7 - RF Description & Troubleshooting

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RF Description and Troubleshooting

The sections below provide instructions how to check, repair and calibrate the RF section of RH-6 phones.

It is assumed that for tuning and repair the phones are disassembled and tested within a repair jig MJ-7.

The following types of measurements can be done for diagnosis and repair of RH-6 phone modules:

- RF measurements are done using a Spectrum Analyzer together with a high-frequency probe. (Note, that signal will be significantly attenuated). Correct attenuation can be checked using a "good" phone board, for example.
- LF (Low frequency) and DC measurements are done with a an oscilloscope together with an 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-7.
- Output level measurements of the transmitter are done with a power meter, which is connected to the antenna port using the repair jig MJ-7.

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 (as stated on MJ-7) and the connecting cable when realigning the phone.

Most RF semiconductors are static discharge sensitive. ESD protection must be used during repair (wrist straps and ESD proof soldering irons).

Mjoelner RF ASIC is moisture sensitive. Therefore, Mjoelner RF ASIC must be in appropriate condition or 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 the following sections there are a lot of discrete components (resistors, inductors and capacitors) for which troubleshooting is done by checking if soldering of the component is done properly and checking if the component is missing from PWB. Capacitors can be checked for short-circuiting and resistors for value by means of an ohm-meter, but be aware: in-circuit measurement results have to be evaluated carefully.

Below the following abbreviations can be used interchangeably:

EGSM and EGSM900 to refer to GSM low band.
DCS or PCN or GSM1800 GSM mid band.
PCS and GSM1900 GSM high band.

RF key component placement

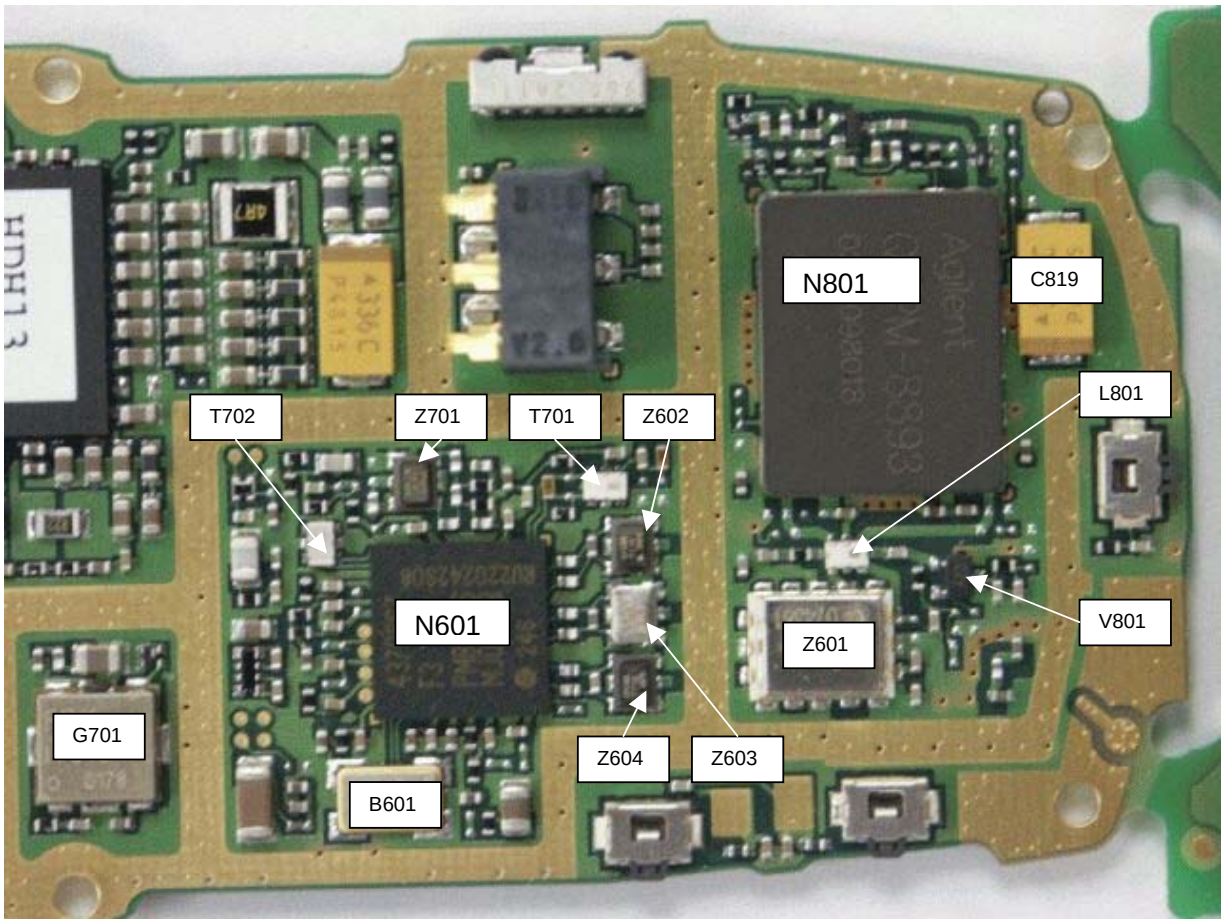


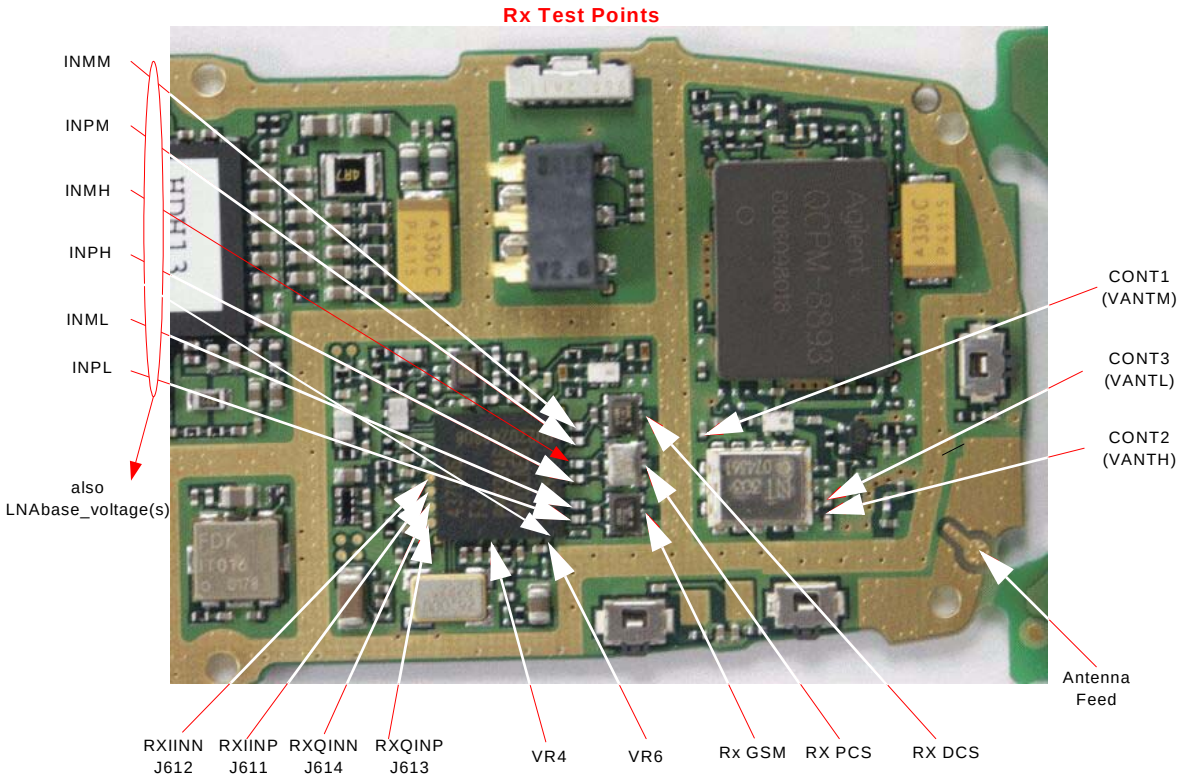
Figure 1: RF key components placement

Position	Component Name	Supplier and Description	Code
N801	TX-PA	Hitachi, PF8109BN-TB, aluminium substrate	4350409
L801	Directional Coupler	Murata, LDC15D190A0010A	4551015
Z601	Antenna Switch Module	Hitachi Metals, SHS-L090	4510385
Z602	SAW1800 RX	Epcos, B7714	4511313
Z603	SAW1900 RX	Murata, SX-B195F	4511325
Z604	SAW900 RX	Epcos, B7710	4511279
Z701	SAW900 TX	Epcos, B7715	4511311
N601	Mjölner	Infineon, F3	4370867
B601	XTAL	NDK and Toyocom	4510337
G701	VCO	FDK, IT016	4350315

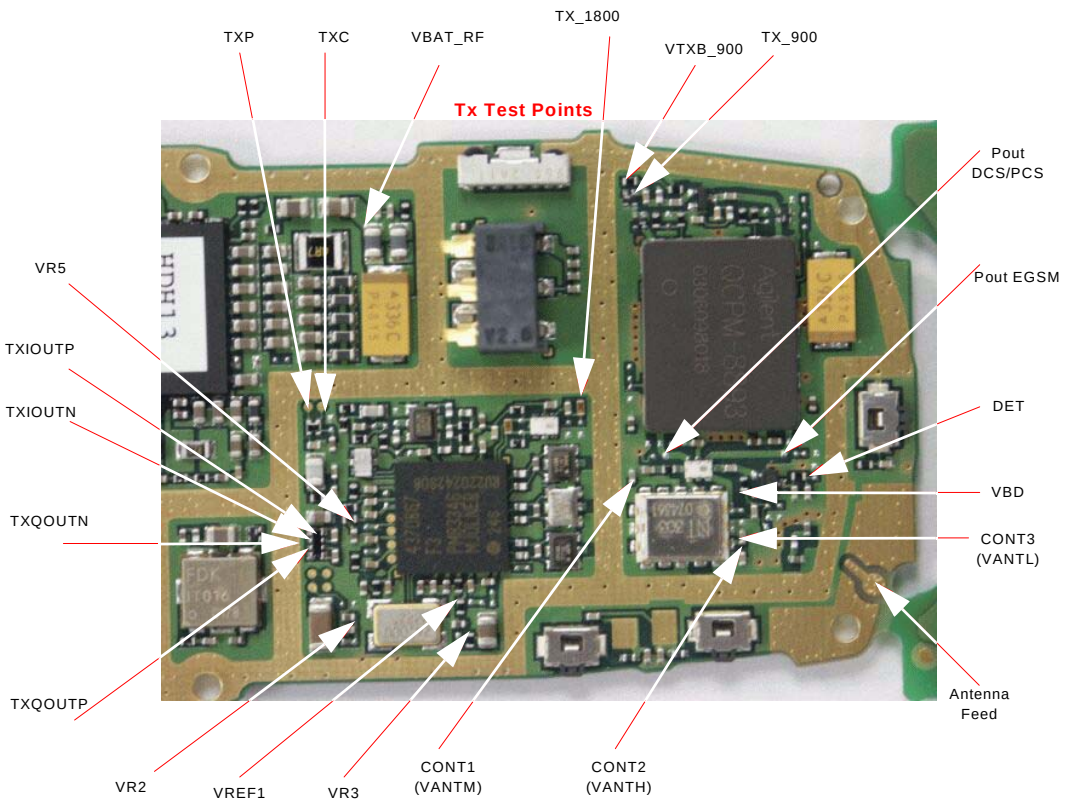
RF measurement points

The RF power supplies are generated in the UEM and can be measured either in the Mjoelner chamber or in the baseband chamber. The pictures below indicate with red circles where the test points are located.

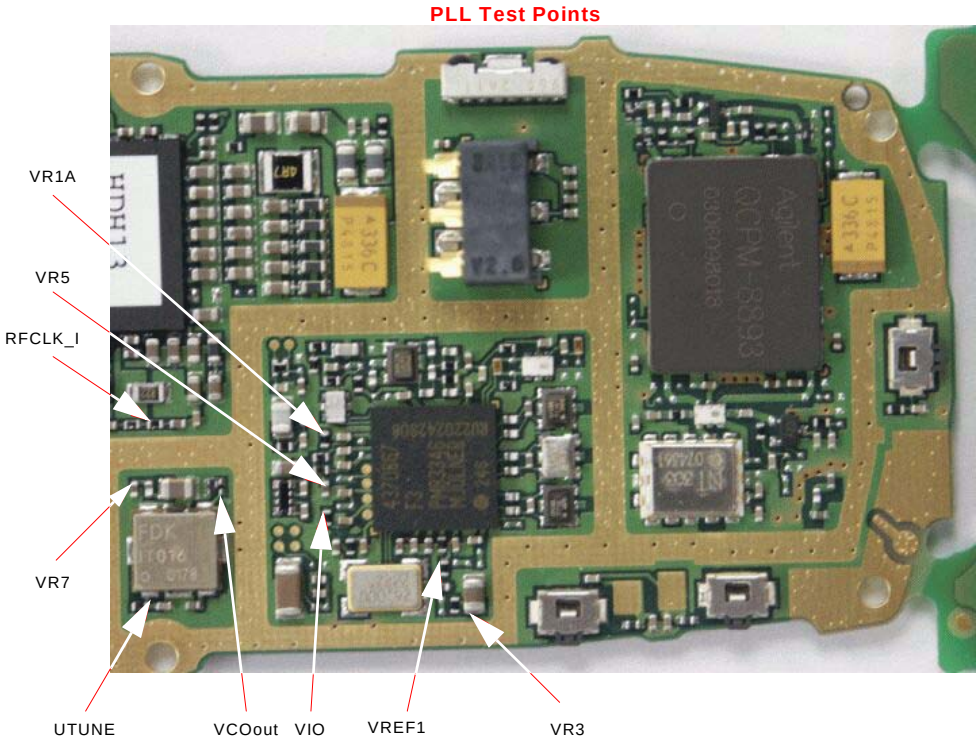
Receiver test points



Transmitter test points



Synthesizer test points



RF Implementation in RH-6

The RH-6 RF part is a triple-band direct conversion transceiver. Using direct conversion, no intermediate frequencies are used for up- or down-conversion.

The VCO is set to either twice or four times 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 baseband. All up- and down-conversions take place in the RF ASIC named Mjoelner (N601).

Mjoelner RF ASIC also contains PLL and LNAs for all used bands. A DC control section is included in to power and/or control EGSM 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 done via the serial interface of Mjoelner.

The 26 MHz reference clock is interfaced to the UPP.

The RF supports HSCSD (High Speed Circuit Switched Data) and GPRS (General Packed Radio Service), meaning multi-slot operation. (This does not require special equipment or procedures in repair situations.)

The following pictures show the RF frequency plan and the RF block diagram.

RF frequency plan

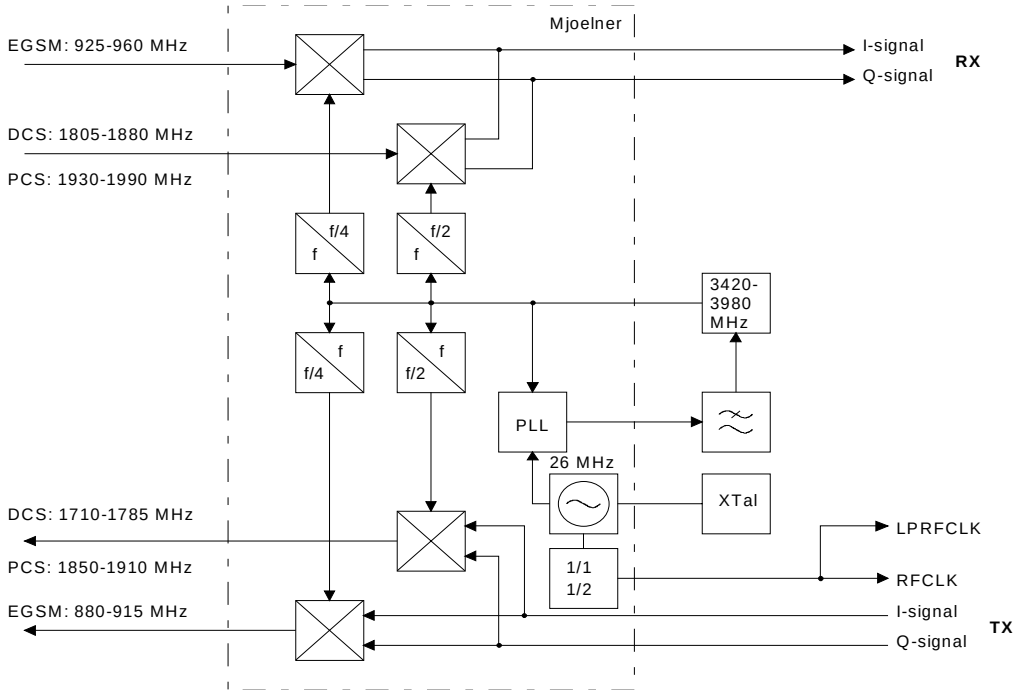


Figure 5: RF frequency plan

RF block diagram

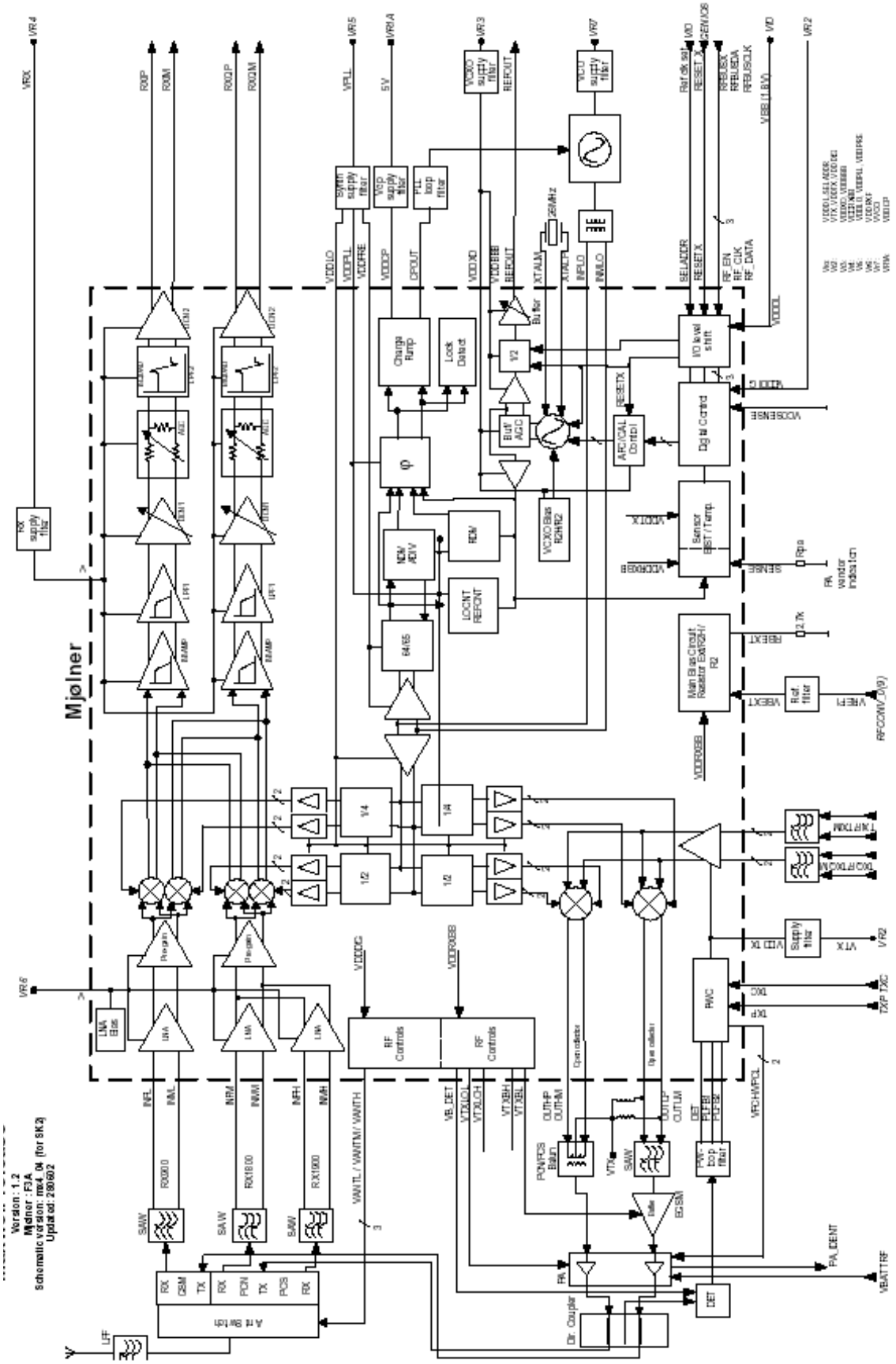


Figure 6: RF block diagram

RF power supply configuration

All power supplies for the RH-6 RF Section are generated in the UEM IC (D200). 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.

Note, that not all currents can be measured directly. Spots for measuring of voltages are indicated in the above "test points" sections.

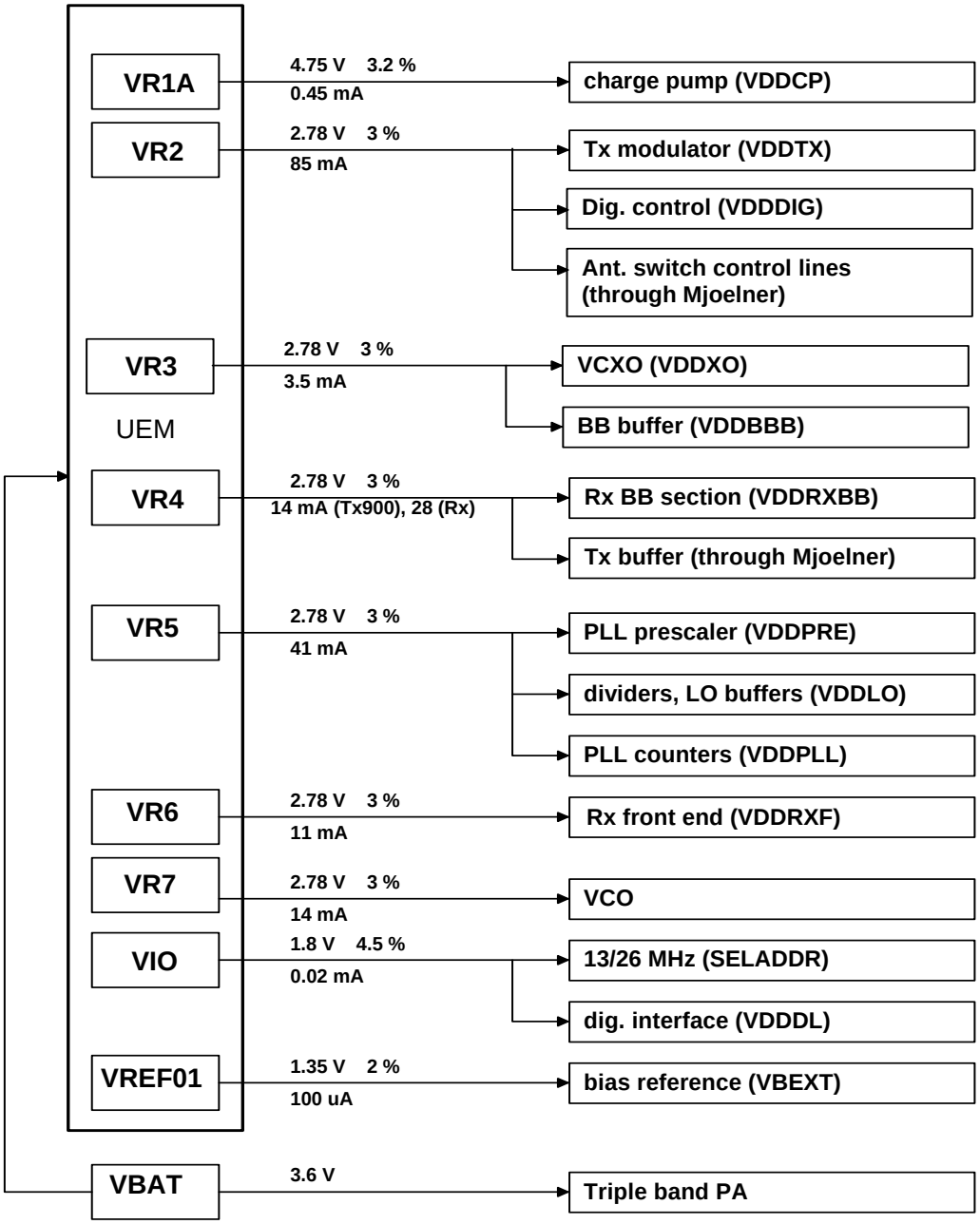


Figure 7: RF Power distribution diagram

Receiver Description and Troubleshooting

RX signal paths

The signal paths of the receiver are shown in following block diagram. Note that the picture shows EGSM900 receiver (upper left part), GSM1900 receiver (middle) and GSM1800 receiver (lower).

