7 - RF Description and Troubleshooting

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Abbreviations

BB	Baseband
PCS	GSM1900
GSM	GSM850
ESD	Electro Static Discharge
GPRS	General Packed Radio Service
HSCSD	High Speed Circuit Switched Data
LNA	Low Noise Amplifier
LO	Local Oscillator
PA	Power Amplifier
PWB	Printed Wired Board
PLL	Phase Locked Loop
RF	Radio Frequency
RX	Receiver
SA	Spectrum Analyzer
TX	Transmitter
VCO	Voltage Controlled Oscillator

Introduction to RF

The RF front-end is a dual-band direct conversion transceiver. Using direct conversion, no intermediate frequencies are used for up- or down -conversions.

The VCO oscillates on the doubled respectively quadruplicated frequency of the wanted RX or TX frequency, depending on the band used. The VCO frequency is divided by either 2 or 4 and fed to the mixers (down-conversion) or modulators (up-conversion). Up- or down-conversion is done in one step, directly between RF frequency and base band. All up- and down-conversion takes place in the RF ASIC named Mjoelner (N601).

Mjoelner RF ASIC also contains PLL and LNAs for all used bands. ADC control section is included to power and/or control GSM850 TX buffer, detector and antenna switch. The Mjoelner RF ASIC is controlled via a serial bus.

Mjoelner RF ASIC contains an integrated VCXO which uses an external 26 MHz Xtal. No analogue AFC signal is needed. AFC is realized via the serial interface port of Mjoelner.

The UPP is supplied by the 26 MHz reference clock of Mjoelner.

The phone supports GPRS (General Packet Radio Service), meaning multi-slot operation. This will not require special equipment or procedures in repair situations.

The following diagrams show the RF frequency scheme and the RF block diagram.

Figure 1: RF frequency scheme

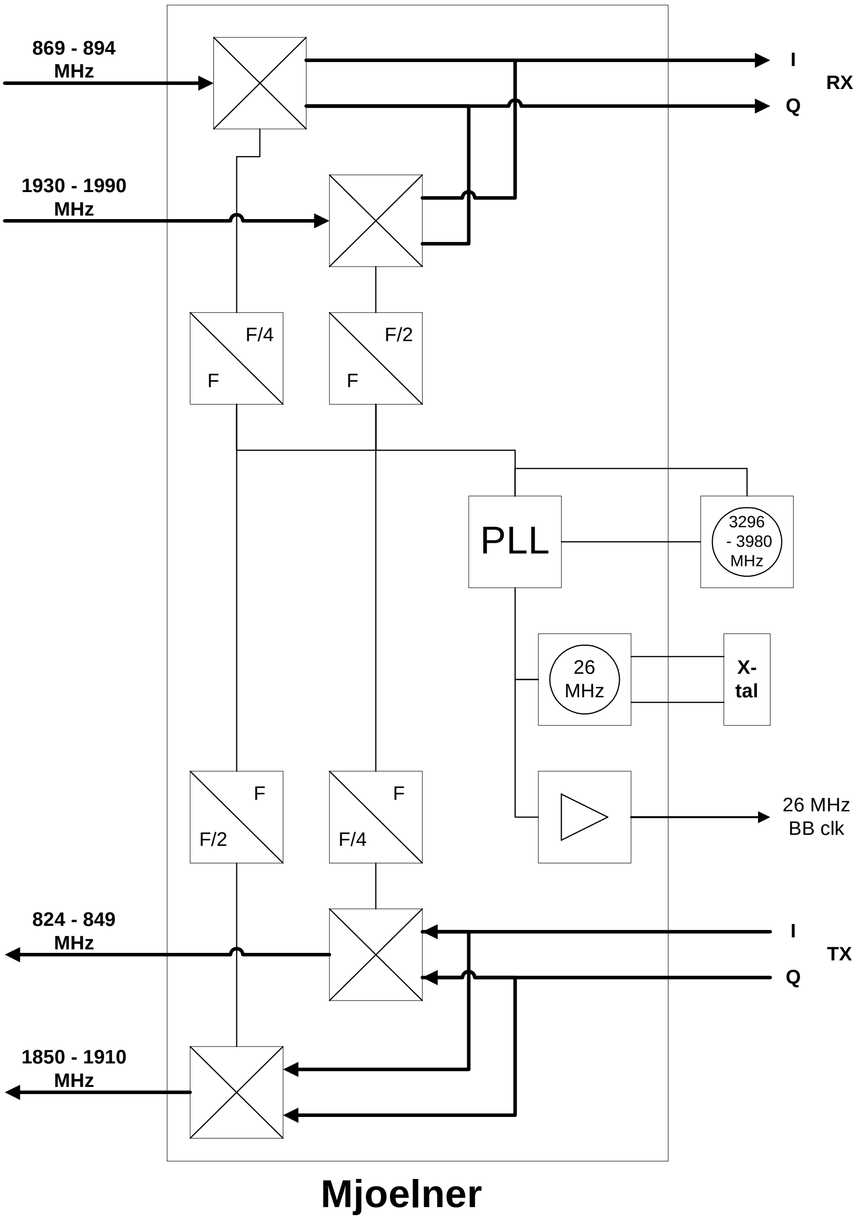
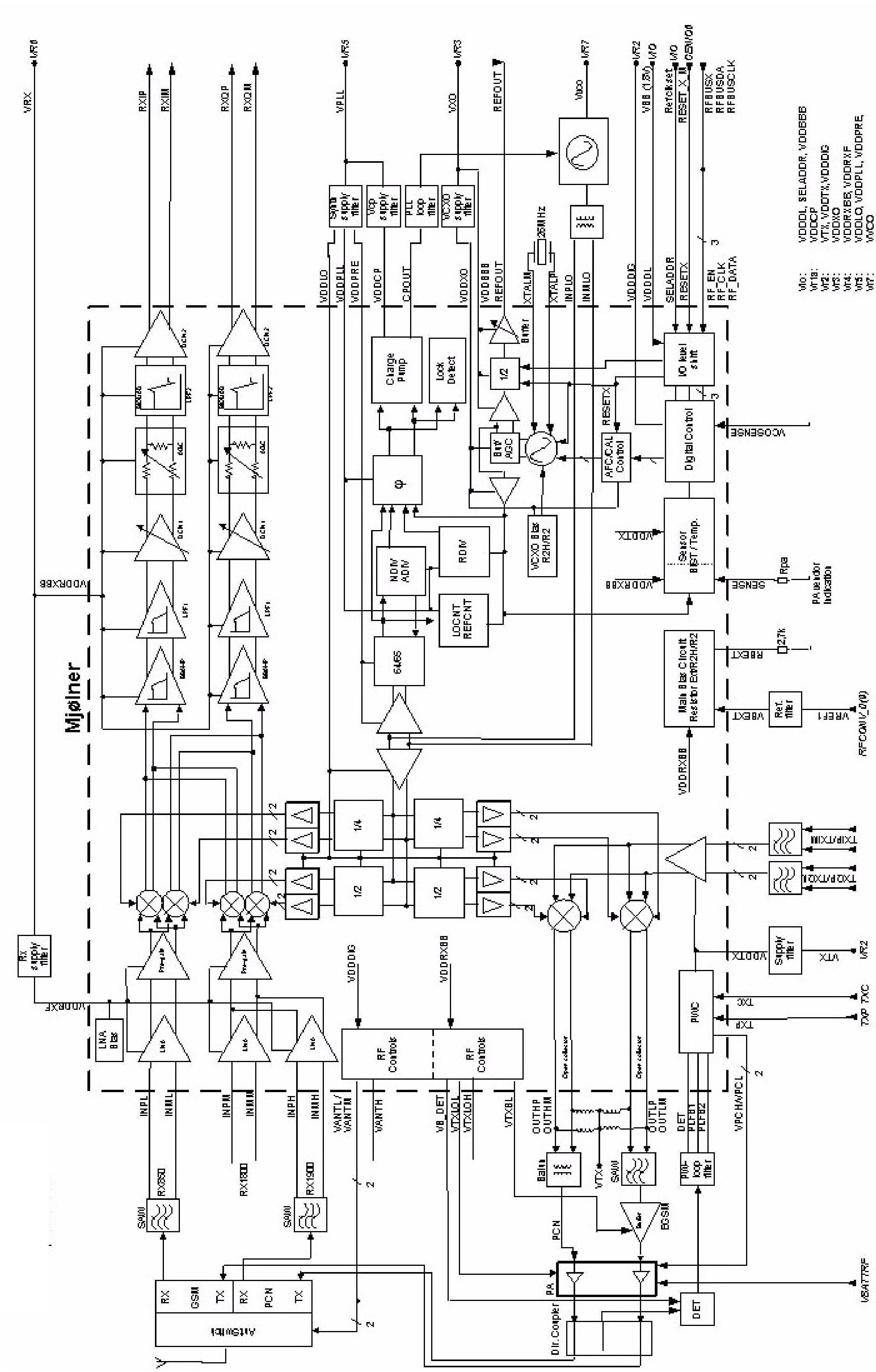


Figure 2: RF block diagram

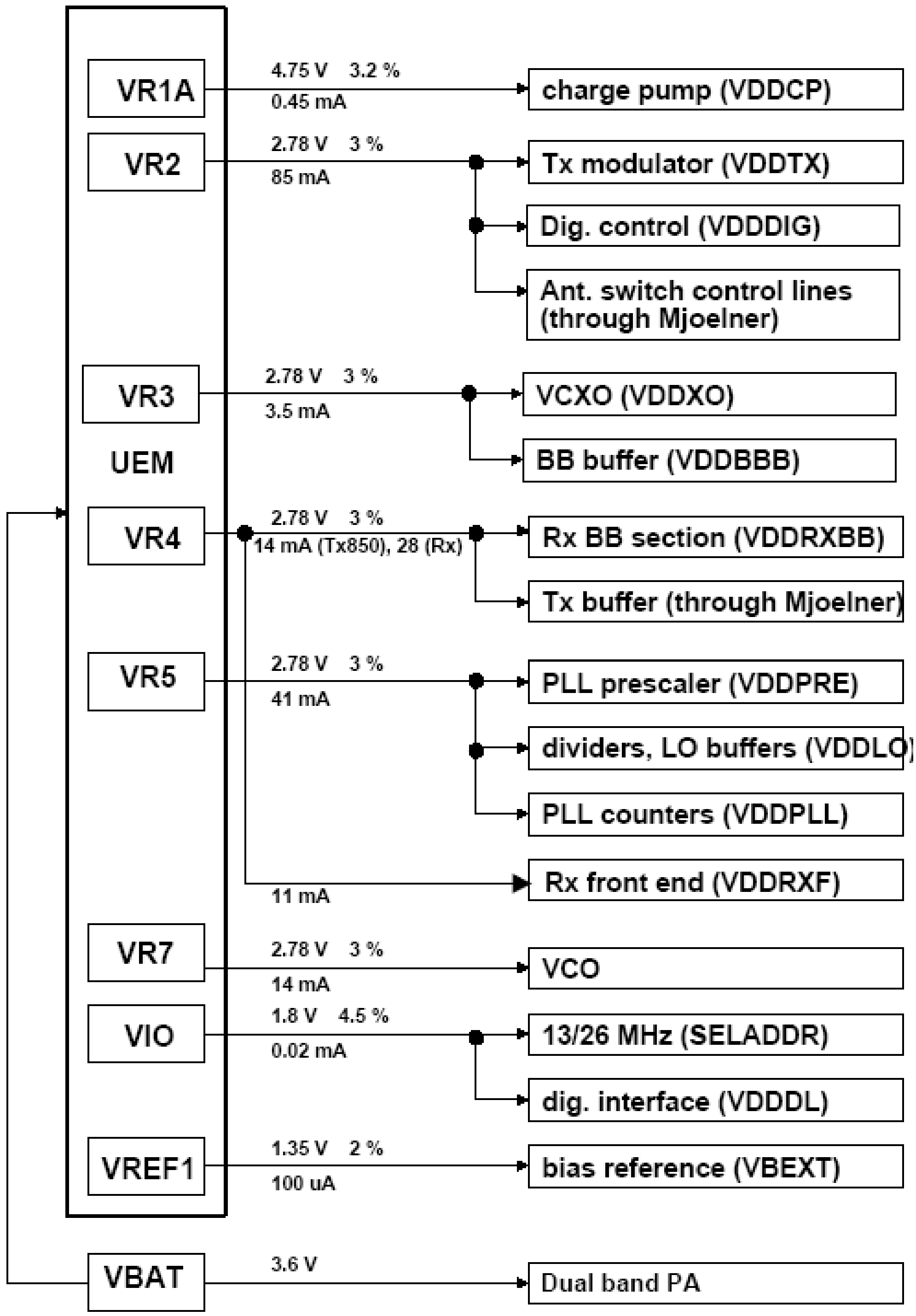


RF power supply configuration

All power supplies for the RF Unit are generated in the UEM IC (D190). All RF supplies can be checked either in Mjoelner or in BB chamber.

The power supply configuration used is shown in the block diagram below. Values of voltages are given as nominal outputs of UEM. Currents are typical values.

Figure 3: RF power distribution diagram



General specifications of transceiver RH-47

Parameter	Unit
Cellular System	GSM850, GSM1900
RX Frequency Band	GSM850: 869 ... 894 MHz GSM1900: 1930 ... 1990 MHz
TX Frequency Band	GSM850: 824 ... 849 MHz GSM1900: 1850 ... 1910 MHz
Output Power	GSM850: +5 ... +33 dBm (3.2 mW ... 2 W) GSM1900: +0 ... +30 dBm (1.0 mW ... 1 W)
Duplex Spacing	GSM850: 45 MHz GSM1900: 80 MHz
Number of RF Channels	GSM850: 124 GSM1900: 299
Channel Spacing	200 kHz (each band)
Number of TX Power Levels	GSM850: 15 GSM1900: 16
Sensitivity, static channel	GSM850: -102 dBm GSM1900: -102 dBm
Frequency Error, static channel	< 0.1 ppm
RMS Phase Error	< 5.0 °
Peak Phase Error	< |20.0 °|

Introduction to RF Troubleshooting

This document shall provide instructions, how to check, repair and calibrate RH-47 phones. It is assumed, that the phones are disassembled and tested within a repair jig MJ-21.

The following types of measurements have to be done for repair of the phone boards:

- RF measurements are made by using a Spectrum Analyzer together with a high-frequency probe (i.e. hp 85024A   Note, that signal levels are not accurate). Correct attenuation can be checked using a "good" phone board for example.
- LF (Low frequency) and DC measurements are made with an oscilloscope together with a 10:1 probe.
- For receiver measurements a signal generator with frequencies up to 2000 MHz is required. Most of the radio communication testers like CMD55 or CMU200 can be used as signal generator. The signal generator is connected to the antenna port using the repair jig MJ-21.
- Output level measurements of the transmitter are made with a power meter or a calibrated spectrum analyser, which is connected to the antenna port using the repair jig MJ-21.

Always make sure that the measurement set-up is calibrated when measuring RF parameters at the antenna port. Remember to include the correct losses of the module repair jig and the connecting cable when realigning the phone.

Most RF semiconductors are static discharge sensitive. ESD protection must be taken into account during repair (ground straps and ESD soldering irons).

Mjoelner RF ASIC is moisture sensitive. Therefore, Mjoelner RF ASIC must be pre-baked prior to soldering.

Rx calibration done via Phoenix software is temperature sensitive because of calibration of the 26 MHz reference oscillator (VCXO). According to Mjoelner specification ambient temperature has to be in a range from 22°C to 36°C.

Apart from key-components described in this document there are a lot of discrete components (resistors, inductors and capacitors) for which trouble shooting is done by checking its proper soldering and complete assembly on the PWB. Capacitors and resistors can be checked by means of an LCR meter, but be aware in-circuit measurements should be evaluated carefully.

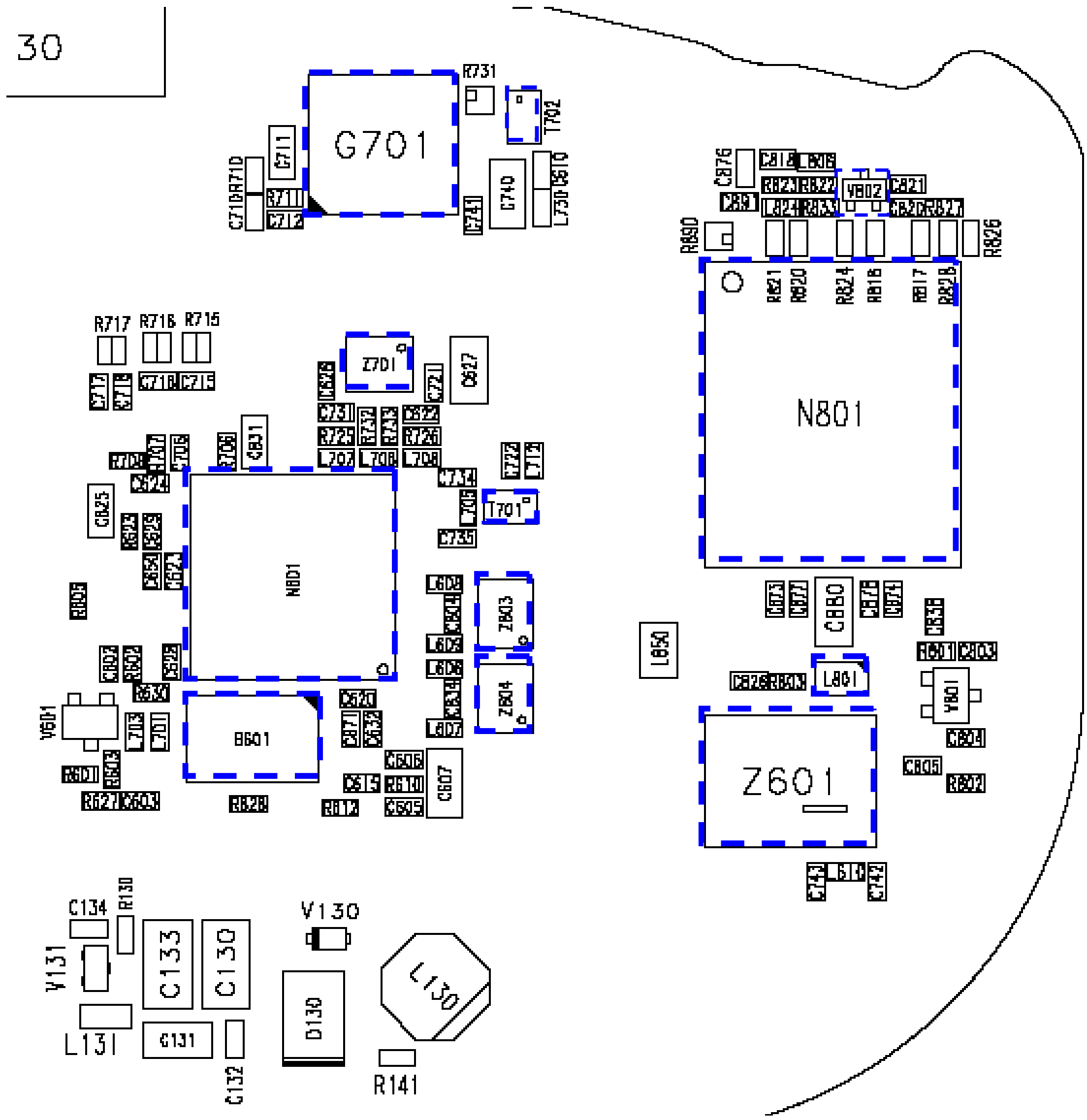
In the following GSM850 will be used for the low band, and PCS or GSM1900 for the high band.

Note: In this document there are example measurements being depicted with Phoenix Internal Service Software A2003.42.1.48 pictures.

Printed Wired Board

RF key component placement

Figure 4: RF key component placement



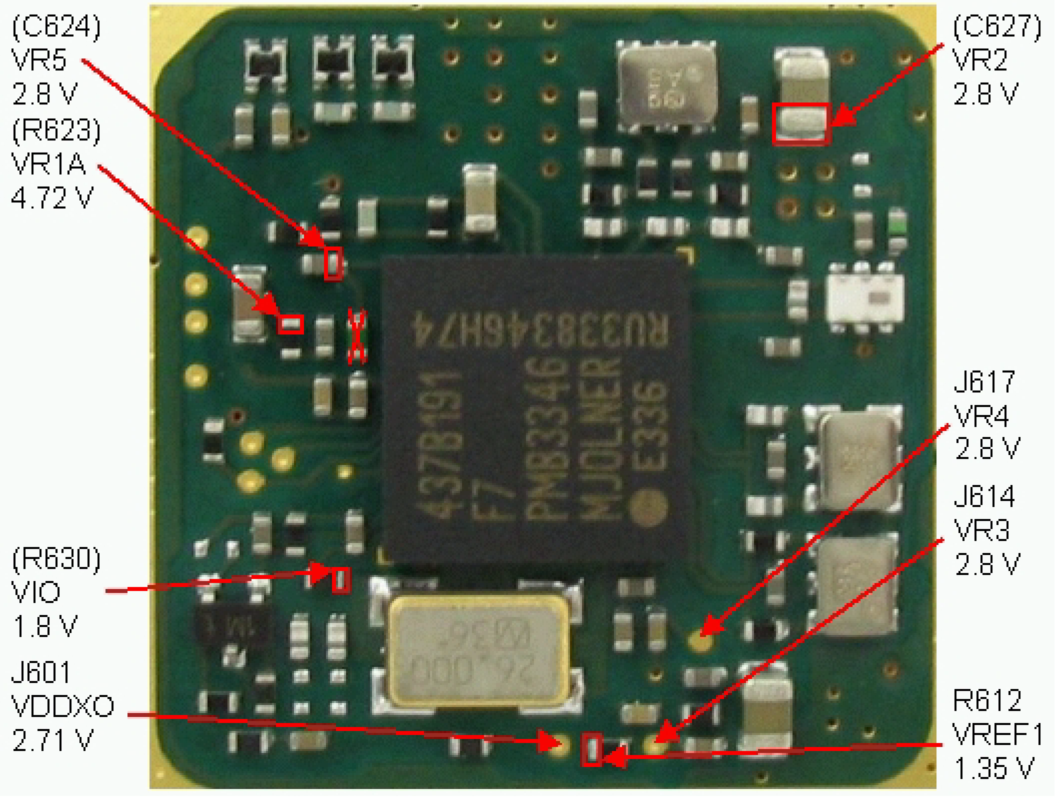
Description / Part Code	Manufacturer's code	NMP Code	Supplier
Dual band PA (N801)	PF08130B-TB	4350403	Renesas
Mjölner RF ASIC F7 (N601)		4380013	Infineon
BT202i (N430)		0700085	Murata
UHF VCO (G701)	ENFVJSW2S08	4350431	Matsushita
UHF VCO Balun (T702)	LDB213G6010C-001	4550187	Murata
1900 Tx Balun (T701)	LDB211G8005C-001	4550191	Murata

1900 Rx SAW (Z603)		4511325	Murata
850 Tx SAW (Z701)		4511317	Murata
850 Rx SAW (Z604)		4511323	Murata
Antenna switch (Z601)	LMZ0170	4510449	Murata
Crystal (B601)	TSX-8A-25850	4510337	Toyocom
Tx Coupler (L801)	LDC21836M19D-185	4550197	Murata
Tx850 buffer (V802)	BFR949T-E6327	4210171	Infineon

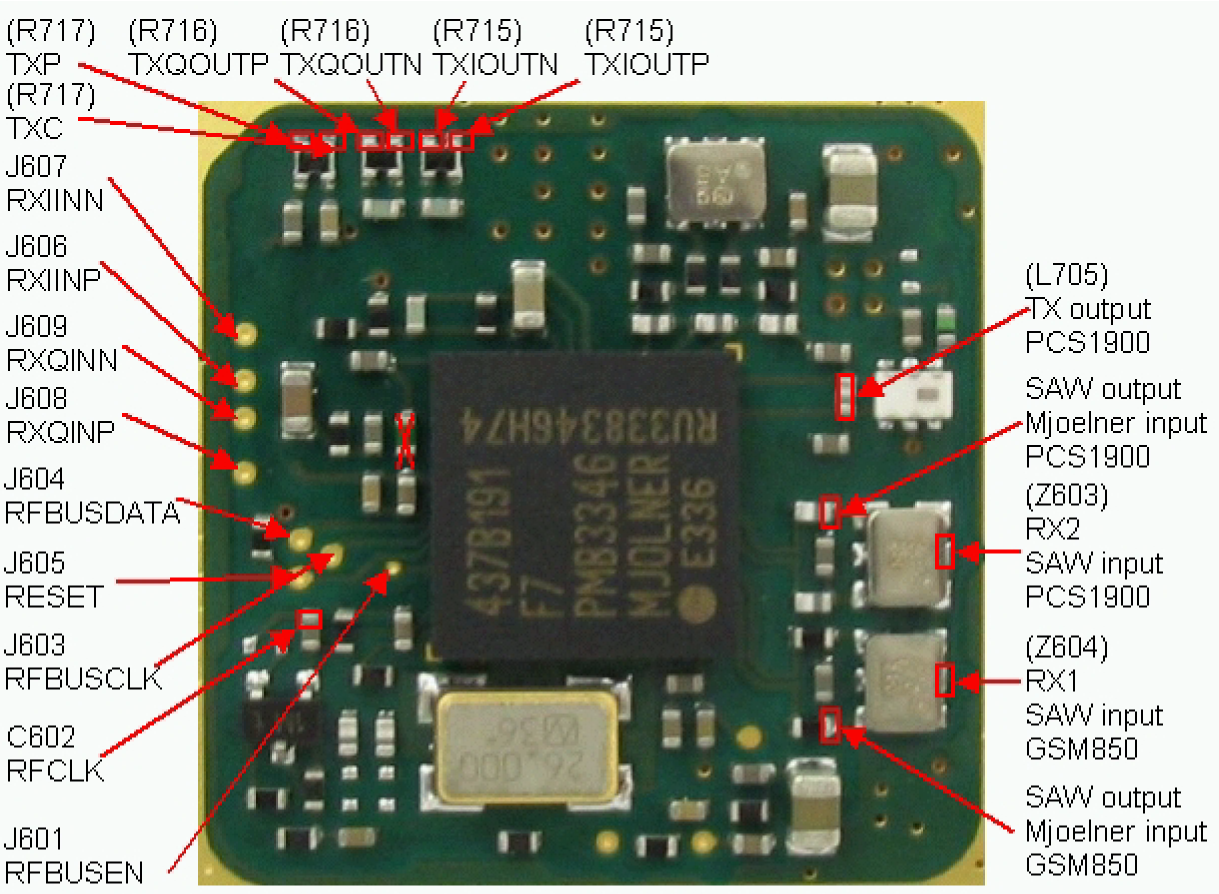
RF test points

The RF power supplies are generated in the UEM and can be measured either in the Mjoelner chamber or in the base band chamber. On the drawing below small circles show the locations of the test points.

