of the applicable RX test case.

The analysis follows the classical "RX-link-budget" approach: the impact of the various functional blocks along the RX path, are summed up to the I/Q interface, where some condition required for the baseband correct functionality are verified. The critical parameter will be usually:

- the Signal-to-Noise Ratio (SNR) within the baseband channel select filter passband, where 8dB are assumed to be the minimum requirement
- the Signal-to-Noise plus Distortion (co-channel interference) Ratio (S/N+I), same 8dB requirement as SNR.
- the maximum input level that doesn't overdrive the baseband ADC, i.e. differential 2.0Vpp typ., 1.9Vpp min

For each test case, the typical and worst case analysis are performed. Of course the worst case results are often too pessimistic, given the likelihood that all components exhibit worst case performances may also never occur.
Moreover must be underlined that the first approximation approach cannot give ultimate performances and therefore doesn't fully represent the platform limits, where fully compliant FTA and laboratory measurements should be regarded as reference. For example, the SNR baseband requirement is usually lower than the assumed 8dB for most of the testcases.

The analysis is typically accomplished by Excel sheet: please refer to "*Globe6_RXlinkbudget.xls*" fro resulting performances.

6.1 Reference Sensitivity (3GPP TS 51.010 Sub 14.2)

The system should guarantee the Nominal Error Rate (usually 2.4% class Ib RBER for static channel) with a useful input RF signal of -102dBm.

This performance is mainly limited by the noise added by the receiver, therefore the analysis is done by evaluating the Signal-to-Noise Ratio (SNR) degradation through the receiver chain, and verifying that the SNR at baseband I/Q interface is greater than the minimum target performance. Signal gain and noise figure are calculated through the receiver chain, and summed by classical Friis formulas to get the overall Noise Figure performances at baseband I/Q analog interface, where the noise introduced by ADC is also summed.

6.2 Adjacent channels rejection (3GPP TS 45.005 Sub 6.3)

In case of Adjacent channel (200 kHz) and Alternate channel (400 kHz) rejection, worst case is stated by the 3GPP TS 45.005 (formerly 05.05) Sub 6.3 (test defined in 3GPP TS 51.010 Sub 14.5).
The specification prescribes that for GSM (i.e. non GPRS) handset, the mobile should achieve the Nominal Error Rate with the wanted signal level 20dB above the reference sensitivity level, and GMSK modulated disturbing signal at following levels, relative to wanted signal:

for adjacent (200 kHz) interference C/Ia1 = -9 dB
for adjacent (400 kHz) interference C/Ia2 = -41 dB

In case of EGPRS, the situation is slightly worse, even for GSMK modulated data packets. The reference test case is also according to 3GPP TS 51.010 Sub 14.18.3, both specs defines the disturbing signal level is defined to be

for adjacent (200 kHz) interference C/Ia1 = C/Ic - 18 dB
for adjacent (400 kHz) interference C/Ia2 = C/Ic - 50 dB

where C/Ic is the minimum interference ratio for which the reference performance for cochannel interference (C/Ic) shall be met, according to some given Tables with entry as the type of data channel (e.g. Coding Scheme CS, PDTCH or other logical channel, etc) and to the propagation condition (usually TU50 fading is the worst case where specifications apply)

Note that the co-channel interference effect on demodulator is only related to baseband performances, mainly DSP algorithms and therefore is out of the scope of this document.

Such C/Ic co-channel interference ratio for GMSK modulation worst case is for PDTCH/CS-4 scenario and TU50 propagation channel model, where the figure is C/Ic = 24dB (22dB in TS 51.010), for GSM900/GSM850, or C/Ic = 27dB (23dB), for DCS1800/PCS1900. This makes sense, because the CS-4 is the Coding Scheme less protected, therefore the implementation margin is greater than other logical channels. But it must be noted that the same parameter is also used to set the useful signal input level, therefore a greater signal power will result for this test, so worse stressing conditions for receiver dynamic range.