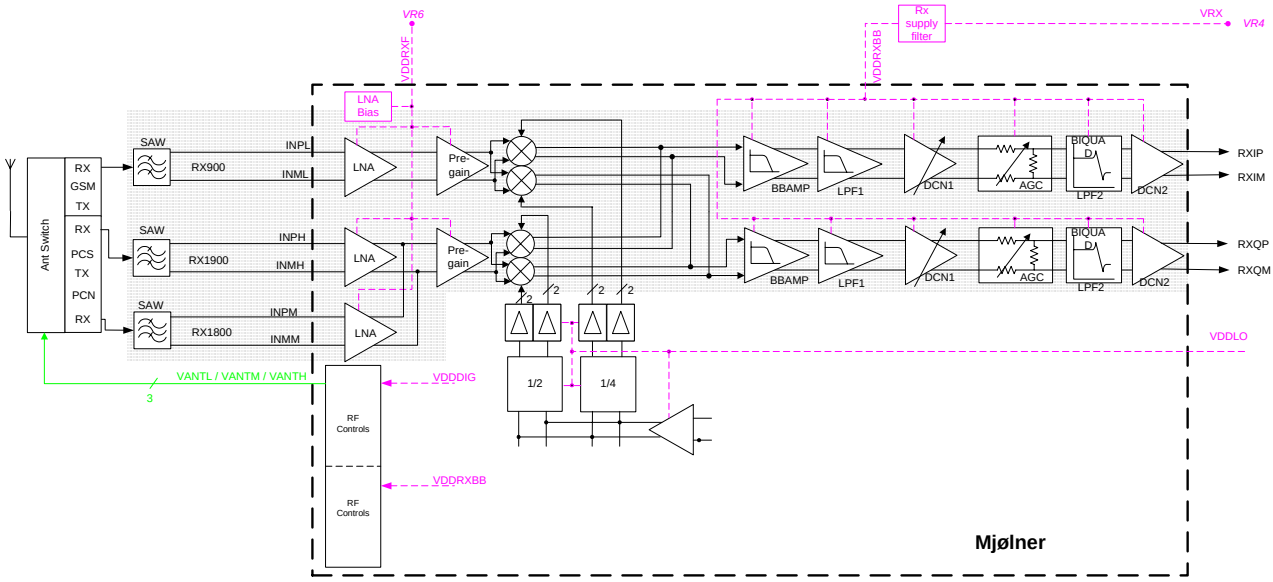


Figure 8: RX signal paths

Antenna switch (RX/TX switch)

From the antenna-pad (J615) the RF signal is fed through the antenna low pass (C601, L608, C602) to the antenna switch (Z601).

The antenna switch works as a diplexer. EGSM900 input signals pass to GSM_RX output. GSM1800 input signals pass to PCN_RX output or PCS_RX output, depending on the control signal VANTH (Cont2).

From RX1-GSM output of the antenna switch, the RX signal is routed to the EGSM900 SAW filter (Z604). From RX2-DCS output the GSM1800 RX signal is routed to the GSM1800 SAW filter (Z602). From RX3-PCS output the RX GSM1900 signal is routed to the GSM1900 SAW filter (Z603).

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

1.3dB@EGSM900, 1.6dB@GSM1800 and 1.6dB@GSM1900.

RX front-end

The RX front end includes three SAW filters (EGSM900 (Z604)GSM1800 (Z602), GSM1900 (Z603)). Each of the SAW filters is matched with a differential matching circuit (LC-type) to the corresponding LNA input of Mjoelner RF ASIC (N601). 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 which provides a balanced RX signal to the corresponding input of the Mjoelner RF ASIC.

The SAW filters have maximum insertion losses of:

- 3.5dB@EGSM900
- 4.0dB@GSM1800
- 4.0dB@GSM1900

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 with a LO signal coming from the local oscillator.

The RX paths of Mjoelner RF ASIC consist of following building blocks:

- Separate LNAs for each of the three bands: EGSM900, GSM1800 and GSM1900.
- Two PREGAIN amplifiers, one for EGSM900 and one common for GSM1800 and GSM1900.
- Two passive I/Q mixers (MIX), one for EGSM900 and one common for GSM1800 and GSM1900.

The resulting BB signal is further amplified in the BB chain. For that no external circuitry is required:

- Baseband amplifiers (BBAMP1). These amplifiers implement the initial channel filtering.
- Low pass filters (LPF1).
- DC compensation / AGC amplifiers (DCN1). These implement gain steps from 0dB to 24dB in 6dB steps.
- Attenuators (AGC). These 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 baseband outputs are internally DC coupled and can be connected directly to the ADC inputs of the RF converter chip. The common mode level is set equal to the VBEXT reference voltage.

Fault finding chart for receiver

The phone layout offers 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.

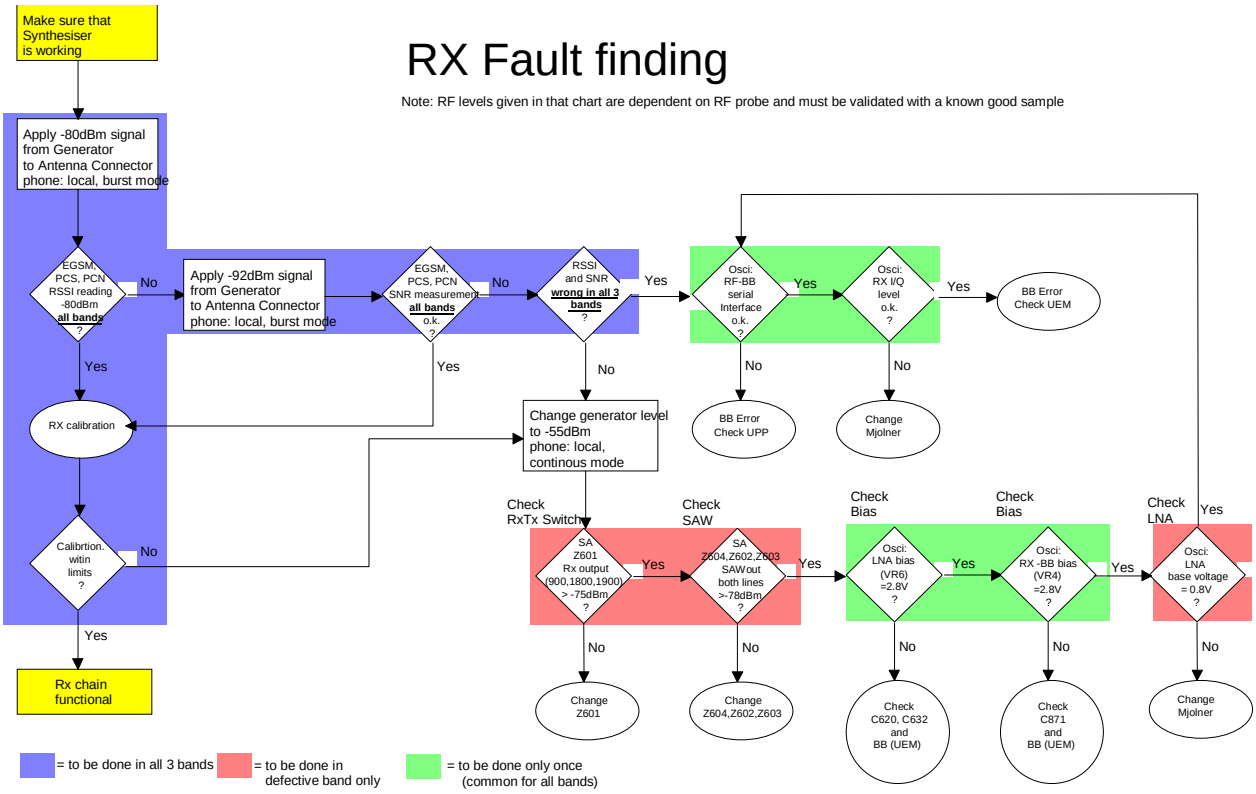
$$RSSIreading\ [dBm] = 20\log(U_{BB}) + AGC_{calibrated}$$

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 have a reasonable RSSI reading, although the front end shows excessive losses.

If it is not sure whether **incorrect re-calibration** has been taken place, following steps can be done:

- Check if AGC calibration is within limits
- Check if SNR reading is o.k.
  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 so, then check the path from the antenna pad J615 to the antenna switch Z601 (see RX fault finding "Check RXTX switch").

General instructions for RX troubleshooting

Connect the phone module to a PC that runs Phoenix by appropriate means. Supply the phone module with DC voltage of 3.6 V.

Then follow the instructions below.

Measuring RX I/Q signals using RSSI reading

Start Phoenix Service Software and open FBUS connection.

Select	Scan Product	Ctrl-R

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

Set operating mode to local mode

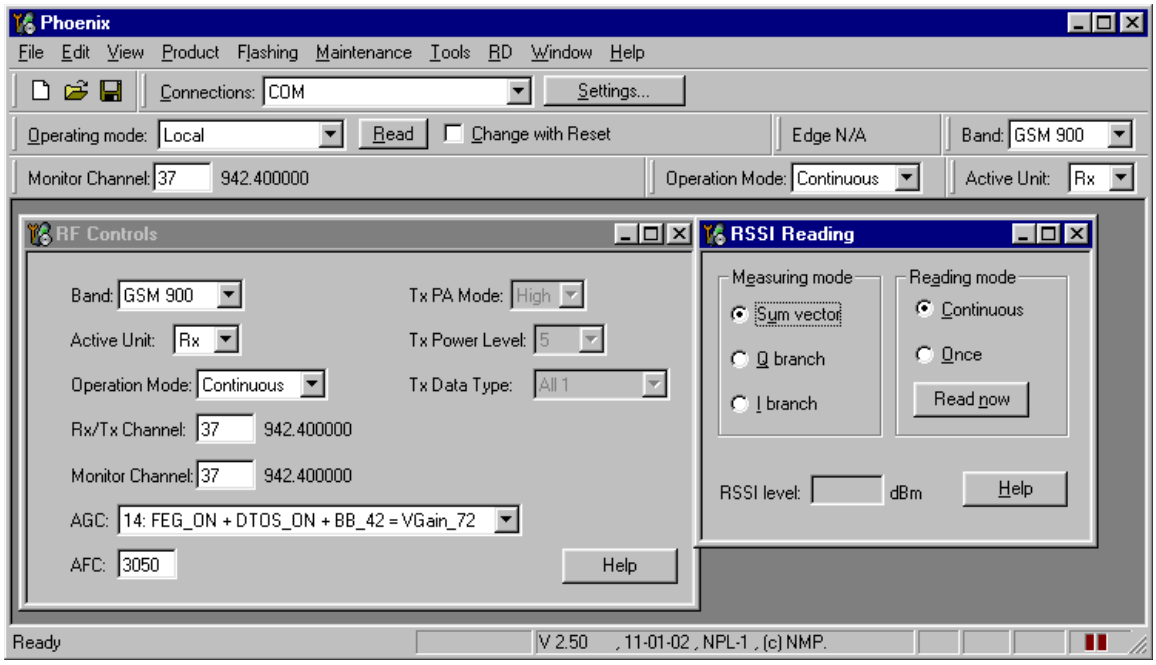
Select	Maintenance		Alt-M
	Testing		T
		RF Controls	F

Wait until the RF Controls window pops up

Select	Band	GSM 900 or GMS1800 or GSM1900
	Active unit	RX
	Operation mode	**Burst**
	RX/TX Channel	37 or 700 or 661

Select	Maintenance		Alt-M
	Testing		T
		RSSI reading	R

The setup should now look like this:



Apply a signal with a frequency of

EGSM:	942.46771 MHz (channel 37 + 67.710kHz offset)
GSM1800:	1842.86771 MHz (channel 700 + 67.710kHz offset)
GSM1900:	1960.06771 MHz (channel 661 + 67.710kHz offset)

and a power level of – **80dBm** to the antenna connector/test jig (remember to compensate for cable and jig attenuation).

In RSSI reading click on Read now.

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

Measuring RX performance using SNR measurement

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.

Set operating mode to local mode.

Select	Maintenance		Alt-M
	Testing		T
		RF Controls	F

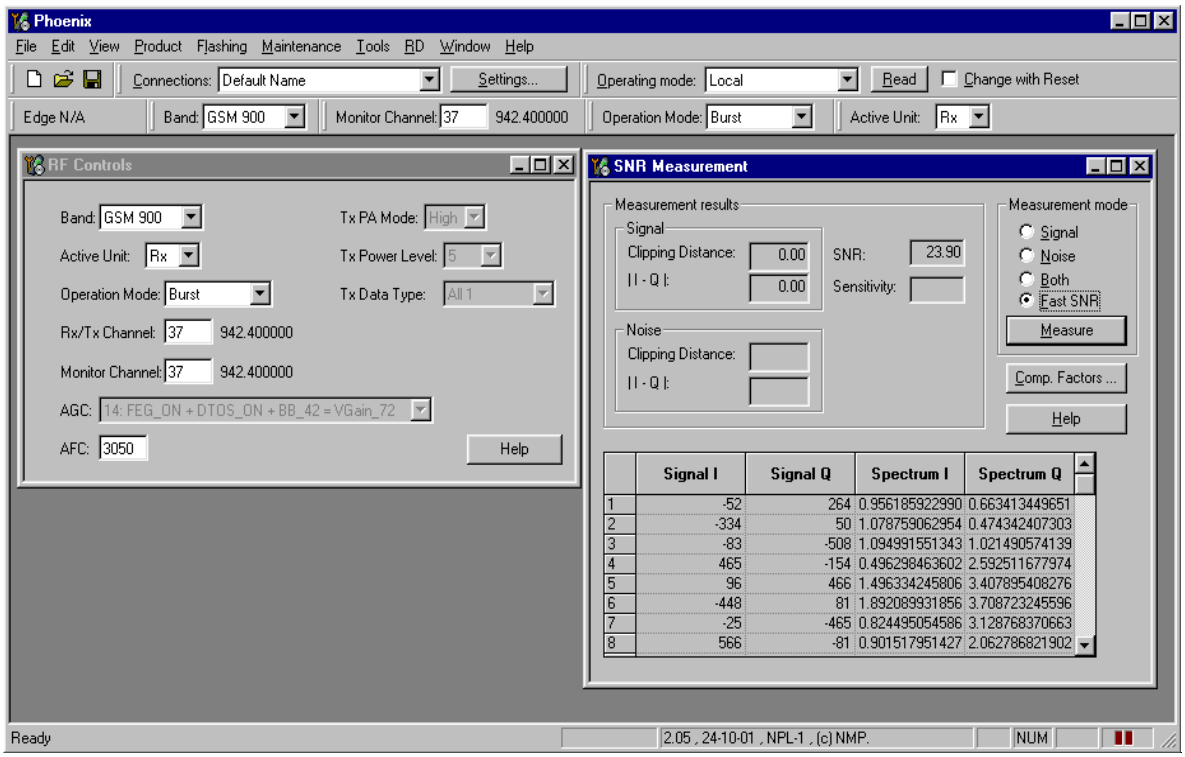
Wait until the RF Controls window pops up.

Select	Band	GSM 900 or GMS1800 or GSM1900
	Active unit	RX
	Operation mode	**Burst**
	RX/TX Channel	37 or 700 or 661

Select	Maintenance		Alt-M
	Testing		T
		SNR Measurement	M

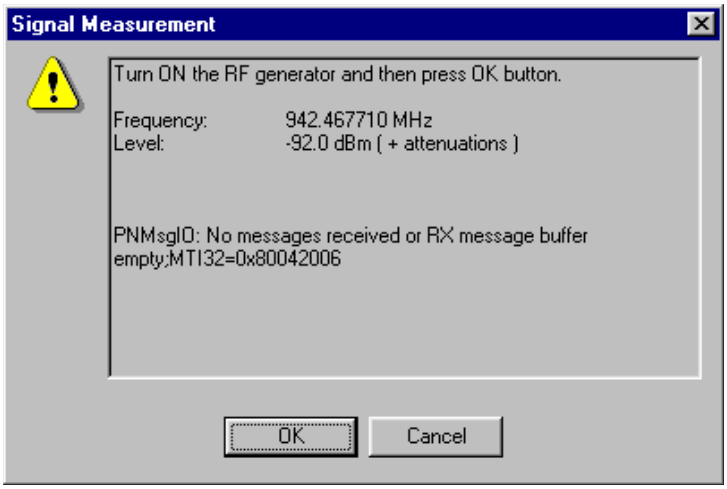
Select	Fast SNR (Radio Button)	

The setup should now look like this:



Choose respective band (EGSM900, GSM1800, GSM1900).

Press measure. A window pops up, e.g. for EGSM900 band:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses.

Press ok and the window closes.

Read the SNR result. SNR should be:

EGM900 >20dB
GSM1800 >18dB
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 a resistive probe (50Ohm semi-rigid cable).

Start Phoenix Service Software and open FBUS connection.

Select	Scan Product	Ctrl-R

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

Set operating mode to local mode.

Select	Maintenance	Alt-M
	Testing	T
	RF Controls	F

Wait until the RF Controls window pops up

Select	Band	GSM 900 or GMS1800 or GSM1900
	Active unit	RX
	Operation mode	**Continuous**
	RX/TX Channel	37 or 700 or 661

Please refer to the fault finding chart 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 exist dedicated test points for RX I and Q signals. Input level = -80dBm.

Start Phoenix Service Software and open FBUS connection.

Select	Scan Product	Ctrl-R

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

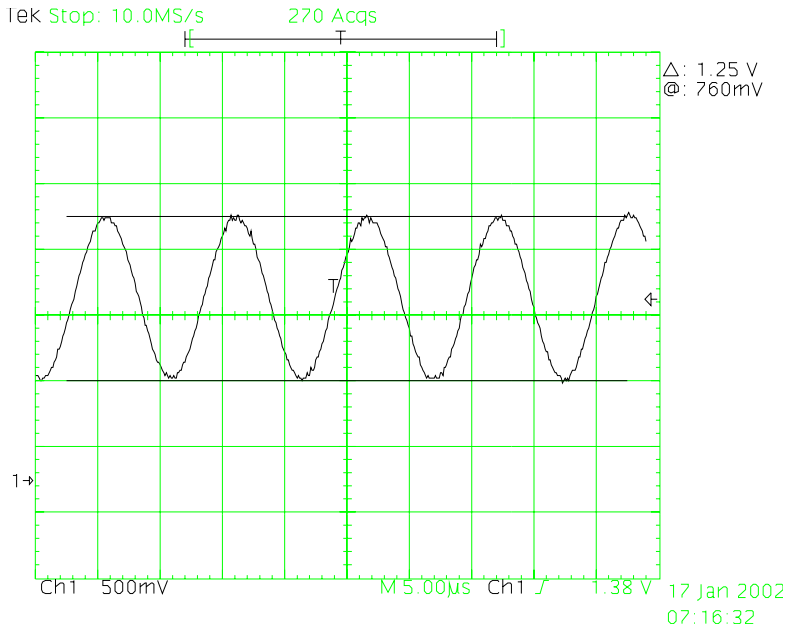
Set operating mode to local mode.

Select	Maintenance	Alt-M
	Testing	T
	RF Controls	F

Wait until the RF Controls window pops up.

Select	Band	GSM 900 or GMS1800 or GSM1900
	Active unit	RX
	Operation mode	**continuous**
	RX/TX Channel	37 or 700 or 661
	AGC	14

Following picture should be seen on a working EGSM receiver:



Signal amplitude	1.25V
DC offset	1,35V
Frequency	67kHz

Transmitter Description and Troubleshooting

TX signal paths

For easy error tracking it is important to know the signal paths of the transmitter. The components can be grouped into blocks and drawn as shown below.

Note that the picture shows both EGSM900 transmitter (bottom) and GSM1800/ GSM1900 transmitter (top).

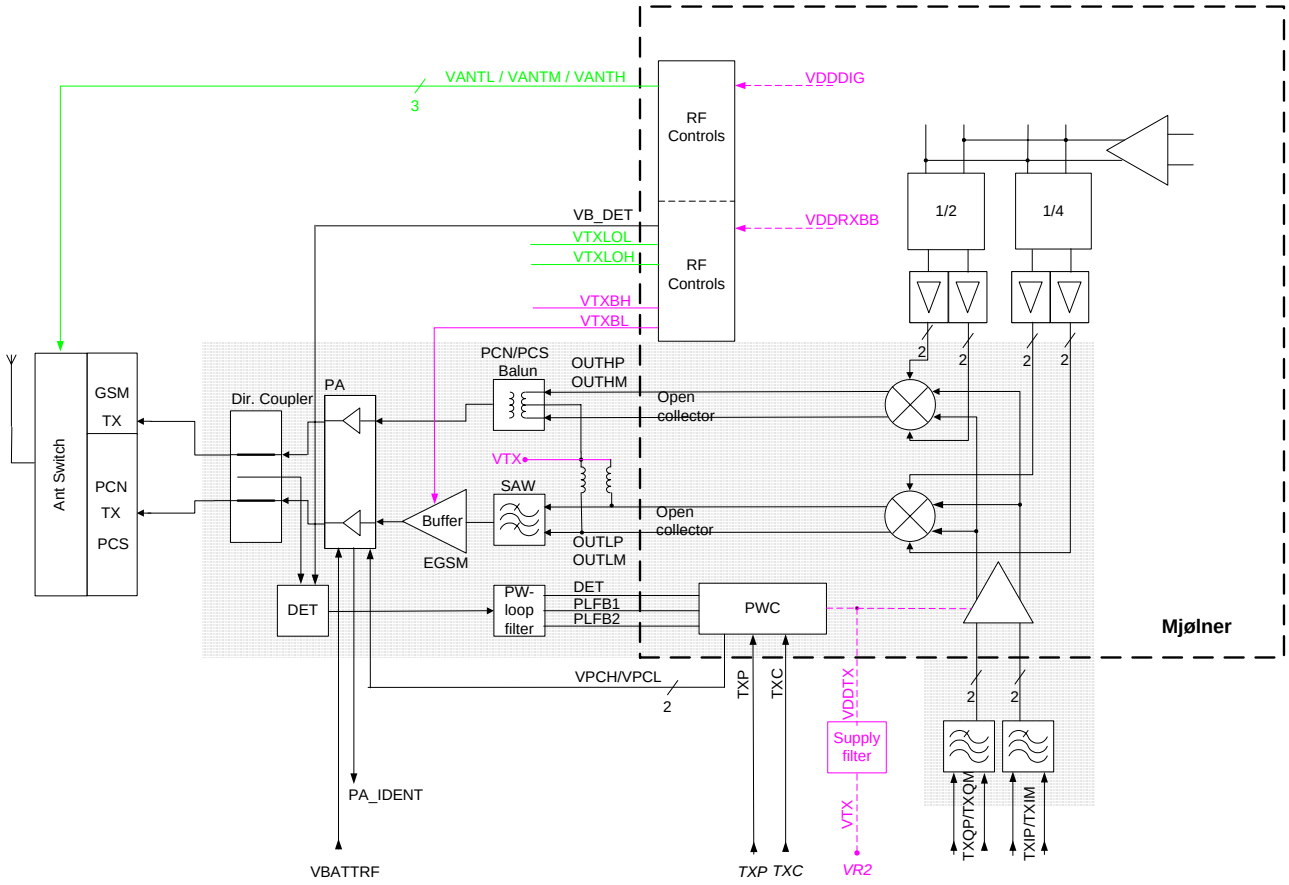


Figure 9: Transmitter signal paths

EGSM900 TX path

The balanced TX signal is provided by the baseband and is coming to the **Mjoelner RF ASIC**. The TX paths of the Mjoelner RF ASIC include mainly two RF modulators for up-conversion of the baseband signals, one for EGSM900 and one common for GSM1800/ GSM1900. The baseband signal is modulated with the LO signal corresponding to the wanted TX channel. The GSM TX output of the Mjoelner RF ASIC is a balanced signal.

From the output of the Mjoelner RF ASIC the signal is fed through the **EGSM TX SAW filter** (balanced to single ended), a 3dB pad, and the **900 MHz buffer** to the EGSM input of the **power amplifier (PA).**

The PA EGSM900 part has a maximum output power of app. 35dBm. Voltage supply is coming directly from the battery connectors.

The EGSM900 output is controlled by the power control loop. From the EGSM900 output of the PA the RF signal is fed through the directional coupler (one of the power control loop components) to the **antenna switch**.

GSM1800 and GSM 1900 TX path

The balanced TX signal from baseband is coming to the **Mjoelner RF ASIC**. The GSM1800 path of Mjoelner RF ASIC includes an common RF modulator for GSM1800 and GSM1900. The BB signal is up-converted with the LO signal corresponding to the wanted TX channel. The GSM1800/GSM1900 TX output of Mjoelner RF ASIC is a balanced signal.

From the balanced output of Mjoelner RF ASIC the signal is fed through the **TX balun** (T701) (balanced to single ended) and a 3dB pad to the GSM1800/1900 input of the **power amplifier (PA)**.

The GSM1800/GSM1900 part of the PA has a maximum output of app. 33dBm. The supply is coming directly from the battery terminals.

The output is controlled by the power control loop. From the output of the PA the signal goes through the directional coupler (one of the power control loop components) to the **antenna switch**.

Antenna switch (TX/RX switch)

The antenna Switch works 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 CONT1, CONT2 and CONT3.

The following table shows the possible different states.

CONT1 [Volt]	CONT2 [Volt]	CONT3 [Volt]	EGSM RX	DCS RX	PCS RX	EGSM TX	DCS/PCS TX
0	0	0	X				
0	0	0		X			
0	0	2.7				X	
0	2.7	0			X		X
2.7	0	0					X

General instructions for TX troubleshooting

Apply a RF cable to the test jig to allow the transmitted signal to act as normal. The RF cable should be connected to the measurement equipment (GSM test equipment, power meter, spectrum analyzer, or similar).

Be sure to use at least a 10dB attenuator, otherwise the results may be incorrect.

1 Connect PC with Phoenix to phone module

2 Provide the phone with power supply (3.6V).

3 Start Phoenix Service Software and open FBUS connection.

4 Select Scan Product Ctrl-R
and wait until phone information is shown in the lower right corner of the screen.

Follow the instructions as given below.

EGSM900 TX troubleshooting

General instructions for EGSM900 TX troubleshooting

Start the investigations as described in section "General Instructions for TX Trouble-shooting".