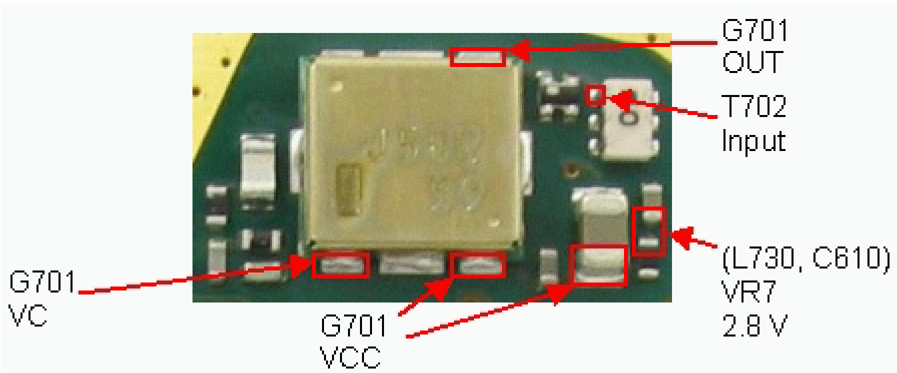
Test points RF supply voltages



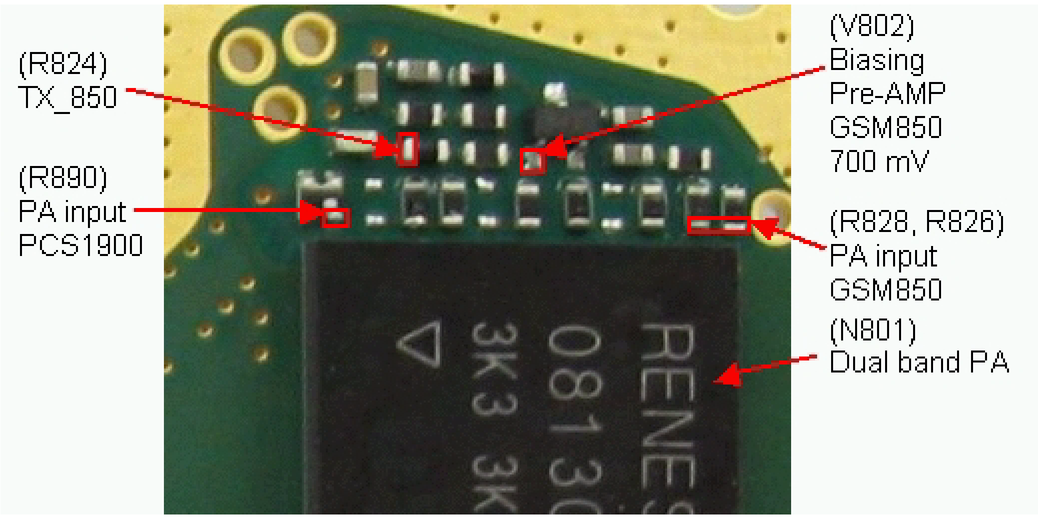
RF test points Mjoelner chamber



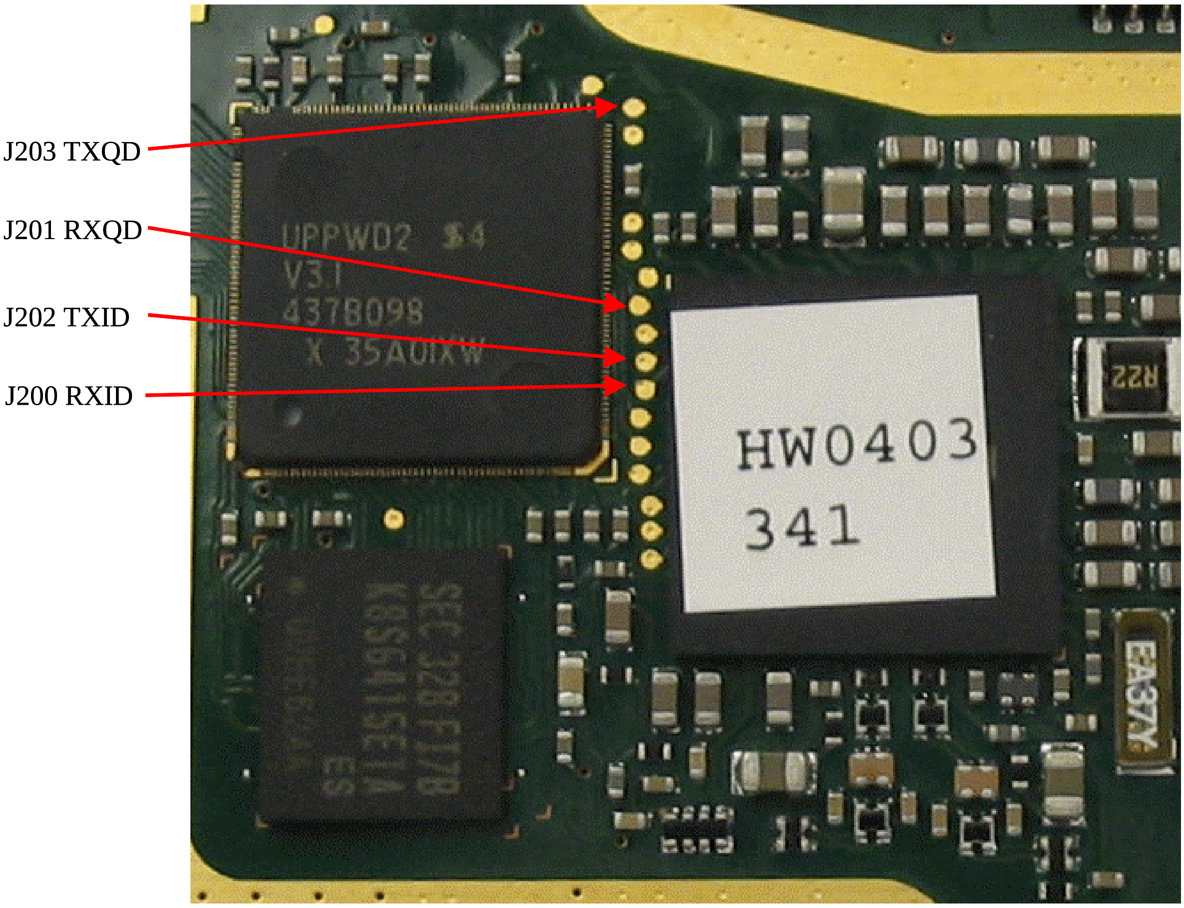
RF test points VCO chamber



RF test points PA chamber



Test points BB area



Receiver Troubleshooting

General instructions for RX troubleshooting

Connect the phone to a PC with Phoenix dongle PKD-1CS and DAU-9S cable (RS232). Follow the instructions below.

Connect the phone to a power supply (DC voltage of 3.6V) and an RF signal generator.

Measuring RX I/Q signals using RSSI reading

1 Start Phoenix Service Software and open FBUS connection:

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower right corner of the screen.

2 Set operating mode to local mode:

Select	Maintenance	Alt-M
	Testing	T
	RF Controls	F

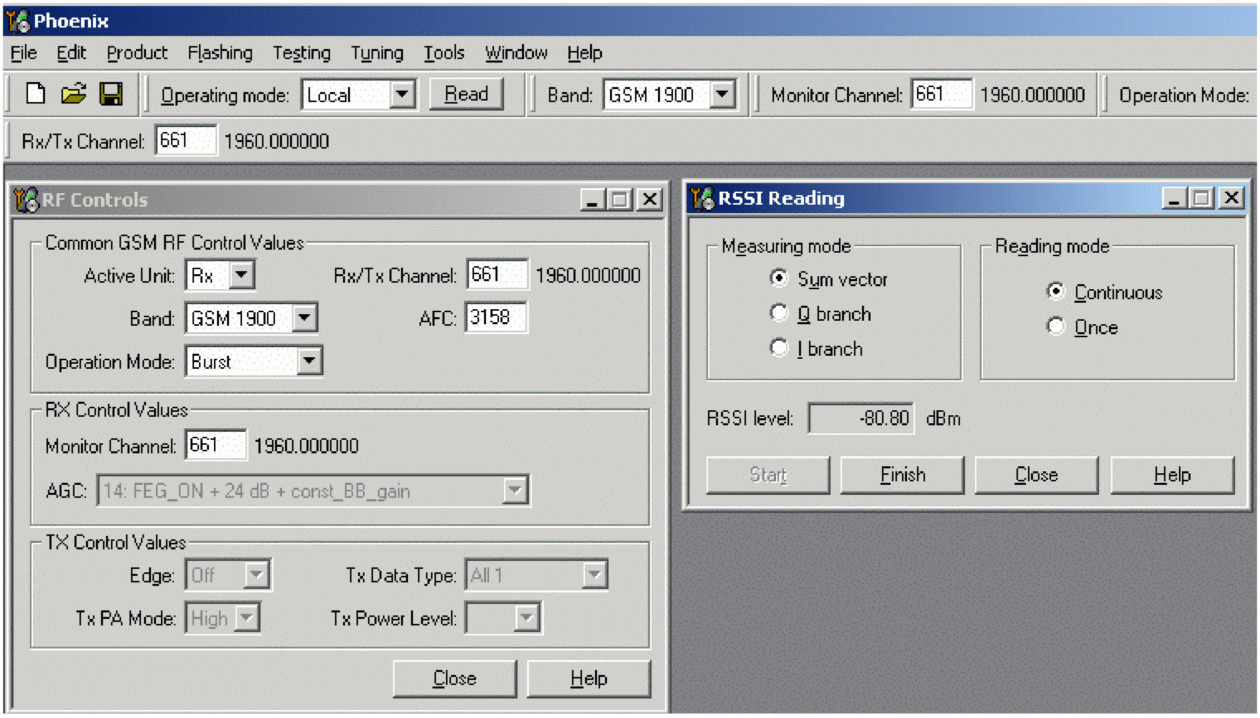
Wait until the RF Controls window pops up.

3 In the RF Controls window:

Select	Band	GSM850 or GSM1900
	Active unit	RX
	Operation mode	**Burst**
	RX/TX Channel	190 or 661

Select	Maintenance	Alt-M
	Testing	T
	RSSI reading	R

The setup should now look like this:



4 Make the following settings on your signal generator:

Frequencies:

GSM850: 881.66771 MHz (channel 190 + 67.710kHz off-set)

GSM1900: 1960.06771 MHz(channel 661 + 67.710kHz off-set)

RF power level:

– 80dBm @ **the antenna connector of the phone** (remembering to compen-sate for the cable and jig attenuation).

5 In RSSI reading, click Read now.

The resulting RSSI level should be – 80dBm +/– 0.5dB in each band.

Measuring RX performance using SNR measurement

1 Start Phoenix Service Software and open FBUS connection.

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower right corner of the screen.

2 Set operating mode to local mode.

Select	Maintenance		Alt-M
	Testing		T
		RF Controls	F

Wait until the RF Controls window pops up.

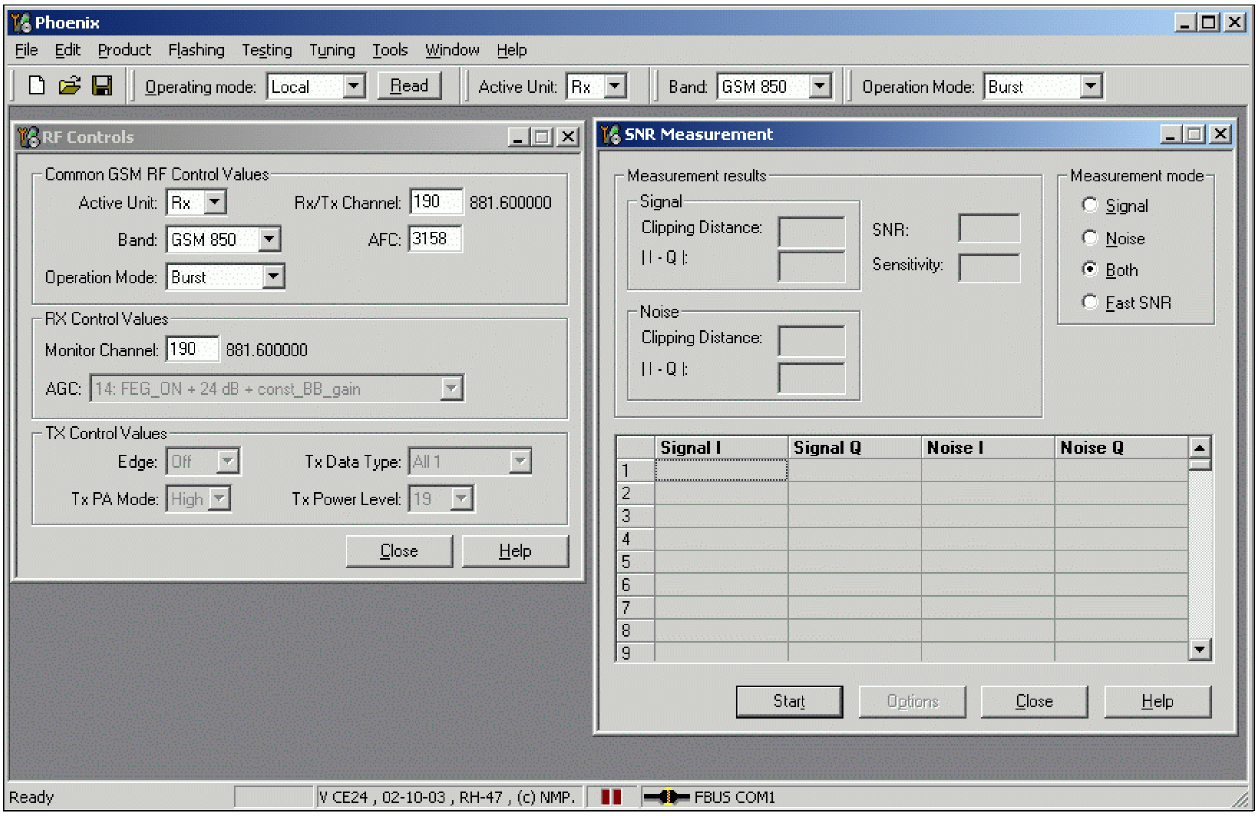
3 In the RF Controls window:

Select	Band	GSM850 or GSM1900
	Active unit	RX
	Operation mode	**Burst**
	RX/TX Channel	190 or 661

Select	Maintenance		Alt-M
	Testing		T
		SNR Measurement	M

Select	Both (Radio Button)

The setup should now look like this:



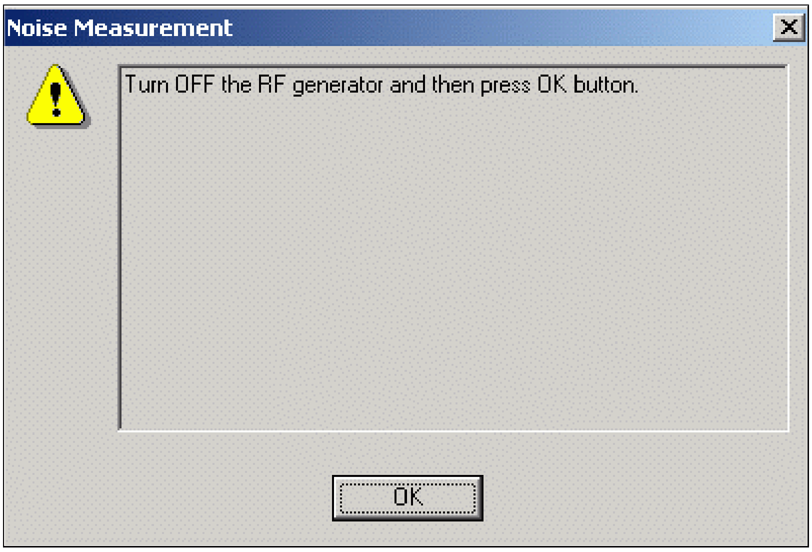
4 Press the Start button.

5 To continue, follow the instructions in the following pop-up windows.

6 Connect an external signal generator to the RF connector of the phone and set

the generator as instructed in the window. Take care for external cable and test jig attenuation losses.

7 Switch off the external RF signal as instructed in the next pop-up window.



8 Press OK and read the SNR result.

The values should be:

GSM850	> 20dB
GSM1900	> 18dB

Measuring front-end power levels using spectrum analyzer

Spectrum Analyzer (SA) level values depend on the probe type and should be validated using a good sample. The levels that are given here are measured using an hp 85024A probe.

1 Start Phoenix Service Software and open FBUS connection:

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower right corner of the screen.

2 Set operating mode to local mode:

Select	Maintenance			Alt-M
		Testing		T
			RF Controls	F

Wait until the RF Controls window pops up

3 In the RF Controls window:

Select	Band	GSM850 or GSM1900
	Active unit	RX
	Operation mode	**Continuous**
	RX/TX Channel	190 or 661

Please refer to the fault-finding chart and Appendix C for proper levels at different test points.

Measuring analogue RX I/Q signals using oscilloscope

Measuring with an oscilloscope on “RXIINN” or “RXQINN” is recommended only if RSSI reading does not provide enough information. There are dedicated test points for RX I and Q signals. Apply an Input signal level of -80dBm.

1 Start Phoenix Service Software and open FBUS connection:

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower right corner of the screen.

2 Set operating mode to local mode:

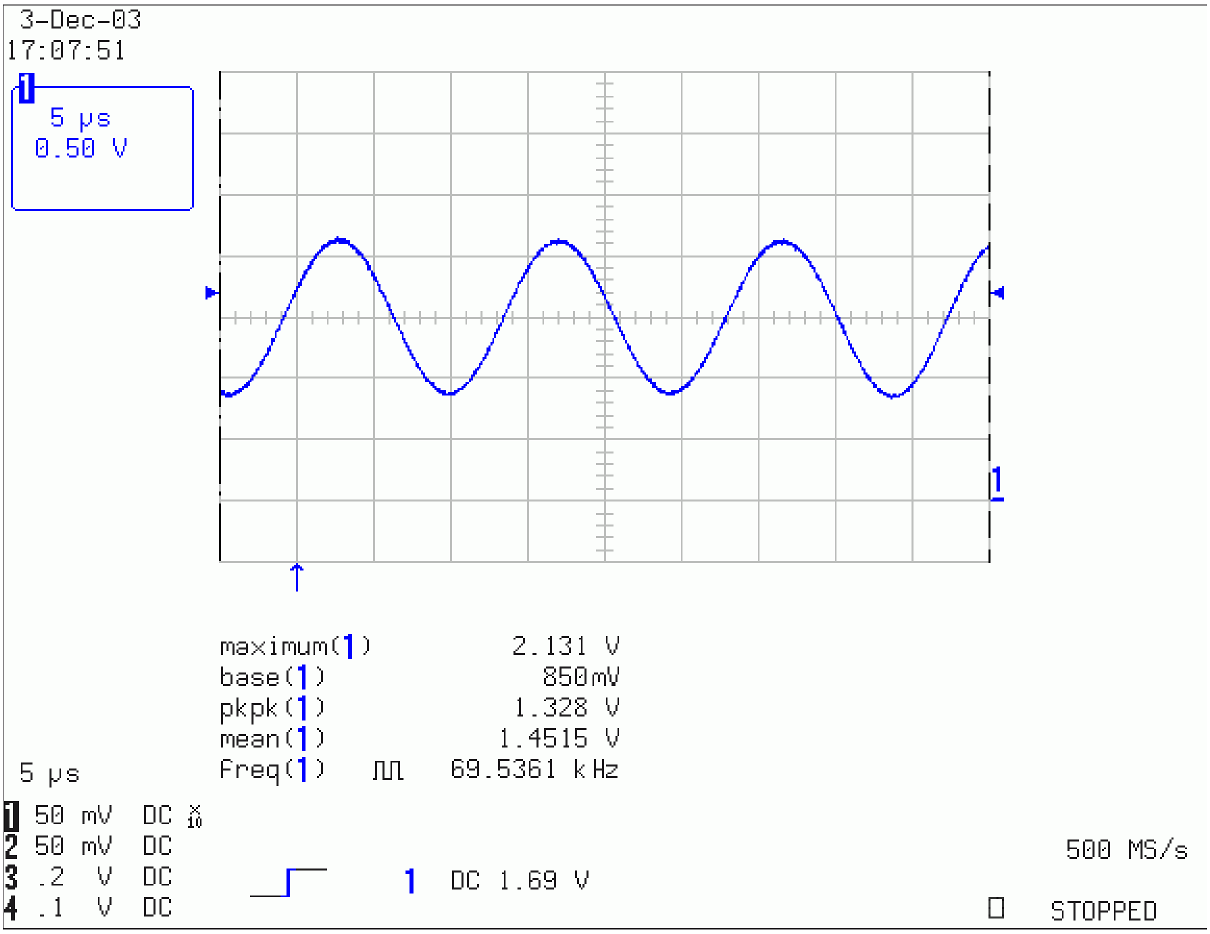
Select	Maintenance	Alt-M
	Testing	T
	RF Controls	F

Wait until the RF Controls window is pops up.