For packet switched, GMSK modulated channels the wanted input signal level shall be -93 dBm + Ir + Corr, where Ir is the interference ratio, i.e. C/Ic, ant the Corr is a correction factor for reference performance that is basically +2dB (for GSM900/GSM850/PCS1900 and 4dB for DCS1800).

The wanted signal power is therefore

for GSM900/GSM850 Pw = -93 dBm + 24dB + 2dB = -67dBm
for DCS1800/PCS1900 Pw = -93 dBm + 27dB + 2dB = -64dBm

For the adjacent (200 kHz) interference it is instead:
Ia1 = Pw - C/Ia2 = (-93 dBm + Ir + Corr) - (C/Ic - 18dB) = -93 dBm + 18dB + Corr

Therefore unwanted signal levels are, with similar evaluation:

for GSM900/GSM850	Ia1 = -93 dBm + 18dB +2dB	= -73 dBm
	Ia2 = -93 dBm + 50dB + 2dB	= -41 dBm
for DCS1800/PCS1900	Ia1 = -93 dBm + 18dB +2dB	= -73 dBm
	Ia2 = -93 dBm + 50dB + 2dB	= -41 dBm

The adjacent and alternate channels are supposed to be fully rejected by baseband digital channel filter before the demodulator, but the analog section of receiver must guarantee that the signal at baseband input will be not high enough to saturate the ADC stages.
Therefore the peak voltage level is monitored at I/Q interface, checking that it doesn't exceed the maximum allowable input range. Moreover, some fading factor is also considered, that rise the peak level according to the fading margin, evaluated for GPRS PDTCH/C2-4 TU50 propagation channel model.

The strong disturbing signals will experience no rejection from the front-end filters, but only at EGOLDradio Transceiver baseband output low-pass filter. Therefore that figure must be accounted while calculating the interfering signals level at baseband I/Q interface. Moreover, the same strong signal will increase the equivalent noise figure behavior, mainly due to non-linear phenomena, but since the resulting noise-like signal has flat power spectral density, this effect is quantified in the EGOLDradio specs as Desensitization NF: the latest figure shall therefore substituted to the noise figure used for reference sensitivity performances while evaluating the impact of adjacent and alternate interfering channels. The result will be worst case performances as long as the disturbing signal at input of receiver will be lower than the declared test condition for EGOLDradio specifications.

6.3 In-band Blocking (3GPP TS 51.010 Sub 14.7)

The wanted signal level at 3dB above the reference sensitivity should be received with Nominal Error Rates even when a static continuous wave signal is added at RF input, at frequency multiples of 200kHz from the wanted signal, with level according to the following table:

Frequency offset	**E- GSM 900 & GSM 850** [dBm]	**DCS 1 800 & PCS 1 900** [dBm]
600 kHz ≤ |f-fo | < 800 kHz	-43	-43
800 kHz ≤ |f-fo | < 1,6 MHz	-43	-43
1,6 MHz ≤ |f-fo | < 3 MHz	-33	-33
3 MHz ≤ |f-fo |	-23	-26

with some allowed exceptions, called spurious response frequencies, namely a maximum of six occurrences for GSM900 and GSM850 bands and a maximum of twelve occurrences for DCS 1 800 and PCS 1 900 band, which if grouped shall not exceed three contiguous occurrences per group, where the above performance shall be met when the continuous sine wave signal is set to a level of -43 dBm.

Items to consider are similar to the Adjacent channel rejection case, therefore Desensitization noise figure must be accounted for SNR evaluation and signal peak must be monitored.

The critical frequencies that will be checked are clearly at every band transition in the specification limit. Typically the worst condition is for the 3MHz blocker.

For the case where the blocker frequency is N x 26MHz, a spurious response might be encountered, where EGOLDradio downconverts a fraction of input blocker power just superposed to baseband signal at I/Q interface. These frequency must be monitored and verified if the resulting S/(N+I) ratio is even high enough to fulfill the requirement, at least with the reduced disturbing signal level allowed for the exception spurious response.