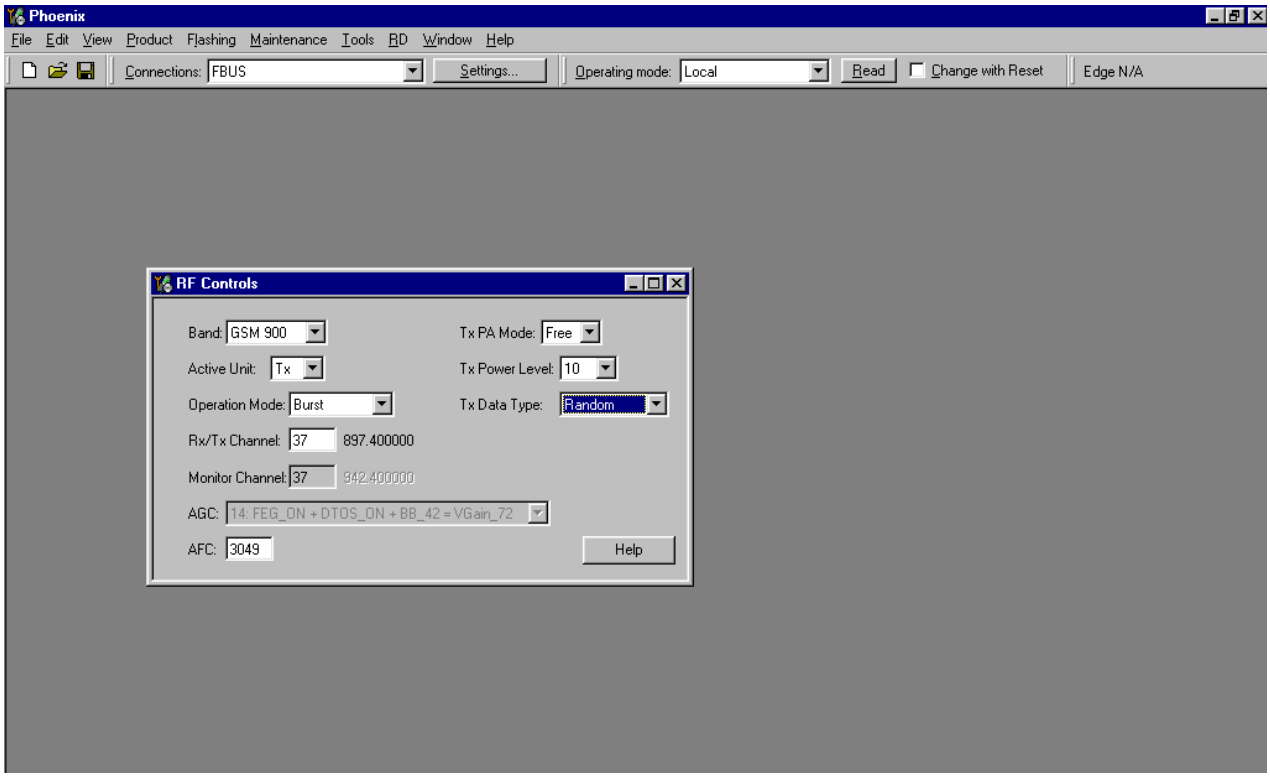
Set operating mode to local mode.

Select	Maintenance	Testing	RF Controls

Wait until the RF Controls window pops up

Select	Band	GSM 900
	Active unit	TX
	Operation mode	Burst
	RX/TX Channel	37
	TX PA Mode	Free
	TX Power Level	10
	TX Data Type	Random

The setup should now look like this:



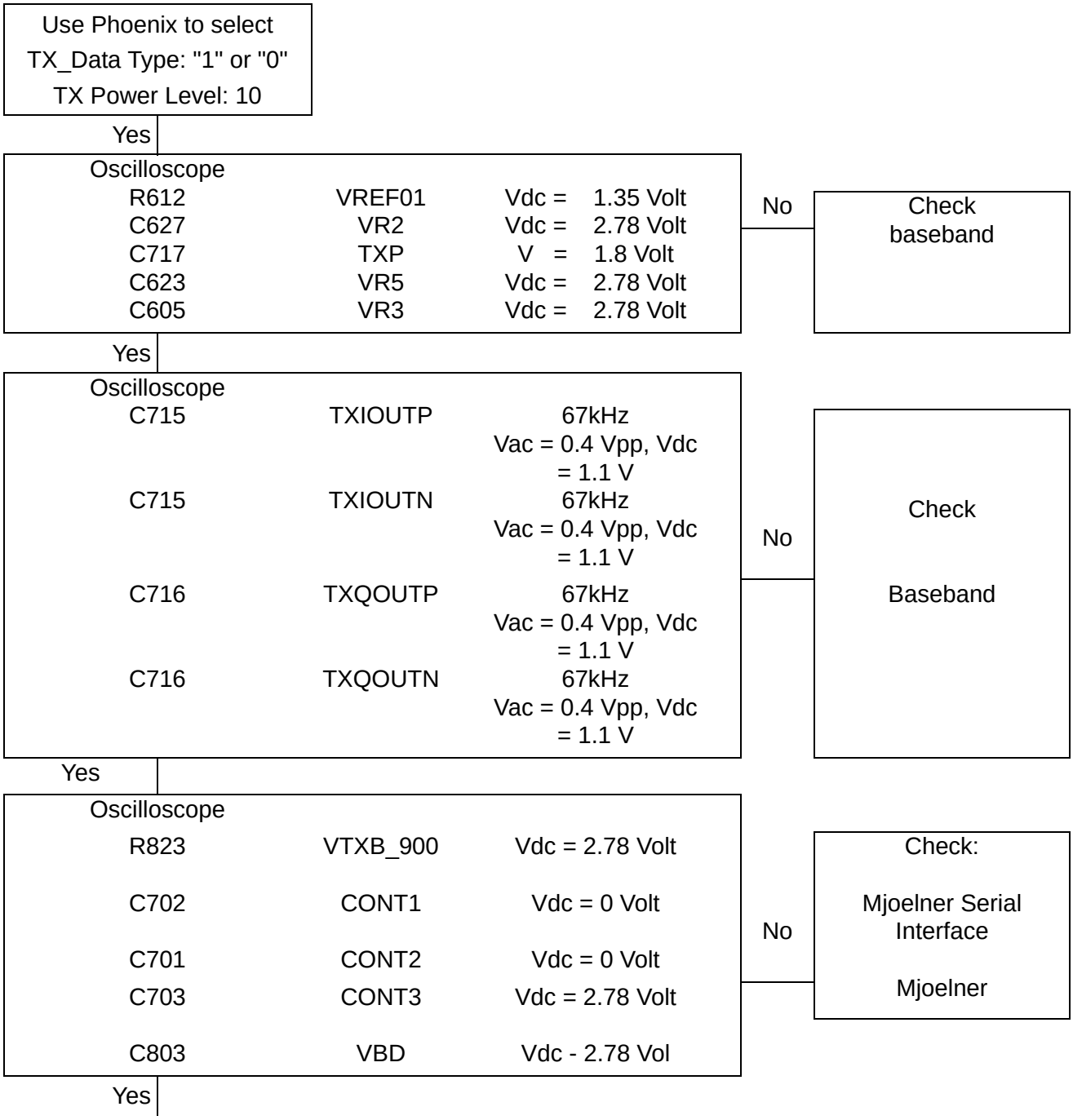
Now the measurement equipment should measure the following output signal from the phone:

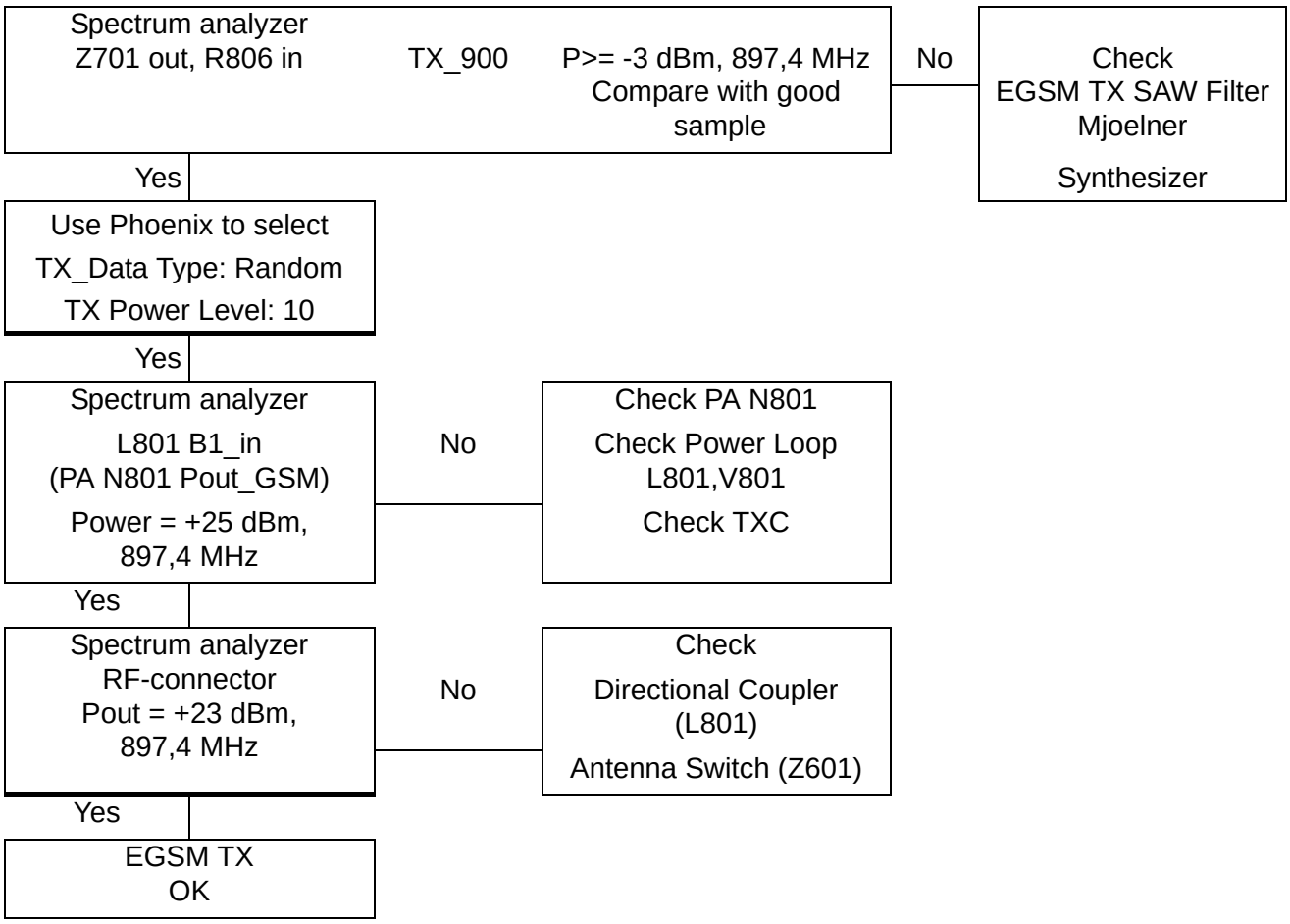
P_{out} = +23dBm @ 897.4MHz

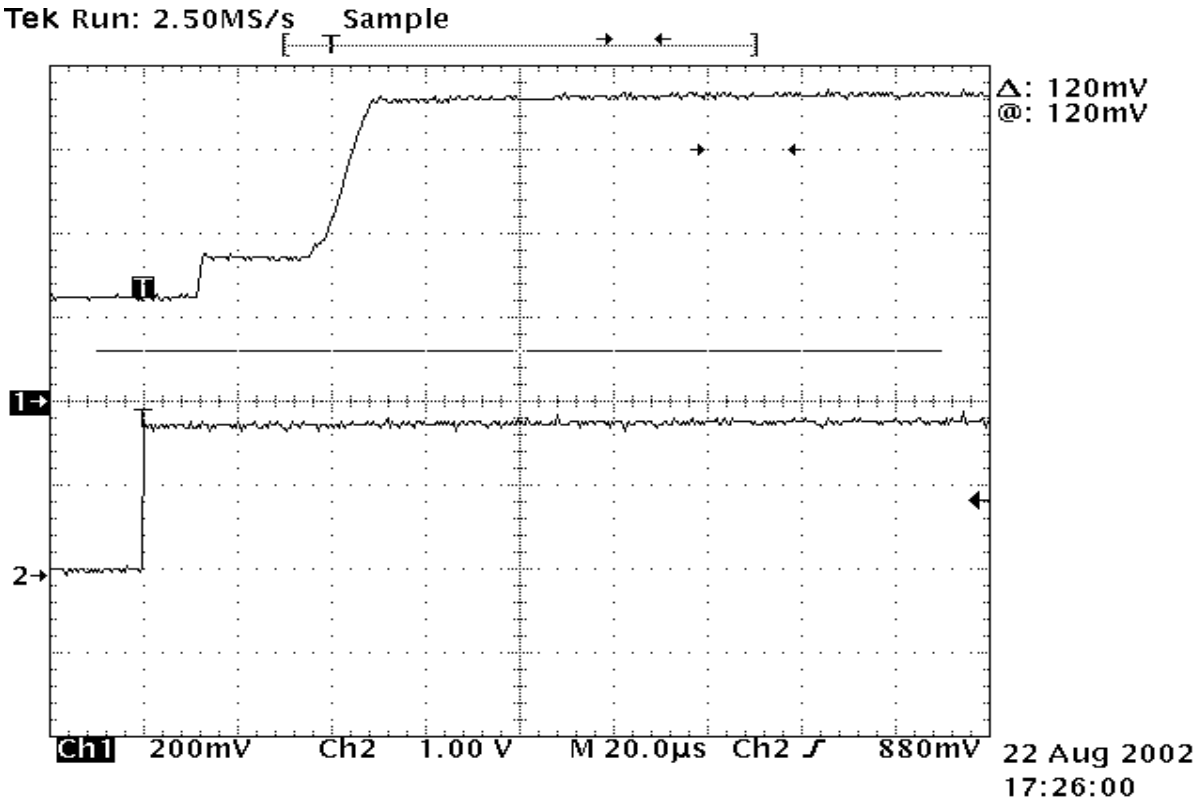
If this is not the case, then go to the next chapter for finding the fault.

Fault finding chart for EGSM900 transmitter

In following, it is assumed that the TXP signal is used as trigger-signal. For that a TXP test point is provided.







GSM1800 TX troubleshooting

Setup for GSM1800 TX troubleshooting

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

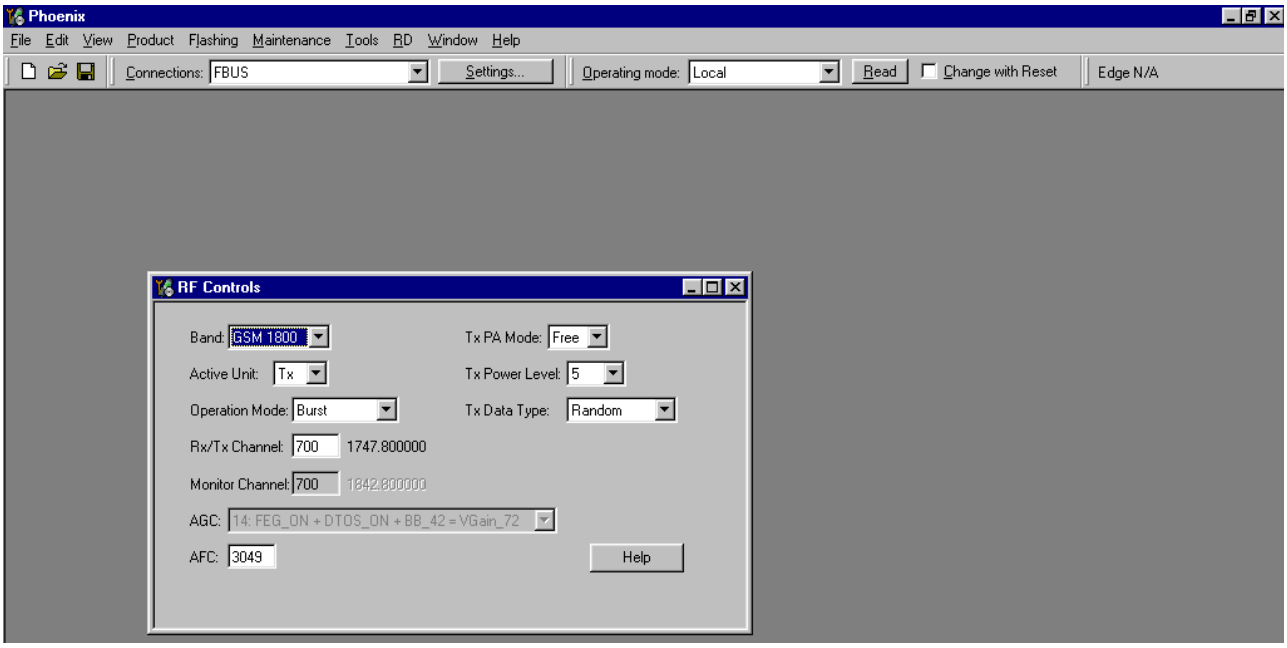
Set operating mode to local mode.

Select	Maintenance	Testing	RF Controls

Wait until the RF Controls window pops up.

Select	Band	GSM 1800
	Active unit	TX
	Operation mode	Burst
	RX/TX Channel	700
	TX PA Mode	Free
	TX Power Level	5
	TX Data Type	Random

The setup should now look like this:



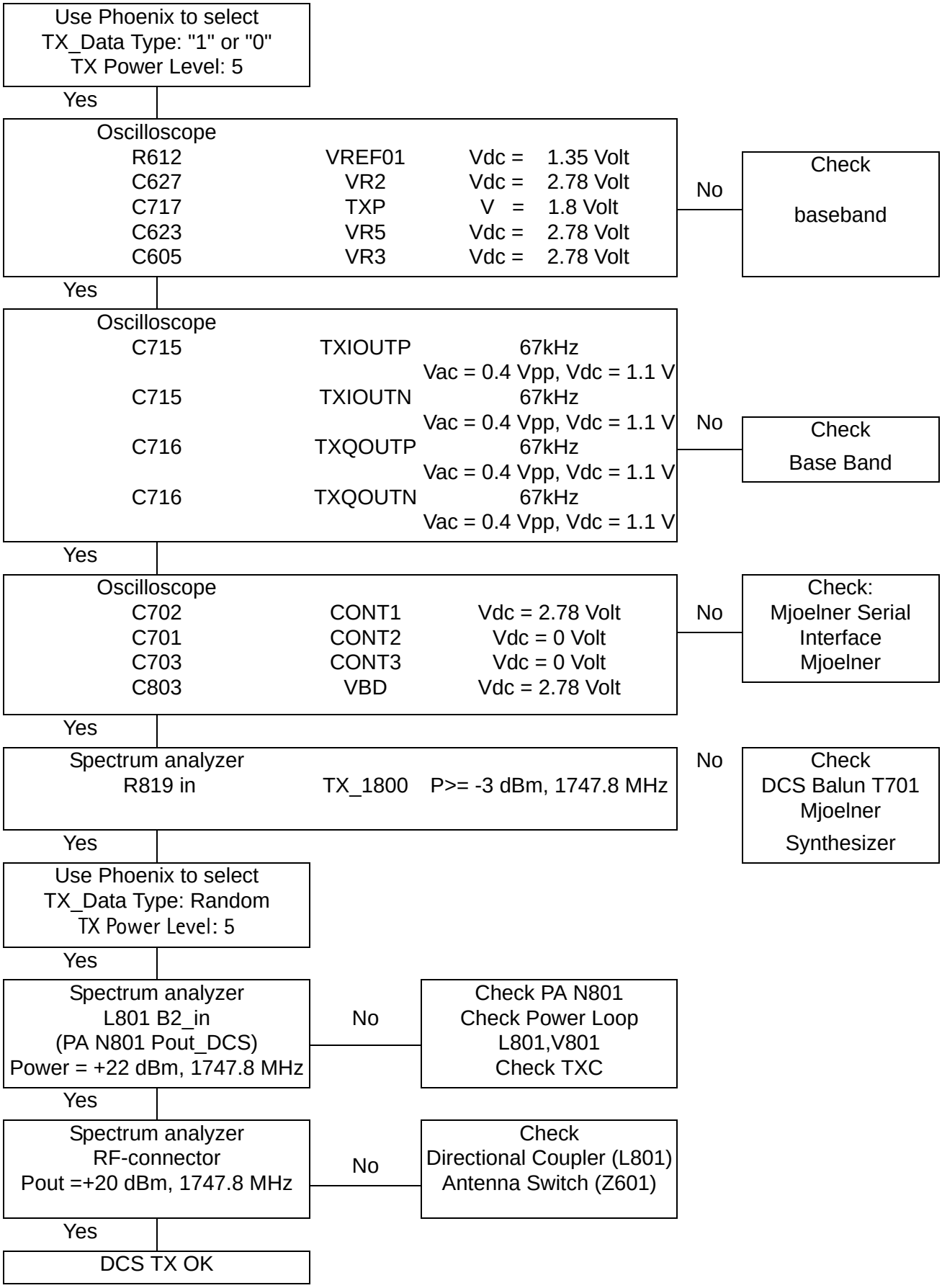
Now the measurement equipment should measure the following output signal from the phone.

P_{out} = +20dBm @ 1747.8MHz

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

Fault finding chart for GSM1800 transmitter

It is useful to use the TXP signal as trigger-signal It is provided at TXP test point.



GSM1900 TX troubleshooting

Setup for GSM1900 TX troubleshooting

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

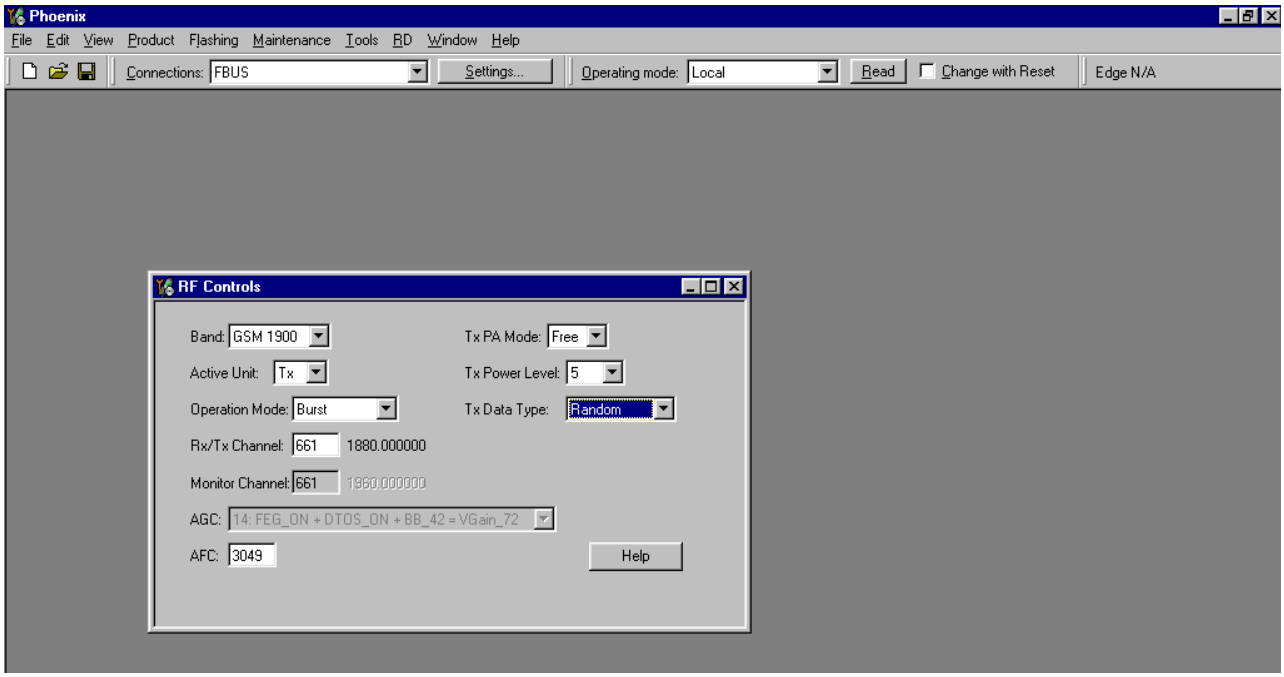
Set operating mode to local mode.