3 In the RF Controls window:

Select	Band	GSM850 or GSM1900
	Active unit	RX
	Operation mode	**Continuous**
	RX/TX Channel	190 or 661
	AGC	14

Following picture should be displayed on an oscilloscope' s screen if the GSM850 receiver is working properly:



Receiver troubleshooting

The phone layout has dedicated test points for the analogue differential RX I and Q signals (RXIINP, RXIINN, RXQINP, RXQINN) from Mjoelner RF ASIC to UEM. The BB part is used to measure those signals by means of RSSI reading. It is assumed that correct calibration of RSSI reading has been carried out in production.

RSSIreading [dBm] $= 20\log(U_{BB}) + AGC_{calibrated}$

Therefore, do not calibrate a defective phone before the phone error has been found.

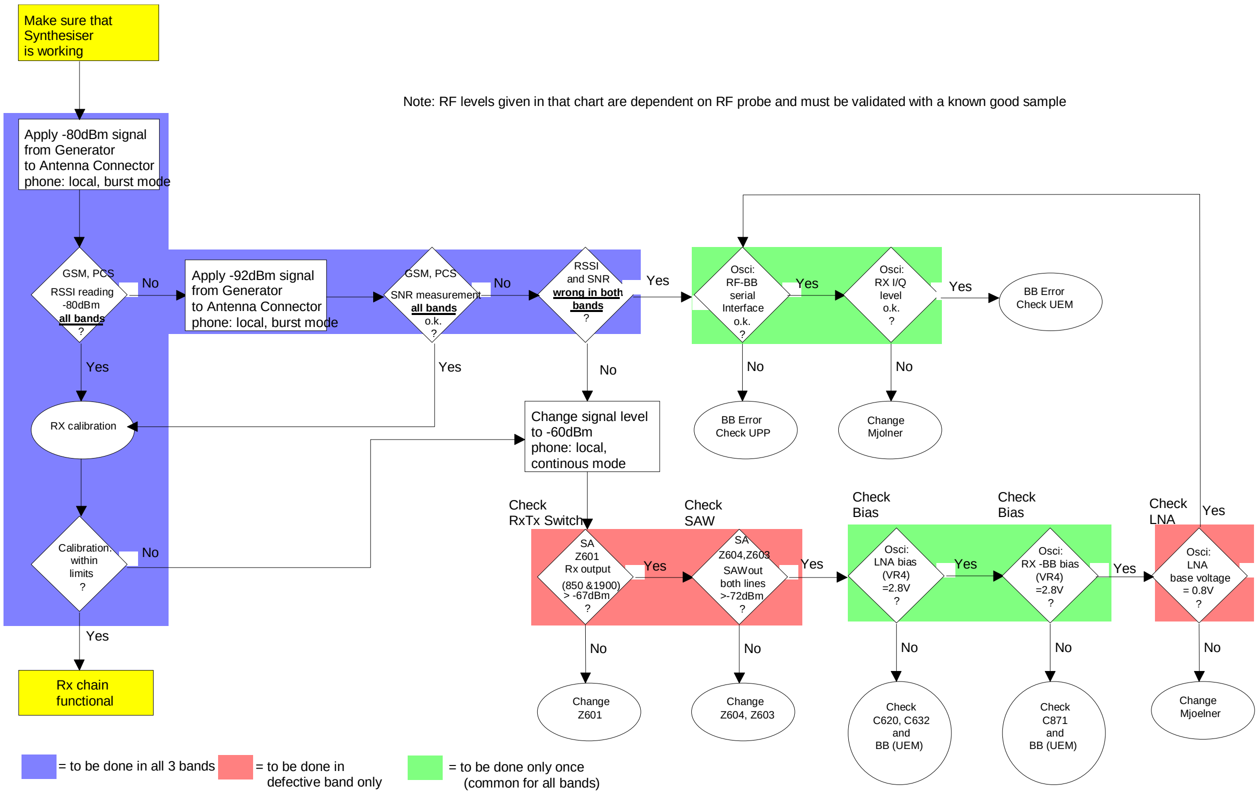
When a defective phone has been calibrated, a possible error in RX front-end might be masked. In that case one can get a reasonable RSSI reading, although the front-end shows excessive losses.

If you are not sure that incorrect re-calibration has been made, the following steps should be done:

1 Check if AGC calibration is within limits.

2 Check if SNR reading is OK.

Use an Oscilloscope to check levels of “RXIINN” and “RXQINN”.

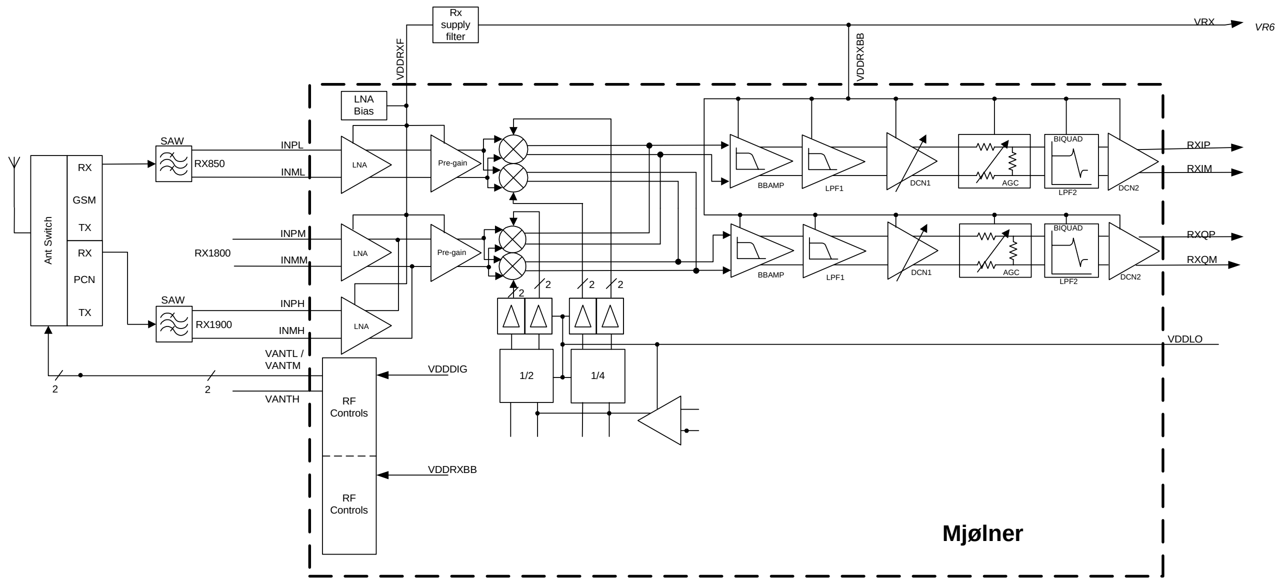


If RX and TX path seem to be faulty it has to be checked if the synthesizer is working. If yes, then check the path from the antenna test pad J800 to the antenna switch Z601 (see RX troubleshooting "Check RXTX switch").

Rx signal paths

The signal paths of the receiver are shown in following block diagram. Note that the diagram shows GSM850 receiver (above) and the GSM1900 receiver (below).

Figure 5: Rx signal paths



Antenna switch (RX/TX Switch)

Signal path of RF: From the antenna-pad (J800) the RF signal is fed through the antenna low pass filter (C743, L610, C748) to the antenna switch (Z601).

The antenna switch has the function of a diplexer which consists of two paths for GSM850 and GSM1900. The GSM850 input signals pass the switch to the GSM_RX output. GSM1900 input signals pass to PCS_RX output. In receive mode both control signals VC1 (VANTL) and VC2 (VANTH) have to be 0 V.

Signal paths:

GSM850: RX1-GSM output of the antenna switch → GSM850 SAW filter (Z604).
GSM1900: RX2-PCS output of the antenna switch → GSM1900 SAW filter (Z603).

The antenna switch including routed lines has following typical insertion losses:

GSM850:	1.3dB
GSM1900:	1.6dB

RX front-end

The RX front-end includes two SAW filters for GSM850 (Z604) and GSM1900 (Z603). They are matched to the corresponding LNA inputs of Mjoelner RF ASIC (N601) with differential matching circuits (LC-type). The SAW filters provide out-of-band blocking immunity. The integrated LNAs provide the front-end gains. Each of the SAW filters has a single-ended input and a balanced output.

The SAW filters have maximum insertion losses of:

GSM850:	3.5dB
GSM1900:	4.0dB

RX paths of Mjoelner RF ASIC

The balanced RX signal is amplified by the integrated LNA and the subsequent pre-gain stage. After amplification the RX signal is down-converted.

The RX paths of Mjoelner RF ASIC consist of following sub units:

Separate LNAs for each of the two bands: GSM850 and GSM1900.
Two PRE-GAIN amplifiers, one for GSM850 and one for GSM1900.
Two passive I/Q mixers (MIX), one for GSM850 and one for GSM1900.

The BB signal paths consist of:

- Baseband amplifiers (BBAMP1). These amplifiers implement the initial channel filtering.
- Low pass filters (LPF1).
- DC compensation / AGC amplifiers (DCN1). These amplifiers implement gain steps from 0dB to 24dB in 6dB steps.
- Attenuators (AGC). They implement gain steps from -48dB to 0dB in 6dB steps, yielding a total gain range of 72dB together with DCN1.
- Bi-quad filters (LPF2).
- DC compensation amplifiers (DCN2).

The differential base band outputs are internally DC-coupled and are connected directly to the ADC inputs of the UEM-ASIC. The common mode level is set equal to the VBEXT reference voltage.

Transmitter

General instructions for TX troubleshooting

Connect an RF cable between the test jig and the measurement equipment (GSM test equipment, power meter, spectrum analyzer, or similar).

Make use of an adequate attenuator at the input of your measurement equipment (10dB to 20dB are recommended for a spectrum analyzer or a power meter). Assure not to overload or destroy the equipment.

Connect the phone to a PC with DAU-9S cable (RS232) and Phoenix dongle PKD-1CS.

Provide the phone with power supply (3.6V).

Start Phoenix Service Software and open FBUS connection:

Select Scan Product Ctrl-R

and wait until phone information is shown in the lower right corner of the screen.

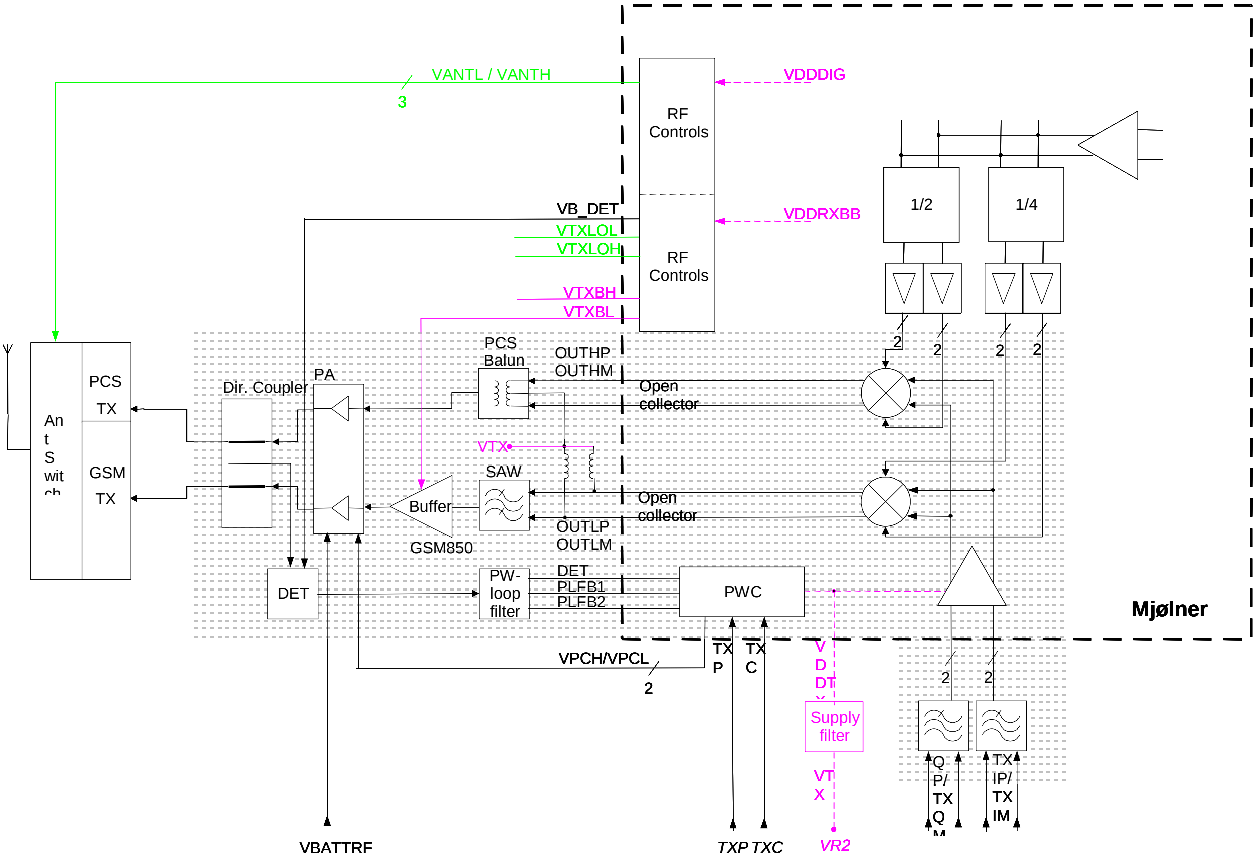
Follow the instructions in the chapters below.

TX signal paths

For easy error tracking it is important to know the signal paths of the transmitter. The components are grouped in blocks and shown in the diagrams below.

Note that the diagram shows both GSM850 transmitter (below) and PCS1900 transmitter (above).

Figure 6: Transmitter signal paths



The balanced TX IQ baseband signals (TXIOUTP, TXIOUTN, TXQOUTP, TXQOUTN) are provided by the baseband and are fed to the **Mjoelner RF ASIC**. The TX path of the Mjoelner RF ASIC includes mainly two RF modulators for up-conversion of the baseband signals, one for GSM850 and one for GSM1900. The baseband signal is up-converted with the LO signal corresponding to the wanted TX channel. Both RF-TX outputs (850MHz and 1900MHz) of the Mjoelner RF ASIC are delivering balanced signals.

The GSM850 output signal of the Mjoelner RF ASIC is fed through the **GSM TX SAW filter** (balanced to single ended) and the **GSM850 MHz buffer** to the GSM input of the **power amplifier (PA).**

The GSM1900 output signal of the Mjoelner RF ASIC is fed through the **TX balun** (T701) (balanced to single ended) and a 2dB pad to the GSM1900 input of the **power amplifier (PA)**.

The Dual Band PA has a maximum output power of approx. 35dBm at 850MHz and 33dBm at 1900MHz. DC-power supply is delivered directly from the battery through an RF choke L850.

The RF output power is controlled by the power control loop. From the output of the PA both signals are fed through a dual directional coupler (one of the power control loop components) to the **antenna switch**.

Antenna switch (TX/RX switch)

The antenna switch operates as a diplexer for the RX and TX signals. Moreover, it suppresses the TX harmonics generated by the PA. The antenna switch is controlled by the Mjoelner RF ASIC using the control signals VC1 and VC2.

The following table shows the possible different states.

Table 1: Logic table for the antenna switching states

VC1 [Volt]	VC2 [Volt]	GSM RX	PCS RX	GSM TX	PCS TX
0	0	X	X		
0	2.7			X	
2.7	0				X

GSM850 transmitter

General instructions for GSM850 TX troubleshooting

Start the preparations as described in chapter General instructions for TX troubleshooting "General instructions for TX troubleshooting".

1 Set operating mode to local mode.

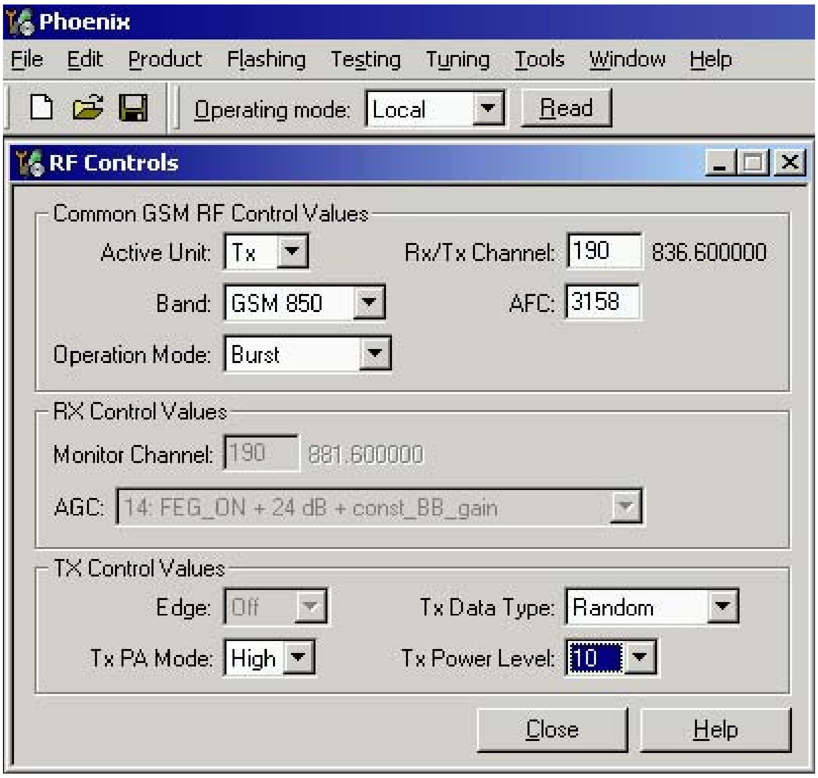
Select	Maintenance Testing	RF Controls

Wait until the RF Controls window pops up.

2 In the RF Controls window:

Select	Band	GSM850
	Active unit	TX
	Operation mode	Burst
	RX/TX Channel	190
	TX Power Level	10
	TX Data Type	Random

The setup should now look like this:



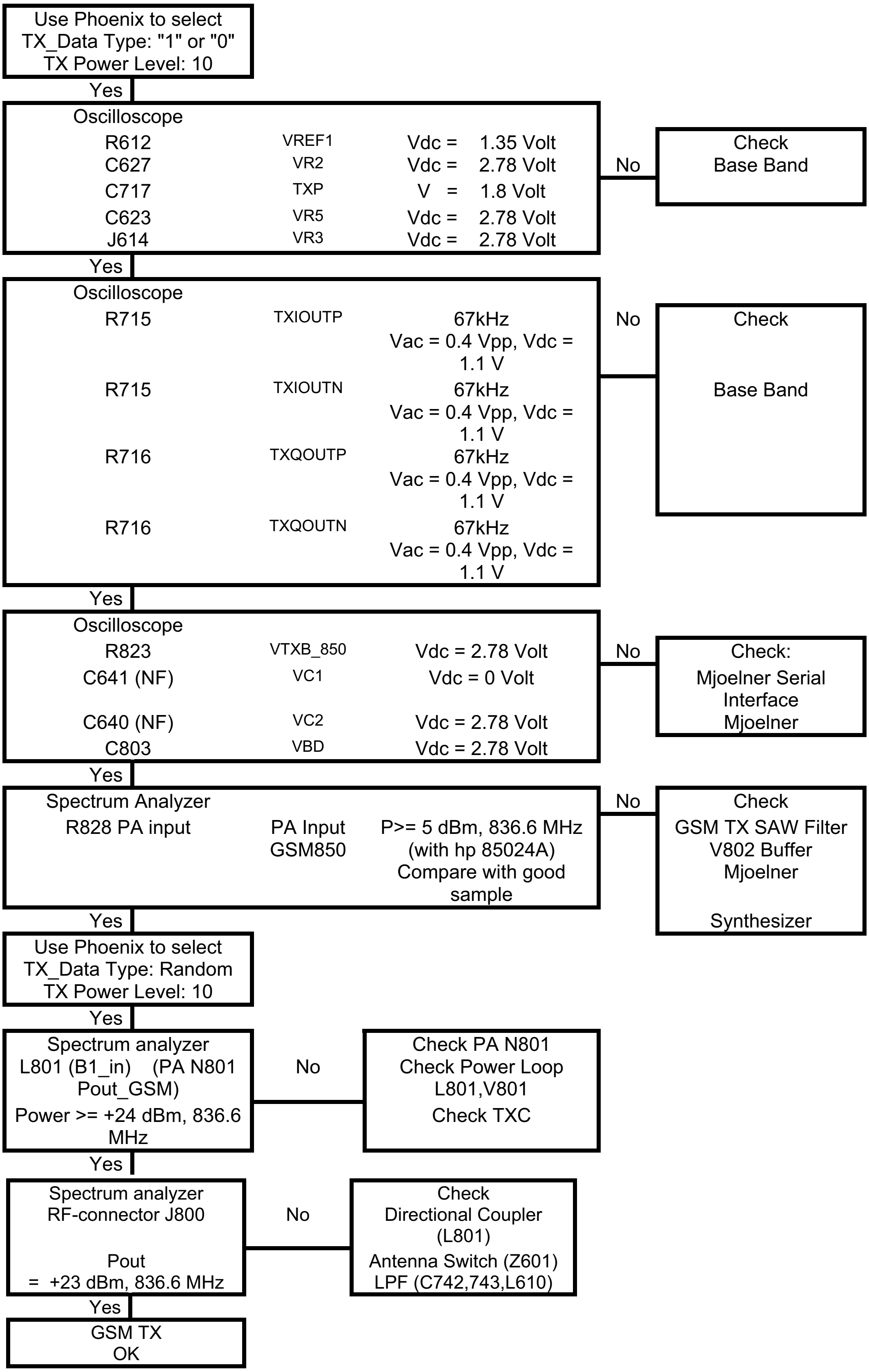
Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +23 ± 1dBm @ 836.6 MHz

If this is not the case, then go to the next chapter for troubleshooting.

Troubleshooting for GSM850 transmitter

In the following troubleshooting chart, the TXP signal is used as a trigger-signal. For this purpose a TXP test point is provided on the PWB, refer to figure *RF test points in the Mjoelner chamber.*


Use Phoenix to select
TX_Data Type: "1" or "0"
TX Power Level: 10
Yes
Oscilloscope
R612 VREF1 Vdc = 1.35 Volt
C627 VR2 Vdc = 2.78 Volt
C717 TXP V = 1.8 Volt
C623 VR5 Vdc = 2.78 Volt
J614 VR3 Vdc = 2.78 Volt
No
Check
Base Band
Yes
Oscilloscope
R715 TXIOUTP 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R715 TXIOUTN 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R716 TXQOUTP 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R716 TXQOUTN 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
No
Check
Base Band
Yes
Oscilloscope
R823 VTXB_850 Vdc = 2.78 Volt
C641 (NF) VC1 Vdc = 0 Volt
C640 (NF) VC2 Vdc = 2.78 Volt
C803 VBD Vdc = 2.78 Volt
No
Check:
Mjoelner Serial Interface
Mjoelner
Yes
Spectrum Analyzer
R828 PA input
PA Input GSM850
P>= 5 dBm, 836.6 MHz (with hp 85024A) Compare with good sample
No
Check
GSM TX SAW Filter
V802 Buffer
Mjoelner
Synthesizer
Yes
Use Phoenix to select
TX_Data Type: Random
TX Power Level: 10
Yes
Spectrum analyzer
L801 (B1_in) (PA N801 Pout_GSM)
Power >= +24 dBm, 836.6 MHz
No
Check PA N801
Check Power Loop
L801,V801
Check TXC
Yes
Spectrum analyzer
RF-connector J800
Pout
= +23 dBm, 836.6 MHz
No
Check
Directional Coupler
(L801)
Antenna Switch (Z601)
LPF (C742,743,L610)
Yes
GSM TX
OK

GSM1900 (PCS) transmitter

General instructions for GSM1900 TX troubleshooting

Start the investigations as described in chapter General instructions for TX troubleshooting "General instructions for TX troubleshooting".