6.4 Out-of-band Blocking (3GPP TS 51.010 Sub 14.7)

Also in case of out-of-band blocking the situation is similar to preceding sections, but with the fundamental difference that the RF SAW BPF will greatly reject the disturbing signal and the matching at input of EGOLDradio will also have some influence as well. The noise figure should considered desensitization worst case.

The wanted signal must be set 3dB above the reference sensitivity, and the injected continuous wave disturbing signal level should be according to following table:

E-GSM 900

FREQUENCY	CW level [dBμVemf]	CW level [dBm]
100 kHz to < 835 MHz	90	-23
835 MHz to < 905 MHz	113	0
905 MHz to < 915 MHz	108	-5
915 MHz to FR - 3 MHz	90	-23
RX band		
FR + 3 MHz to 980 MHz	90	-23
> 980 MHz to 1 000 MHz	113	0
> 1 000 MHz to 12,75 GHz	90	-23

DCS 1 800

FREQUENCY	CW level [dBμVemf]	CW level [dBm]
100 kHz to 1 705 MHz	113	0
> 1 705 MHz to < 1 785 MHz	101	-12
1 785 MHz to FR - 3 MHz	87	-26
RX band		
FR + 3 MHz to 1 920 MHz	87	-26
> 1 920 MHz to 1 980 MHz	101	-12
> 1 980 MHz to 12,75 GHz	90	-23

PCS 1 900

FREQUENCY	CW level [dBμVemf]	CW level [dBm]
100 kHz to 1 830 MHz	113	0
> 1 830 MHz to < 1 910 MHz	101	-12
1 910 MHz to FR - 3 MHz	87	-26
RX band		
FR + 3 MHz to 2 010 MHz	87	-26
> 2 010 MHz to 2 070 MHz	101	-12
> 2 070 MHz to 12,75 GHz	90	-23

GSM 850

FREQUENCY	CW level [dBμVemf]]	CW level [dBm]
100 kHz to < 849 MHz	113	0
849 MHz to FR - 3 MHz	90	-23
RX band		
FR + 3 MHz to 914 MHz	90	-23
> 914 MHz to 12,75 GHz	113	0

with some allowed exceptions, called spurious response frequencies, namely a maximum of 24 occurrences (which if below FR and grouped shall not exceed three contiguous occurrences per group) where the above performance shall be met when the continuous sine wave signal set to a level of -43 dBm.

Each band edge shall be verified, including the BPF rejection that applies at that frequency band. Of course the exact figure for some parameter is not available, then some worst case shall be assumed.

In addition the EGOLDradio spurious response at multiple of RX frequency shall be verified as well: at N x RX frequencies, it might occur that a blocker signal will be downconverted to baseband directly superposed to wanted signal, thus becoming co-channel interference. The S/(N+I) shall be evaluated and the minimum required performance must be met at least with signal level limited to the allowed spurious response level, that is -43 dBm.

The BPF rejection here plays a dominant role, but also the matching of the passive network between the RF SAW BPF and the input of EGOLDradio has some influence. Here the evaluation of rejection in the far blocking band is not easy, since parasitic phenomena appear at several GHz frequency, thus some assumption must be made or also simulations could be performed.
In addition, the signal at input of EGOLDradio is definitely no more differential: at 5.5GHz the signal from the BPF and matching is nearly common mode on the balanced input pins of RX port. Hence the common mode rejection is considered in the RX-link budget, for the occurrence where EGOLDradio specifications states different harmonic rejection performances for the differential and common mode blocker signal.

6.5 Max. Receiver input (3GPP TS 51.010 Sub 14.3)

The mobile station shall guarantee the Nominal Error Rate when the input signal level is set to -15dBm for GSM900 and GSM850 band, and to -23dBm fro DCS1800 and PCS1900.