Select	Maintenance	Testing	RF Controls

Wait until the RF Controls window pops up

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

The setup should now look like this:



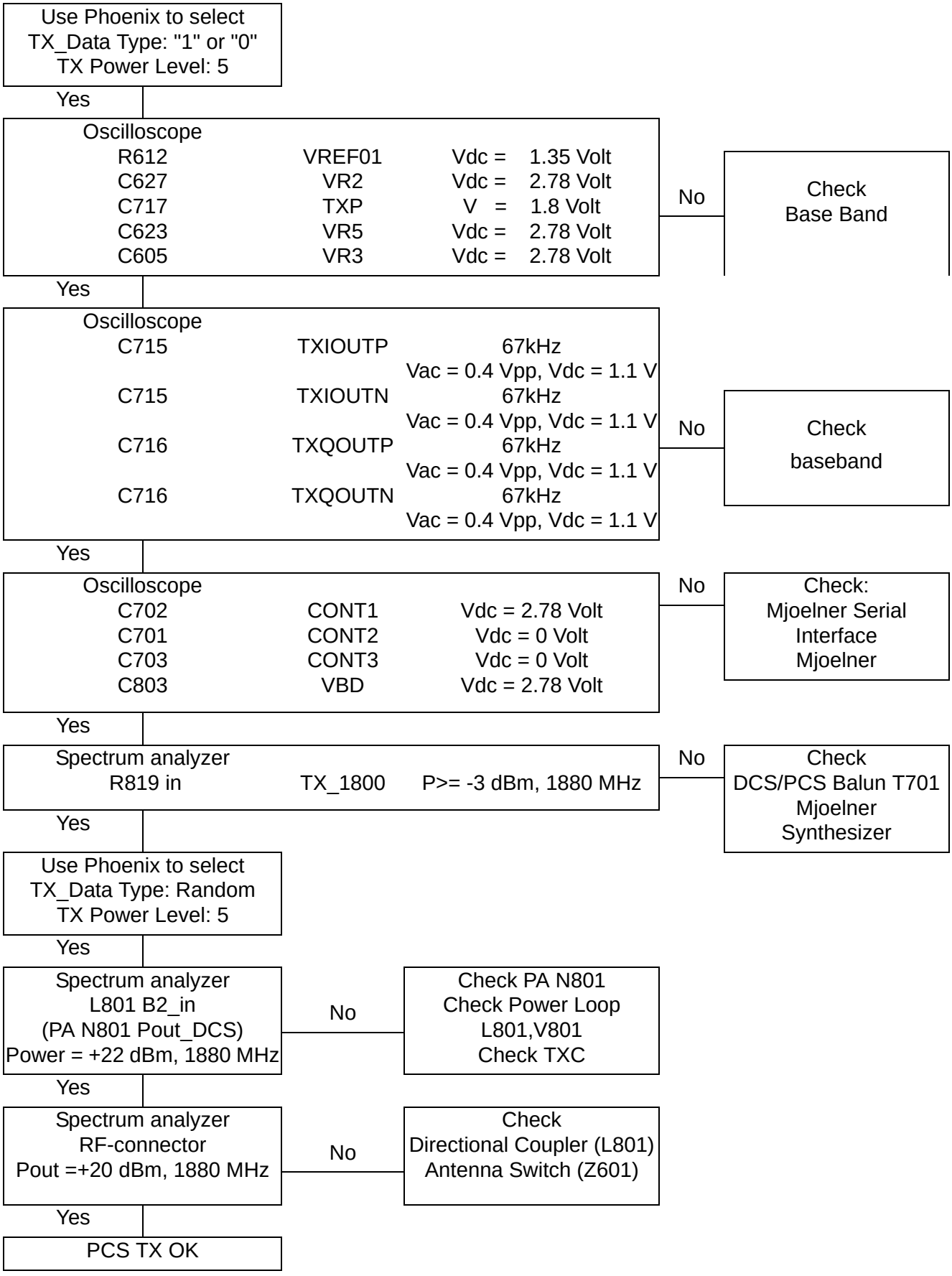
Now the measurement equipment should measure the following output signal from the phone.

P_{out} = +20dBm @ 1880MHz

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

Fault finding chart for GSM1900 transmitter

It is useful to use TXP signal as a trigger-signal. It is provided at TXP test point.



Synthesizer Description and Troubleshooting

One PLL synthesizer is generating all the required frequencies for both RX and TX and for all three bands (EGSM900, GSM1800 and GSM1900). The VCO frequency is divided by 2 or by 4 in Mjoelner depending on which band is active.

26 MHz Reference Oscillator (VCXO)

The 26 MHz reference oscillator (VCXO, Voltage Controlled Crystal Oscillator) is part of the Mjoelner RF-ASIC (N601). It uses an external 26 MHz crystal (B601) as external circuitry.

The reference oscillator has two functions:

- Reference frequency for the PLL synthesizer.
- System clock for BB (RFClk_I = 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 from 3420MHz to 3980MHz when the PLL is working. The frequency of the VCO signal is divided by 2 or by 4 in Mjoelner RF-ASIC. This way it is possible to generate the frequencies of all channels in EGSM900, GSM1800 and GSM1900 (both RX and TX).

The output frequency of the VCO is controlled by a DC voltage (Vc) coming from the PLL loop filter. The valid range of Vc when PLL is in function is 0.7V– 3.8V. The typical tuning sensitivity of the VCO is 240MHz/V. Even if the PLL is not working (Vc outside the valid range) there is a frequency at the output of the VCO, which is between 3 and 4 GHz (if the VCO itself is ok).

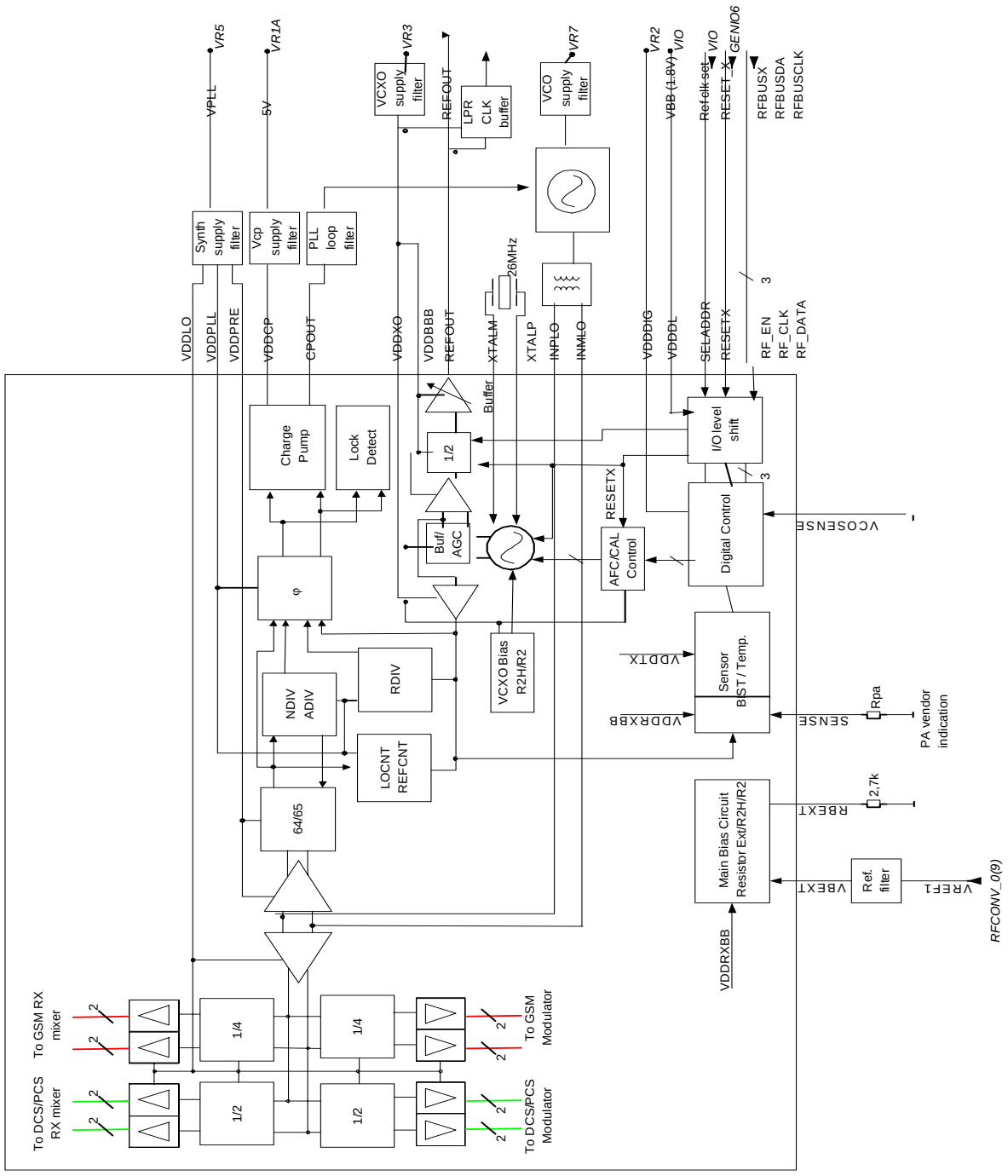


Figure 10: PLL Block Diagram

General instructions for synthesizer troubleshooting

Connect the phone to a PC with Phoenix to phone module.

Then follow the instructions below.

Check synthesizer operation

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.

Set operating mode to local mode.

Start RF Control window:

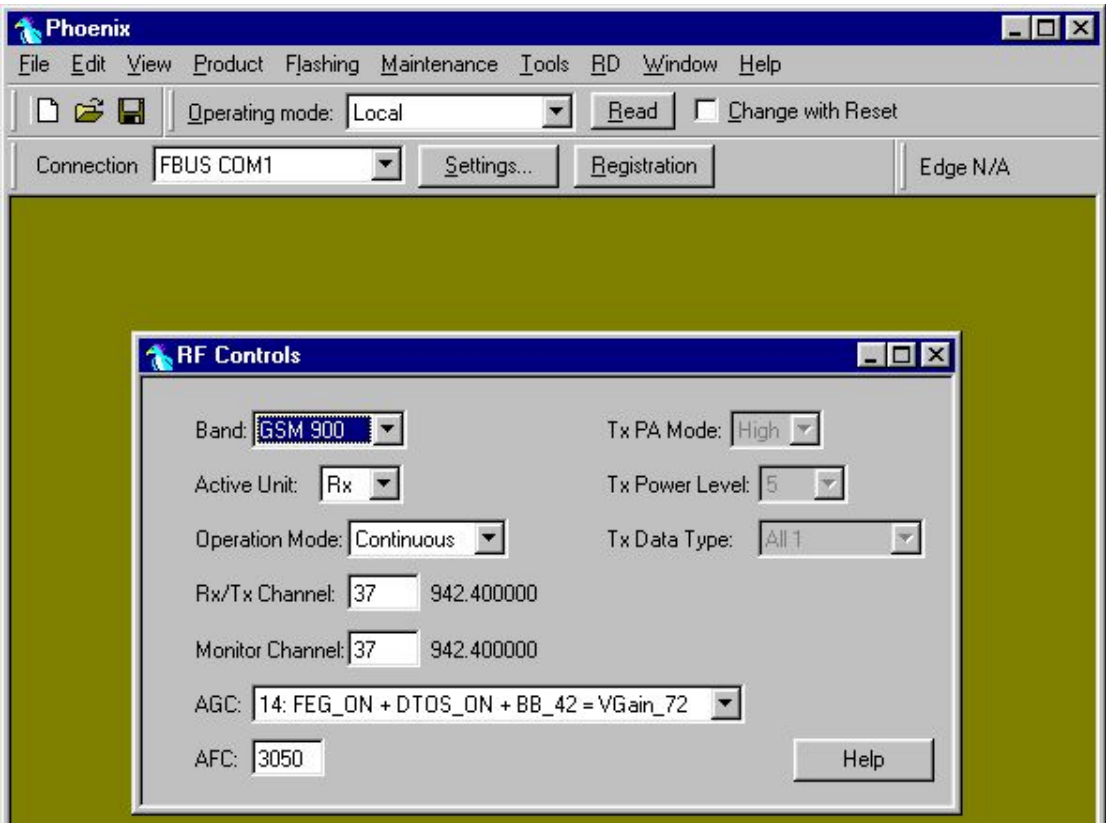
Select	Maintenance	Alt-M
	Tuning	T
	RF Controls	F

Wait until the RF Controls window pops up.

Set the synthesizer to the following mode:

Select	Band	GSM 900
	Active unit	RX
	Operation mode	Continuous
	RX/TX Channel	37

The setup should now look like this:



The frequency of 3769.6MHz at the output of the VCO (G701) is measured using a resistive probe and a spectrum analyzer.

It is possible to measure the tuning voltage at the Vc input of the VCO (C712) easily. For f_{VCO} = 3769.6MHz the tuning voltage should be **$2.3V_{DC}$ .. $2.8V_{DC}$** (Tuning sensitivity of VCO is 240MHz/V typ.).

If this is not the case, please refer to section "Fault finding chart for PLL Synthesizer" below.

Fault finding chart for PLL synthesizer

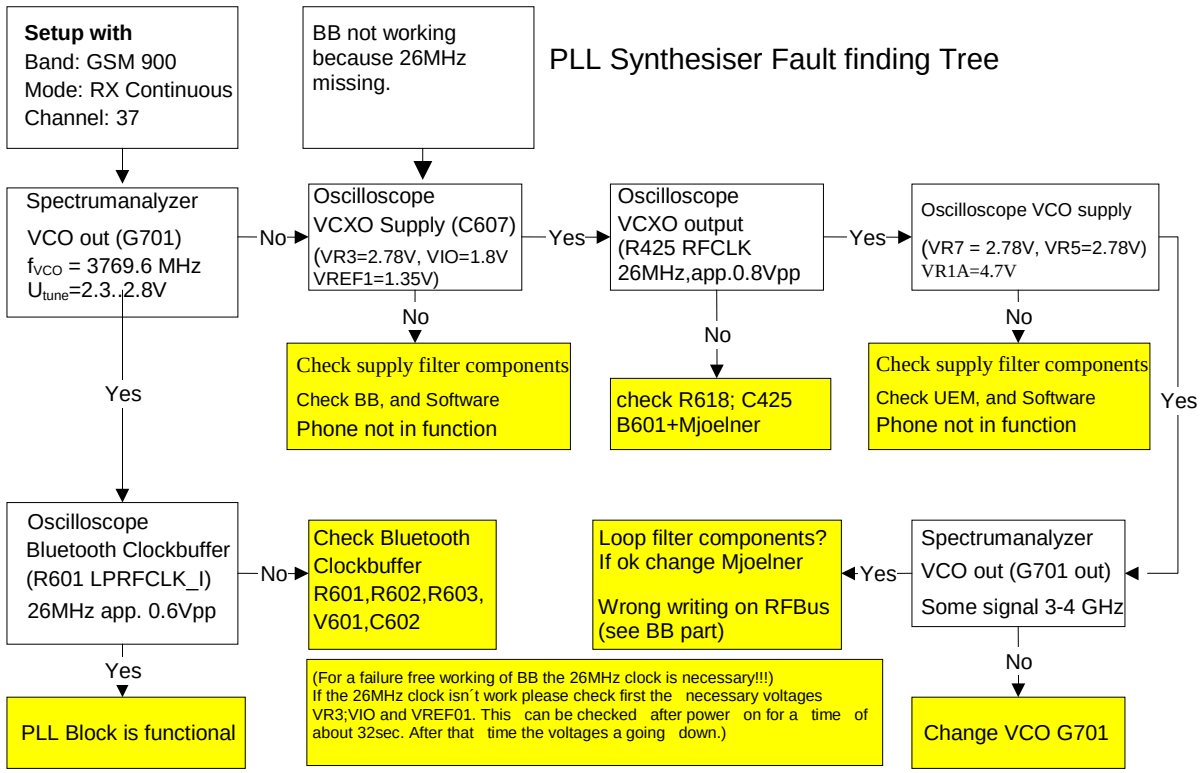


Figure 11: PLL Synthesizer Fault Finding Chart

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'.

Frequency Lists

EGSM900

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
975	880,2	925,2	3520,8	3700,8	1	890,2	935,2	3560,8	3740,8	63	902,6	947,6	3610,4	3790,4
976	880,4	925,4	3521,6	3701,6	2	890,4	935,4	3561,6	3741,6	64	902,8	947,8	3611,2	3791,2
977	880,6	925,6	3522,4	3702,4	3	890,6	935,6	3562,4	3742,4	65	903,0	948,0	3612,0	3792,0
978	880,8	925,8	3523,2	3703,2	4	890,8	935,8	3563,2	3743,2	66	903,2	948,2	3612,8	3792,8
979	881,0	926,0	3524,0	3704,0	5	891,0	936,0	3564,0	3744,0	67	903,4	948,4	3613,6	3793,6
980	881,2	926,2	3524,8	3704,8	6	891,2	936,2	3564,8	3744,8	68	903,6	948,6	3614,4	3794,4
981	881,4	926,4	3525,6	3705,6	7	891,4	936,4	3565,6	3745,6	69	903,8	948,8	3615,2	3795,2
982	881,6	926,6	3526,4	3706,4	8	891,6	936,6	3566,4	3746,4	70	904,0	949,0	3616,0	3796,0
983	881,8	926,8	3527,2	3707,2	9	891,8	936,8	3567,2	3747,2	71	904,2	949,2	3616,8	3796,8
984	882,0	927,0	3528,0	3708,0	10	892,0	937,0	3568,0	3748,0	72	904,4	949,4	3617,6	3797,6
985	882,2	927,2	3528,8	3708,8	11	892,2	937,2	3568,8	3748,8	73	904,6	949,6	3618,4	3798,4
986	882,4	927,4	3529,6	3709,6	12	892,4	937,4	3569,6	3749,6	74	904,8	949,8	3619,2	3799,2
987	882,6	927,6	3530,4	3710,4	13	892,6	937,6	3570,4	3750,4	75	905,0	950,0	3620,0	3800,0
988	882,8	927,8	3531,2	3711,2	14	892,8	937,8	3571,2	3751,2	76	905,2	950,2	3620,8	3800,8
989	883,0	928,0	3532,0	3712,0	15	893,0	938,0	3572,0	3752,0	77	905,4	950,4	3621,6	3801,6
990	883,2	928,2	3532,8	3712,8	16	893,2	938,2	3572,8	3752,8	78	905,6	950,6	3622,4	3802,4
991	883,4	928,4	3533,6	3713,6	17	893,4	938,4	3573,6	3753,6	79	905,8	950,8	3623,2	3803,2
992	883,6	928,6	3534,4	3714,4	18	893,6	938,6	3574,4	3754,4	80	906,0	951,0	3624,0	3804,0
993	883,8	928,8	3535,2	3715,2	19	893,8	938,8	3575,2	3755,2	81	906,2	951,2	3624,8	3804,8
994	884,0	929,0	3536,0	3716,0	20	894,0	939,0	3576,0	3756,0	82	906,4	951,4	3625,6	3805,6
995	884,2	929,2	3536,8	3716,8	21	894,2	939,2	3576,8	3756,8	83	906,6	951,6	3626,4	3806,4
996	884,4	929,4	3537,6	3717,6	22	894,4	939,4	3577,6	3757,6	84	906,8	951,8	3627,2	3807,2
997	884,6	929,6	3538,4	3718,4	23	894,6	939,6	3578,4	3758,4	85	907,0	952,0	3628,0	3808,0
998	884,8	929,8	3539,2	3719,2	24	894,8	939,8	3579,2	3759,2	86	907,2	952,2	3628,8	3808,8
999	885,0	930,0	3540,0	3720,0	25	895,0	940,0	3580,0	3760,0	87	907,4	952,4	3629,6	3809,6
1000	885,2	930,2	3540,8	3720,8	26	895,2	940,2	3580,8	3760,8	88	907,6	952,6	3630,4	3810,4
1001	885,4	930,4	3541,6	3721,6	27	895,4	940,4	3581,6	3761,6	89	907,8	952,8	3631,2	3811,2
1002	885,6	930,6	3542,4	3722,4	28	895,6	940,6	3582,4	3762,4	90	908,0	953,0	3632,0	3812,0
1003	885,8	930,8	3543,2	3723,2	29	895,8	940,8	3583,2	3763,2	91	908,2	953,2	3632,8	3812,8
1004	886,0	931,0	3544,0	3724,0	30	896,0	941,0	3584,0	3764,0	92	908,4	953,4	3633,6	3813,6
1005	886,2	931,2	3544,8	3724,8	31	896,2	941,2	3584,8	3764,8	93	908,6	953,6	3634,4	3814,4
1006	886,4	931,4	3545,6	3725,6	32	896,4	941,4	3585,6	3765,6	94	908,8	953,8	3635,2	3815,2
1007	886,6	931,6	3546,4	3726,4	33	896,6	941,6	3586,4	3766,4	95	909,0	954,0	3636,0	3816,0
1008	886,8	931,8	3547,2	3727,2	34	896,8	941,8	3587,2	3767,2	96	909,2	954,2	3636,8	3816,8
1009	887,0	932,0	3548,0	3728,0	35	897,0	942,0	3588,0	3768,0	97	909,4	954,4	3637,6	3817,6
1010	887,2	932,2	3548,8	3728,8	36	897,2	942,2	3588,8	3768,8	98	909,6	954,6	3638,4	3818,4
1011	887,4	932,4	3549,6	3729,6	37	897,4	942,4	3589,6	3769,6	99	909,8	954,8	3639,2	3819,2
1012	887,6	932,6	3550,4	3730,4	38	897,6	942,6	3590,4	3770,4	100	910,0	955,0	3640,0	3820,0
1013	887,8	932,8	3551,2	3731,2	39	897,8	942,8	3591,2	3771,2	101	910,2	955,2	3640,8	3820,8
1014	888,0	933,0	3552,0	3732,0	40	898,0	943,0	3592,0	3772,0	102	910,4	955,4	3641,6	3821,6
1015	888,2	933,2	3552,8	3732,8	41	898,2	943,2	3592,8	3772,8	103	910,6	955,6	3642,4	3822,4
1016	888,4	933,4	3553,6	3733,6	42	898,4	943,4	3593,6	3773,6	104	910,8	955,8	3643,2	3823,2
1017	888,6	933,6	3554,4	3734,4	43	898,6	943,6	3594,4	3774,4	105	911,0	956,0	3644,0	3824,0
1018	888,8	933,8	3555,2	3735,2	44	898,8	943,8	3595,2	3775,2	106	911,2	956,2	3644,8	3824,8
1019	889,0	934,0	3556,0	3736,0	45	899,0	944,0	3596,0	3776,0	107	911,4	956,4	3645,6	3825,6
1020	889,2	934,2	3556,8	3736,8	46	899,2	944,2	3596,8	3776,8	108	911,6	956,6	3646,4	3826,4
1021	889,4	934,4	3557,6	3737,6	47	899,4	944,4	3597,6	3777,6	109	911,8	956,8	3647,2	3827,2
1022	889,6	934,6	3558,4	3738,4	48	899,6	944,6	3598,4	3778,4	110	912,0	957,0	3648,0	3828,0
1023	889,8	934,8	3559,2	3739,2	49	899,8	944,8	3599,2	3779,2	111	912,2	957,2	3648,8	3828,8
0	890,0	935,0	3560,0	3740,0	50	900,0	945,0	3600,0	3780,0	112	912,4	957,4	3649,6	3829,6
					51	900,2	945,2	3600,8	3780,8	113	912,6	957,6	3650,4	3830,4
					52	900,4	945,4	3601,6	3781,6	114	912,8	957,8	3651,2	3831,2
					53	900,6	945,6	3602,4	3782,4	115	913,0	958,0	3652,0	3832,0
					54	900,8	945,8	3603,2	3783,2	116	913,2	958,2	3652,8	3832,8
					55	901,0	946,0	3604,0	3784,0	117	913,4	958,4	3653,6	3833,6
					56	901,2	946,2	3604,8	3784,8	118	913,6	958,6	3654,4	3834,4
					57	901,4	946,4	3605,6	3785,6	119	913,8	958,8	3655,2	3835,2
					58	901,6	946,6	3606,4	3786,4	120	914,0	959,0	3656,0	3836,0
					59	901,8	946,8	3607,2	3787,2	121	914,2	959,2	3656,8	3836,8
					60	902,0	947,0	3608,0	3788,0	122	914,4	959,4	3657,6	3837,6
					61	902,2	947,2	3608,8	3788,8	123	914,6	959,6	3658,4	3838,4
					62	902,4	947,4	3609,6	3789,6	124	914,8	959,8	3659,2	3839,2