1 Set operating mode to local mode:

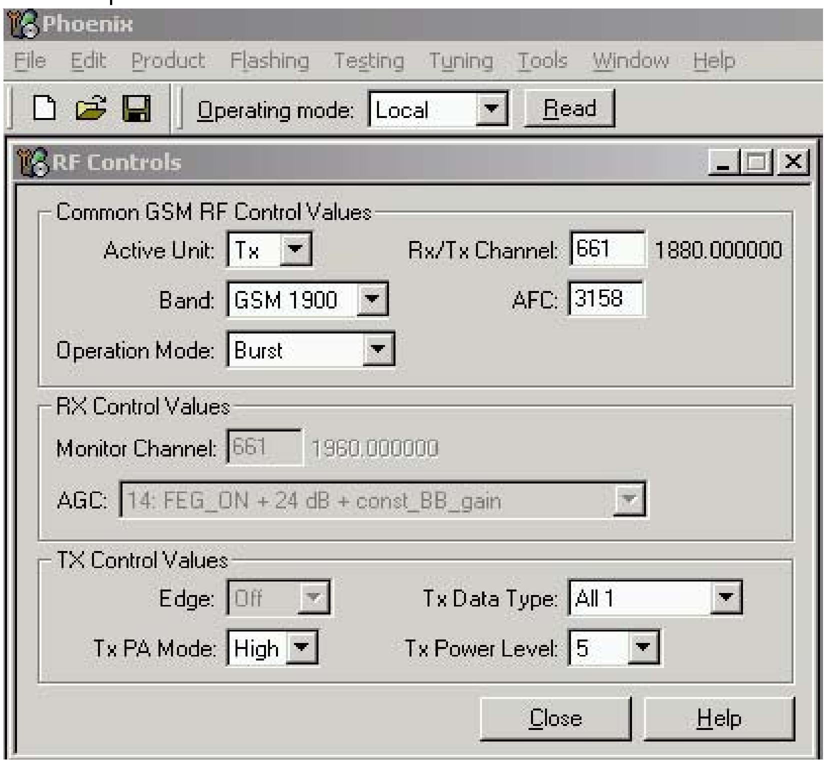
Select	Maintenance Testing	RF Controls

Wait until the RF Controls window pops up.

2 In the RF Controls window:

Select	Band	GSM 1900
	Active unit	TX
	Operation mode	Burst
	RX/TX Channel	661
	TX Power Level	5
	TX Data Type	Random

The setup should now look like this:



Now the measurement equipment should detect the following output signal of the phone:

P_{out} = +20 ± 1dBm @ 1880MHz

If this is not the case, then go to the next chapter for troubleshooting.

Troubleshooting for GSM1900 transmitter

In the following troubleshooting chart, the TXP signal is used as a trigger-signal. For this purpose a TXP test point is provided on the PWB, refer to *RF test points in the Mjoelner chamber*.

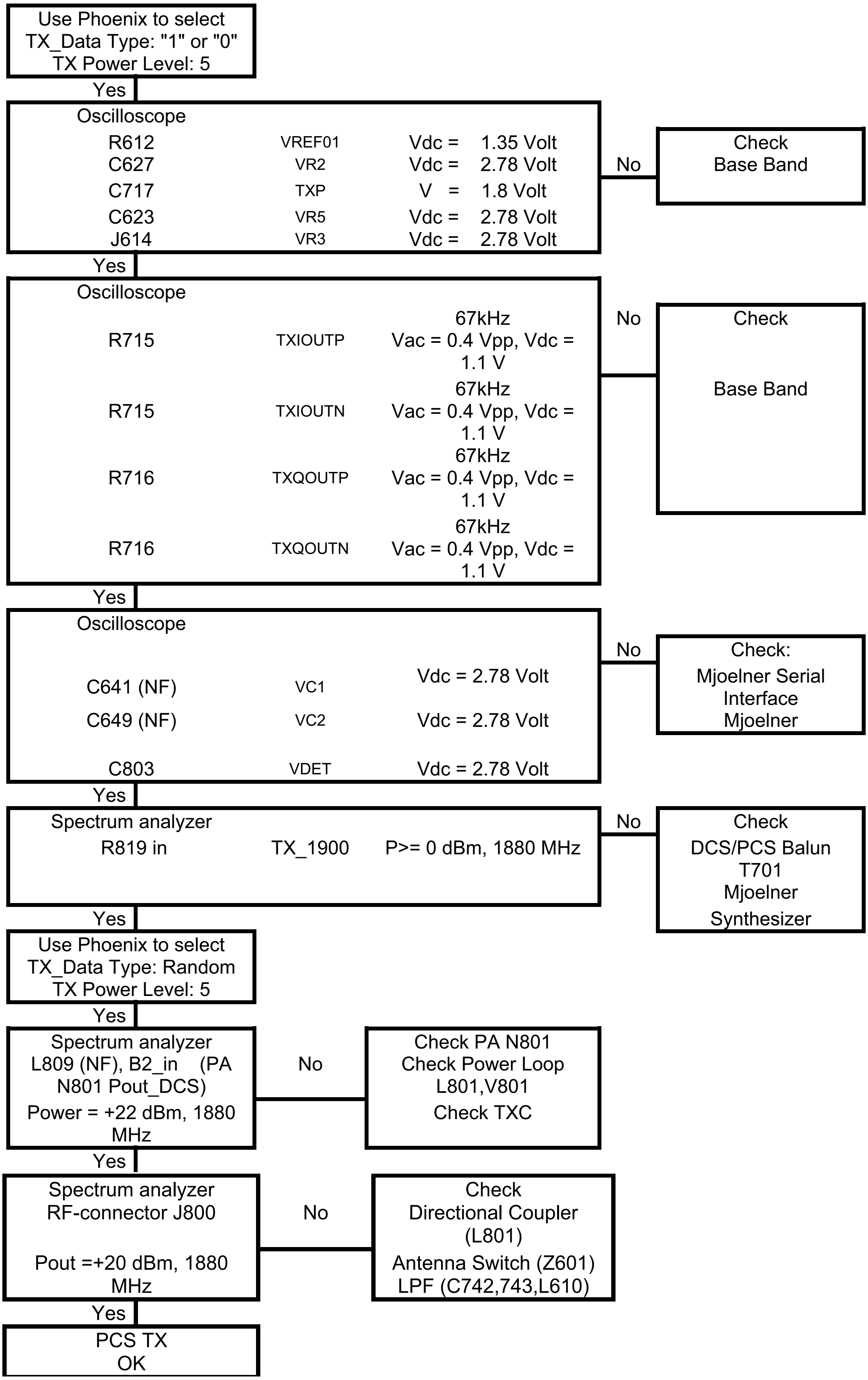
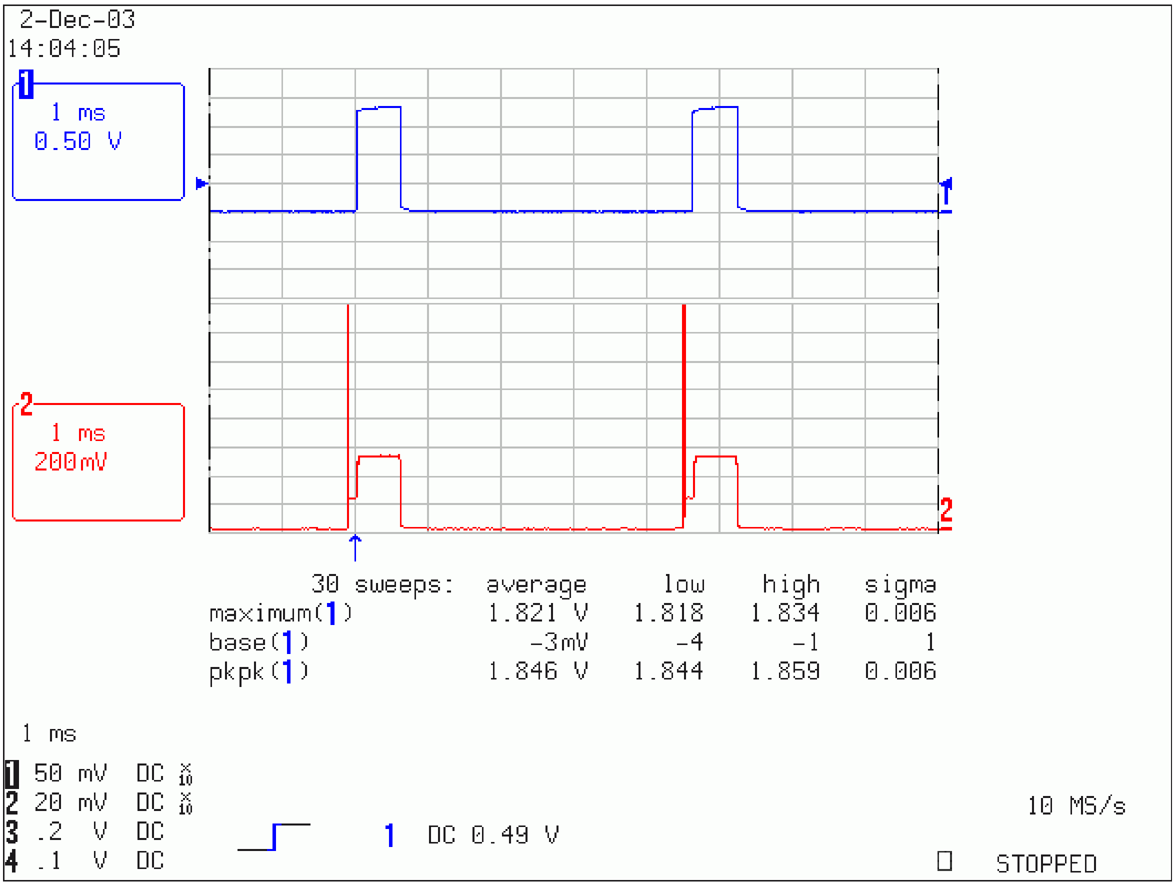

Use Phoenix to select
TX_Data Type: "1" or "0"
TX Power Level: 5
Yes
Oscilloscope
R612 VREF01 Vdc = 1.35 Volt
C627 VR2 Vdc = 2.78 Volt
C717 TXP V = 1.8 Volt
C623 VR5 Vdc = 2.78 Volt
J614 VR3 Vdc = 2.78 Volt
No
Check
Base Band
Yes
Oscilloscope
R715 TXIOUTP 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R715 TXIOUTN 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R716 TXQOUTP 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
R716 TXQOUTN 67kHz Vac = 0.4 Vpp, Vdc = 1.1 V
No
Check
Base Band
Yes
Oscilloscope
C641 (NF) VC1 Vdc = 2.78 Volt
C649 (NF) VC2 Vdc = 2.78 Volt
C803 VDET Vdc = 2.78 Volt
No
Check:
Mjoelner Serial Interface
Mjoelner
Yes
Spectrum analyzer
R819 in TX_1900 P>= 0 dBm, 1880 MHz
No
Check
DCS/PCS Balun
T701
Mjoelner
Synthesizer
Yes
Use Phoenix to select
TX_Data Type: Random
TX Power Level: 5
Yes
Spectrum analyzer
L809 (NF), B2_in (PA N801 Pout_DCS)
Power = +22 dBm, 1880 MHz
No
Check PA N801
Check Power Loop
L801,V801
Check TXC
Yes
Spectrum analyzer
RF-connector J800
Pout =+20 dBm, 1880 MHz
No
Check
Directional Coupler (L801)
Antenna Switch (Z601)
LPF (C742,743,L610)
Yes
PCS TX
OK

Figure 7: Example for TXP and TXC signal waveform (PCS1900 @ PL19)



Synthesizer

One PLL synthesizer is generating all the required frequencies of both bands for Rx and Tx. The VCO frequency is divided by 2 or by 4 in Mjoelner depending on the active band.

General instructions for synthesizer troubleshooting

Connect the phone to a PC with DAU-9S cable (RS232). The PC must have Phoenix Service Software installed and a PKD-1CS dongle is required.

Follow the instructions in the chapters below.

Checking synthesizer operation

1 Start Phoenix Service Software and open FBUS connection:

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower right corner of the screen.

2 Set operating mode to local mode.

3 Start RF Control window:

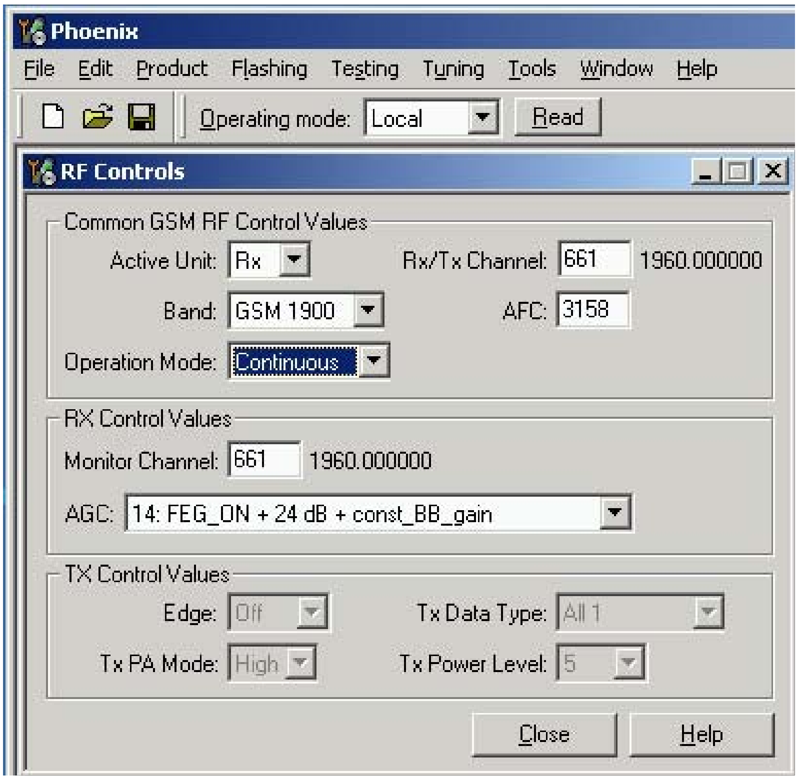
Select	Maintenance	Alt-M
	Tuning	T
	RF Controls	F

Wait until the RF Controls window pops up.

4 Set the synthesizer to the following mode:

Select	Band	PCS1900
	Active unit	RX
	Operation mode	Continuous
	RX/TX Channel	661

The setup should now look like this:



The frequency of 3920MHz at the output of the VCO (G701) has to be measured with an RF probe and a spectrum analyzer.

The tuning voltage can be easily measured at the VC input of the VCO (C712) The tuning voltage should be 3.2 .. 3.4V at f_{VCO} = 3920.0MHz. The tuning sensitivity of the VCO is typically 240MHz/V.

If this is not the case, then go to chapter Troubleshooting for PLL synthesizer.

26 MHz reference oscillator (VCXO)

The VCXO is integrated in the Mjoelner RF-ASIC (N601). The only external component is the 26MHz crystal (B601).

The reference oscillator has two functions:

- Reference frequency for the PLL synthesizer.
- System clock for BB (RFClk = 26 MHz).

For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a VCXO-calibration value is written via the serial Bus into the RefOSCCAL register of Mjoelner and an additional bit in the RefOSCCntl register of the Mjoelner. That is necessary for the rough calibration of the VCXO.

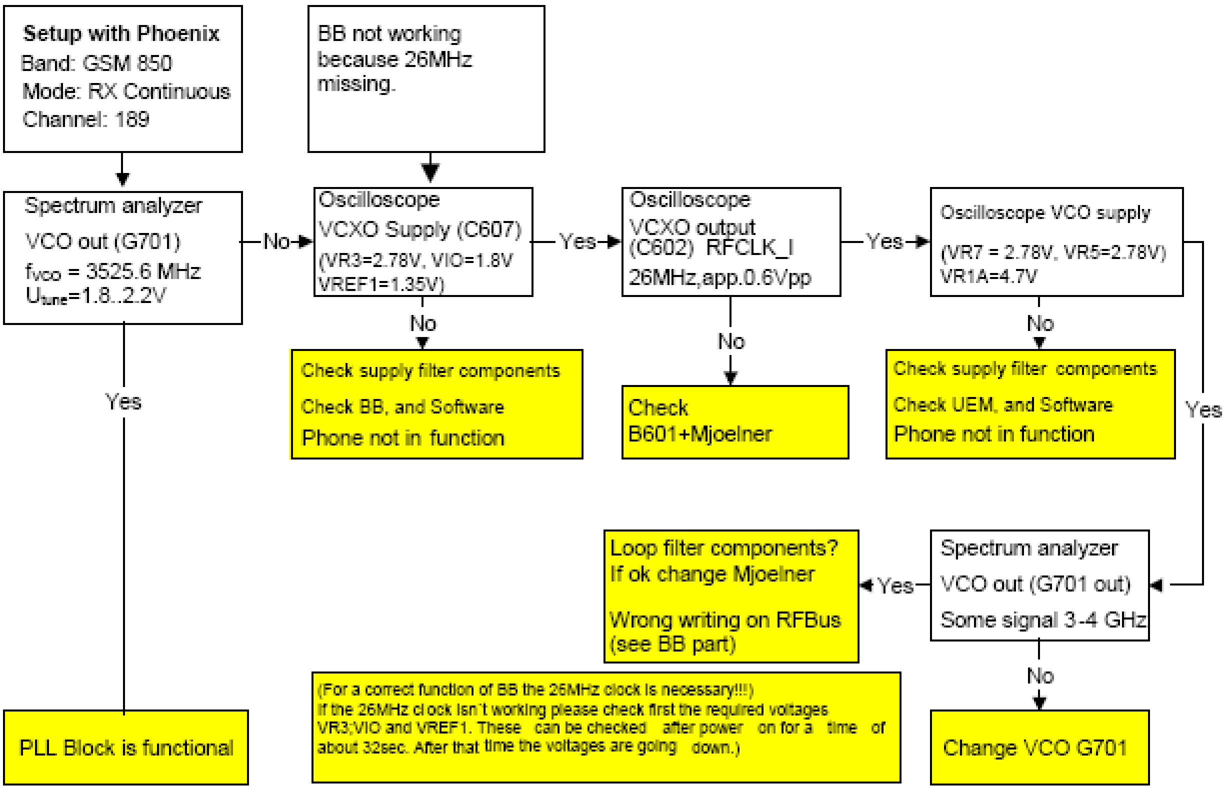
The VCXO is fine tuned by programming the AFC value via the serial bus of Mjoelner. The necessary AFC value is written into the RefOSCAFC register in Mjoelner.

VCO

The VCO is able to generate frequencies in the range of 3296.8 MHz to 3979.6 MHz when the PLL is working properly. The frequency of the VCO signal is divided by 2 or by 4 in Mjoelner RF-ASIC. This allows the generation of all the frequencies in the GSM850 and the GSM1900 bands, both RX and TX.

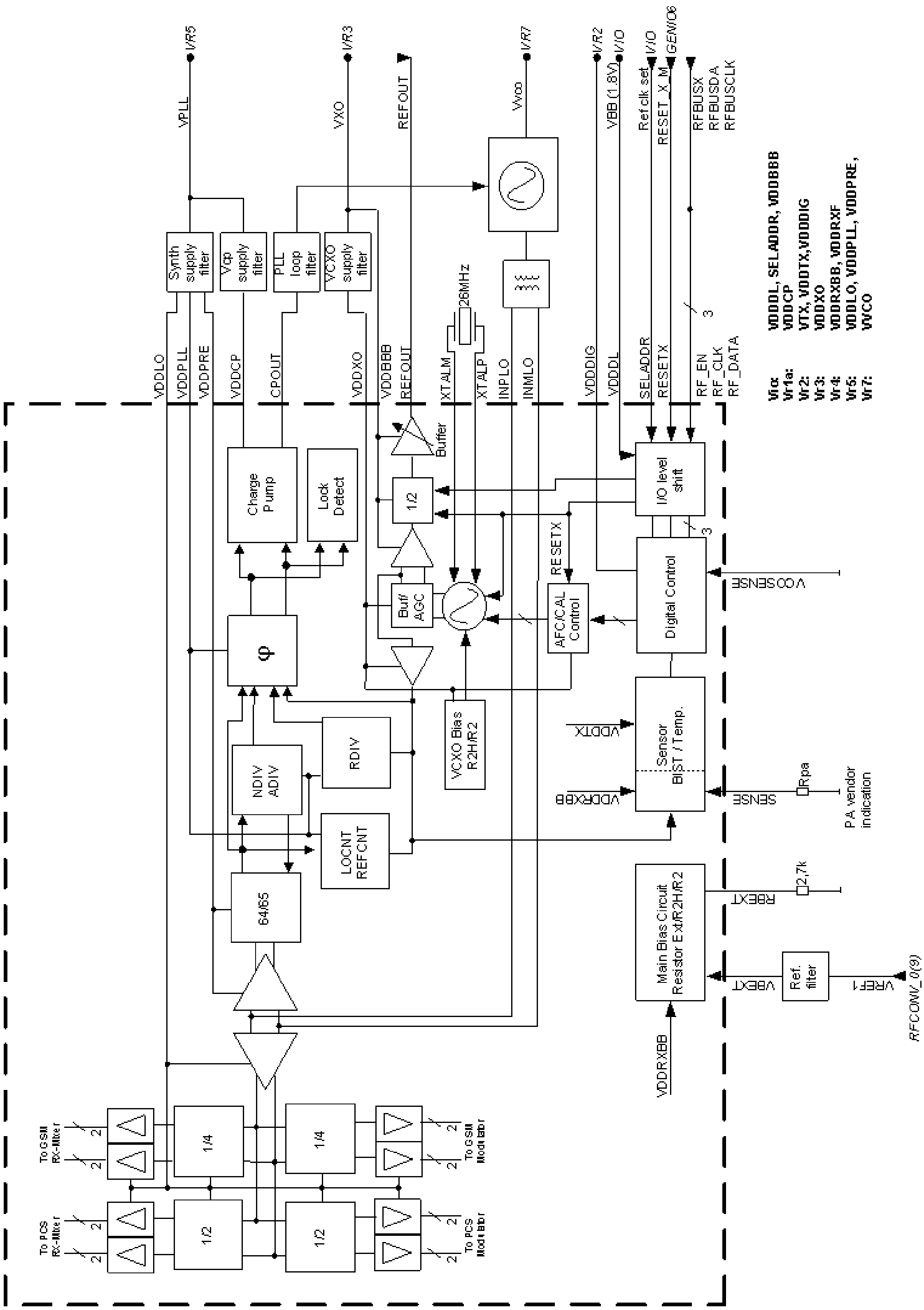
The output frequency of the VCO is controlled by a DC voltage (VC) of the PLL loop filter. The valid range of VC is 0.7V– 3.8V when the PLL is in steady state. The typical tuning sensitivity is 240MHz/V. Even if the PLL is not working properly (VC outside the valid range) a frequency at the output of the VCO can be detected between 3GHz and 4 GHz (if the VCO itself is OK).

Troubleshooting for PLL synthesizer



It is important to note that the power supply of the VCXO (VR3) is only switched off in the so-called 'Deep Sleep Mode' and the power supply of the VCO G701 (VR7) is switched off in so-called 'Sleep Mode'.