This will impact the compression point of EGOLDradio receiver, that will of course be set in low-gain mode and therefore increased NF shall be accounted. The SNR at I/Q interface shall be evaluated, as well as the resulting signal peak, in order to verify that baseband demodulator will have enough margin to operate with prescribed Nominal Error Rate and also that the ADC dynamic range will not be exceeded.

6.6 Intermodulation (3GPP TS 51.010 Sub 14.6)

The intermodulation attenuation is the ratio of the power level of the wanted signal to the power level of an intermodulation component. It is a measure of the capability of the transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal reaching the transmitter via the antenna, or by non linear combining and amplification of multiple carriers.

The reference sensitivity performance shall be met when the input to the receiver is fed with a useful signal at frequency f_0, 3 dB above the reference sensitivity level and a combination of a continuous, static sine wave signal at frequency f_A and a level of -49 dBm; plus a GMSK modulated signal at frequency f_B, and a level of -49 dBm; such that $f_0 = 2f_A - f_B$ and $|f_B - f_A| = 800$ kHz.

The test condition clearly stress the so-called third-order intermodulation performances of the RF front-end, since the interferers frequencies are defined such that the 3-rd order intermodulation product will lie just superposed to useful signal, therefore becoming a co-channel interferer.

The classical formula to be used is:
$P_{IM3@out}$ [dBm] = 2 $P_{A@in}$ [dBm] + $P_{B@in}$ [dBm] – 2 IIP3 [dBm] + G [dB]

where P_{IM3} is the intermodulation product level at output of EGOLDradio RF transceiver, the IIP3 is the third-order input-referred intermodulation intercept point for EGOLDradio, P_A and P_B are the blocker level at input of EGOLDradio, and G is the gain for useful signal of SD itself.

At I/Q interface, the S/(N+I) shall be monitored in order to find if it exceed the wanted minimum level.

6.7 AM suppression (3GPP TS 51.010 Sub 14.8)

The reference sensitivity performance shall be met when the following signals are simultaneously input to the receiver: a useful signal, at frequency fo, 3 dB above the reference sensitivity level and a GSM TDMA signal modulated in GMSK at a level of -31dBm, at frequency in the relevant receive band, | f-fo | > 6 MHz, which is an integer multiple of 200 kHz. The interferer shall have one timeslot active and the frequency shall be at least 2 channels separated from any identified spurious response. The transmitted bursts shall be synchronized to but delayed in time between 61 and 86 bit periods relative to the bursts of the wanted signal.

What is stressing this test is the even-order nonlinearity of the direct-conversion receiver, since the even order distortion will produce a DC contribution that will become superposed to downconverted signal at baseband output. What can be expected is a DC step in the middle of the RX burst at the baseband interface, which level is estimated through the AM suppression figure started in the EGOLDradio specification, actually the ratio of the I/Q levels peak-to-peak to DC step.

Therefore that is the monitored parameter for this test case.

6.8 Threshold behavior

For the normal working functionality of the receiver, three main gain step are defined:

63dB gain for input level less than -88dBm
57dB for input level ranging from -91 dBm to -54dBm
23dB for input level above -57dBm

Please note the input ranges are overlapping because of hysteresis mechanism, which is implemented to limit the transitions between contiguous gain states for received signal at the edge of the ranges.

In the limit conditions is useful to estimate the SNR at I/Q interface as well as the foreseen signal peak level, in order to verify that the target working condition for baseband demodulator will be fulfilled (with some margin) and signal peak will be not too high to run the risk of overloading the ADC range.

7 Document change report

	Change Reference		Record of changes made to previous released version	
Rev	**Date**	**CR**	**Section**	**Comment**
1.0	17/02/2006	M.Vlacci		First Release

8 Approval

Revision	Approver(s)	Date	Source/signature
1.0	Dario Antonaz	20/02/2006	Document stored on N7 server