GSM1800

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	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	794	1766.6	1861.6	3533.2	3723.2
513	1710.4	1805.4	6841.6	7221.6	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	795	1766.8	1861.8	3533.6	3723.6
514	1710.6	1805.6	6842.4	7222.4	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	796	1767.0	1862.0	3534.0	3724.0
515	1710.8	1805.8	6843.2	7223.2	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	797	1767.2	1862.2	3534.4	3724.4
516	1711.0	1806.0	6844.0	7224.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	798	1767.4	1862.4	3534.8	3724.8
517	1711.2	1806.2	6844.8	7224.8	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	799	1767.6	1862.6	3535.2	3725.2
518	1711.4	1806.4	6845.6	7225.6	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	800	1767.8	1862.8	3535.6	3725.6
519	1711.6	1806.6	6846.4	7226.4	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	801	1768.0	1863.0	3536.0	3726.0
520	1711.8	1806.8	6847.2	7227.2	614	1730.6	1825.6	3461.2	3651.2	708	1749.4	1844.4	3498.8	3688.8	802	1768.2	1863.2	3536.4	3726.4
521	1712.0	1807.0	6848.0	7228.0	615	1730.8	1825.8	3461.6	3651.6	709	1749.6	1844.6	3499.2	3689.2	803	1768.4	1863.4	3536.8	3726.8
522	1712.2	1807.2	6848.8	7228.8	616	1731.0	1826.0	3462.0	3652.0	710	1749.8	1844.8	3499.6	3689.6	804	1768.6	1863.6	3537.2	3727.2
523	1712.4	1807.4	6849.6	7229.6	617	1731.2	1826.2	3462.4	3652.4	711	1750.0	1845.0	3500.0	3690.0	805	1768.8	1863.8	3537.6	3727.6
524	1712.6	1807.6	6850.4	7230.4	618	1731.4	1826.4	3462.8	3652.8	712	1750.2	1845.2	3500.4	3690.4	806	1769.0	1864.0	3538.0	3728.0
525	1712.8	1807.8	6851.2	7231.2	619	1731.6	1826.6	3463.2	3653.2	713	1750.4	1845.4	3500.8	3690.8	807	1769.2	1864.2	3538.4	3728.4
526	1713.0	1808.0	6852.0	7232.0	620	1731.8	1826.8	3463.6	3653.6	714	1750.6	1845.6	3501.2	3691.2	808	1769.4	1864.4	3538.8	3728.8
527	1713.2	1808.2	6852.8	7232.8	621	1732.0	1827.0	3464.0	3654.0	715	1750.8	1845.8	3501.6	3691.6	809	1769.6	1864.6	3539.2	3729.2
528	1713.4	1808.4	6853.6	7233.6	622	1732.2	1827.2	3464.4	3654.4	716	1751.0	1846.0	3502.0	3692.0	810	1769.8	1864.8	3539.6	3729.6
529	1713.6	1808.6	6854.4	7234.4	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	811	1770.0	1865.0	3540.0	3730.0
530	1713.8	1808.8	6855.2	7235.2	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	812	1770.2	1865.2	3540.4	3730.4
531	1714.0	1809.0	6856.0	7236.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	813	1770.4	1865.4	3540.8	3730.8
532	1714.2	1809.2	6856.8	7236.8	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	814	1770.6	1865.6	3541.2	3731.2
533	1714.4	1809.4	6857.6	7237.6	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	815	1770.8	1865.8	3541.6	3731.6
534	1714.6	1809.6	6858.4	7238.4	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	816	1771.0	1866.0	3542.0	3732.0
535	1714.8	1809.8	6859.2	7239.2	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	817	1771.2	1866.2	3542.4	3732.4
536	1715.0	1810.0	6860.0	7240.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	818	1771.4	1866.4	3542.8	3732.8
537	1715.2	1810.2	6860.8	7240.8	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	819	1771.6	1866.6	3543.2	3733.2
538	1715.4	1810.4	6861.6	7241.6	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	820	1771.8	1866.8	3543.6	3733.6
539	1715.6	1810.6	6862.4	7242.4	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	821	1772.0	1867.0	3544.0	3734.0
540	1715.8	1810.8	6863.2	7243.2	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	822	1772.2	1867.2	3544.4	3734.4
541	1716.0	1811.0	6864.0	7244.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	823	1772.4	1867.4	3544.8	3734.8
542	1716.2	1811.2	6864.8	7244.8	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	824	1772.6	1867.6	3545.2	3735.2
543	1716.4	1811.4	6865.6	7245.6	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	825	1772.8	1867.8	3545.6	3735.6
544	1716.6	1811.6	6866.4	7246.4	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	826	1773.0	1868.0	3546.0	3736.0
545	1716.8	1811.8	6867.2	7247.2	639	1735.6	1830.6	3471.2	3661.2	733	1754.4	1849.4	3508.8	3698.8	827	1773.2	1868.2	3546.4	3736.4
546	1717.0	1812.0	6868.0	7248.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	828	1773.4	1868.4	3546.8	3736.8
547	1717.2	1812.2	6868.8	7248.8	641	1736.0	1831.0	3472.0	3662.0	735	1754.8	1849.8	3509.6	3699.6	829	1773.6	1868.6	3547.2	3737.2
548	1717.4	1812.4	6869.6	7249.6	642	1736.2	1831.2	3472.4	3662.4	736	1755.0	1850.0	3510.0	3700.0	830	1773.8	1868.8	3547.6	3737.6
549	1717.6	1812.6	6870.4	7250.4	643	1736.4	1831.4	3472.8	3662.8	737	1755.2	1850.2	3510.4	3700.4	831	1774.0	1869.0	3548.0	3738.0
550	1717.8	1812.8	6871.2	7251.2	644	1736.6	1831.6	3473.2	3663.2	738	1755.4	1850.4	3510.8	3700.8	832	1774.2	1869.2	3548.4	3738.4
551	1718.0	1813.0	6872.0	7252.0	645	1736.8	1831.8	3473.6	3663.6	739	1755.6	1850.6	3511.2	3701.2	833	1774.4	1869.4	3548.8	3738.8
552	1718.2	1813.2	6872.8	7252.8	646	1737.0	1832.0	3474.0	3664.0	740	1755.8	1850.8	3511.6	3701.6	834	1774.6	1869.6	3549.2	3739.2
553	1718.4	1813.4	6873.6	7253.6	647	1737.2	1832.2	3474.4	3664.4	741	1756.0	1851.0	3512.0	3702.0	835	1774.8	1869.8	3549.6	3739.6
554	1718.6	1813.6	6874.4	7254.4	648	1737.4	1832.4	3474.8	3664.8	742	1756.2	1851.2	3512.4	3702.4	836	1775.0	1870.0	3550.0	3740.0
555	1718.8	1813.8	6875.2	7255.2	649	1737.6	1832.6	3475.2	3665.2	743	1756.4	1851.4	3512.8	3702.8	837	1775.2	1870.2	3550.4	3740.4
556	1719.0	1814.0	6876.0	7256.0	650	1737.8	1832.8	3475.6	3665.6	744	1756.6	1851.6	3513.2	3703.2	838	1775.4	1870.4	3550.8	3740.8
557	1719.2	1814.2	6876.8	7256.8	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	839	1775.6	1870.6	3551.2	3741.2
558	1719.4	1814.4	6877.6	7257.6	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	840	1775.8	1870.8	3551.6	3741.6
559	1719.6	1814.6	6878.4	7258.4	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	841	1776.0	1871.0	3552.0	3742.0
560	1719.8	1814.8	6879.2	7259.2	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	842	1776.2	1871.2	3552.4	3742.4
561	1720.0	1815.0	6880.0	7260.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	843	1776.4	1871.4	3552.8	3742.8
562	1720.2	1815.2	6880.8	7260.8	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	844	1776.6	1871.6	3553.2	3743.2
563	1720.4	1815.4	6881.6	7261.6	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	845	1776.8	1871.8	3553.6	3743.6
564	1720.6	1815.6	6882.4	7262.4	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	846	1777.0	1872.0	3554.0	3744.0
565	1720.8	1815.8	6883.2	7263.2	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	847	1777.2	1872.2	3554.4	3744.4
566	1721.0	1816.0	6884.0	7264.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	848	1777.4	1872.4	3554.8	3744.8
567	1721.2	1816.2	6884.8	7264.8	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	849	1777.6	1872.6	3555.2	3745.2
568	1721.4	1816.4	6885.6	7265.6	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	850	1777.8	1872.8	3555.6	3745.6
569	1721.6	1816.6	6886.4	7266.4	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	851	1778.0	1873.0	3556.0	3746.0
570	1721.8	1816.8	6887.2	7267.2	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4
571	1722.0	1817.0	6888.0	7268.0	665	1740.8	1835.8	3481.6	3671.6	759	1759.6	1854.6	3519.2	3709.2	853	1778.4	1873.4	3556.8	3746.8
572	1722.2	1817.2	6888.8	7268.8	666	1741.0	1836.0	3482.0	3672.0	760	1759.8	1854.8	3519.6	3709.6	854	1778.6	1873.6	3557.2	3747.2
573	1722.4	1817.4	6889.6	7269.6	667	1741.2	1836.2	3482.4	3672.4	761	1760.0	1855.0	3520.0	3710.0	855	1778.8	1873.8	3557.6	3747.6
574	1722.6	1817.6	6890.4	7270.4	668	1741.4	1836.4	3482.8	3672.8	762	1760.2	1855.2	3520.4	3710.4	856	1779.0	1874.0	3558.0	3748.0
575	1722,8	1817,8	6891,2	7271,2	669	1741,6	1836,6	3483,2	3673,2	763	1760,4	1855,4	3520,8	3710,8	857	1779,2	1874,2	3558,4	3748,4
576	1723,0	1818,0	6892,0	7272,0	670	1741,8	1836,8	3483,6	3673,6	764	1760,6	1855,6	3521,2	3711,2	858	1779,4	1874,4	3558,8	3748,8
577	1723,2	1818,2	6892,8	7272,8	671	1742,0	1837,0	3484,0	3674,0	765	1760,8	1855,8	3521,6	3711,6	859	1779,6	1874,6	3559,2	3749,2
578	1723,4	1818,4	6893,6	7273,6	672	1742,2	1837,2	3484,4	3674,4	766	1761,0	1856,0	3522,0	3712,0	860	1779,8	1874,8	3559,6	3749,6
579	1723,6	1818,6	6894,4	7274,4	673	1742,4	1837,4	3484,8	3674,8	767	1761,2	1856,2	3522,4	3712,4	861	1780,0	1875,0	3560,0	3750,0
580	1723,8	1818,8	6895,2	7275,2	674	1742,6	1837,6	3485,2	3675,2	768	1761,4	1856,4	3522,8	3712,8	862	1780,2	1875,2	3560,4	3750,4
581	1724,0	1819,0	6896,0	7276,0	675	1742,8	1837,8	3485,6	3675,6	769	1761,6	1856,6	3523,2	3713,2	863	1780,4	1875,4	3560,8	3750,8
582	1724,2	1819,2	6896,8	7276,8	676	1743,0	1838,0	3486,0	3676,0	770	1761,8	1856,8	3523,6	3713,6	864	1780,6	1875,6	3561,2	3751,2
583	1724,4	1819,4	6897,6	7277,6	677	1743,2	1838,2	3486,4	3676,4	771	1762,0	1857,0	3524,0	3714,0	865	1780,8	1875,8	3561,6	3751,6
584	1724,6	1819,6	6898,4	7278,4	678	1743,4	1838,4	3486,8	3676,8	772	1762,2	1857,2	3524,4	3714,4	866	1781,0	1876,0	3562,0	3752,0
585	1724,8	1819,8	6899,2	7279,2	679	1743,6	1838,6	3487,2	3677,2	773	1762,4	1857,4	3524,8	3714,8	867	1781,2	1876,2	3562,4	3752,4
586	1725,0	1820,0	6900,0	7280,0	680	1743,8	1838,8	3487,6	3677,6	774	1762,6	1857,6	3525,2	3715,2	868	1781,4	1876,4	3562,8	3752,8
587	1725,2	1820,2	6900,8	7280,8	681	1744,0	1839,0	3488,0	3678,0	775	1762,8	1857,8	3525,6	3715,6	869	1781,6	1876,6	3563,2	3753,2
588	1725,4	1820,4	6901,6	7281,6	682	1744,2	1839,2	3488,4	3678,4	776	1763,0	1858,0	3526,0	3716,0	870	1781,8	1876,8	3563,6	3753,6
589	1725,6	1820,6	6902,4	7282,4	683	1744,4	1839,4	3488,8	3678,8	777	1763,2	1858,2	3526,4	3716,4	871	1782,0	1877,0	3564,0	3754,0
590	1725,8	1820,8	6903,2	7283,2	684	1744,6	1839,6	3489,2	3679,2	778	1763,4	1858,4	3526,8	3716,8	872	1782,2	1877,2	3564,4	3754,4
591	1726,0	1821,0	6904,0	7284,0	685	1744,8	1839,8	3489,6	3679,6	779	1763,6	1858,6	3527,2	3717,2	873	1782,4	1877,4	3564,8	3754,8
592	1726,2	1821,2	6904,8	7284,8	686	1745,0	1840,0	3490,0	3680,0	780	1763,8	1858,8	3527,6	3717,6	874	1782,6	1877,6	3565,2	3755,2
593	1726,4	1821,4	6905,6	7285,6	687	1745,2	1840,2	3490,4	3680,4	781	1764,0	1859,0	3528,0	3718,0	875	1782,8	1877,8	3565,6	3755,6
594	1726,6	1821,6	6906,4	7286,4	688	1745,4	1840,4	3490,8	3680,8	782	1764,2	1859,2	3528,4	3718,4	876	1783,0	1878,0	3566,0	3756,0
595	1726,8	1821,8	6907,2	7287,2	689	1745,6	1840,6	3491,2	3681,2	783	1764,4	1859,4	3528,8	3718,8	877	1783,2	1878,2	3566,4	3756,4
596	1727,0	1822,0	6908,0	7288,0	690	1745,8	1840,8	3491,6	3681,6	784	1764,6	1859,6	3529,2	3719,2	878	1783,4	1878,4	3566,8	3756,8
597	1727,2	1822,2	6908,8	7288,8	691	1746,0	1841,0	3492,0	3682,0	785	1764,8	1859,8	3529,6	3719,6	879	1783,6	1878,6	3567,2	3757,2
598	1727,4	1822,4	6909,6	7289,6	692	1746,2	1841,2	3492,4	3682,4	786	1765,0	1860,0	3530,0	3720,0	880	1783,8	1878,8	3567,6	3757,6
599	1727,6	1822,6	6910,4	7290,4	693	1746,4	1841,4	3492,8	3682,8	787	1765,2	1860,2	3530,4	3720,4	881	1784,0	1879,0	3568,0	3758,0
600	1727,8	1822,8	6911,2	7291,2	694	1746,6	1841,6	3493,2	3683,2	788	1765,4	1860,4	3530,8	3720,8	882	1784,2	1879,2	3568,4	3758,4
601	1728,0	1823,0	6912,0	7292,0	695	1746,8	1841,8	3493,6	3683,6	789	1765,6	1860,6	3531,2	3721,2	883	1784,4	1879,4	3568,8	3758,8
602	1728,2	1823,2	6912,8	7292,8	696	1747,0	1842,0	3494,0	3684,0	790	1765,8	1860,8	3531,6	3721,6	884	1784,6	1879,6	3569,2	3759,2
603	1728,4	1823,4	6913,6	7293,6	697	1747,2	1842,2	3494,4	3684,4	791	1766,0	1861,0	3532,0	3722,0	885	1784,8	1879,8	3569,6	3759,6
604	1728,6	1823,6	6914,4	7294,4	698	1747,4	1842,4	3494,8	3684,8	792	1766,2	1861,2	3532,4	3722,4					
605	1728,8	1823,8	6915,2	7295,2	699	1747,6	1842,6	3495,2	3685,2	793	1766,4	1861,4	3532,8	3722,8					

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					
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					

RF Tuning Instructions

Setup for RF tuning

1 Provide the phone with power supply (nominal voltage is 3.7V).

2 Connect the phone to a PC with DAU-9T cable (RS232) or DKU-5 cable (USB).

3 Start Phoenix Service Software (dongle required).

4 Open FBUS connection.

5 Select: File Alt-F
Scan Product P
Shortcut: Ctrl-R

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

RF tuning after repairs

Different repairs require different tuning. In general it is necessary to determine in which section the repair was done to select which tunings to perform. To determine if RF tuning is necessary after repair it is important that the functionality of the repaired circuit is well understood.

General rules:

- Repairs in the TX part will require "TX Power Level Tuning". If changes around the modulator (RF path from UEM via Mjoelner to RF PA) have been done, "TX IQ Tuning" is additionally required.
- In general repairs in the RX part or the PLL part always require "RX Calibration" and "RX Band Filter Calibration".
- If Mjoelner is changed all calibrations have to be done.

Other parts interfacing to TX, RX or PLL might require tuning, but common sense should be used, e.g. if a component that has no influence on RF performance has been changed, e.g. the microphone, on/off key, mechanical parts or similar, there is no need to do any RF tuning.

RX calibration

The **RX Calibration** is used to determine the gain at different gain settings for front-end and Mjoelner and needs to be done in all three bands.

RX Calibration requires an external signal generator. Most of the radio communication testers like CMD55 or CMU200 can be used as signal generator, producing a continuous signal with defined level and frequency.

RX Calibration in EGSM900 combines two alignments, VCXO calibration and AGC calibration. Calibration of GSM1800 and GSM1900 band only determines the AGC values.

The **VCXO calibration** finds out a calibration value for VCXO control, an AFC initial value and 3 AFC-slope coefficients. The VCXO calibration ensures the function of an initial synchronization (before location update is done) when the phone is in Normal mode. For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a **VCXO cal** value is written into the RefOSCCAL register of the Mjoelner.

During VCXO-calibration, the **VCXO cal** value is changed by a DSP-algorithm until a synchronization is possible. This means the VCXO oscillates at 26 MHz with a sufficient minimum frequency error.

To further minimize the frequency error, an initial **AFC value** is determined by the DSP and written into RefOSCAFC register of the Mjoelner.

Additionally the DSP algorithm determines three AFC slope coefficients **Slope C1...3** during VCXO calibration. One AFC slope value is not sufficient for Mjoelner, because the AFC slope is non-linear in this chip.

The **AGC-calibration** finds the gain values of the RX chain. The AGC consists of RF LNA, which can be either on or off (gain difference between on and off state is nominally 30dB) and BB gain which can be controlled in 6dB steps. This gives 15 gain steps RSSI0 to RSSI14. LNA is off for steps RSSI0 to RSSI4.

AGC-calibration measures the gain at gain step RSSI4 and RSSI7. The other gain values are calculated.

A value **RF_TEMP**, which represents the RF hardware temperature, is determined during RX Calibration. This temperature value is used by DSP for RSSI reporting correction in Normal mode of the phone. It is not visible in the calibration process.

The RX calibration is only valid if the results are within certain limits. For the most recent limits see the production limits of FLALI and FINUI testers.

If the results are not within these limits, there is a fault in the RX chain.

RX calibration EGSM900

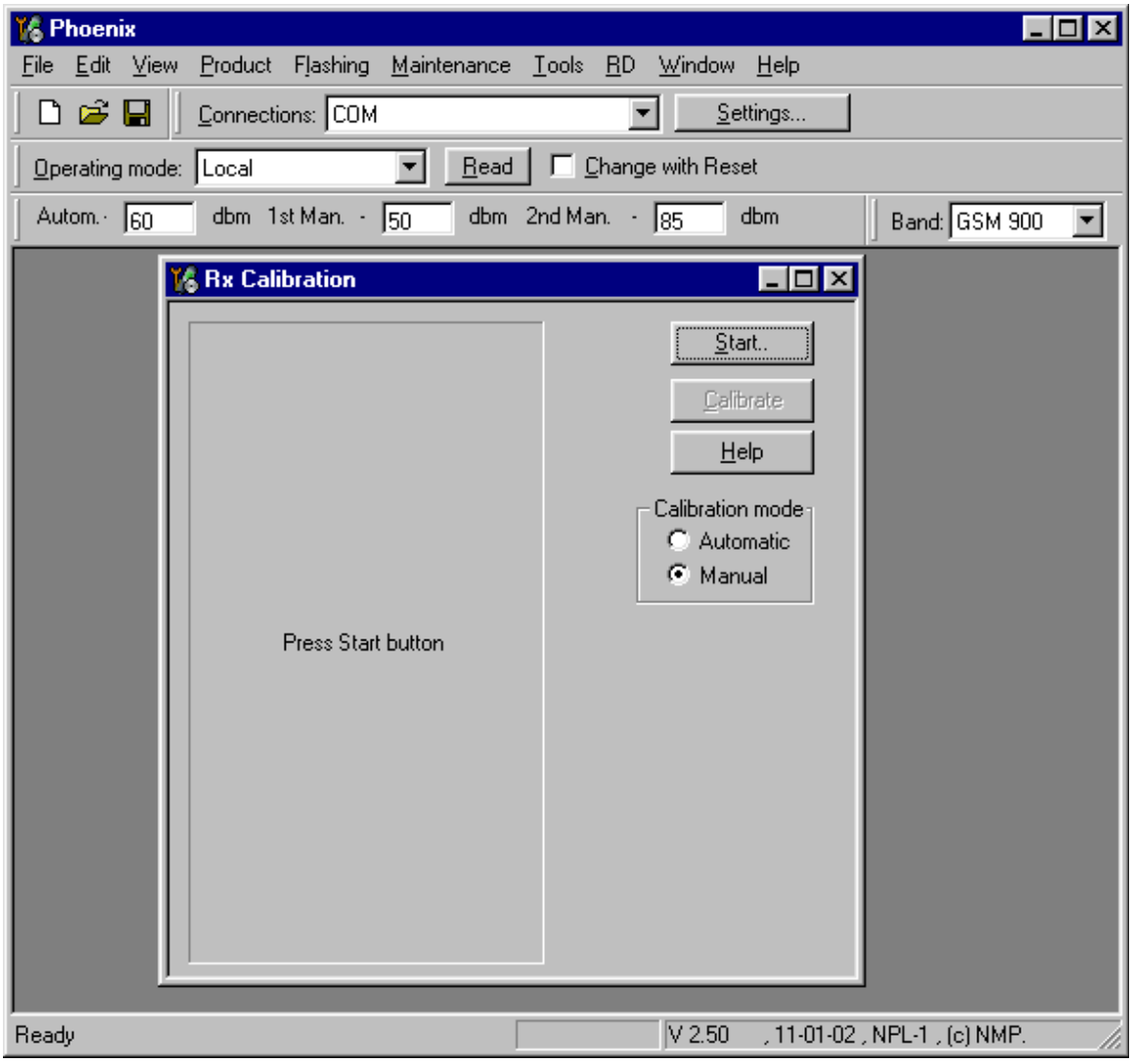
Set operating mode to local mode.

Select	Maintenance		Alt-M
		Tuning	T
			RX Calibration C

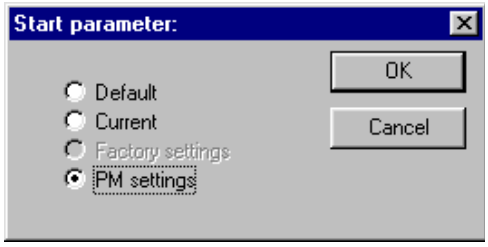
Wait until the RX Calibration window pops up.

Select	Band	GSM 900
	Autom.-	60

The setup should now look like this:



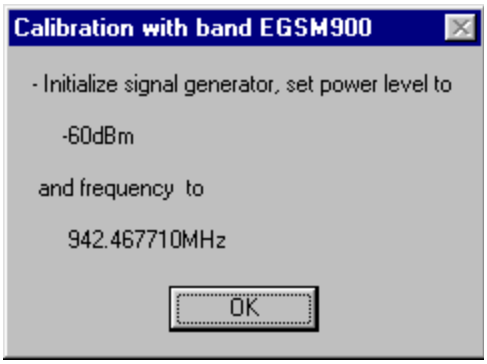
Select Automatic, press Start and a new window pops up:



Select PM settings, press OK and the window closes.

Now it is possible to press the **Calibrate** button in the RX Calibration window.

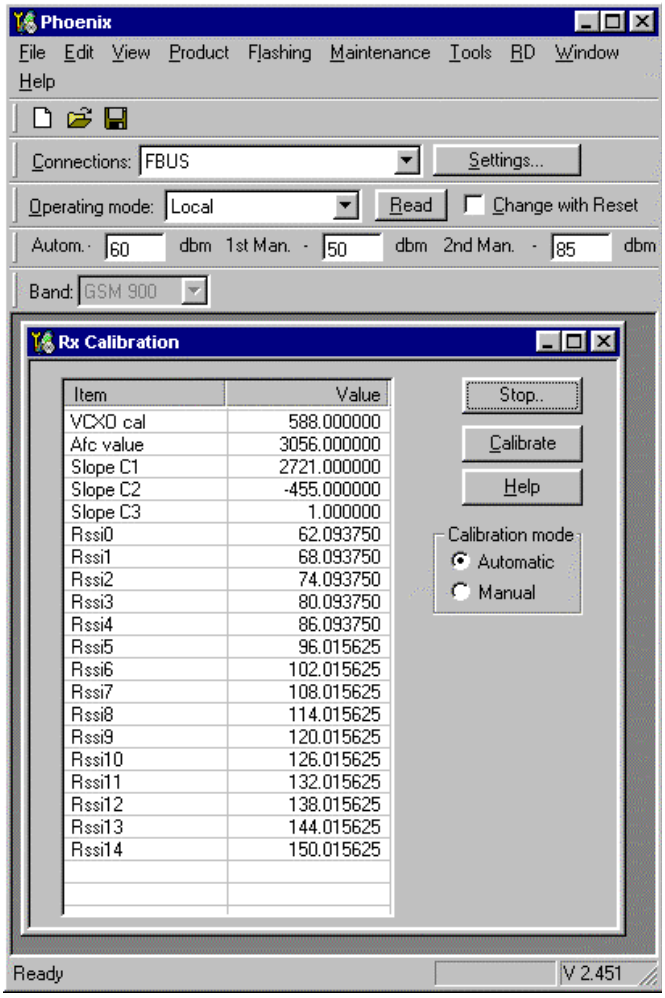
Press Calibrate and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

Press OK and the window closes.

A typical result will look like this:

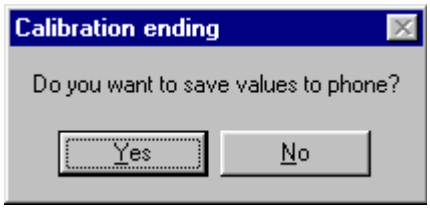


The results must be checked against the following limits:

Value	Typical	Limit min.	Limit max.
VCXO cal	568	128	767
AFC value	3150	3062	3262
Slope C1	2760	1500	3500
Slope C2	-480	-700	-300
Slope C3	1	0	1
Rssi 4	79	77	82
Rssi 7	102	100	105

If Rssi 4 and Rssi 7 are within the limits, all other Rssi values are valid, too.

Press Stop in the RX Calibration window and a new window pops up:



Press Yes and the EGSM RX Calibration is finished.