Figure 8: PLL block diagram



Frequency lists

GSM850

Channel	TX	RX	TX VCO	RX VCO	Channel	TX	RX	TX VCO	RX VCO
128	824,2	869,2	3296,8	3476,8	190	836,6	881,6	3346,4	3526,4
129	824,4	869,4	3297,6	3477,6	191	836,8	881,8	3347,2	3527,2
130	824,6	869,6	3298,4	3478,4	192	837	882	3348	3528
131	824,8	869,8	3299,2	3479,2	193	837,2	882,2	3348,8	3528,8
132	825	870	3300	3480	194	837,4	882,4	3349,6	3529,6
133	825,2	870,2	3300,8	3480,8	195	837,6	882,6	3350,4	3530,4
134	825,4	870,4	3301,6	3481,6	196	837,8	882,8	3351,2	3531,2
135	825,6	870,6	3302,4	3482,4	197	838	883	3352	3532
136	825,8	870,8	3303,2	3483,2	198	838,2	883,2	3352,8	3532,8
137	826	871	3304	3484	199	838,4	883,4	3353,6	3533,6
138	826,2	871,2	3304,8	3484,8	200	838,6	883,6	3354,4	3534,4
139	826,4	871,4	3305,6	3485,6	201	838,8	883,8	3355,2	3535,2
140	826,6	871,6	3306,4	3486,4	202	839	884	3356	3536
141	826,8	871,8	3307,2	3487,2	203	839,2	884,2	3356,8	3536,8
142	827	872	3308	3488	204	839,4	884,4	3357,6	3537,6
143	827,2	872,2	3308,8	3488,8	205	839,6	884,6	3358,4	3538,4
144	827,4	872,4	3309,6	3489,6	206	839,8	884,8	3359,2	3539,2
145	827,6	872,6	3310,4	3490,4	207	840	885	3360	3540
146	827,8	872,8	3311,2	3491,2	208	840,2	885,2	3360,8	3540,8
147	828	873	3312	3492	209	840,4	885,4	3361,6	3541,6
148	828,2	873,2	3312,8	3492,8	210	840,6	885,6	3362,4	3542,4
149	828,4	873,4	3313,6	3493,6	211	840,8	885,8	3363,2	3543,2
150	828,6	873,6	3314,4	3494,4	212	841	886	3364	3544
151	828,8	873,8	3315,2	3495,2	213	841,2	886,2	3364,8	3544,8
152	829	874	3316	3496	214	841,4	886,4	3365,6	3545,6
153	829,2	874,2	3316,8	3496,8	215	841,6	886,6	3366,4	3546,4
154	829,4	874,4	3317,6	3497,6	216	841,8	886,8	3367,2	3547,2
155	829,6	874,6	3318,4	3498,4	217	842	887	3368	3548
156	829,8	874,8	3319,2	3499,2	218	842,2	887,2	3368,8	3548,8
157	830	875	3320	3500	219	842,4	887,4	3369,6	3549,6
158	830,2	875,2	3320,8	3500,8	220	842,6	887,6	3370,4	3550,4
159	830,4	875,4	3321,6	3501,6	221	842,8	887,8	3371,2	3551,2
160	830,6	875,6	3322,4	3502,4	222	843	888	3372	3552
161	830,8	875,8	3323,2	3503,2	223	843,2	888,2	3372,8	3552,8
162	831	876	3324	3504	224	843,4	888,4	3373,6	3553,6
163	831,2	876,2	3324,8	3504,8	225	843,6	888,6	3374,4	3554,4
164	831,4	876,4	3325,6	3505,6	226	843,8	888,8	3375,2	3555,2
165	831,6	876,6	3326,4	3506,4	227	844	889	3376	3556
166	831,8	876,8	3327,2	3507,2	228	844,2	889,2	3376,8	3556,8
167	832	877	3328	3508	229	844,4	889,4	3377,6	3557,6
168	832,2	877,2	3328,8	3508,8	230	844,6	889,6	3378,4	3558,4
169	832,4	877,4	3329,6	3509,6	231	844,8	889,8	3379,2	3559,2
170	832,6	877,6	3330,4	3510,4	232	845	890	3380	3560
171	832,8	877,8	3331,2	3511,2	233	845,2	890,2	3380,8	3560,8
172	833	878	3332	3512	234	845,4	890,4	3381,6	3561,6
173	833,2	878,2	3332,8	3512,8	235	845,6	890,6	3382,4	3562,4
174	833,4	878,4	3333,6	3513,6	236	845,8	890,8	3383,2	3563,2
175	833,6	878,6	3334,4	3514,4	237	846	891	3384	3564
176	833,8	878,8	3335,2	3515,2	238	846,2	891,2	3384,8	3564,8
177	834	879	3336	3516	239	846,4	891,4	3385,6	3565,6
178	834,2	879,2	3336,8	3516,8	240	846,6	891,6	3386,4	3566,4
179	834,4	879,4	3337,6	3517,6	241	846,8	891,8	3387,2	3567,2
180	834,6	879,6	3338,4	3518,4	242	847	892	3388	3568
181	834,8	879,8	3339,2	3519,2	243	847,2	892,2	3388,8	3568,8
182	835	880	3340	3520	244	847,4	892,4	3389,6	3569,6
183	835,2	880,2	3340,8	3520,8	245	847,6	892,6	3390,4	3570,4
184	835,4	880,4	3341,6	3521,6	246	847,8	892,8	3391,2	3571,2
185	835,6	880,6	3342,4	3522,4	247	848	893	3392	3572
186	835,8	880,8	3343,2	3523,2	248	848,2	893,2	3392,8	3572,8
187	836	881	3344	3524	249	848,4	893,4	3393,6	3573,6
188	836,2	881,2	3344,8	3524,8	250	848,6	893,6	3394,4	3574,4
189	**836,4**	**881,4**	**3345,6**	**3525,6**	251	848,8	893,8	3395,2	3575,2

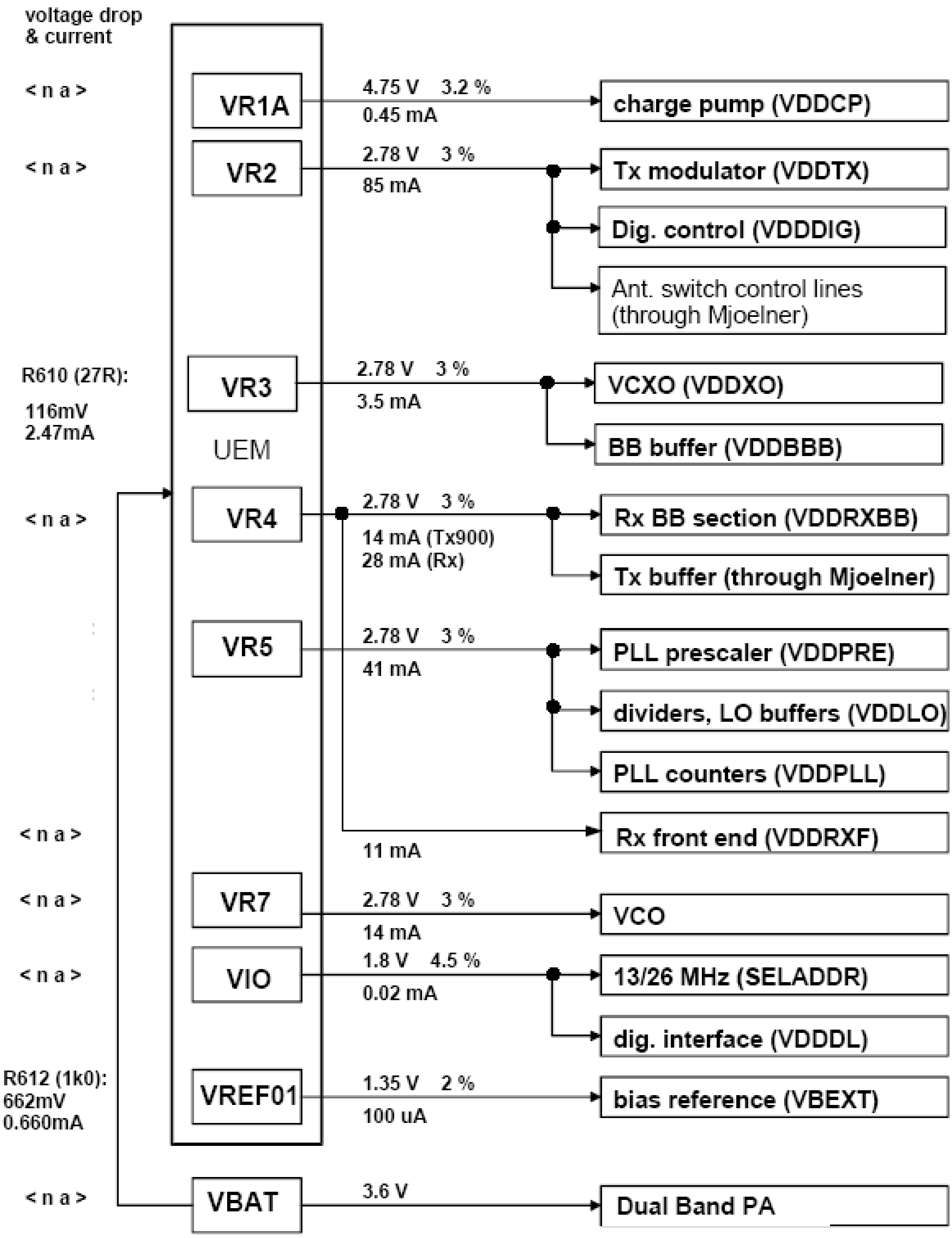
GSM1900

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1850,2	1930,2	3700,4	3860,4	606	1869,0	1949,0	3738,0	3898,0	700	1887,8	1967,8	3775,6	3935,6	794	1906,6	1986,6	3813,2	3973,2
513	1850,4	1930,4	3700,8	3860,8	607	1869,2	1949,2	3738,4	3898,4	701	1888,0	1968,0	3776,0	3936,0	795	1906,8	1986,8	3813,6	3973,6
514	1850,6	1930,6	3701,2	3861,2	608	1869,4	1949,4	3738,8	3898,8	702	1888,2	1968,2	3776,4	3936,4	796	1907,0	1987,0	3814,0	3974,0
515	1850,8	1930,8	3701,6	3861,6	609	1869,6	1949,6	3739,2	3899,2	703	1888,4	1968,4	3776,8	3936,8	797	1907,2	1987,2	3814,4	3974,4
516	1851,0	1931,0	3702,0	3862,0	610	1869,8	1949,8	3739,6	3899,6	704	1888,6	1968,6	3777,2	3937,2	798	1907,4	1987,4	3814,8	3974,8
517	1851,2	1931,2	3702,4	3862,4	611	1870,0	1950,0	3740,0	3900,0	705	1888,8	1968,8	3777,6	3937,6	799	1907,6	1987,6	3815,2	3975,2
518	1851,4	1931,4	3702,8	3862,8	612	1870,2	1950,2	3740,4	3900,4	706	1889,0	1969,0	3778,0	3938,0	800	1907,8	1987,8	3815,6	3975,6
519	1851,6	1931,6	3703,2	3863,2	613	1870,4	1950,4	3740,8	3900,8	707	1889,2	1969,2	3778,4	3938,4	801	1908,0	1988,0	3816,0	3976,0
520	1851,8	1931,8	3703,6	3863,6	614	1870,6	1950,6	3741,2	3901,2	708	1889,4	1969,4	3778,8	3938,8	802	1908,2	1988,2	3816,4	3976,4
521	1852,0	1932,0	3704,0	3864,0	615	1870,8	1950,8	3741,6	3901,6	709	1889,6	1969,6	3779,2	3939,2	803	1908,4	1988,4	3816,8	3976,8
522	1852,2	1932,2	3704,4	3864,4	616	1871,0	1951,0	3742,0	3902,0	710	1889,8	1969,8	3779,6	3939,6	804	1908,6	1988,6	3817,2	3977,2
523	1852,4	1932,4	3704,8	3864,8	617	1871,2	1951,2	3742,4	3902,4	711	1890,0	1970,0	3780,0	3940,0	805	1908,8	1988,8	3817,6	3977,6
524	1852,6	1932,6	3705,2	3865,2	618	1871,4	1951,4	3742,8	3902,8	712	1890,2	1970,2	3780,4	3940,4	806	1909,0	1989,0	3818,0	3978,0
525	1852,8	1932,8	3705,6	3865,6	619	1871,6	1951,6	3743,2	3903,2	713	1890,4	1970,4	3780,8	3940,8	807	1909,2	1989,2	3818,4	3978,4
526	1853,0	1933,0	3706,0	3866,0	620	1871,8	1951,8	3743,6	3903,6	714	1890,6	1970,6	3781,2	3941,2	808	1909,4	1989,4	3818,8	3978,8
527	1853,2	1933,2	3706,4	3866,4	621	1872,0	1952,0	3744,0	3904,0	715	1890,8	1970,8	3781,6	3941,6	809	1909,6	1989,6	3819,2	3979,2
528	1853,4	1933,4	3706,8	3866,8	622	1872,2	1952,2	3744,4	3904,4	716	1891,0	1971,0	3782,0	3942,0	810	1909,8	1989,8	3819,6	3979,6
529	1853,6	1933,6	3707,2	3867,2	623	1872,4	1952,4	3744,8	3904,8	717	1891,2	1971,2	3782,4	3942,4					
530	1853,8	1933,8	3707,6	3867,6	624	1872,6	1952,6	3745,2	3905,2	718	1891,4	1971,4	3782,8	3942,8					
531	1854,0	1934,0	3708,0	3868,0	625	1872,8	1952,8	3745,6	3905,6	719	1891,6	1971,6	3783,2	3943,2					
532	1854,2	1934,2	3708,4	3868,4	626	1873,0	1953,0	3746,0	3906,0	720	1891,8	1971,8	3783,6	3943,6					
533	1854,4	1934,4	3708,8	3868,8	627	1873,2	1953,2	3746,4	3906,4	721	1892,0	1972,0	3784,0	3944,0					
534	1854,6	1934,6	3709,2	3869,2	628	1873,4	1953,4	3746,8	3906,8	722	1892,2	1972,2	3784,4	3944,4					
535	1854,8	1934,8	3709,6	3869,6	629	1873,6	1953,6	3747,2	3907,2	723	1892,4	1972,4	3784,8	3944,8					
536	1855,0	1935,0	3710,0	3870,0	630	1873,8	1953,8	3747,6	3907,6	724	1892,6	1972,6	3785,2	3945,2					
537	1855,2	1935,2	3710,4	3870,4	631	1874,0	1954,0	3748,0	3908,0	725	1892,8	1972,8	3785,6	3945,6					
538	1855,4	1935,4	3710,8	3870,8	632	1874,2	1954,2	3748,4	3908,4	726	1893,0	1973,0	3786,0	3946,0					
539	1855,6	1935,6	3711,2	3871,2	633	1874,4	1954,4	3748,8	3908,8	727	1893,2	1973,2	3786,4	3946,4					
540	1855,8	1935,8	3711,6	3871,6	634	1874,6	1954,6	3749,2	3909,2	728	1893,4	1973,4	3786,8	3946,8					
541	1856,0	1936,0	3712,0	3872,0	635	1874,8	1954,8	3749,6	3909,6	729	1893,6	1973,6	3787,2	3947,2					
542	1856,2	1936,2	3712,4	3872,4	636	1875,0	1955,0	3750,0	3910,0	730	1893,8	1973,8	3787,6	3947,6					
543	1856,4	1936,4	3712,8	3872,8	637	1875,2	1955,2	3750,4	3910,4	731	1894,0	1974,0	3788,0	3948,0					
544	1856,6	1936,6	3713,2	3873,2	638	1875,4	1955,4	3750,8	3910,8	732	1894,2	1974,2	3788,4	3948,4					
545	1856,8	1936,8	3713,6	3873,6	639	1875,6	1955,6	3751,2	3911,2	733	1894,4	1974,4	3788,8	3948,8					
546	1857,0	1937,0	3714,0	3874,0	640	1875,8	1955,8	3751,6	3911,6	734	1894,6	1974,6	3789,2	3949,2					
547	1857,2	1937,2	3714,4	3874,4	641	1876,0	1956,0	3752,0	3912,0	735	1894,8	1974,8	3789,6	3949,6					
548	1857,4	1937,4	3714,8	3874,8	642	1876,2	1956,2	3752,4	3912,4	736	1895,0	1975,0	3790,0	3950,0					
549	1857,6	1937,6	3715,2	3875,2	643	1876,4	1956,4	3752,8	3912,8	737	1895,2	1975,2	3790,4	3950,4					
550	1857,8	1937,8	3715,6	3875,6	644	1876,6	1956,6	3753,2	3913,2	738	1895,4	1975,4	3790,8	3950,8					
551	1858,0	1938,0	3716,0	3876,0	645	1876,8	1956,8	3753,6	3913,6	739	1895,6	1975,6	3791,2	3951,2					
552	1858,2	1938,2	3716,4	3876,4	646	1877,0	1957,0	3754,0	3914,0	740	1895,8	1975,8	3791,6	3951,6					
553	1858,4	1938,4	3716,8	3876,8	647	1877,2	1957,2	3754,4	3914,4	741	1896,0	1976,0	3792,0	3952,0					
554	1858,6	1938,6	3717,2	3877,2	648	1877,4	1957,4	3754,8	3914,8	742	1896,2	1976,2	3792,4	3952,4					
555	1858,8	1938,8	3717,6	3877,6	649	1877,6	1957,6	3755,2	3915,2	743	1896,4	1976,4	3792,8	3952,8					
556	1859,0	1939,0	3718,0	3878,0	650	1877,8	1957,8	3755,6	3915,6	744	1896,6	1976,6	3793,2	3953,2					
557	1859,2	1939,2	3718,4	3878,4	651	1878,0	1958,0	3756,0	3916,0	745	1896,8	1976,8	3793,6	3953,6					
558	1859,4	1939,4	3718,8	3878,8	652	1878,2	1958,2	3756,4	3916,4	746	1897,0	1977,0	3794,0	3954,0					
559	1859,6	1939,6	3719,2	3879,2	653	1878,4	1958,4	3756,8	3916,8	747	1897,2	1977,2	3794,4	3954,4					
560	1859,8	1939,8	3719,6	3879,6	654	1878,6	1958,6	3757,2	3917,2	748	1897,4	1977,4	3794,8	3954,8					
561	1860,0	1940,0	3720,0	3880,0	655	1878,8	1958,8	3757,6	3917,6	749	1897,6	1977,6	3795,2	3955,2					
562	1860,2	1940,2	3720,4	3880,4	656	1879,0	1959,0	3758,0	3918,0	750	1897,8	1977,8	3795,6	3955,6					
563	1860,4	1940,4	3720,8	3880,8	657	1879,2	1959,2	3758,4	3918,4	751	1898,0	1978,0	3796,0	3956,0					
564	1860,6	1940,6	3721,2	3881,2	658	1879,4	1959,4	3758,8	3918,8	752	1898,2	1978,2	3796,4	3956,4					
565	1860,8	1940,8	3721,6	3881,6	659	1879,6	1959,6	3759,2	3919,2	753	1898,4	1978,4	3796,8	3956,8					
566	1861,0	1941,0	3722,0	3882,0	660	1879,8	1959,8	3759,6	3919,6	754	1898,6	1978,6	3797,2	3957,2					
567	1861,2	1941,2	3722,4	3882,4	661	1880,0	1960,0	3760,0	3920,0	755	1898,8	1978,8	3797,6	3957,6					
568	1861,4	1941,4	3722,8	3882,8	662	1880,2	1960,2	3760,4	3920,4	756	1899,0	1979,0	3798,0	3958,0					
569	1861,6	1941,6	3723,2	3883,2	663	1880,4	1960,4	3760,8	3920,8	757	1899,2	1979,2	3798,4	3958,4					
570	1861,8	1941,8	3723,6	3883,6	664	1880,6	1960,6	3761,2	3921,2	758	1899,4	1979,4	3798,8	3958,8					

570	1861,8	1941,8	3723,6	3883,6	664	1880,6	1960,6	3761,2	3921,2	758	1899,4	1979,4	3798,8	3958,8				
571	1862,0	1942,0	3724,0	3884,0	665	1880,8	1960,8	3761,6	3921,6	759	1899,6	1979,6	3799,2	3959,2				
572	1862,2	1942,2	3724,4	3884,4	666	1881,0	1961,0	3762,0	3922,0	760	1899,8	1979,8	3799,6	3959,6				
573	1862,4	1942,4	3724,8	3884,8	667	1881,2	1961,2	3762,4	3922,4	761	1900,0	1980,0	3800,0	3960,0				
574	1862,6	1942,6	3725,2	3885,2	668	1881,4	1961,4	3762,8	3922,8	762	1900,2	1980,2	3800,4	3960,4				
575	1862,8	1942,8	3725,6	3885,6	669	1881,6	1961,6	3763,2	3923,2	763	1900,4	1980,4	3800,8	3960,8				
576	1863,0	1943,0	3726,0	3886,0	670	1881,8	1961,8	3763,6	3923,6	764	1900,6	1980,6	3801,2	3961,2				
577	1863,2	1943,2	3726,4	3886,4	671	1882,0	1962,0	3764,0	3924,0	765	1900,8	1980,8	3801,6	3961,6				
578	1863,4	1943,4	3726,8	3886,8	672	1882,2	1962,2	3764,4	3924,4	766	1901,0	1981,0	3802,0	3962,0				
579	1863,6	1943,6	3727,2	3887,2	673	1882,4	1962,4	3764,8	3924,8	767	1901,2	1981,2	3802,4	3962,4				
580	1863,8	1943,8	3727,6	3887,6	674	1882,6	1962,6	3765,2	3925,2	768	1901,4	1981,4	3802,8	3962,8				
581	1864,0	1944,0	3728,0	3888,0	675	1882,8	1962,8	3765,6	3925,6	769	1901,6	1981,6	3803,2	3963,2				
582	1864,2	1944,2	3728,4	3888,4	676	1883,0	1963,0	3766,0	3926,0	770	1901,8	1981,8	3803,6	3963,6				
583	1864,4	1944,4	3728,8	3888,8	677	1883,2	1963,2	3766,4	3926,4	771	1902,0	1982,0	3804,0	3964,0				
584	1864,6	1944,6	3729,2	3889,2	678	1883,4	1963,4	3766,8	3926,8	772	1902,2	1982,2	3804,4	3964,4				
585	1864,8	1944,8	3729,6	3889,6	679	1883,6	1963,6	3767,2	3927,2	773	1902,4	1982,4	3804,8	3964,8				
586	1865,0	1945,0	3730,0	3890,0	680	1883,8	1963,8	3767,6	3927,6	774	1902,6	1982,6	3805,2	3965,2				
587	1865,2	1945,2	3730,4	3890,4	681	1884,0	1964,0	3768,0	3928,0	775	1902,8	1982,8	3805,6	3965,6				
588	1865,4	1945,4	3730,8	3890,8	682	1884,2	1964,2	3768,4	3928,4	776	1903,0	1983,0	3806,0	3966,0				
589	1865,6	1945,6	3731,2	3891,2	683	1884,4	1964,4	3768,8	3928,8	777	1903,2	1983,2	3806,4	3966,4				
590	1865,8	1945,8	3731,6	3891,6	684	1884,6	1964,6	3769,2	3929,2	778	1903,4	1983,4	3806,8	3966,8				
591	1866,0	1946,0	3732,0	3892,0	685	1884,8	1964,8	3769,6	3929,6	779	1903,6	1983,6	3807,2	3967,2				
592	1866,2	1946,2	3732,4	3892,4	686	1885,0	1965,0	3770,0	3930,0	780	1903,8	1983,8	3807,6	3967,6				
593	1866,4	1946,4	3732,8	3892,8	687	1885,2	1965,2	3770,4	3930,4	781	1904,0	1984,0	3808,0	3968,0				
594	1866,6	1946,6	3733,2	3893,2	688	1885,4	1965,4	3770,8	3930,8	782	1904,2	1984,2	3808,4	3968,4				
595	1866,8	1946,8	3733,6	3893,6	689	1885,6	1965,6	3771,2	3931,2	783	1904,4	1984,4	3808,8	3968,8				
596	1867,0	1947,0	3734,0	3894,0	690	1885,8	1965,8	3771,6	3931,6	784	1904,6	1984,6	3809,2	3969,2				
597	1867,2	1947,2	3734,4	3894,4	691	1886,0	1966,0	3772,0	3932,0	785	1904,8	1984,8	3809,6	3969,6				
598	1867,4	1947,4	3734,8	3894,8	692	1886,2	1966,2	3772,4	3932,4	786	1905,0	1985,0	3810,0	3970,0				
599	1867,6	1947,6	3735,2	3895,2	693	1886,4	1966,4	3772,8	3932,8	787	1905,2	1985,2	3810,4	3970,4				
600	1867,8	1947,8	3735,6	3895,6	694	1886,6	1966,6	3773,2	3933,2	788	1905,4	1985,4	3810,8	3970,8				
601	1868,0	1948,0	3736,0	3896,0	695	1886,8	1966,8	3773,6	3933,6	789	1905,6	1985,6	3811,2	3971,2				
602	1868,2	1948,2	3736,4	3896,4	696	1887,0	1967,0	3774,0	3934,0	790	1905,8	1985,8	3811,6	3971,6				
603	1868,4	1948,4	3736,8	3896,8	697	1887,2	1967,2	3774,4	3934,4	791	1906,0	1986,0	3812,0	3972,0				
604	1868,6	1948,6	3737,2	3897,2	698	1887,4	1967,4	3774,8	3934,8	792	1906,2	1986,2	3812,4	3972,4				
605	1868,8	1948,8	3737,6	3897,6	699	1887,6	1967,6	3775,2	3935,2	793	1906,4	1986,4	3812,8	3972,8				

DC Supply Current Check

For a quick check of DC power supplies refer to the diagram below. Voltage drops are measured at the respective resistors pads. Note, that not all currents can be checked in such a way, see the marking <na> (not applicable) in the diagram.



Phoenix Tunings after Repairs

The following tunings have to be performed after repairs:

- Repairs in the TX part require "TX Power Level Tuning".
- When component replacements around the modulator area (RF path from UEM via RF ASIC to RF PA) have been done, "TX IQ Tuning" is additionally required.
- In RX general repairs, front-end always require "RX Calibration" and “Rx Band Filter Calibration” for all three bands.
- Repairs in the PLL circuit always require "RX Calibration" of the low band.
- If the RF ASIC is replaced, all calibrations mentioned above have to be done.

Refer to Chapter 3, Service Software Instructions, for instructions on the above-mentioned tunings.

APPENDIX A: FLALI Test Cases with Hints for Repair

testplan
aquarius_335
(Flali)

Step Nr.	Sequence Name	Step Name	Low Limits	High Limits	Unit	RF Tests	Repair Comment
1	MainSequence	Copyright * 2002 Nokia Mobile Phones	Label				
2		Set Flash_Enable flag	State-ment				
3		Flash_Detect	Action				
4		Check_Flash_Enable_Flag	Action				
5		Flash_Program	Action				
6		Start_Phone_After_Flash	Action				
7		Check_Start_Phone_Result	0	4	Num		
8		Measure_Local_Mode_Current	40	100	mA		
9		Read_BSI_ADC_Value	0	50	ADC		
10		Write_Production_Info	Action				
11		Read_PCI_Version	0	5	ADC		
12		Write_Product_Profile	Action				
13	Seq_Calibrate_ADC	Calibrate_ADC	Action				
14		Check_VBATGScalV	10000	11000	ADC		
15		Check_VBATOffScal	2400	2600	ADC		
16		Check_BSICalGain	860	1180	ADC		
17		Check_BTEMPValue	200	450	ADC		
18		Check_VCXOTEMPValue	200	450	ADC		
19		Check_ADCCalGain	26000	29500	ADC		
20		Check_ADCCalVOff	-50	50	ADC		
21	MainSequence	Check_MCU_SW_Version	0	50	Ver		
22		Select_PCI_Layer	Action				
23		Check_RFIC	String Val-ueTest				
24		Set_Zocus_Cal_Current	Action				
73		Tune_Channel_Select_Filter	1	63	ADC	x	Check RXIQ Signals

74		Check_Channel_Select_Filter_VIPP	8000	20000	ADC	x	most likely cause is defect N601 Mjölner
75		Check_Channel_Select_Filter_VQPP	1700	4000	ADC	x	also check all supply voltages to N601 Mjölner and check RFDATABus functionality
25	Seq_Tuning_GSM850_Rx	Tuning_GSM850_Rx	Action			x	
29		Check_GSM850_RSSI_3	75	85	ADC	x	Check GSM850 RX path (Z601, Z604 etc.) Heat solder joints. If RSSI 6-10 dB too low, change Z604.
32		Check_GSM850_RSSI_6	97	107	ADC	x	If no signal, check RX path up to RXIQ interface. If RXIQ not ok, check N601, If RXIQ ok, check BB
35		Check_VCXO_Value	128	767	ADC	x	
36		Check_AFC_Value	3062	3262	ADC	x	VCXO/AFC calibration can only be done when GSM850 RX Tuning was successful
37		Check_AFC_Coeff_0	1500	3500	ADC	x	If calibration fails at all, check RFBUS Signals to N601
38		Check_AFC_Coeff_1	-700	-300	ADC	x	Check voltage supplies VDDXO @ C607 (2.7V), VDDBBB @ C628 (1.8V), VBEXT @ C615 (1.35V)
39		Check_AFC_Coeff_2	0	1	ADC	x	If voltages are ok, the crystal B601 or N601 (Mjölner) can be defective
40		Check AFC alignment criteria	1	1		x	
41	Seq_Tuning_GSM1900Rx	Tuning_GSM1900_Rx	Action			x	Check GSM1900 RX path (Z601, Z603). Heat solder joints. If RSSI is 6-10dB too low, change Z603
45		Check_GSM1900_RSSI_3	73	83	ADC	x	If no signal, check RX path up to RXIQ interface. If RXIQ not ok, check N601, If RXIQ ok, check BB

48		Check_GSM1900_RSSI_6	94	104	ADC	x	
51	MainSequence	Zocus_Calibration	0	255	ADC		
52		Check_Zocus_Cal_Current	-503	-497	mA		
53	Seq_Calibrate_GSM850_Rx_Filter	Calibrate_GSM850_Rx_Filter	Action			x	If one of the steps 54-62 fails, change RX850 SAW Z604
54		Check_GSM850_Rx_Filter_First	-6	2	dB	x	Also consider the RF calibration of the FLALI
55		Check_GSM850_Rx_Filter_N1	-3	1	dB	x	
56		Check_GSM850_Rx_Filter_N2	-3	1	dB	x	
57		Check_GSM850_Rx_Filter_N3	-3	1	dB	x	
58		Check_GSM850_Rx_Filter_N4	-2	1	dB	x	
59		Check_GSM850_Rx_Filter_N5	-3	1	dB	x	
60		Check_GSM850_Rx_Filter_N6	-3	1	dB	x	
61		Check_GSM850_Rx_Filter_N7	-3	1	dB	x	
62		Check_GSM850_Rx_Filter_N8	-6	2	dB	x	
63	Seq_Calibrate_GSM1900_Rx_Filter	Calibrate_GSM1900_Rx_Filter	Action			x	If one of the steps 64-72 fails, change RX1900 SAW Z603
64		Check_GSM1900_Rx_Filter_First	-6	2	dB	x	Also consider the RF calibration of the FLALI
65		Check_GSM1900_Rx_Filter_N1	-3	1	dB	x	
66		Check_GSM1900_Rx_Filter_N2	-3	1	dB	x	
67		Check_GSM1900_Rx_Filter_N3	-2	2	dB	x	
68		Check_GSM1900_Rx_Filter_N4	-2	1	dB	x	
69		Check_GSM1900_Rx_Filter_N5	-2	2	dB	x	

70		Check_GSM1900_Rx_Filter_N6	-3	1	dB	x	
71		Check_GSM1900_Rx_Filter_N7	-3	1	dB	x	
72		Check_GSM1900_Rx_Filter_N8	-6	2	dB	x	
76	Seq_Tune_GSM850_Tx_Power	Set_SA_GSM850_Base_level_Tuning	Action			x	If one of the steps 77-98 fails check the TX850 path from modulator
77		Tune_GSM850_Base_Level	-35	-25	dBm	x	output to the antenna. This includes the following groups:
78		Check_GSM850_Base_Level_Coef	0,1	0,2	ADC	x	850 Modulator output and TX850 SAW
79		Set_SA_GSM850_Tx_Power_Tuning	Action			x	Buffer circuit
80		Measure_GSM850_Tuning_Samples	Action			x	PA circuit
81		Tune_GSM850_Tx_Power	Action			x	Power control loop and Antenna switch
82		Check_GSM850_Tx_Coeff5	0,5	0,7	ADC	x	
83	Seq_Measure_GSM850_Tx_Levels	Measure_GSM850_MID_Ch_Levels	Action			x	
84		Check_GSM850_MID_Ch_Tx_Lev5	31,5	33	dBm	x	
98		Check_GSM850_MID_Ch_Tx_Lev19	2	8	dBm	x	
99	Seq_Tune_GSM1900_Tx_Power	Set_SA_GSM1900_Base_level_Tuning	Action			x	If one of the steps 100 - 122 fails check the TX1900 path from modulator
100		Tune_GSM1900_Base_Level	-35	-25	dBm	x	output to the antenna. This includes the following groups:
101		Check_GSM1900_Base_Level_Coef	0,1	0,2	ADC	x	1900 Modulator and 1900 TX Balun
102		Set_SA_GSM1900_Tx_Power_Tuning	Action			x	PA circuit
103		Measure_GSM1900_Tuning_Samples	Action			x	Power control loop and Antenna switch
104		Tune_GSM1900_Tx_Power	Action			x	

105		Check_GSM1900_Tx_Coeff0	0,75	1,0	ADC	x	
106	Seq_Measure_GSM1900_Tx_Levels	Measure_GSM1900_MID_Ch_Levels	Action			x	
107		Check_GSM1900_MID_Ch_Tx_Lev0	28,5	30,50	dBm	x	
122		Check_GSM1900_MID_Ch_Tx_Lev15	-3	3	dBm	x	
123	Seq_Tune_GSM850_Tx_IQ	Set_SA_GSM850_TX_IQ_Tuning	Action			x	Check TX850 path around the modulator (L706,L707,L708, R725, R726, R732,R733, Z701)
124		Tune_GSM850_I_DC_Offset	-6	6	mV	x	
125		Tune_GSM850_Q_DC_Offset	-6	6	mV	x	Check TXIQ Signals with oscilloscope (TXIOUTP, TXIOUTN, TXQOUTP, TXQOUTN)
126		Tune_GSM850_I_DC_Offset_2	-6	6	mV	x	
127		Tune_GSM850_Q_DC_Offset_2	-6	6	mV	x	Check TX850 SAW filter Z604 and Buffer Transistor V802
128		Tune_GSM850_IQ_Phase_Difference	70	110	deg	x	
129		Tune_GSM850_IQ_Amplitude_Difference	-1,2	1,2	mV	x	Maybe Mjölner N601 must be replaced
130		Tune_GSM850_IQ_Phase_Difference_2	70	110	deg	x	
131		Measure_GSM850_TX_IQ	Action			x	
132		Check_GSM850_TX_IQ_f0	-120	-35	dBc	x	
133		Check_GSM850_TX_IQ_f0_+67710	-120	-40	dBc	x	
134	Seq_Tune_GSM1900_Tx_ IQ	Set_SA_1900_TX_IQ_Tuning	Action			x	Check TX1900 path aroung the modulator (L705, C734, C735, T701, L712, C721, C722)
135		Tune_GSM1900_I_DC_Offset	-6	6	mV	x	

136		Tune_GSM1900_Q_DC_Offset	-6	6	mV	x	Check TXIQ Signals with ocilloscope (TXIOUTP, TXIOUTN, TXQOUTP, TXQOUTN)
137		Tune_GSM1900_I_DC_Offset_2	-6	6	mV	x	
138		Tune_GSM1900_Q_DC_Offset_2	-6	6	mV	x	Check TX Balun T701
139		Tune_GSM1900_IQ_Phase_Difference	70	110	deg	x	
140		Tune_GSM1900_IQ_Amplitude_Difference	-1,2	1,2	mV	x	Maybe Mjölner N601 must be replaced
141		Tune_GSM1900_IQ_Phase_Difference_2	70	110	deg	x	
142		Measure_GSM1900_TX_IQ	Action			x	
143		Check_GSM1900_TX_IQ_f0	-120	-35	dBc	x	
144		Check_GSM1900_TX_IQ_f0_+67710	-120	-40	dBc	x	
145	MainSequence	MMC_test	0	0			
146		Selftest_A	0	0			
149		Measure_GSM850_Tx_On_Current	1,3	2,1	A		
150		Measure_GSM1900_Tx_On_Current	0,8	1,5	A		

APPENDIX B: FINUI Test Cases with Hints for Repair

Table 2:

testplan aquarius_440 (FinUI)

Step Nr.	Sequence Name	Step Name	Low Limits	High Limits	Unit	RF Test	Repair comment
1	MainSequence	Copyright * 2004 Nokia Mobile Phones	Label				
2		Keypad_Start_Test	0	10			
3		Calibration Initialize	PassFailTest				
4		Check Battery Voltage	0	1023	ADC		
5		Testmode Current Meas	35	150	mA		
6		Set Voltage (3V6)	0	10	-		
7		Initialize Keithley 2015	PassFailTest				
8		Charge Volt &Curr	-0,6	-0,1	A		
9		Charge Volts ADC	57000	63000	ADC		
10		Charge Current ADC	3600	5000	ADC		
11		Check Headset Detect	17	17	-		
12		Check Sim Card Inserted	PassFailTest				
13		Meas Vibra Current	45	120	mA		
14		Check Keypad func	1	1	rpt		
15		Audio Robot Move To MIC	0	10	-		
16		Measure XEAR->MIC @1kHz	-6	6			
17		Move robot On the Earp	-0,5	0,5	-		
18		Measure EAR->XMIC @1kHz	-6	6	dB		
19		Move robot Home	-0,5	0,5	-		

20		Measure IHF->XMIC @800Hz	-6	6	dB		
21		Vision: Load group Aquarius	Action				
22		Vision: Start LED test	Action				
23		Vision: Check LED test	1	1			
24		Vision: Start LED_OFF test	Action				
25		Vision: Check LED_OFF test	1	1			
26		Vision: Start PATTERN 'M' test	Action				
27		Vision: Check PATTERN 'M' test	1	1			
28		Vision: Start LCD_OFF	Action				
29		Vision: Check LCD_OFF	1	1			
30		Stop Vision test in phone	Action				
31		BlueTooth BER Test	-0,1	0,1			
32		Initialize PCI	PassFailTest				
33		PrePare Call for GSM850	Action			X	
34		SetFast-ServeChannel GSM850	PassFailTest			X	
35		WaitForService MS GSM850	0	40	sec	X	
36		MS Originated Call Test GSM850	PassFailTest			X	
37	GSM850 High	Handoff to GSM850 C=H TxL=5	0	5	sec	X	
38		Meas GSM850 All C=H TxL=5	0	1000	sec	X	
39		GSM850 POWER BURST C=H TxL=5	31	35	dBm	X	

40		GSM850 BURST t=1 C=H TxL=5	-110	-30	dB	X	Burst template failure: Check Detector Diode V801 and Loop
41		GSM850 BURST t=2 C=H TxL=5	-70	-6	dB	X	components: C804, R802, C805, R801, C803.
42		GSM850 BURST t=4 C=H TxL=5	-1	1	dB	X	also consider components near Mjölner: R708,R707, R706,
43		GSM850 BURST t=9 C=H TxL=5	-1	1	dB	X	C706 or C831.
44		GSM850 BURST t=11 C=H TxL=5	-70	-6	dB	X	
45		GSM850 BURST t=12 C=H TxL=5	-90	-30	dB	X	
46		GSM850 FREQ ERR PEAK C=H TxL=5	-90	90	Hz	X	Check shielding and antenna connection
47		GSM850 PHASE ERR RMS C=H TxL=5	0	5	deg	X	Check the following capacitors for correct soldering:
48		GSM850 PHASE ERR PEAK C=H TxL=5	0	20	deg	X	C610, C740, C741, C626, C710, C711, C712
49		GSM850 Ramping Spectra +400Khz C=H TxL=5	-90	-19	dBm	X	
50		GSM850 Ramping Spectra - 400Khz C=H TxL=5	-90	-19	dBm	X	
51		GSM850 Mod Spectra +400Khz C=H TxL=5	-100	-60	dBc	X	Check C715 and C716 for correct soldering
52		GSM850 Mod Spectra -400Khz C=H TxL=5	-100	-60	dBc	X	Check Buffer Circuit around V802
53		GSM850 BER - 102 C=H TxL=5	0	2	%	X	Check antenna connection, check Filter C742, C743 and L610

54		GSM850 SACCH - 102 C=H TxL=5	4	14	-	X	Check Z601 and RX850 Path (Z604, C634, L606, L607)
55		Handoff to GSM850 C=H TxL=6	0	5	sec	X	
56		Meas GSM850 All C=H TxL=6	0	1000	sec	X	
57		GSM850 POWER BURST C=H TxL=6	29	33	dBm	X	
58		GSM850 Tx Linearity C=H TxL=5 & 6	0,5	3,5	dBm	X	
59		Handoff to GSM850 C=H TxL=19	0	5	sec	X	
60		Meas GSM850 All C=H TxL=19	0	1000	sec	X	
61		GSM850 POWER BURST C=H TxL=19	2	8	dBm	X	
62		GSM850 BURST t=1 C=H TxL=19	-110	-25	dB	X	
63		GSM850 BURST t=2 C=H TxL=19	-70	-1	dB	X	
64		GSM850 BURST t=4 C=H TxL=19	-1	1	dB	X	
65		GSM850 BURST t=9 C=H TxL=19	-1	1	dB	X	
66		GSM850 BURST t=11 C=H TxL=19	-70	-1	dB	X	
67		GSM850 BURST t=12 C=H TxL=19	-90	-25	dB	X	
68	GSM850 Low	Handoff to GSM850 C=L TxL=5	0	5	sec	X	
69		Meas GSM850 All C=L TxL=5	0	1000	sec	X	
70		GSM850 POWER BURST C=L TxL=5	31	34	dBm		Check shielding and antenna connection

71		GSM850 PHASE ERR RMS C=L TxL=5	0	5	deg	X	Check the following capacitors for correct soldering:
72		GSM850 PHASE ERR PEAK C=L TxL=5	0	20	deg	X	C610, C740, C741, C626, C710, C711, C712
73		GSM850 Ramping Spectra +400Khz C=L TxL=5	-90	-19	dBm	X	
74		GSM850 Ramping Spectra -400Khz C=L TxL=5	-90	-19	dBm	X	Check C715 and C716 for correct soldering
75		GSM850 Mod Spectra +400Khz C=L TxL=5	-100	-60	dBc	X	Check Buffer Circuit around V802
76		GSM850 Mod Spectra -400Khz C=L TxL=5	-100	-60	dBc	X	
77	GSM850 Mid	Handoff to GSM850 C=M TxL=5	0	5	sec	X	
78		Meas GSM850 All C=M TxL=5	0	1000	sec	X	
79		GSM850 POWER BURST C=M TxL=5	31	35	dBm		Check shielding and antenna connection
80		GSM850 PHASE ERR RMS C=M TxL=5	0	5	deg	X	Check the following capacitors for correct soldering:
81		GSM850 PHASE ERR PEAK C=M TxL=5	0	20	deg	X	C610, C740, C741, C626, C710, C711, C712
82		GSM850 Ramping Spectra +400Khz C=M TxL=5	-90	-19	dBm	X	
83		GSM850 Ramping Spectra -400Khz C=M TxL=5	-90	-19	dBm	X	Check C715 and C716 for correct soldering
84		GSM850 Mod Spectra +400Khz C=M TxL=5	-100	-60	dBc	X	Check Buffer Circuit around V802

85		GSM850 Mod Spectra -400Khz C=M TxL=5	-100	-60	dBc	X	
86	PCS1900 High	Handoff to PCS1900 C=H TxL=0	0	5	sec	X	
87		Meas PCS1900 All C=H TxL=0	0	1000	sec	X	
88		PCS1900 POWER BURST C=H TxL=0	28	32	dBm	X	
89		PCS1900 BURST t=1 C=H TxL=0	-110	-30	dB	X	
90		PCS1900 BURST t=2 C=H TxL=0	-70	-6	dB	X	
91		PCS1900 BURST t=4 C=H TxL=0	-1	1	dB	X	
92		PCS1900 BURST t=9 C=H TxL=0	-1	1	dB	X	
93		PCS1900 BURST t=11 C=H TxL=0	-70	-6	dB	X	
94		PCS1900 BURST t=12 C=H TxL=0	-90	-30	dB	X	
95		PCS1900 FREQ ERR PEAK C=H TxL=0	-180	180	Hz	X	Check shielding and antenna connection
96		PCS1900 PHASE ERR RMS C=H TxL=0	0	5	deg	X	Check the following capacitors for correct soldering:
97		PCS1900 PHASE ERR PEAK C=H TxL=0	0	20	deg	X	C610, C740, C741, C626, C710, C711, C712,
98		PCS1900 Ramping Spectra +400Khz C=H TxL=0	-90	-22	dBm	X	
99		PCS1900 Ramping Spectra -400Khz C=H TxL=0	-90	-22	dBm	X	Check C715 and C716 for correct soldering
100		PCS1900 Mod Spectra +400Khz C=H TxL=0	0	15	dB	X	Check TX1900 MHZ path (T701 and surrounding components)

101		PCS1900 Mod Spectra -400Khz C=H TxL=0	0	15	dB	X	
102		PCS1900 BER - 102 C=H TxL=0	0	2	%	X	Check antenna connection, Check Filter C742,C743 and L610
103		PCS1900 SACCH - 102 C=H TxL=0	4	12	-	X	Check RX1900 path (Z601, Z603, C604, L608, L609)
104		Handoff to PCS1900 C=H TxL=1	0	5	sec	X	also look at RXIQ Signal
105		Meas PCS1900 All C=H TxL=1	0	1000	sec	X	
106		PCS1900 POWER BURST C=H TxL=1	26	30	dBm	X	
107		PCS1900 Tx Linearity C=H TxL=0 & 1	0,5	3,5	dBm	X	
108		Handoff to PCS1900 C=H TxL=15	0	5	sec	X	
109		Meas PCS1900 All C=H TxL=15	0	1000	sec	X	
110		PCS1900 POWER BURST C=H TxL=15	-3	3	dBm	X	Burst template failure: Check Detector Diode V801 and Loop
111		PCS1900 BURST t=1 C=H TxL=15	-110	-23	dB	X	components: C804, R802, C805, R801, C803.
112		PCS1900 BURST t=2 C=H TxL=15	-70	-1	dB	X	also consider components near Mjölner: R708,R707, R706,C706,
113		PCS1900 BURST t=4 C=H TxL=15	-1	1	dB	X	or C831.
114		PCS1900 BURST t=9 C=H TxL=15	-1	1	dB	X	
115		PCS1900 BURST t=11 C=H TxL=15	-70	-1	dB	X	
116		PCS1900 BURST t=12 C=H TxL=15	-90	-23	dB	X	