RX calibration GSM1800

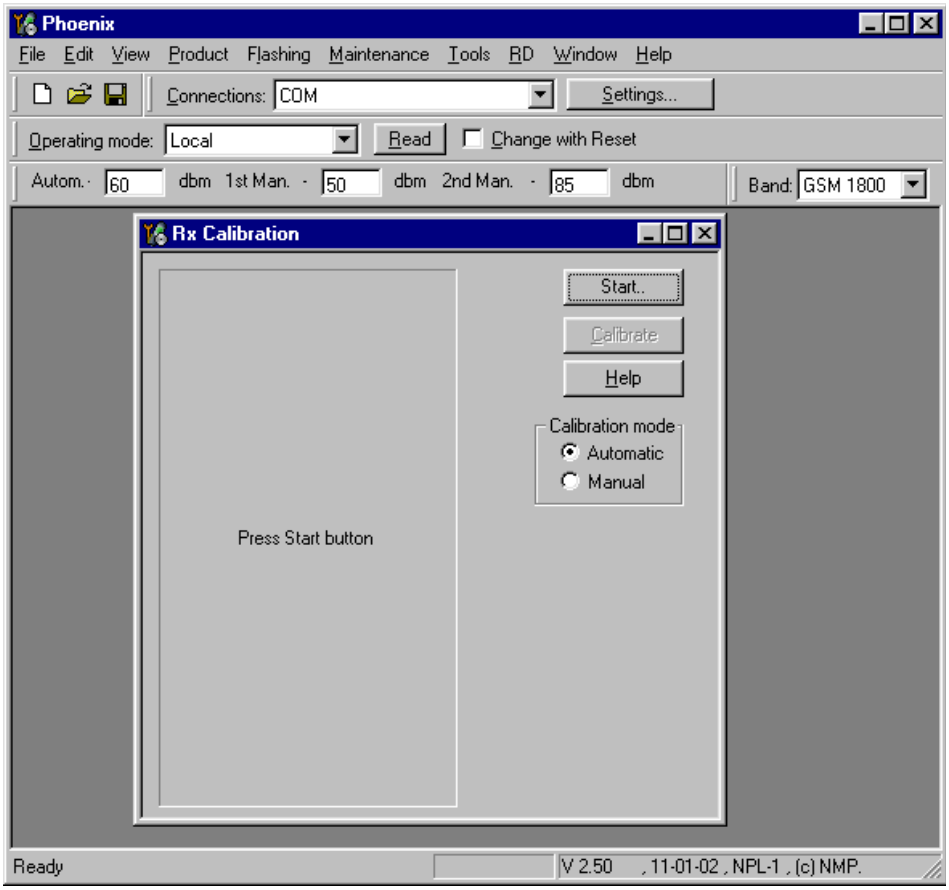
Set operating mode to local mode.

Select	Maintenance		Alt-M
	Tuning		T
		RX Calibration	C

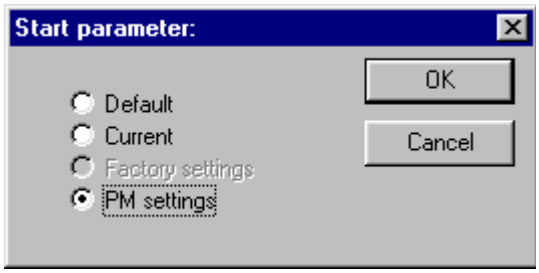
Wait until the RX Calibration window pops up.

Select	Band	GSM 1800
	Autom.-	60
	1st Man.-	50
	2nd Man.-	85

The setup should now look like this:



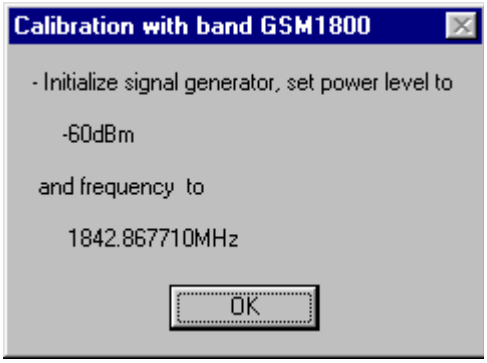
Select Automatic, press Start and a new window pops up:



Select PM settings, press OK and the window closes.

Now it is possible to press the calibrate button in the RX Calibration window.

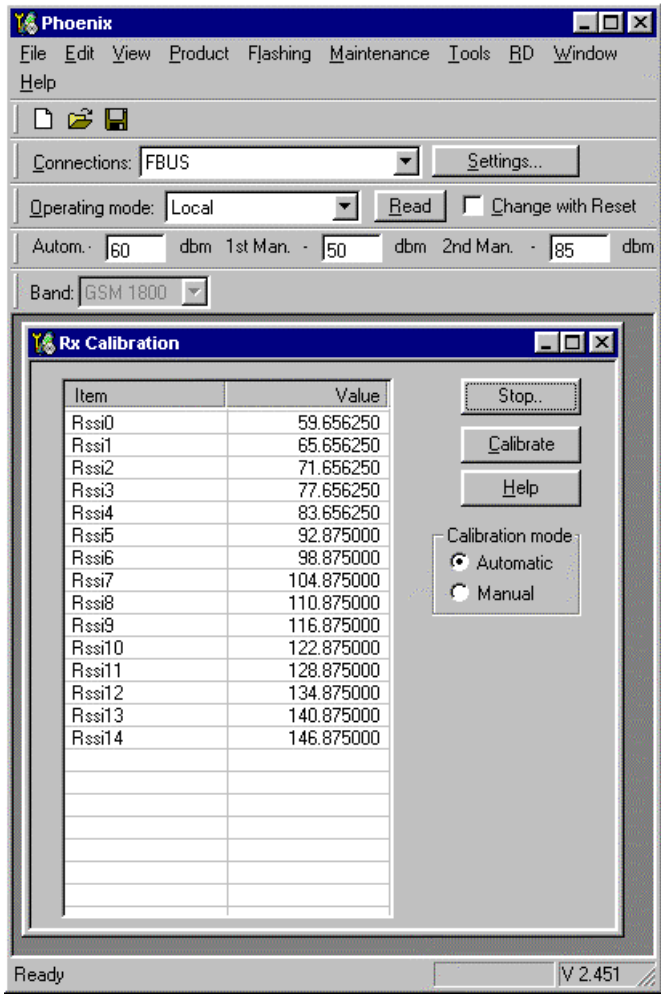
Press Calibrate and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

Press ok and the window closes.

A typical result will look like this:

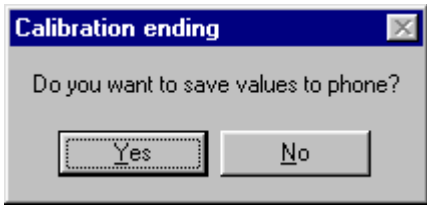


The results must be checked against the following limits:

Value	Typical	Limit min.	Limit max.
Rssi 4	76	74	79
Rssi 7	99	96	103

If Rssi 4 and Rssi 7 are within the limits, all other Rssi values are valid, too.

Press Stop in the RX Calibration window and a new window pops up:



Press Yes and the GSM1800 RX Calibration is finished.

RX calibration GSM1900

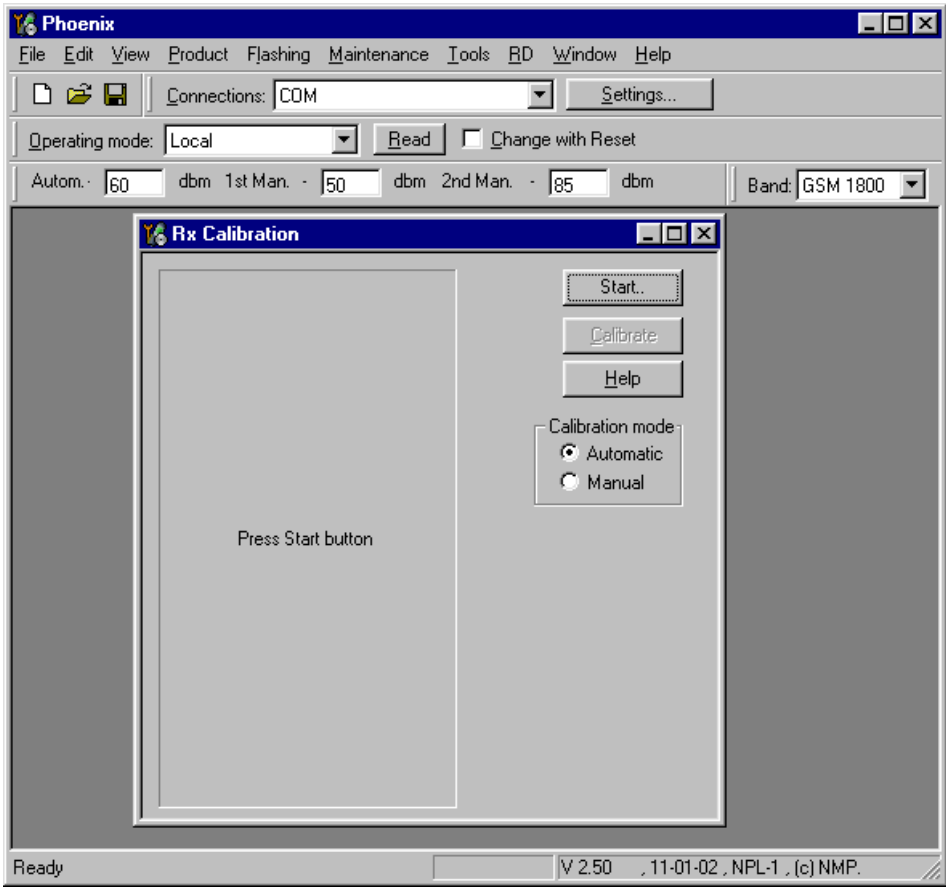
Set operating mode to local mode.

Select	Maintenance		Alt-M
	Tuning		T
		RX Calibration	C

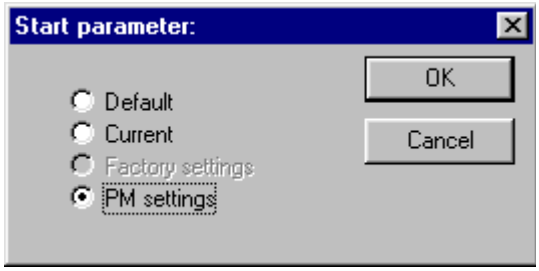
Wait until the RX Calibration window pops up.

Select	Band	GSM 1900
	Autom.-	60
	1st Man.-	50
	2nd Man.-	85

The setup should now look like this:



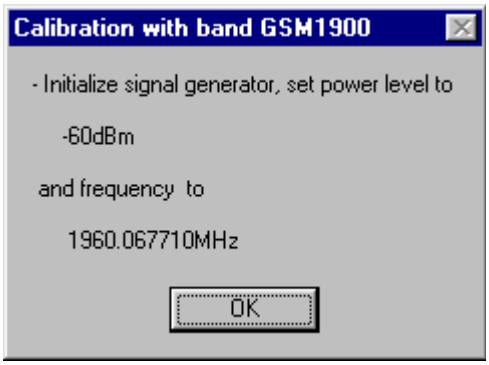
Select Automatic, press Start and a new window pops up:



Select PM settings, press OK and the window closes.

Now it is possible to press the calibrate button in the RX Calibration window.

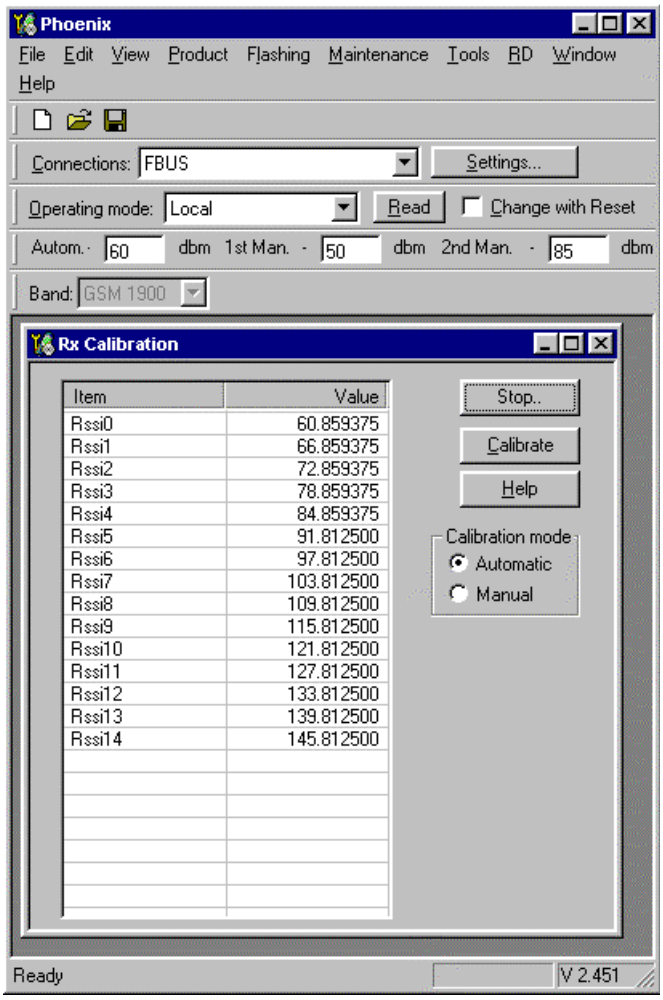
Press Calibrate and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

Press ok and the window closes.

A typical result will look like this:

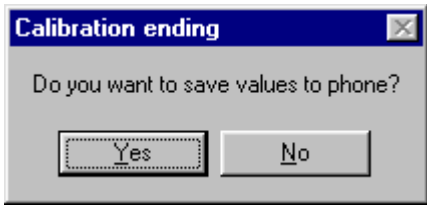


The results must be checked against the following limits:

Value	Typical	Limit min.	Limit max.
Rssi 4	78	76	81
Rssi 7	98	96	101

If Rssi 4 and Rssi 7 are within the limits, all other Rssi values are valid, too.

Press Stop in the RX Calibration window and a new window pops up:



Press Yes and the GSM1900 RX Calibration is finished.

RX band filter response compensation

This alignment is necessary to compensate the frequency response of the RX band filters (SAW filters).

RX band filter response EGSM900

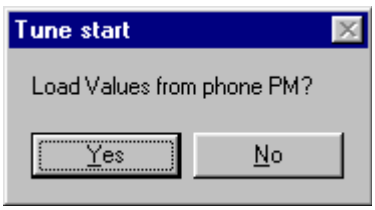
Set operating mode to local mode.

Select	Maintenance		Alt-M
	Tuning		T
		RF Controls	F

Wait until the RF Controls window pops up.

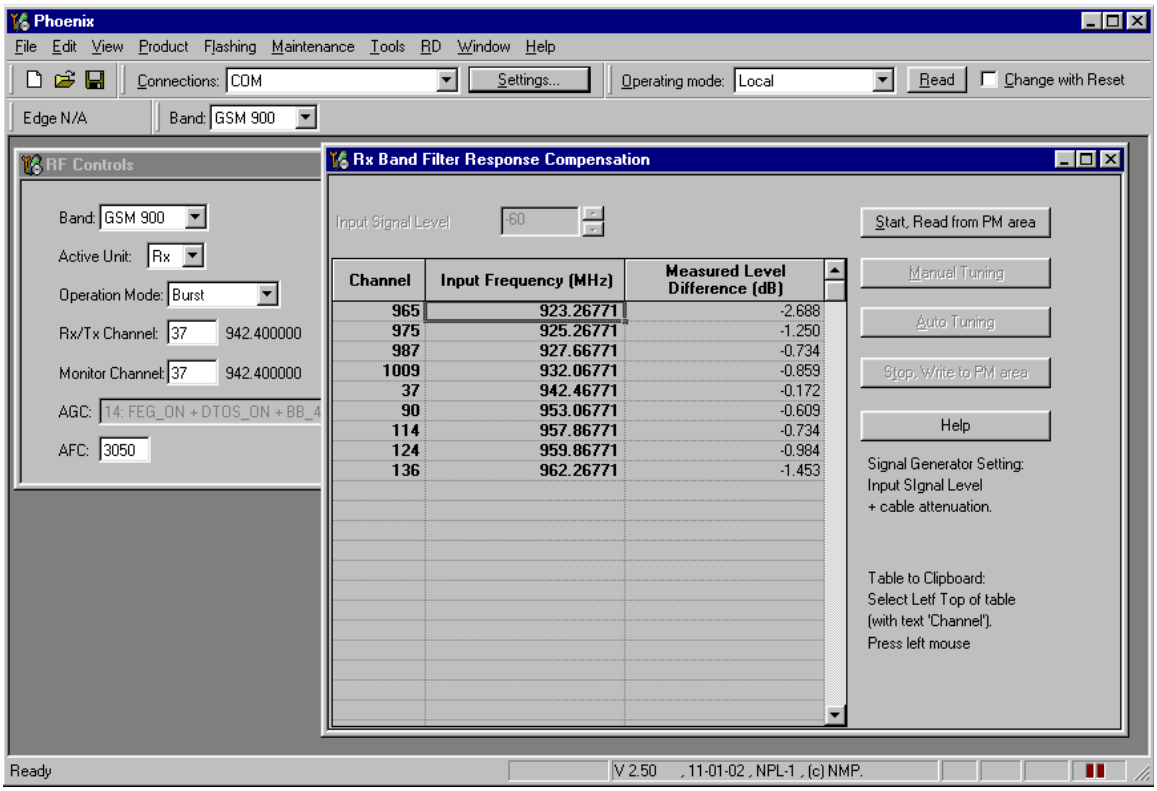
Select	Band	GSM 900	
Select	Maintenance		Alt-M
	Tuning		T
		RX Band Filter Response Compensation	B

A window pops up:



Select Yes and the RX Band Filter Response Compensation window pops up.

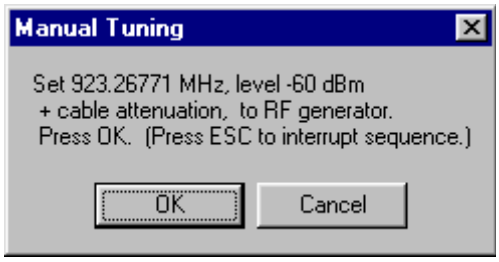
The setup should now look like this:



Select Input Signal Level -60

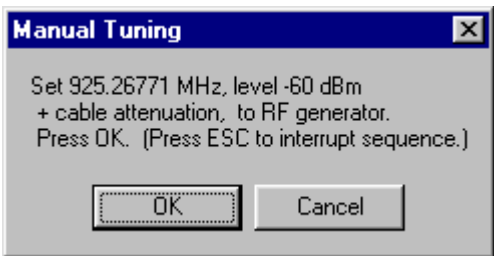
Manual tuning

Press Manual tuning and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

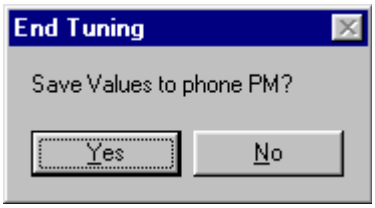
Press OK and a new window pops up:



Set the generator as told in the window.

Press OK and a new window pops up. Repeat this sequence **9 times** until all channels are done.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Auto tuning

A faster and more convenient method for Band Filter Calibration can be performed by clicking on "Auto Tuning". This requires a Signal Generator that can be programmed to step through a user defined list of frequencies.

Program the signal generator to the list of frequencies that are visible in the column "Input Frequency (MHz)".

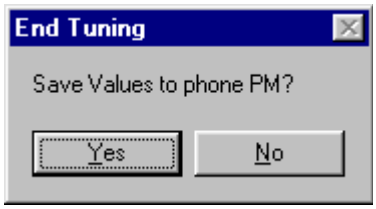
Press Auto tuning and a window pops up:

Connect an external signal generator to the RF connector of the phone and let the signal generator step through the programmed frequency list.

Press OK.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and

a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Limits

Regarding limits the value for N4 is given here. For the other filter frequencies please have a look to Appendix A where all FLALI test cases are listed together with the limits.

Value	Typical	Limit min.	Limit max.
N4	0	-0.3	0.3

RX band filter response GSM1800

Set operating mode to local mode.

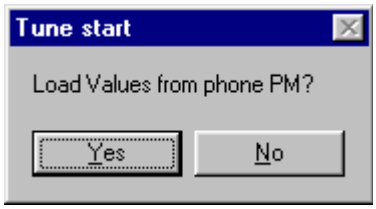
Select	Maintenance		Alt-M
	Tuning		T
		RF Controls	F

Wait until the RF Controls window pops up

Select	Band	GSM 1800	

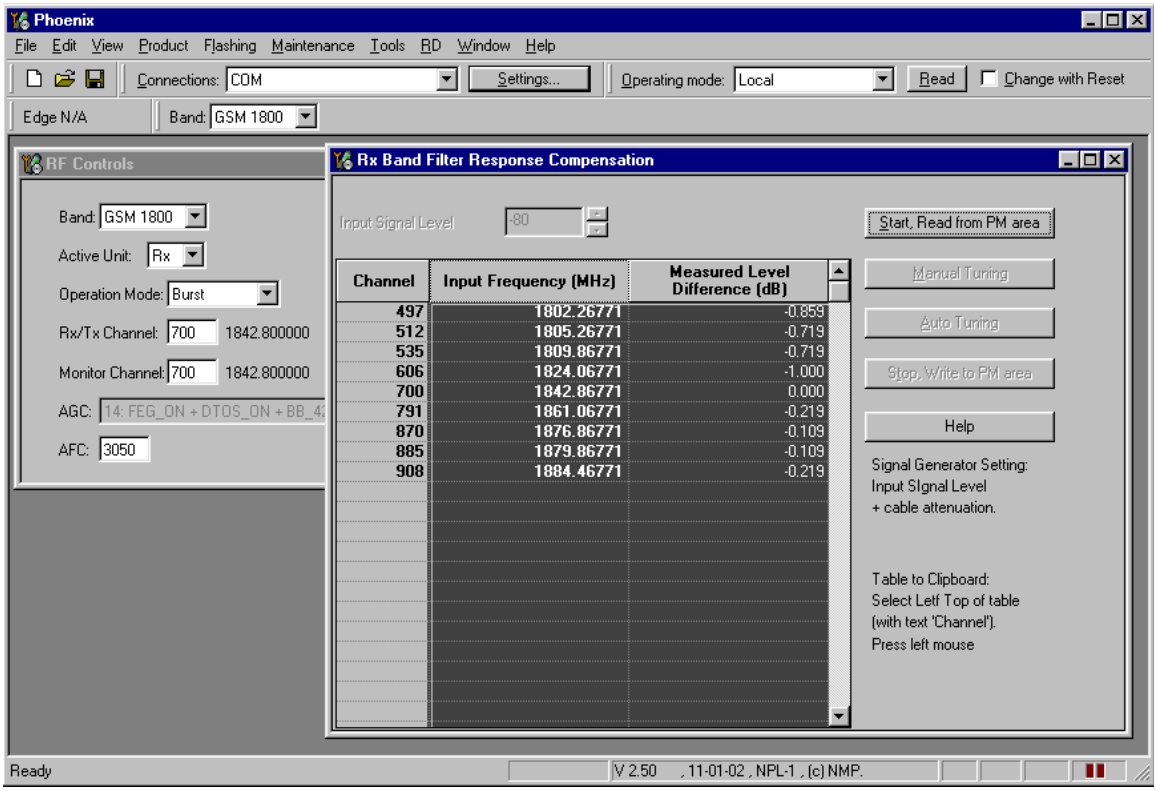
Select	Maintenance		Alt-M
	Tuning		T
		RX Band Filter Response Compensation	B

The following window pops up:



Select Yes and the RX Band Filter Response Compensation window pops up.

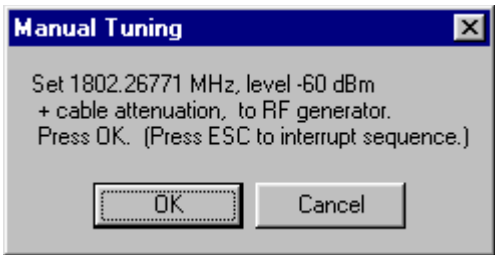
The setup should now look like this:



Select Input Signal Level -60

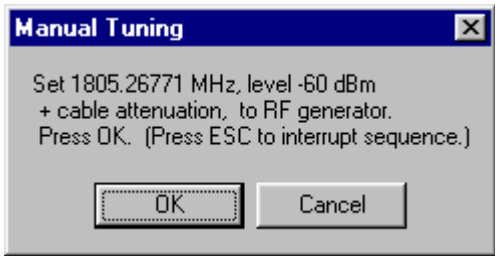
Manual tuning

Press Manual tuning and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

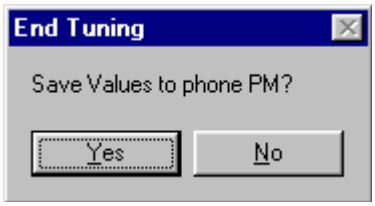
Press OK and a new window pops up:



Set the generator as told in the window.

Press OK and a new window pops up. Repeat this sequence **9 times** until all channels are done.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Auto tuning

A faster and more convenient method for Band Filter Calibration can be performed by clicking on "Auto Tuning". This requires a signal Generator that can be programmed to seep a user defined list of frequencies.

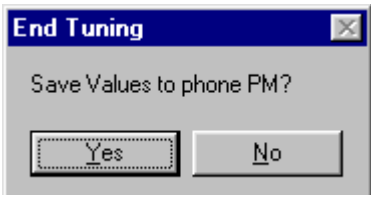
Program the signal generator to the list of frequencies that are visible in the column "Input Frequency (MHz)".

Press Auto tuning and a window pops up:

Connect an external signal generator to the RF connector of the phone and let the signal generator step sweep through the programmed frequency list.

Press OK.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Limits

Regarding limits the value for N4 is given here. For the other filter frequencies please have a look to Appendix A where all FLALI test cases are listed together with the limits.