117	PCS1900 Low	Handoff to PCS1900 C=L TxL=0	0	5	sec	X	
118		Meas PCS1900 All C=L TxL=0	0	1000	sec	X	
119		PCS1900 POWER BURST C=L TxL=0	28	32	dBm		
120		PCS1900 PHASE ERR RMS C=L TxL=0	0	5	deg	X	Check shielding and antenna connection
121		PCS1900 PHASE ERR PEAK C=L TxL=0	0	20	deg	X	Check the following capacitors for correct soldering:
122		PCS1900 Ramping Spectra +400Khz C=L TxL=5	-90	-22	dBm	X	C610, C740, C741, C626, C710, C711, C712,
123		PCS1900 Ramping Spectra -400Khz C=L TxL=5	-90	-22	dBm	X	
124		PCS1900 Mod Spectra +400Khz C=L TxL=5	0	15	dB	X	Check C715 and C716 for correct soldering
125		PCS1900 Mod Spectra -400Khz C=L TxL=5	0	15	dB	X	Check TX1900 MHZ path (T701 and surrounding components)
126	PCS1900 Mid	Handoff to PCS1900 C=M TxL=0	0	5	sec	X	
127		Meas PCS1900 All C=M TxL=0	0	1000	sec	X	
128		PCS1900 POWER BURST C=M TxL=0	28	32	dBm		
129		PCS1900 PHASE ERR RMS C=M TxL=0	0	5	deg	X	Check shielding and antenna connection
130		PCS1900 PHASE ERR PEAK C=M TxL=0	0	20	deg	X	Check the following capacitors for correct soldering:
131		PCS1900 Ramping Spectra +400Khz C=M TxL=5	-90	-22	dBm	X	C610, C740, C741, C626, C710, C711, C712,

132		PCS1900 Ramping Spectra -400Khz C=M TxL=5	-90	-22	dBm	X	
133		PCS1900 Mod Spectra +400Khz C=M TxL=5	0	15	dB	X	Check C715 and C716 for correct soldering
134		PCS1900 Mod Spectra -400Khz C=M TxL=5	0	15	dB	X	Check TX1900 MHZ path (T701 and surrounding components)
135	MainSequence	EndCall	Action			X	
136		Meas Vibra (Sensor) SNR_3	16	50	dB(SNR)		
137		SelfTest C	0	0			
138		Sleep Mode Current	0,1	3,5	mA		
139		Off Mode Current	-0,2	0,2	mA		

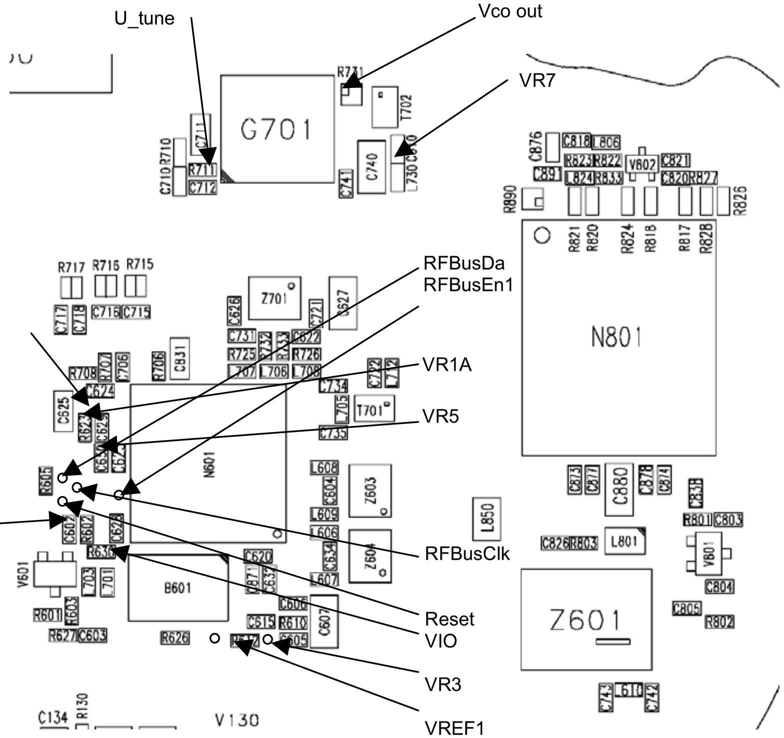
APPENDIX C: Component Placement with Test Points & Detailed Description

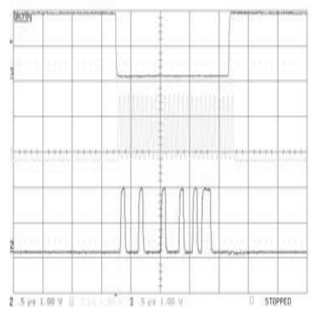
See 4 pages with

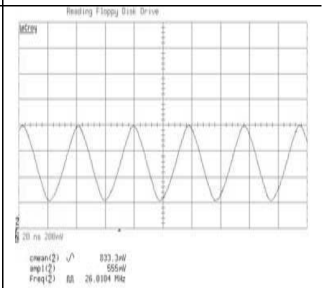
Synthesizer Test Points (1 page)
Receiver Test Points (1 page)
Transmitter Test Points (2 pages)

Synthesizer Test Points

Testpoint	U_tune / VCO out	
Band	GSM850	GSM1900
Active unit	TX	RX
Mode	Continuous	Continuous
Channel	128	810
Freq.	3296.8 MHz	3979.6 MHz
DC lev.	0.8 V	3.55 V
RF Pwr (hp probe)		



Testpoint	RFBUSCLK, DA, EN1
Active Unit	RX
Operation Mode	Burst
Channel	190
Signal Amplitude	~ 2V
Graph RFBusEn RFBusClk RFBusDa	

Testpoint	RFCLK
Active Unit	RX
Operation Mode	Continuous
Channel	190
DC offset	0.8V
Signal Amplitude	~600mV
Graph (measured with probe (to be specified)	

Testpoint	VREF1
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	1.35V

Testpoint	VR3
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	2.8V

Testpoint	VR7
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	2.8V

Testpoint	VIO
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	1.8V

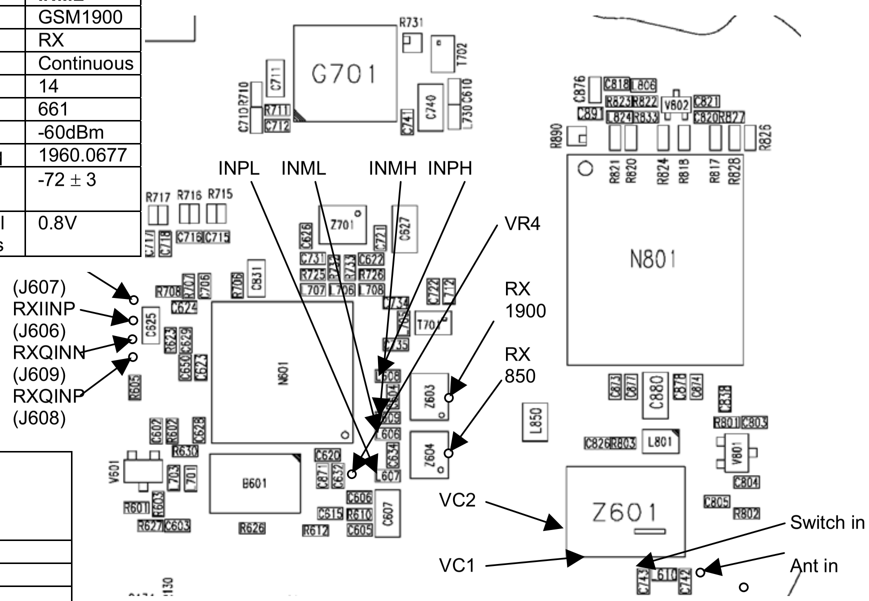
Testpoint	VR5
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	2.78V

Testpoint	VR1A
Band	GSM850
Active unit	RX
Operation mode	Continuous or burst
Channel	190
DC Level	4.75V

Receiver Test Points

Testpoint	INPL INML
Band	GSM850
RX/TX	RX
Mode	Continuous
AGC	14
Channel	190
Inp. Pwr	-60dBm
Inp. Freq	881.6677
Probe Pwr (hp)	-63 ± 2
DC Level LNA bias	0.8V

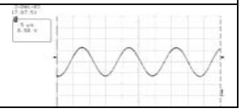
Testpoint	INPL INML
Band	GSM1900
RX/TX	RX
Mode	Continuous
AGC	14
Channel	661
Inp. Pwr	-60dBm
Inp. Freq	1960.0677
Probe Pwr (hp)	-72 ± 3
DC Level LNA bias	0.8V



Testpoint	VR4
Band	GSM850
RX/TX	RX
Mode	Cont. or burst
Channel	190
DC level	~ 2.78V

Testpoint	RX1900	RX850
Band	1900	850
RX/TX	RX	RX
Mode	Continuous	Continuous
AGC	14	14
Channel	661	190
Inp Pwr.	-60dBm	-60dBm
Inp.Freq.	1960.0677	881.6677
Probe Pwr (hp probe)	-66 ± 2	-62 ± 2

Testpoint	Switch in	
Band	850	1900
RX/TX	RX	RX
Mode	Cont.	Cont.
AGC	14	14
Channel	190	661
Input pwr	-60dBm	-60dBm
Inp.Freq	881.6677	1960.0677
Probed Pwr (hp)	-65 ± 2.	-66 ± 2

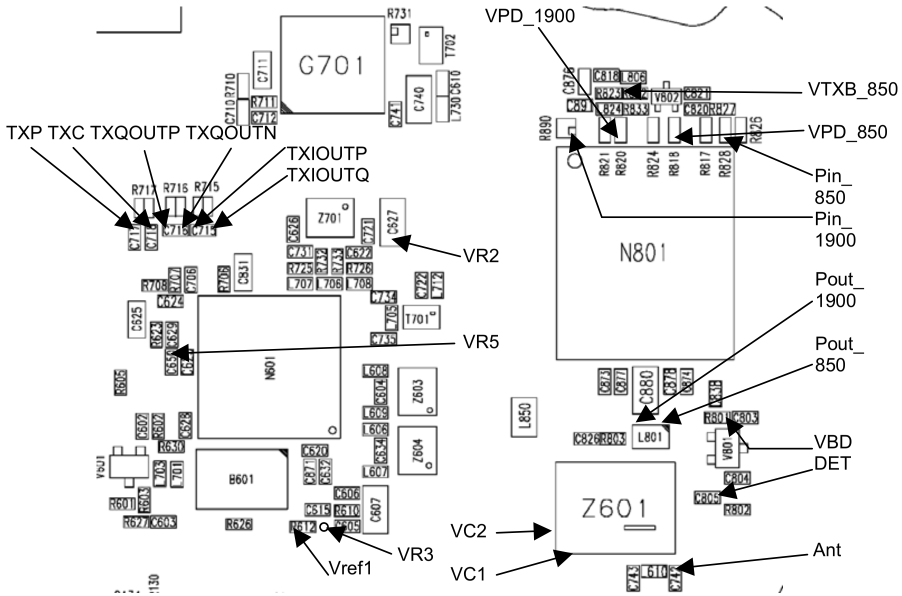
Testpoint	RXQINP (J608) RXQINN (J609) RXIINP (J606) RXIINN (J607)
Band	850 and 1900
RX/TX	RX
Mode	Continuous
AGC	14
Channel	190 or 661
Input Power	-80dBm
Input Freq.	881.6677 or 1960.0677 MHz
Signal Ampl.	1.2Vpp
DC offset	1.35Vdc
Frequency	67kHz
Graph (typical for all TP and bands)	

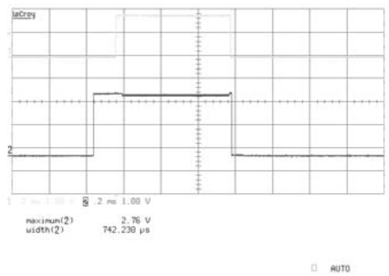
Testpoint	VC1, VC2	
Band	GSM850	
RX/TX	RX	
Mode	Continuous	
AGC	14	
Channel	190	
Testpoint	VC1 VANTL	VC2 VANTH
DC Level	0 V	0 V

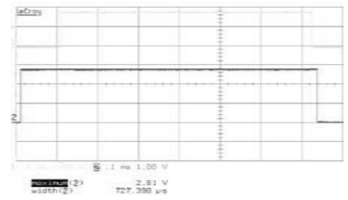
Testpoint	VC1, VC2	
Band	GSM1900	
RX/TX	RX	
Mode	Continuous	
AGC	14	
Channel	661	
Testpoint	VC1 VANTL	VC2 VANTH
DC Level	0 V	0 V

Testpoint	Ant in	
Band	850	1900
RX/TX	RX	RX
Mode	Cont.	Cont.
AGC	14	14
Channel	190	661
Input pwr	-60dBm	-60dBm
Inp.Freq	881.6677	1960.0677
Probed Pwr (hp)	-62 ± 2.	-65 ± 2

Transmitter Test Points (1/2)



Testpoint	VTXB_850 (supply voltage for TX Buffer
Band	850
RX/TX	TX
Mode	Burst
Graph Trigger TXP VTXB_ 850 (~2.75V)	

Testpoint	VBD (supply voltage for Detector
Band	GSM850 / 1900
RX/TX	TX
Mode	Burst
Graph Trigger TXP VBD (~2.8V)	

Testpoint	VREF1
Band	GSM850
RX/TX	TX
Mode	Continuous or burst
Channel	190
DC Level	1.35V

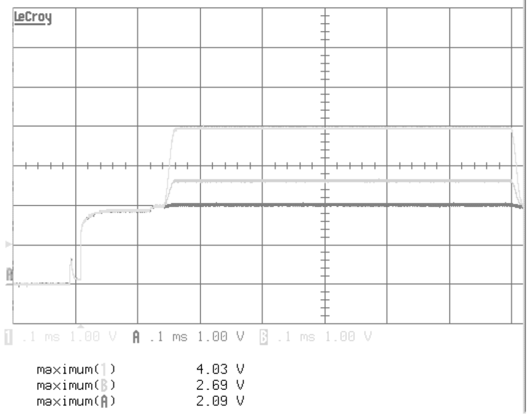
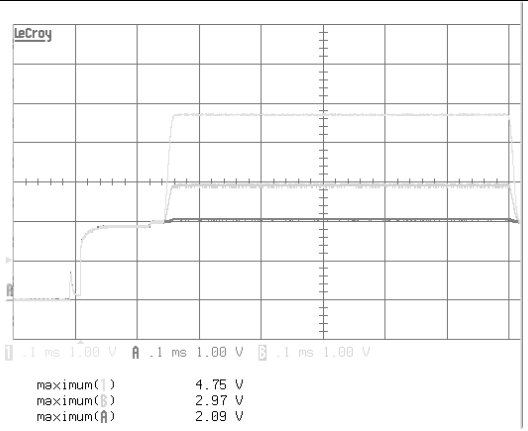
Testpoint	VR3
Band	GSM850
RX/TX	RX
Mode	Continuous or burst
Channel	190
DC Level	2.8V

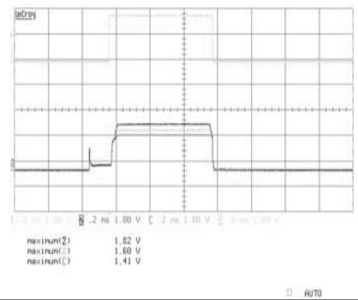
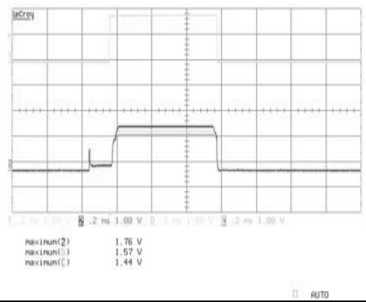
Testpoint	Ant	
Band	850	1900
RX/TX	TX	
Mode	Burst	
Channel	190	661
PCL	5	0
Power (hp)	32.5 ± 2	29.5 ± 2

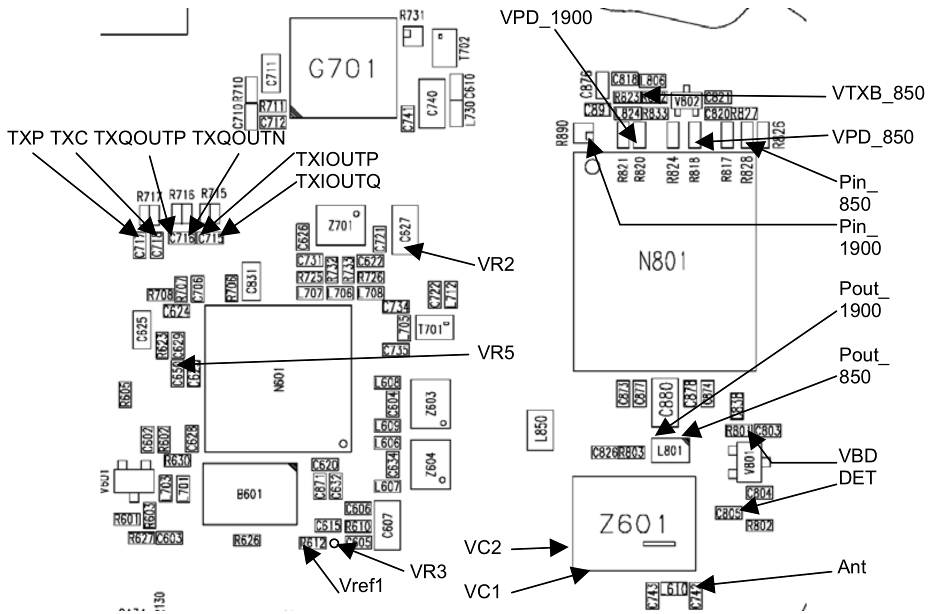
Testpoint	Pout850	Pout1900
Band	850	1900
RX/TX	TX	TX
Mode	Burst	Burst
Channel	190	661
PCL	5	0
Power(hp)	33 ± 2	30 ± 2

Testpoint	Pin_850	Pin_1900
Band	850	1900
RX/TX	TX	TX
Mode	Burst	Burst
Channel	190	661
PCL	5	0
Power(hp)	4 ± 3	0 ± 3

Transmitter Test Points (2/2)

Testpoint	VDET
Band	GSM850
RX/TX	TX
Mode	Burst
Graph VDET PCL 5 PCL 15 PCL 19	
Band	GSM1900
Graph VDET PCL 0 PCL 10 PCL 15	

Testpoint	VPD 1900	VPD_850
Band	1900	850
RX/TX	TX	TX
Mode	Burst	Burst
Graph GSM1900 (850) PCL 5 (0) PCL 15 (10) PCL 19 (15)		



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APPENDIX D: Calibration of the DA-17/JXS-2 jig, Autotuning and BT Testing

Requirements

- U.S. AMS requirement is to align/check the phone completely assembled (in addition to the alignment in the MJ-21 repair jig which is still possible).
- RF couplers must be used because there is no RF connector on RH-47.
- DUT must be placed in a shielded box (JXS-2) to achieve accuracy and in order to avoid external interference.
- First Symbian OS phone to support "RF autotuning".
- Normal to Local mode switching must be done manually as Symbian OS does not support SW switching.

Calibration Problems

- PA (Hitachi PF 08130B-TB) O/P power is very sensitive to LOAD variations.
- GSM Dual band antenna match is only -5 dB on GSM850 TX band.
- Battery BL-6C is part of the antenna (GSM850) – but in the DA-17 jig, the battery is removed -> antenna resonance is shifted!
- Coupler is self-resonant and must be very close to the GSM antenna -> Further resonance shift of GSM antenna.

=> very careful "active calibration" method is needed

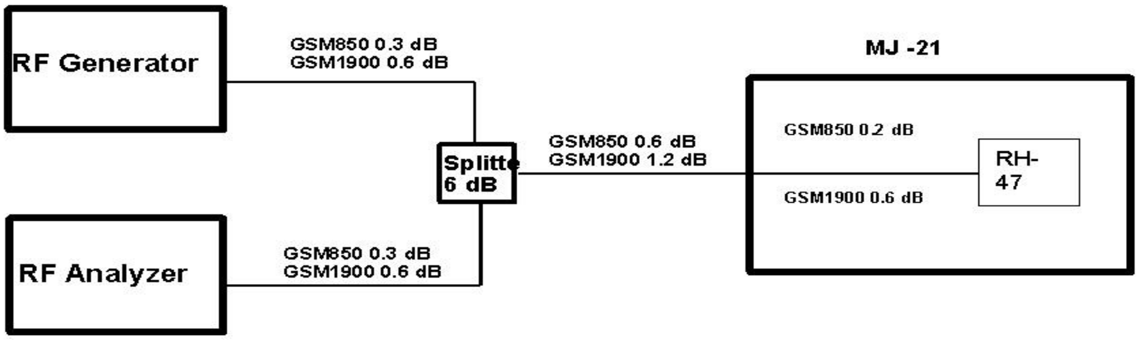
Active calibration: basic idea

- DA-17/JXS-2 system is seen as a "black box".
- Calibration of the "black box" can be done with any functional phone sample and MJ-21 repair jig.
- Once the calibration has been done, no changes inside the black box are allowed (except removing and fitting the phone).
- All calibration data from the black box is based on conducted measurement with MJ-21.
- The best accuracy is achieved for the highest TX power level (PCL0 / PCL5).

Calibration procedure setup MJ-21

The initial setup is shown below. The phone is disassembled and the engine PWB is placed in the MJ-21 which is connected via Fbus to the Phoenix PC.

The phone is in local mode and VCC = 3.6V



The attenuation values for all components are known:

MJ-21:

- 0.2dB (850)
- 0.6 dB (1900)

Cable (in this case):

- 6.9dB (850)
- 7.8dB (1900)

Note that attenuation values are equal for all channels on each band.

Data acquisition MJ-21

The following data must be measured in the MJ-21 jig:

- TX power on MID channel (GSM850 PCL=5, GSM1900 PCL=0)
- RX RSSI level on LOW channel (GSM850, GSM1900)
- RX RSSI level on MID channel (GSM850, GSM1900)
- RX RSSI level on HIGH channel (GSM850, GSM1900)

The attenuation values of the cables (incl. power splitter when used) and the MJ-21 jig must be taken into account when measuring the data.

The measurement is done in local mode.

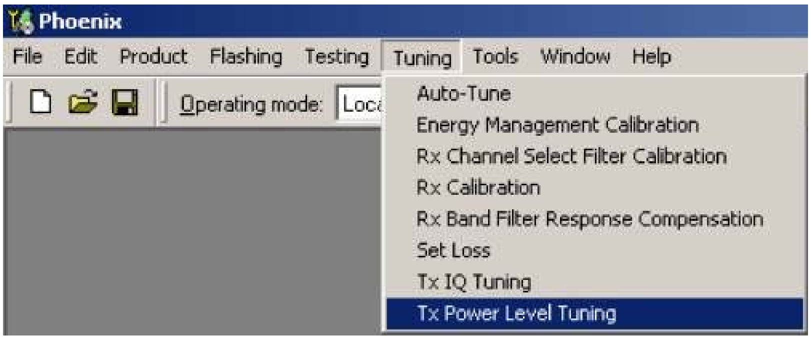
TX power is measured in the Zero Span mode with RBW being 3MHz or more. The RBW value also depends on the RF analyser used.

MJ-21 TX power measurement

Procedure:

1 Start the phone in Local mode.

2 From the Tuning menu, choose “Tx Power Level Tuning”.



The “Power Level Tuning” window opens.