Value	Typical	Limit min.	Limit max.
N4	0	-0.3	0.3

RX band filter response GSM1900

Set operating mode to local mode

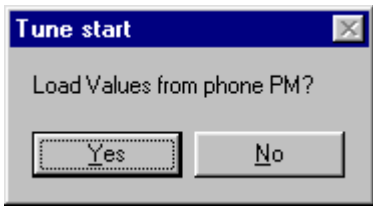
Select Maintenance Alt-M
Tuning T
RF Controls F

Wait until the RF Controls window pops up

Select Band GSM 1900

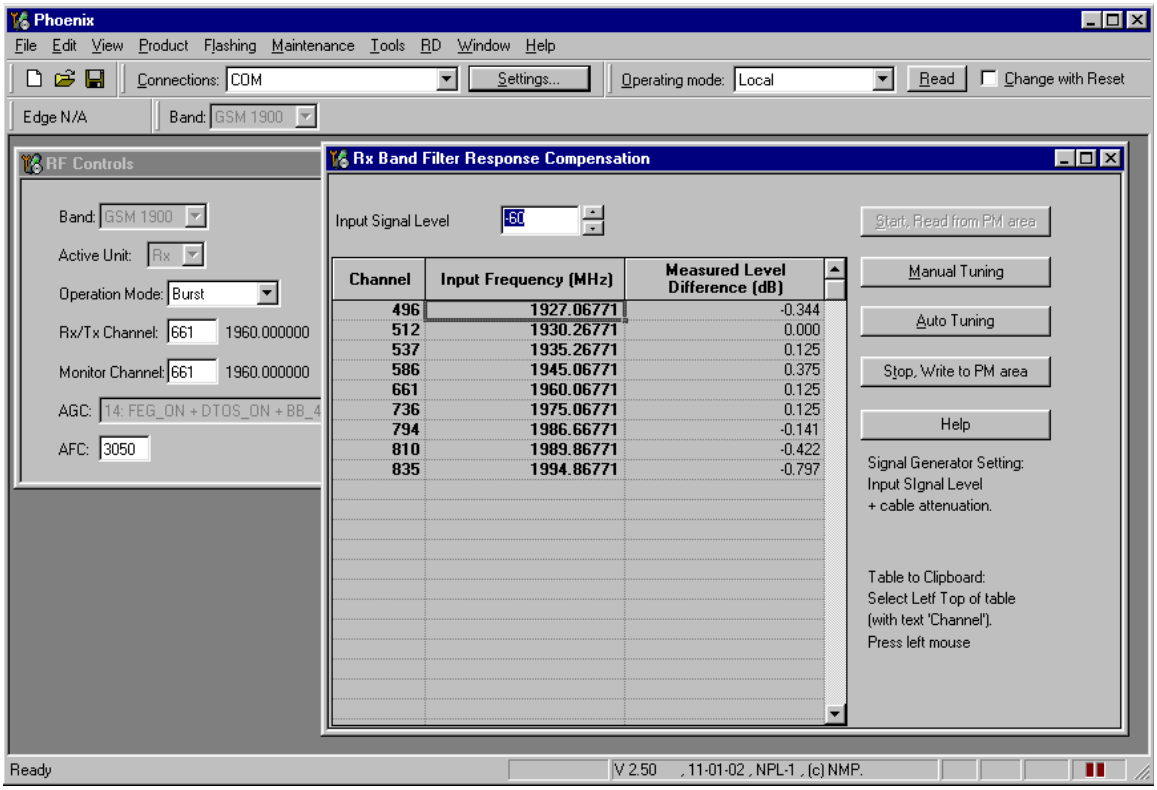
Select Maintenance Alt-M
Tuning T
RX Band Filter B
Response Compensation

A window pops up:



Select Yes and the RX Band Filter Response Compensation window pops up.

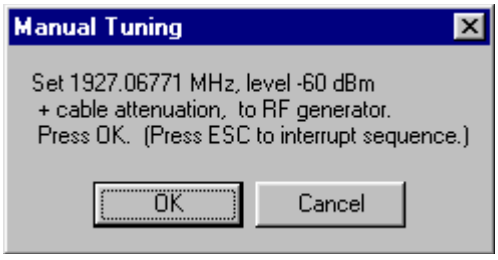
The setup should now look like this:



Select Input Signal Level -60

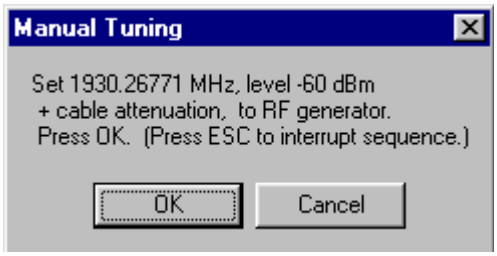
Manual tuning

Press Manual tuning and a window pops up:



Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses. If a radio communication tester (CMD55, CMU200, 8960, MT8801) is used, be sure to have it running in continuous mode and with modulation switched off.

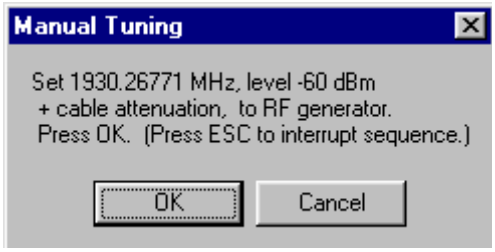
Press OK and a new window pops up:



Set the generator as told in the window.

Press OK and a new window pops up. Repeat this sequence **9 times** until all channels are done.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Auto tuning

A faster and more convenient method for Band Filter Calibration can be performed by clicking on "Auto Tuning". This requires a signal Generator that can be programmed to seep a user defined list of frequencies.

Program the signal generator to the list of frequencies that are visible in the column "Input Frequency (MHz)".

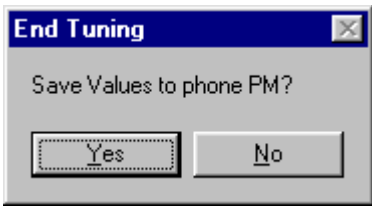
Press Auto tuning and a window pops up:

Connect an external signal generator to the RF connector of the phone and let the signal generator step sweep through the programmed frequency list.

Press OK.

Press Stop, Write to PM Area (In the RX Band Filter Response Compensation window) and

a window pops up:



Press Yes and the EGSM RX Band Filter Response Compensation is finished.

Limits

Regarding limits the value for N4 is given here. For the other filter frequencies please have a look to Appendix A where all FLALI test cases are listed together with the limits.

Value	Typical	Limit min.	Limit max.
N4	0	-0.3	0.3

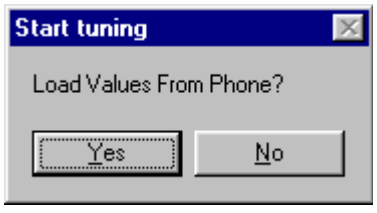
RX channel select filter calibration

This calibration is calibrating the Baseband filter inside Mjoelner. It is done by internally measuring a prototype filter, for this reason the calibration is done once, not separately in 3 bands.

Set operating mode to local mode

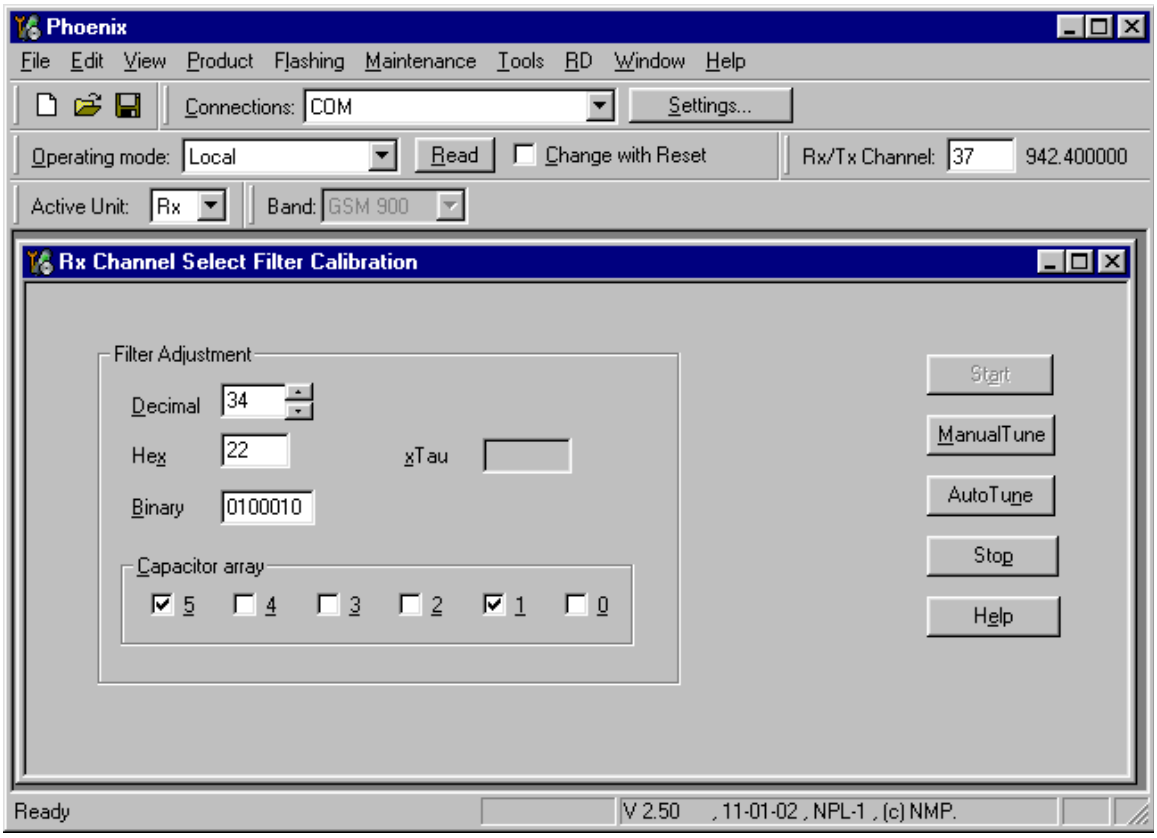
Select	Maintenance	Alt-M
	Tuning	T
	RX Channel Select filter Calibration	H

A window pops up:



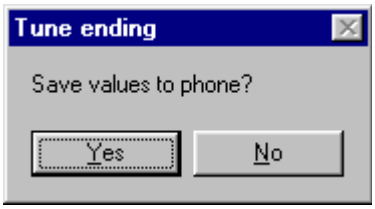
Select Yes and the RX Channel Select Filter Calibration window pops up.

The setup should now look like this:



Press Autotune and the optimal values are found.

Press Stop and a new window pops up:



Press Yes and the RX Channel Select Filter Calibration is finished.

Limits for the GTR value = Filter adjustment value "decimal" format:

Value	Typical	Limit min.	Limit max.
GTR	34	28	40

RX AM suppression – not needed

The RH-6 RFIC Mjoelner does not require tuning of AM suppression.

TX power level tuning

This tuning must be done in all three bands.

Note: TX Power tuning must be done with a peak power meter, e.g. Anritsu model ML2408A with Anritsu Peak Power Sensor MA2442A and a suitable attenuator.

The use of power meter in GSM testers is likely to cause larger error than the use of a dedicated power meter and might cause the phone to be non-compliant with GSM specifications.

Set power supply voltage Vcc=3.6V!

TX Power level tuning EGSM900

Set operating mode to local mode.

Select Maintenance
Tuning
TX Power Level Tuning

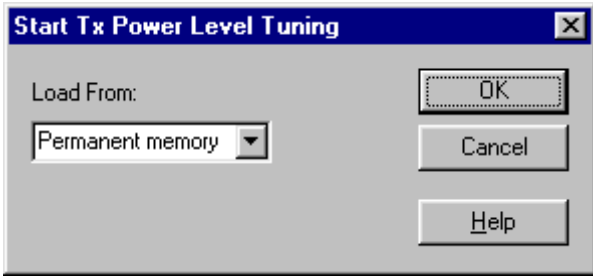
Wait until the TX Power Level Tuning window pops up.

Connect a **calibrated** power meter to the RF connector of the phone.

Select Band GSM 900

Active Unit TX

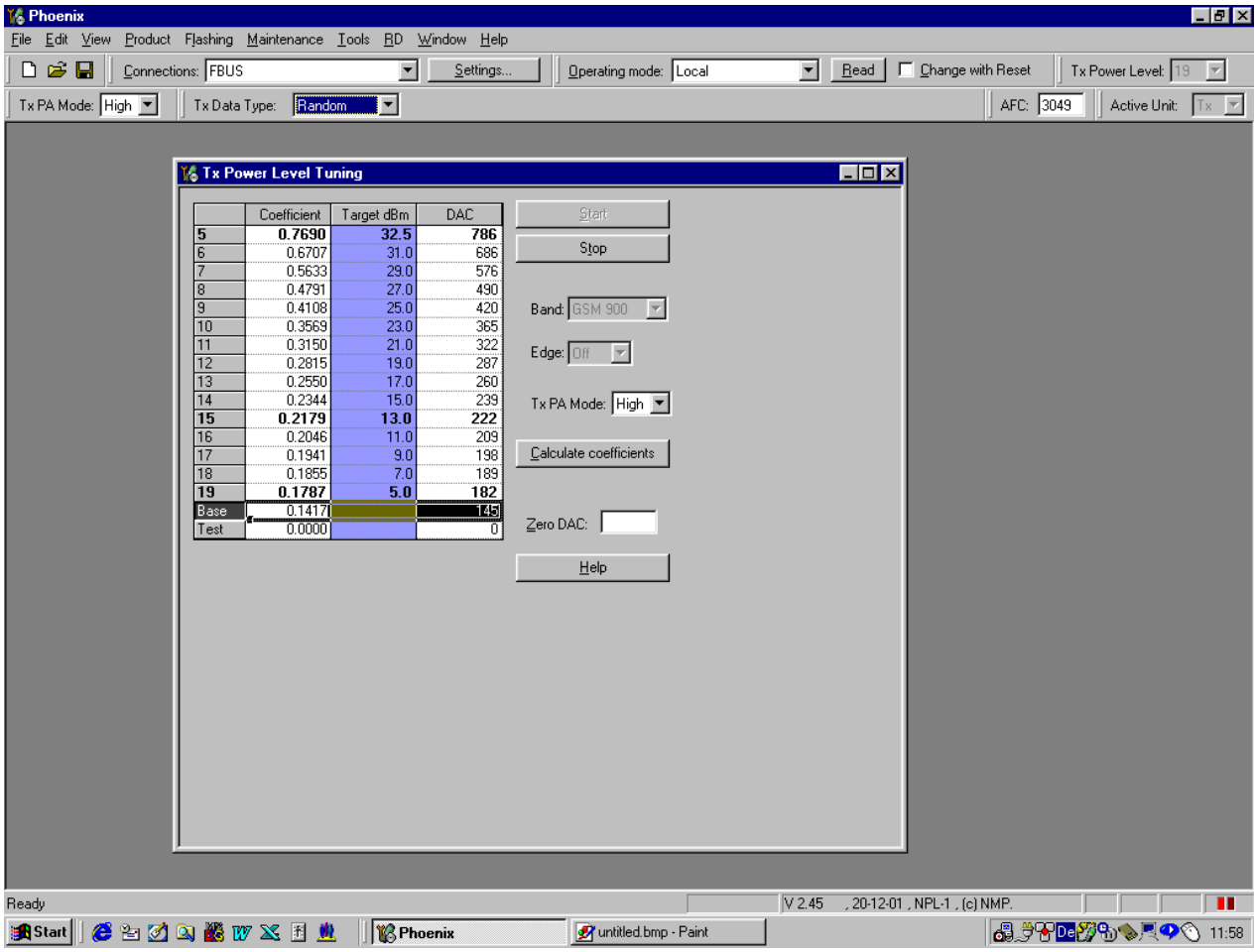
Press Start and a window pops up:



Select Permanent memory, press OK and the window closes.

Select TX Data Type Random

The setup should now look like this:



Select TX PA Mode High

Tune Base level to –27 dBm.

Adjust DAC Values for Power Level 5 (32.5 dBm), 15 (13 dBm) and 19 (5 dBm) according to the target values. The power levels may differ from in Phoenix mentioned target power levels.

Make sure that the output power for Power Level 5 is equal or lower than 1dB below the saturation output power. Determine the saturation power by setting the DAC Value to its maximum. (For example: If the saturation output power is only 33.3dBm, then adjust the DAC Value for Power Level 5 to 32.3dBm)

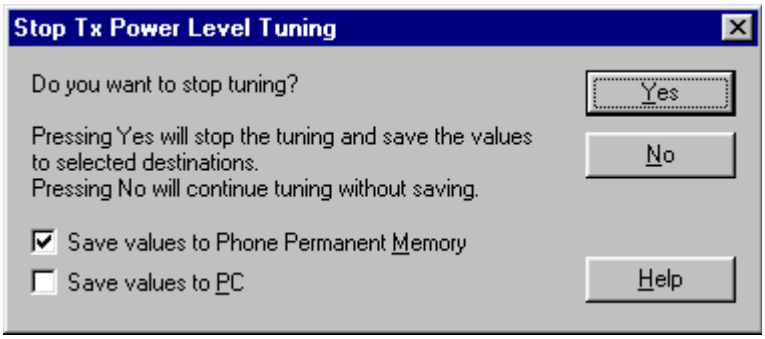
Press calculate, check if all levels match the target values, correct if necessary.

Select TX PA Mode Low

Adjust DAC Values for Power Level 7, 15 and 19 according to target values.

Press calculate, check if all levels match the target values, correct if necessary.

Press Stop and a window pops up:



Select 'Save values to Phone Permanent Memory'

Press Yes and the EGSM TX Power Level Tuning is finished.

TX power level tuning GSM1800

Set operating mode to local mode

Select Maintenance
Tuning
TX Power Level Tuning

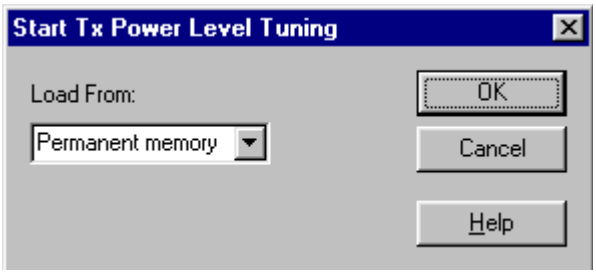
Wait until the TX Power Level Tuning window pops up.

Connect a **calibrated** power meter to the RF connector of the phone.

Select Band GSM 1800

Active Unit TX

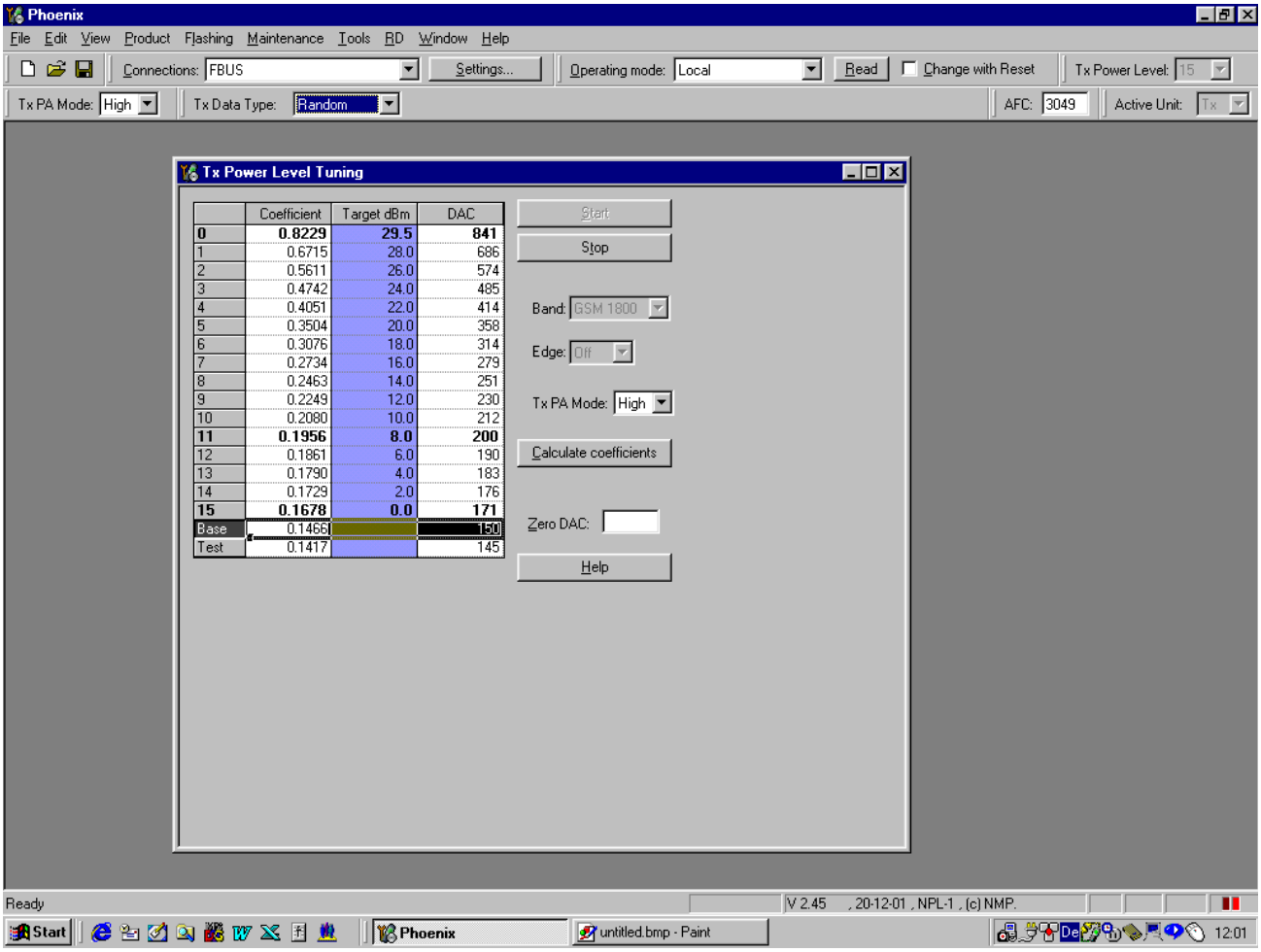
Press Start and a window pops up:



Select Permanent memory, press OK and the window closes.

Select TX Data Type Random

The setup should now look like this:



Select TX PA Mode High

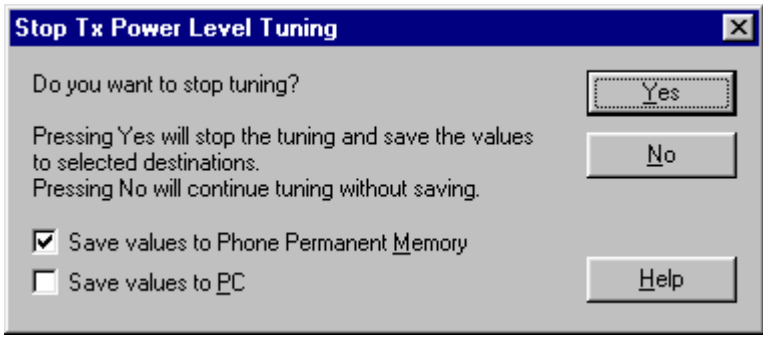
Tune Base level to –27 dBm.

Adjust DAC Values for Power Level 0 (30 dBm), 11 (8 dBm) and 15 (0 dBm). The Power levels may differ from in Phoenix mentioned target power levels.

Make sure that the output power for Power Level 0 is equal or lower than 1dB below the saturation output power. Determine the saturation power by setting the DAC Value to its maximum. (For example: If the saturation output power is only 30.7dBm, then adjust the DAC Value for Power Level 0 to 29.7dBm)

Press calculate, check if all levels match the target values, correct if necessary.

Press Stop and a window pops up:



Select 'Save values to Phone Permanent Memory'

Press Yes and the GSM1800 TX Power Level Tuning is finished.

TX power level tuning GSM1900

Set operating mode to local mode.

Select Maintenance
Tuning
TX Power Level Tuning

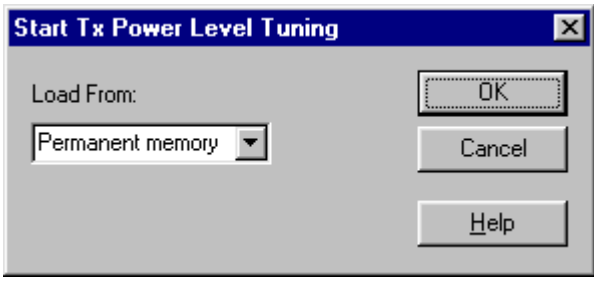
Wait until the TX Power Level Tuning window pops up.

Connect a **calibrated** power meter to the RF connector of the phone.

Select Band GSM 1900

Active Unit TX

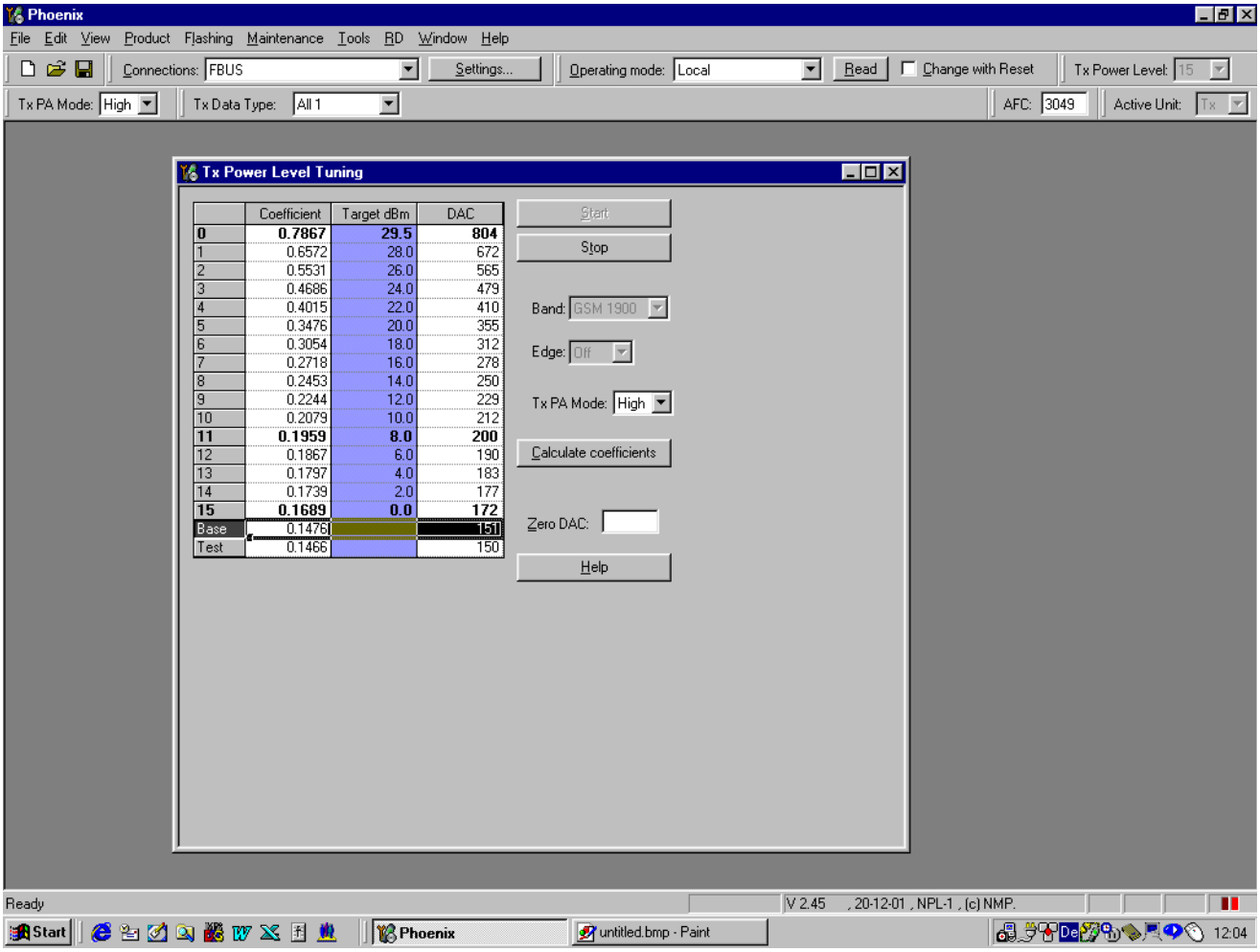
Press Start and a window pops up:



Select Permanent memory, press OK and the window closes.