3 Select the band and power level to be measured.

MJ-21 GSM850 power measurement

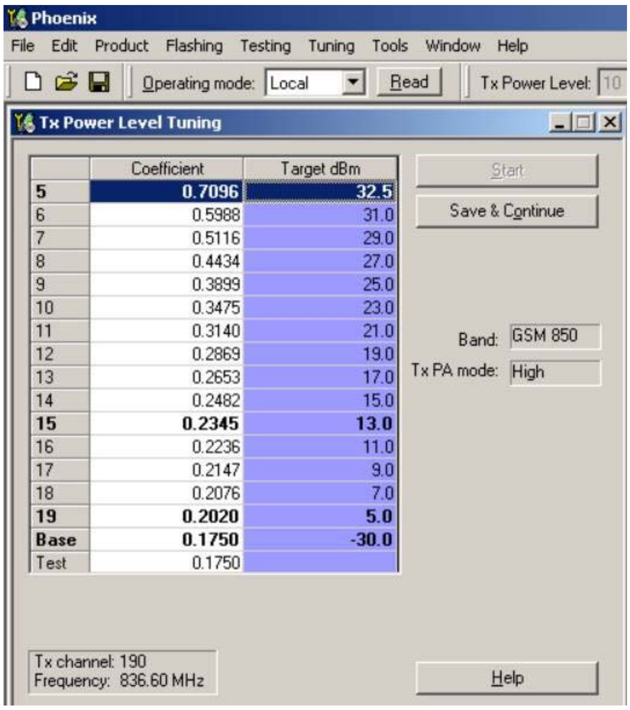
Procedure:

1 Move the cursor to PCL=5.

2 Align the phone exactly to 32.5 dBm using the “+” and “-” keys.

3 Click the “Save & Continue” button

- RF analyser set to mid channel (190) 836.6MHz
- Zero-Span
- RBW >=3MHz
- Video Trigger
- RMS power

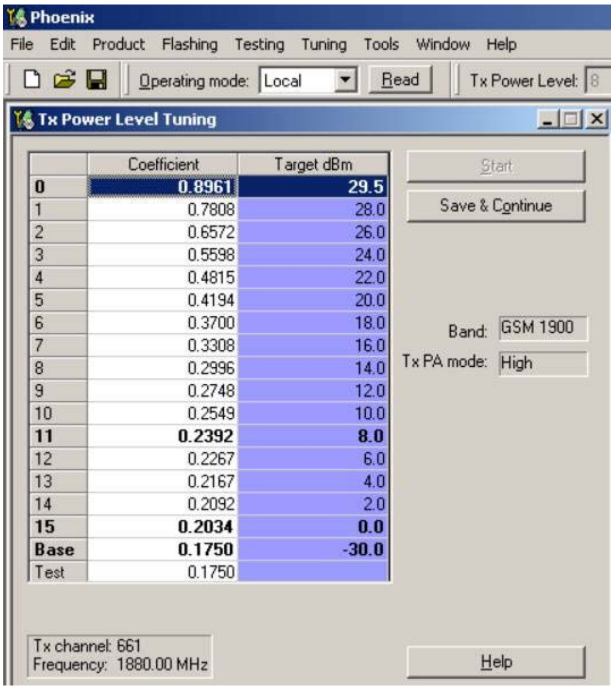


MJ-21 GSM1900 power measurement

After the GSM850 power measurement is done the phone switches automatically to the GSM1900 band.

Move the cursor to PCL=0 and align the phone exactly to 29.5 dBm.

- RF analyser set to mid channel (661) 1880MHz
- Zero-Span
- RBW >=3MHz
- Video Trigger
- RMS power



MJ-21 receiver RSSI measurement

RSSI measurement must be performed on Low, Mid and High channels on both bands (GSM850 and 1900).

Table 3: Channel assignment

Band	Low	Mid	High
GSM 850	128	190	251
GSM 1900	512	661	810

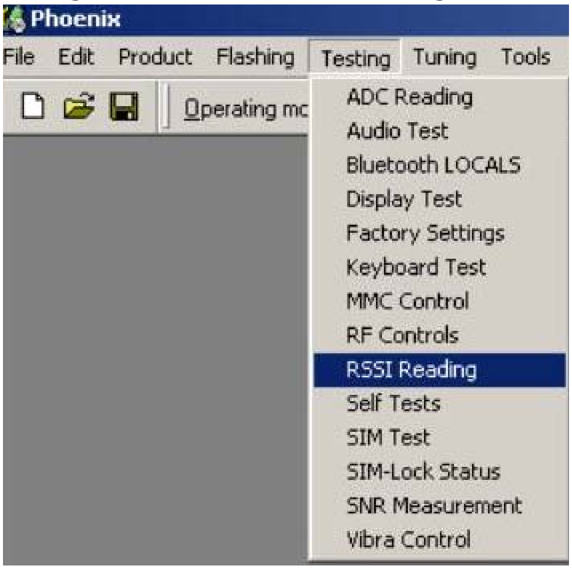
The following frequencies must be set to the RF generator used for RSSI:

		Low[MHz]	Mid [MHz]	High [MHz]
GSM850	RX	869,26771	881,66771	893,86771
GSM1900	RX	1930,26771	1960,06771	1989,86771

MJ-21 RSSI procedure

1 Start the phone in Local mode.

2 From the Testing menu, choose “RSSI Reading”.



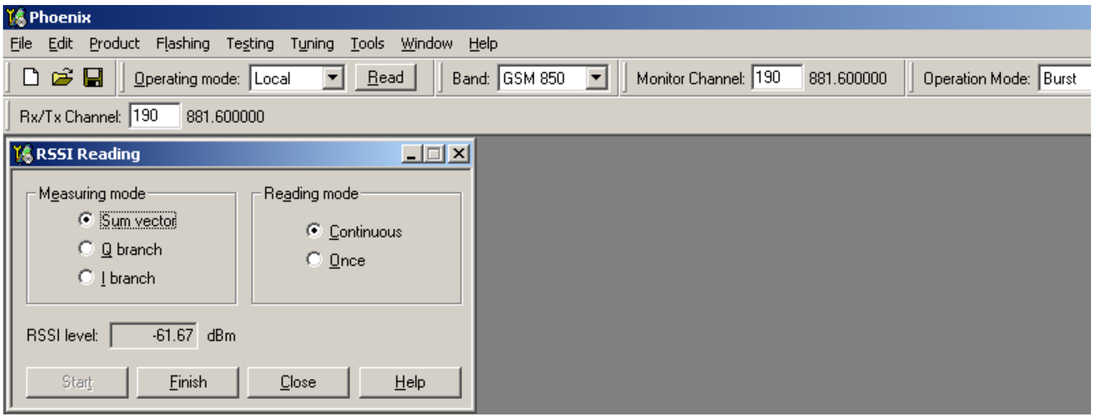
The “RSSI Reading” window opens with further settings for the RSSI reading feature.

MJ-21 RSSI values

Use the default settings:

- Measuring mode -> Sum vector
- Reading mode -> Continuous

After selecting the above settings, click the Start button.



Set the RF generator power to –60dBm (taking into account the losses caused by cables and MJ-21 jig mentioned before) and frequencies from the table.

Perform the measurement on Low, Mid and High channels on both bands.

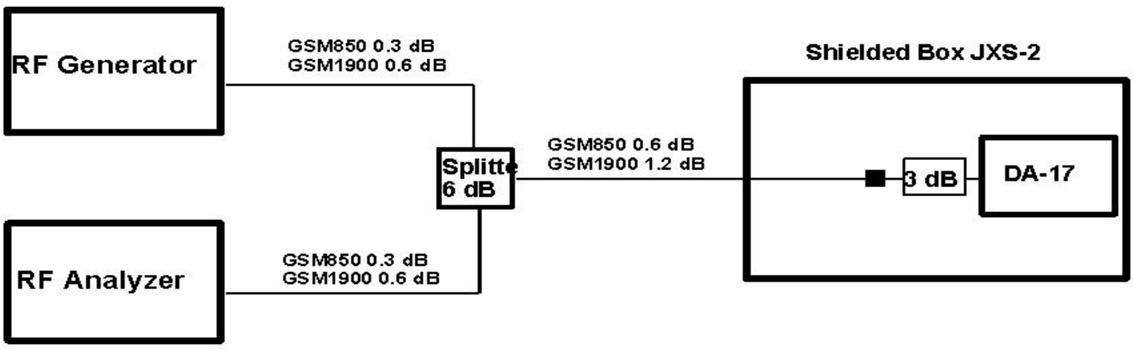
MJ-21 example figures

Parameter	Example value
MJ21_TX_850	32.5dBm
MJ21_TX_1900	29.5dBm
MJ21_RX_850_LOW	-61.5dBm
MJ21_RX_850_MID	-60.7dBm
MJ21_RX_850_HIGH	-60.7dBm
MJ21_RX_1900_LOW	-61 dBm
MJ21_RX_1900_MID	-60.6dBm
MJ21_RX_1900_HIGH	-60.5dBm

Before assembling the phone and setting up the shielded box JXS-2 with DA-17, the parameters must be known.

JXS-2 / DA-17 "blackbox" setup

- The assembled phone is placed on the DA-17 test adapter. This must be fitted with the AQ_AMSCPL_01 directional coupler assembly and the Bluetooth directional coupler assembly.
- A 3 dB attenuator is connected to the SMA-socket of the GSM coupler. A short coaxial cable is connected to the SMA-feedthrough on the backside of JXS-2.
- A ferrite bead is placed on the coaxial cable at a distance of 4cm from the SMA connector at the GSM coupler.



Data acquisition JXS-2 / DA-17

The switch on the left side of DA-17 must be set to Local mode (lower position).

The supply voltage VCC=3.8V is fed through the JBV-1 adapter.

The shielded box has to be closed for all RF measurements.

The same parameters must be measured as for MJ-21. Follow the instructions given earlier.

- TX Power on MID channel (GSM850 PCL=5, GSM1900 PCL=0)

- RX RSSI level on LOW channel (GSM850, GSM1900)
- RX RSSI level on MID channel (GSM850, GSM1900)
- RX RSSI level on HIGH channel (GSM850, GSM1900)

The cable attenuation values (incl. power splitter when used) must be taken into account in the measurement process. However, disregard the attenuation of the "black box" because this is the value to be determined.

DA-17/JXS-2 example figures

After the measurement in the "black box", the following parameters are determined (typical values listed below).

Parameter	Example value
DA17_TX_850	24.5dBm
DA17_TX_1900	22.5dBm
DA17_RX_850_LOW	-70.5dBm
DA17_RX_850_MID	-69.5dBm
DA17_RX_850_HIGH	-69.6dBm
DA17_RX_1900_LOW	-68 dBm
DA17_RX_1900_MID	-68 dBm
DA17_RX_1900_HIGH	-68.3dBm

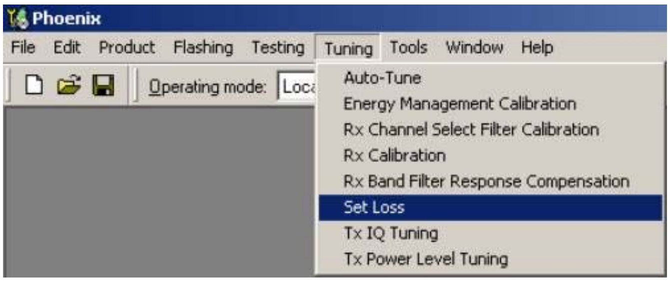
The calibration factor needed for the RF autotuning in DA-17/JXS-2 is calculated by subtracting the DA-17 value from the MJ-21 value. This must be done for each of the eight values.

Setting cable loss for Auto-Tuning

Phoenix allows you to set separate loss values at different frequencies for cables and the jig.

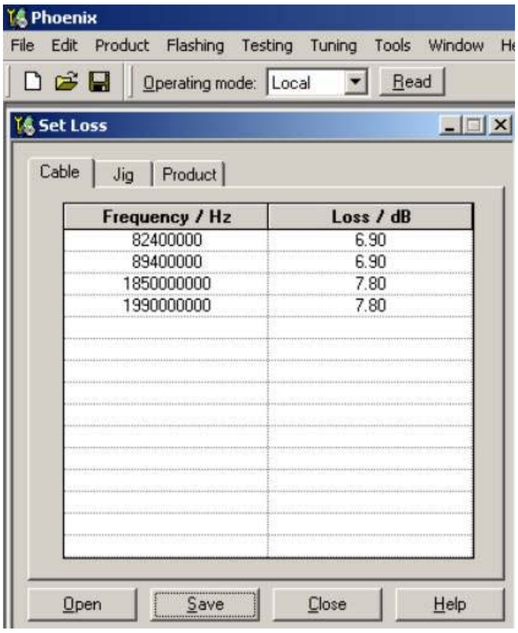
Procedure:

1 From the Tuning menu, choose Set Loss.



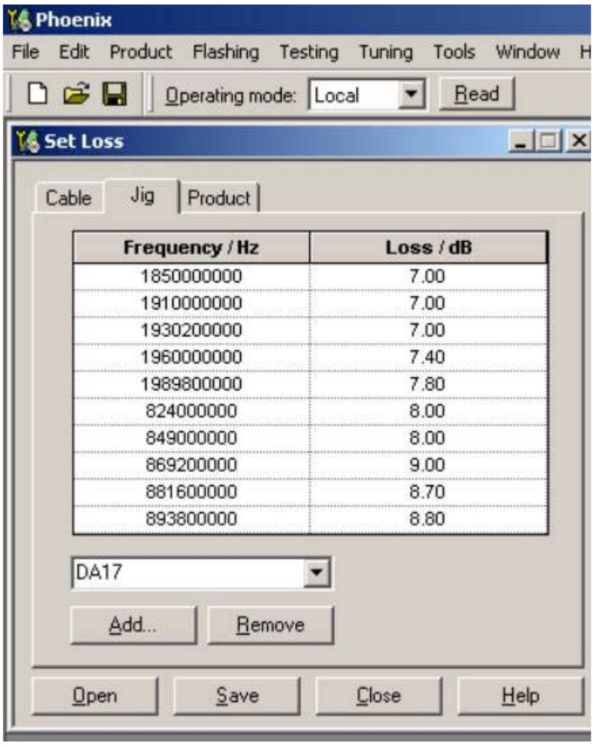
2 Enter the cable losses (incl. Power splitter if used) for GSM850 at 824 and 894 MHz and for GSM1900 at 1850 and 1990 MHz.

The values in between are interpolated.



3 To store the data, click Save.

Setting DA-17/JXS-2 calibration loss



Procedure:

1 Enter the calibration factors (DA-17 values subtracted from the MJ-21 values) to the Jig column.

Note that there are different calibration factors for the TX and RX channels

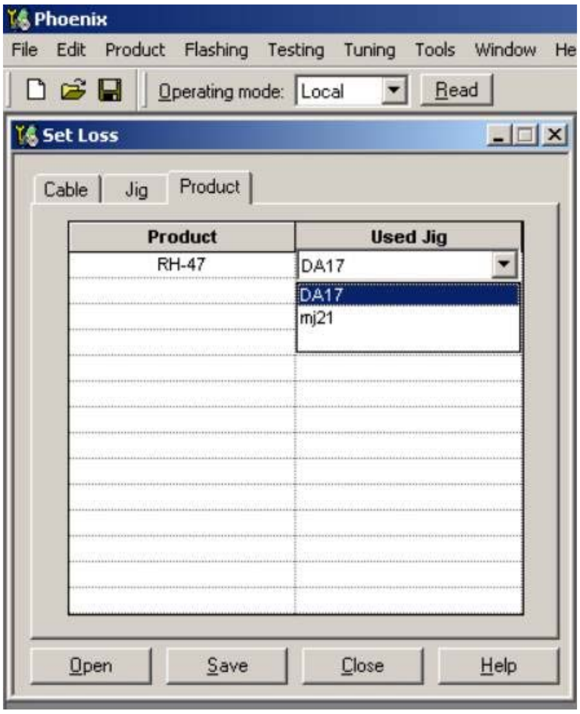
2 Enter the loss values for the RX Low, Mid and High channels on both bands.

3 If the jig “DA-17” is not defined yet, you must generate it by clicking the Add button. Assign it the name DA-17.

4 Click Save.

Assigning the product to the jig

To make the calibration data valid, it is necessary to assign the DA-17 jig to the product “RH-47”.



Procedure:

1 Click the Product tab.

2 Enter “RH-47” into the Product column.

3 From the “Used Jig” dropdown menu, choose DA-17.

4 First click Save and then Close.

You are ready for Autotuning.

GPIB Setup for Autotuning

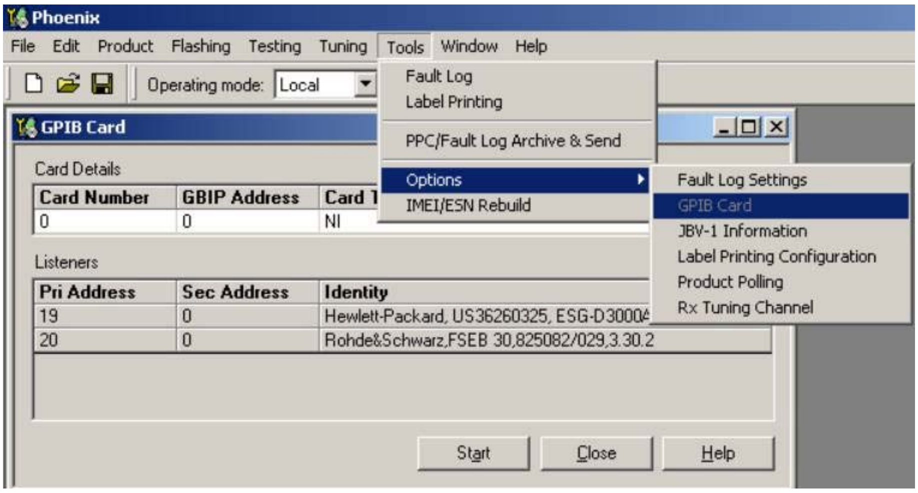
Prerequisites:

- GPIB card on Phoenix PC must be installed and working.

Procedure:

1 Connect the RF analyser and RF generator to the GPIB card.

2 Open Tools -> Options -> GPIB cards.



3 Click the Start button.

Generators:

- R&S CMU200
- R&S SME
- Agilent ESG

Analyzers:

- R&S CMU200
- R&S FSx series
- Agilent PSA/VSA

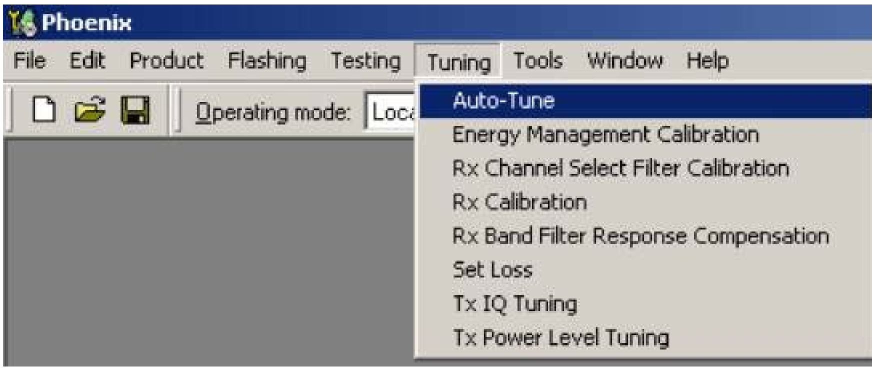
Use different GPIB address for different devices!

Autotuning

Procedure:

1 To start tuning the phone in the DA-17/JXS-2 box, choose Auto-Tune from the

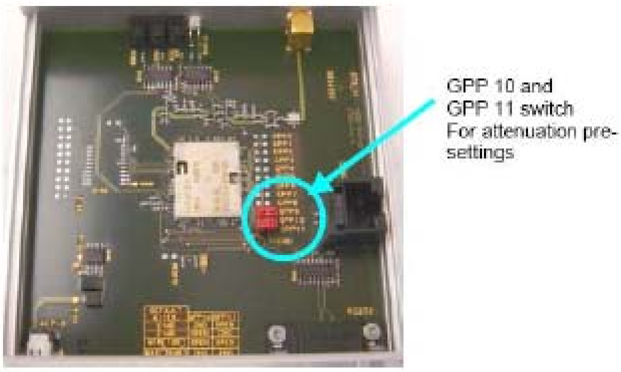
Tuning menu.



2 Click the Tune button in the Auto-Tune window and wait approximately 2 minutes before the autotuning algorithm has finished.

Make sure that the “Autotune_RH47.ini” file is stored in the Phoenix directory.

Bluetooth test setup



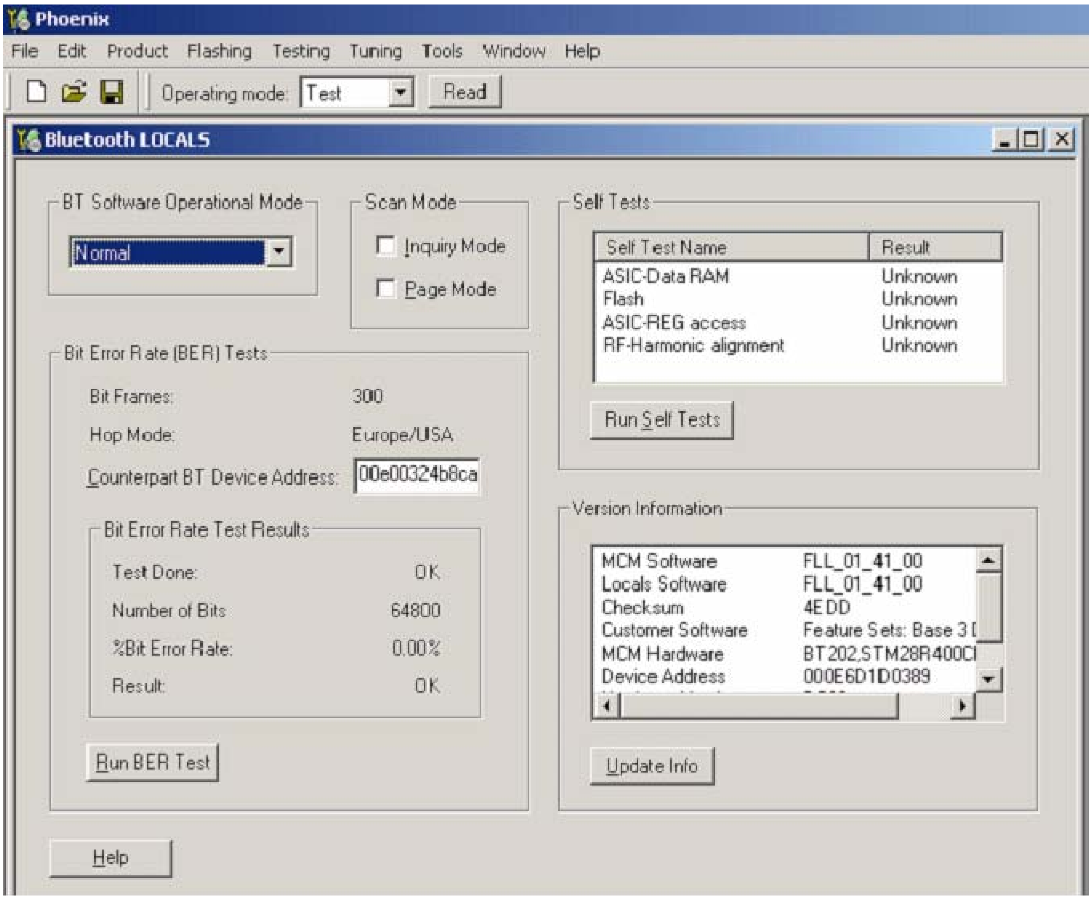
DA-17 Bluetooth coupler is connected to RF I/O via a 30 dB attenuator

Bluetooth testing

Procedure:

1 From the “Operating mode” dropdown menu, choose Test.

2 From the Testing menu, choose “Bluetooth LOCALS”.



3 In the “BT Software Operational Mode” pane, choose Normal.

4 Enter the BD address of BT Box 2 on the “Counterpart BT Device Address” line.

BER must be <0.1%.

5 Click the “Run BER Test” button and wait approximately 2 seconds for the result.