Select TX Data Type Random

The setup should now look like this:



Select TX PA Mode High

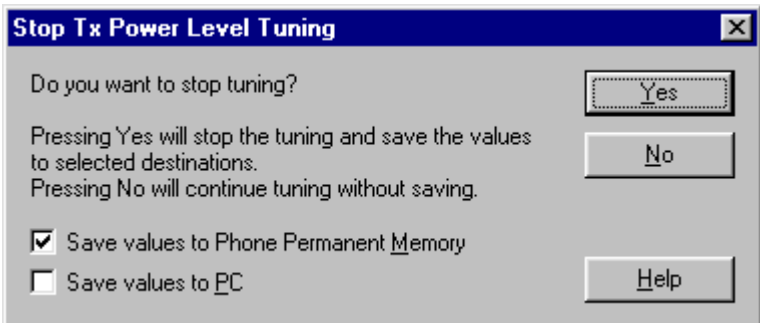
Tune Base level to –27 dBm.

Adjust DAC Values for Power Level 0 (30 dBm), 11 (8 dBm) and 15 (0 dBm). The Power levels may differ from in Phoenix mentioned target power levels.

Make sure that the output power for Power Level 0 is equal or lower than 1dB below the saturation output power. Determine the saturation power by setting the DAC Value to its maximum. (For example: If the saturation output power is only 30.7dBm, then adjust the DAC Value for Power Level 0 to 29.7dBm)

Press calculate, check if all levels match the target values, correct if necessary.

Press Stop and a window pops up:



Select 'Save values to Phone Permanent Memory'.

Press Yes and the GSM1900 TX Power Level Tuning is finished.

TX I/Q tuning

This tuning must be performed in all three bands.

TX I/Q tuning GSM900

Caution: In the case you use a spectrum analyzer make sure that the external attenuation (20-30dB) between phone and spectrum analyzer is high enough that the input of the analyzer can't be destroyed. Adjust the reference level offset according to the insertion loss from the phone to the spectrum analyzer.

Note: During TX I/Q Tuning in EGSM900 band, an additional calibration value for the battery voltage A/D converter is taken. Therefore it is important to set the operating voltage for this alignment to 3.6V.

PC/Phone operation:

Set operating mode to local mode.

Set supply voltage to 3.6V.

Select	Maintenance	Alt-M
	Tuning	T
	TX IQ Tuning	I

Wait until the TX IQ Tuning window pops up.

Select	Maintenance	Alt-M
	Tuning	T
	RF Controls	F

Wait until the RF Controls window pops up.

Connect a Spectrum Analyzer or GSM tester with the option *Narrow Spectrum' to the antenna pads of the phone.

If a spectrum analyzer is used then use the following settings.

	EGSM/EGSM900
Center Frequency	897.4 MHz
Frequency Span	300 kHz
Resolution Bandwidth	3kHz
Video Bandwidth	3kHz
Sweep Time	3 sec.
Sweep Type	Clear/Write
Detector Type	Max Peak
Reference level	35 dBm
Marker 1	897.33229 MHz
Marker 2	897.4 MHz
Marker 3	897.46771 MHz

Select in the RF Controls Window:

Select Band GSM 900
Active UnitTX
Operation ModeBurst
RX/TX Channel 37
TX PA ModeFree
TX Data Type All1

Select in the TX IQ tuning window:

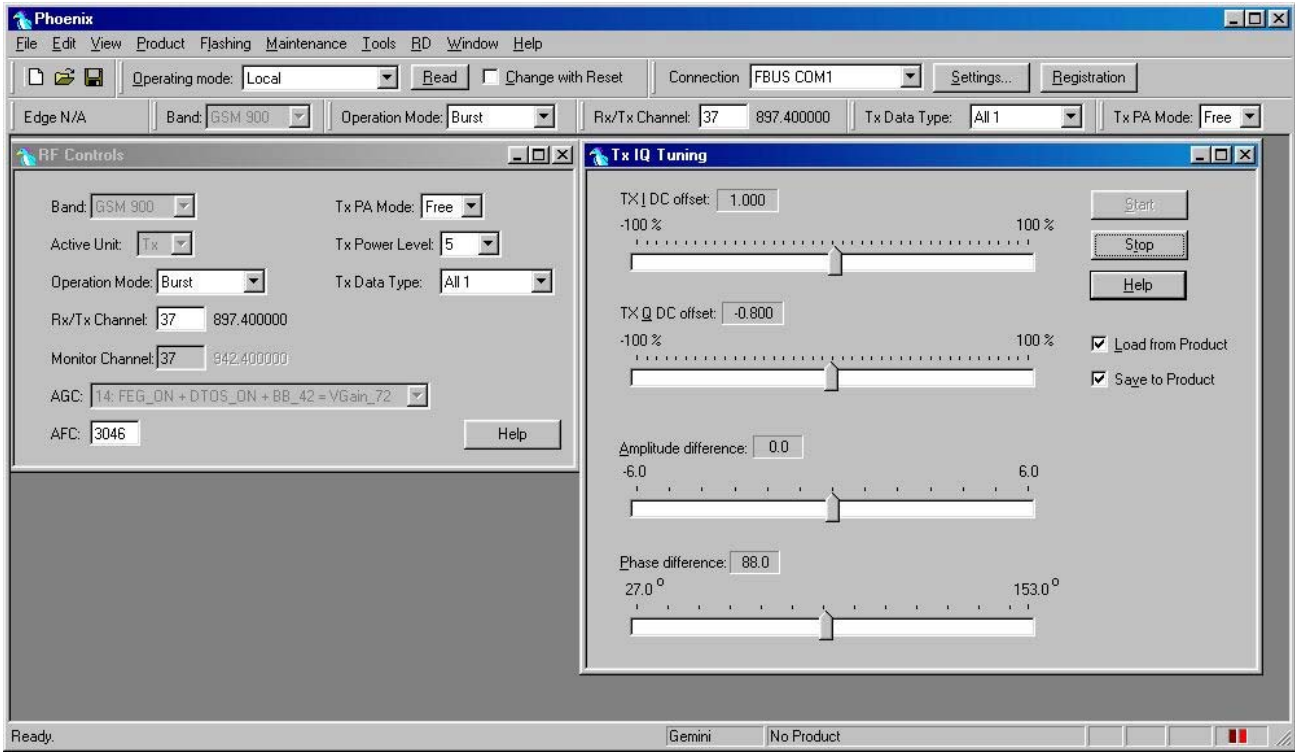
Select ☑ Load from Product

Press Start

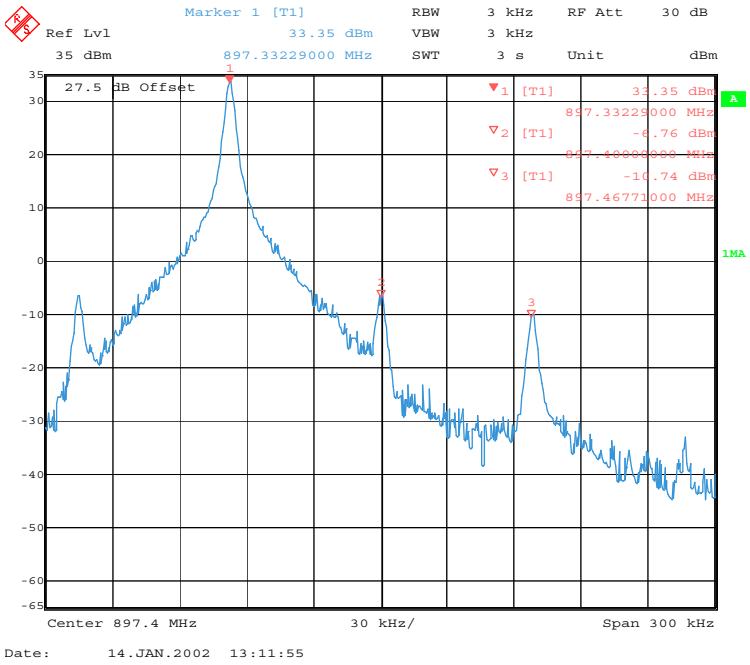
Select again in the RF Controls Window:

Select TX Power Level 9

The setup should now look like this:



The Spectrum Analyzer now shows a plot like this:

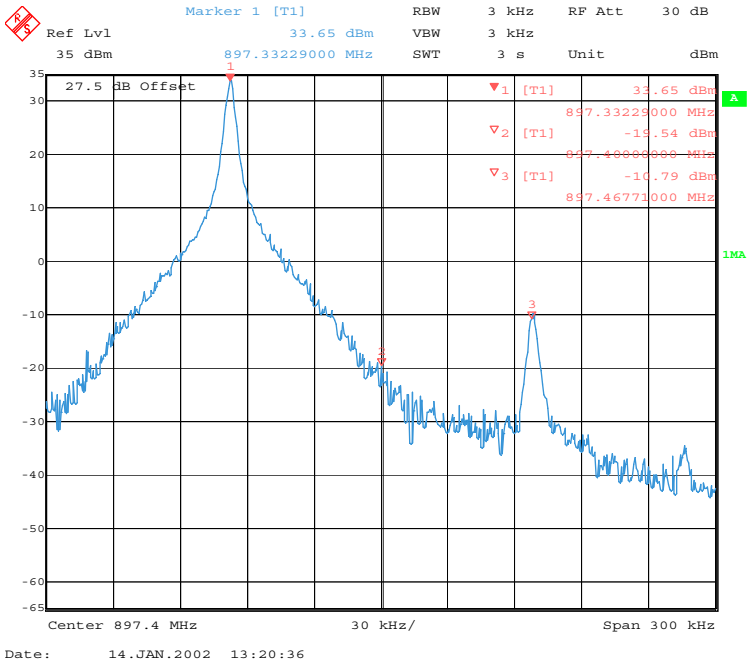


The purpose of this alignment is to tune the carrier signal (at marker 2) and the +67kHz signal (at marker 3) to a minimum level.

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (marker 2). Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 2 and the peak levels at marker 1 must exceed 40dB.

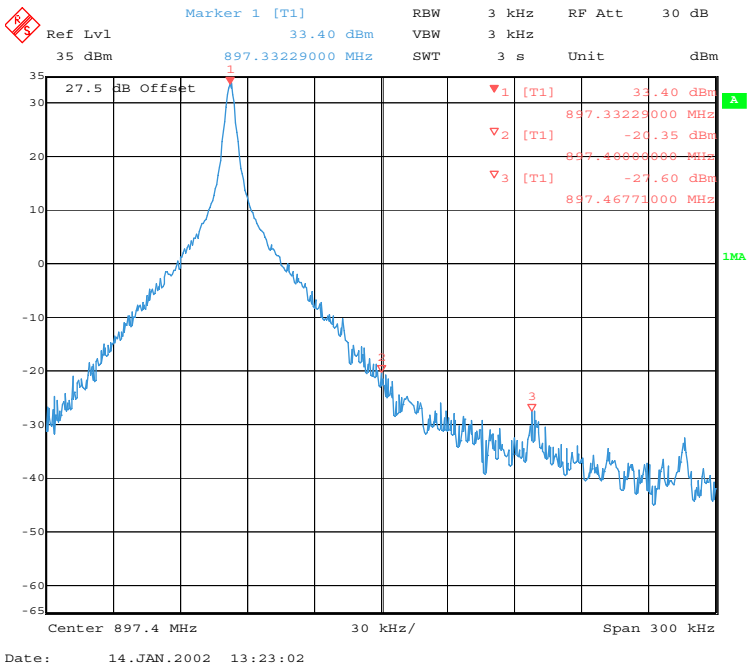
The Spectrum Analyzer now shows a plot like this:



Use the variables 'Amplitude difference' and 'Phase difference' to adjust the +67kHz signal to a minimum level (Marker 3). Tuning is possible by using the arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 3 and the peak level at marker 1 must exceed 40dB.

The Spectrum Analyzer now shows a plot like this:



Check the results in the TX IQ Tuning Window against the limits:

Value	Typical	Limit min.	Limit max.
TX I DC offset	0.1	-6	6
TX Q DC offset	0	-6	6
Amplitude difference	0	-1	1
Phase difference	87.5	80	100

Select in the TX IQ Tuning Window:

Select ☑ Save to Product

Press Stop

and the values are stored in the phone. The GSM1800 TX IQ Tuning is now finished.

Note: The optimum values for "TX I and Q Offset" and "Amplitude and Phase Difference" vary from phone to phone.

TX I/Q tuning GSM1800

Caution: In the case you use a spectrum analyzer make sure that the external attenuation (20-30dB) between phone and spectrum analyzer is high enough that the input of the analyzer can't be destroyed. Adjust the reference level offset according to the insertion loss from the phone to the spectrum analyzer.

PC/Phone operation:

Set operating mode to local mode.

Select	Maintenance	Alt-M
	Tuning	T
	TX IQ Tuning	I

Wait until the TX IQ Tuning window pops up.

Select	Maintenance	Alt-M
	Tuning	T
	RF Controls	F

Wait until the RF Controls window pops up.

Connect a Spectrum Analyzer or GSM tester with the option *Narrow Spectrum' to the RF connector of the phone.

If a spectrum analyzer is used then use the following settings.

	GSM1800
Center Frequency	1747.8MHz
Frequency Span	300 kHz
Resolution Bandwidth	3 kHz
Video Bandwidth	3 kHz
Sweep Time	3 sec.
Sweep Type	Clear/Write
Detector Type	Max Peak
Reference level	35 dBm
Marker 1	1747.73229 MHz
Marker 2	1747.8 MHz
Marker 3	1747.86771 MHz

Select in the RF controls window:

Select	Band GSM 1800
	Active UnitTX
	Operation ModeBurst
	RX/TX Channel 700
	TX PA Mode Free
	TX Data Type All1

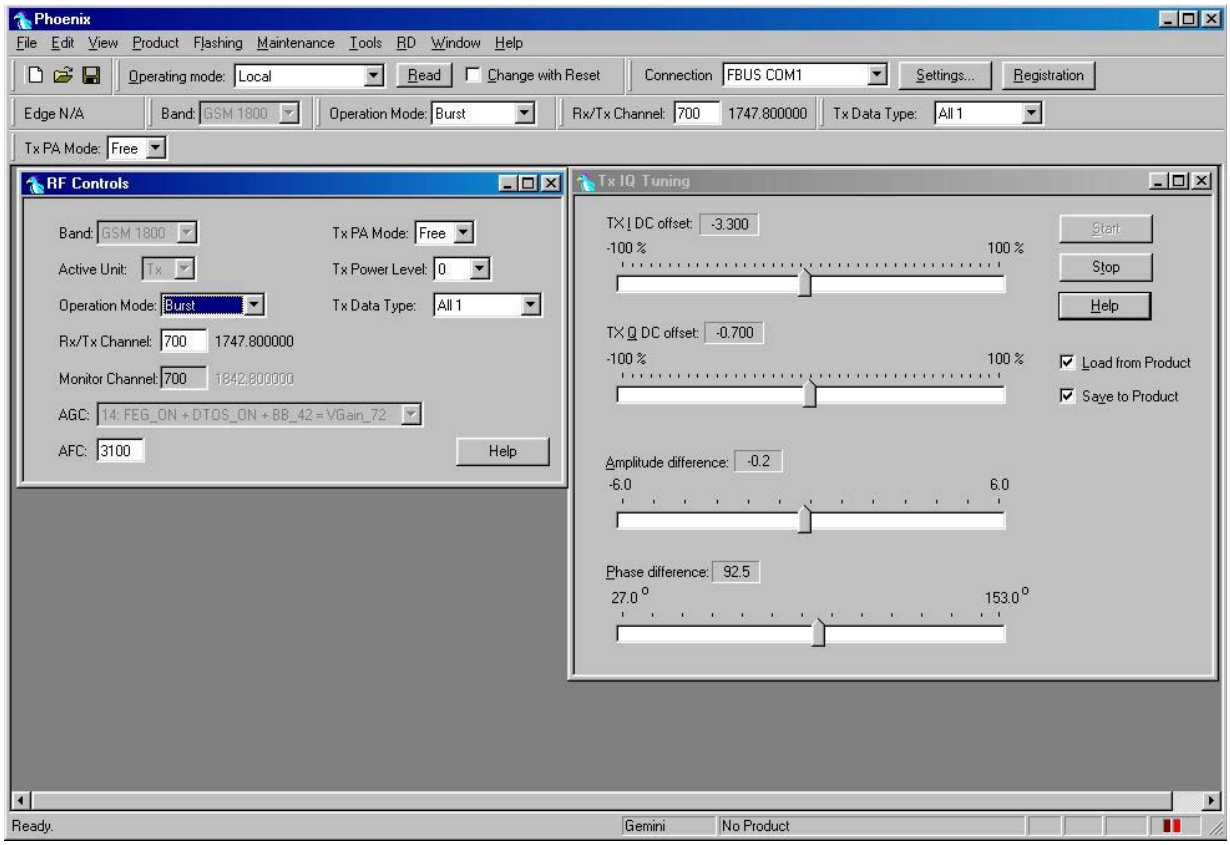
Select in the TX IQ Tuning Window:

Select	☑ Load from Product
Press	Start

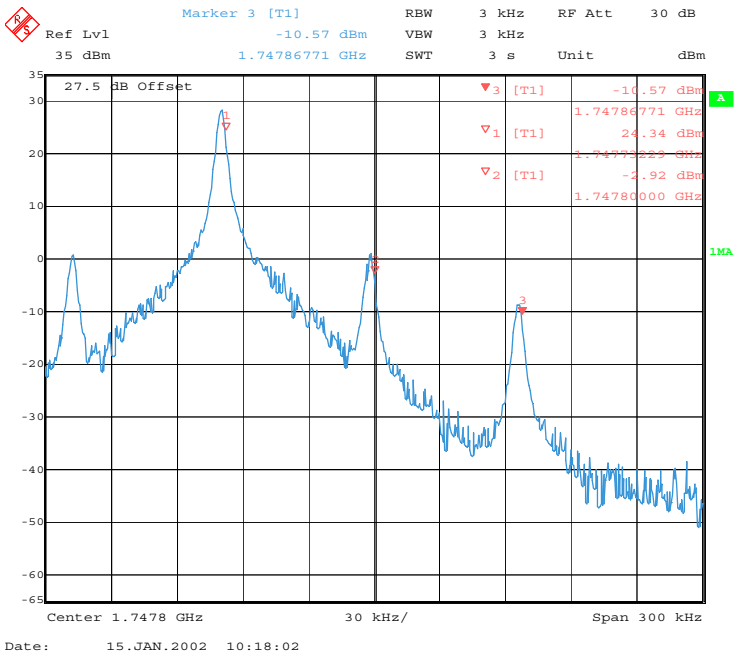
Select again in the RF Controls Window:

Select TX Power Level 4

The setup should now look like this:



The Spectrum Analyzer now shows a plot like this:

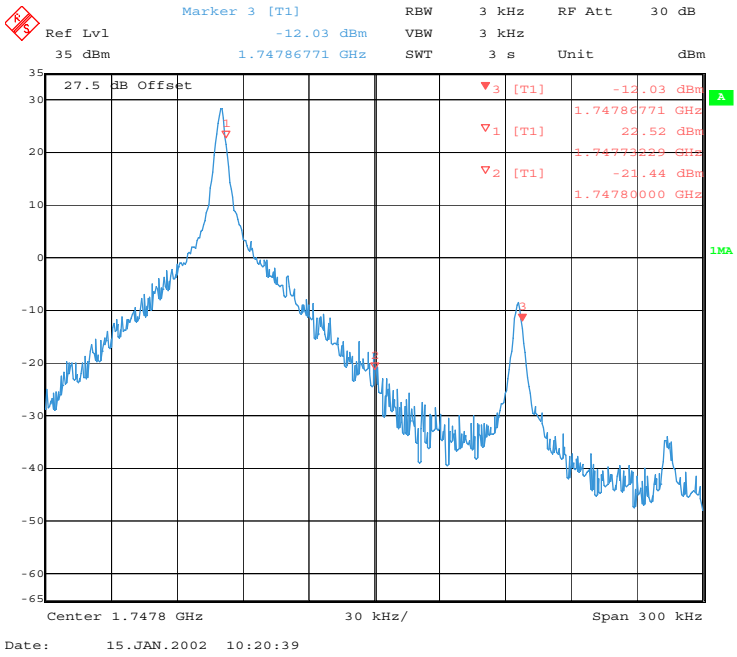


The purpose of this alignment is to tune the carrier signal (at marker 2) and the +67kHz signal (at marker 3) to a minimum level.

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (Marker 2). Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 2 and the peak levels at marker 1 must exceed 40dB.

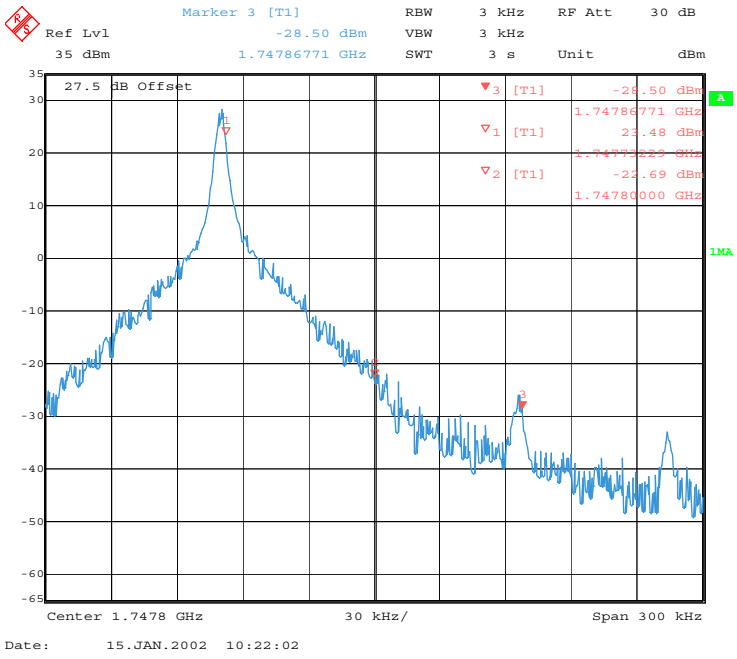
The Spectrum Analyzer now shows a plot like this:



Use the variables 'Amplitude difference' and 'Phase difference' to adjust the +67kHz signal to a minimum level (Marker 3). Tuning is possible by using the arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 3 and the peak level at marker 1 must exceed 40dB.

The Spectrum Analyzer now shows a plot like this:



Check the results in the TX IQ Tuning Window against the limits:

Value	Typical	Limit min.	Limit max.
TX I DC offset	0.1	-6	6
TX Q DC offset	-0.1	-6	6
Amplitude difference	-0.1	-1	1
Phase difference	89.5	80	100

Select in the TX IQ Tuning Window:

Select ☑ Save to Product

Press Stop

and the values are stored in the phone. The GSM1800 TX IQ Tuning is now finished.

Note: The optimum values for "TX I and Q Offset" and "Amplitude and Phase Difference" vary from phone to phone.

TX I/Q tuning GSM1900

Caution: In the case you use a spectrum analyzer make sure that the external attenuation (20-30dB) between phone and spectrum analyzer is high enough that the input of the analyzer can't be destroyed. Adjust the reference level offset according to the insertion loss from the phone to the spectrum analyzer.

PC/Phone operation:

Set operating mode to local mode

Select	Maintenance		Alt-M
	Tuning		T
		TX IQ Tuning	I

Wait until the TX IQ Tuning window pops up.

Select	Maintenance		Alt-M
	Tuning		T
		RF Controls	F

Wait until the RF Controls window pops up.

Connect a Spectrum Analyzer or GSM tester with the option *Narrow Spectrum' to the RF connector of the phone.

If a spectrum analyzer is used then use the following settings.

	GSM1900
Center Frequency	1880MHz
Frequency Span	300 kHz
Resolution Bandwidth	3 kHz
Video Bandwidth	3 kHz
Sweep Time	3 sek.
Sweep Type	Clear/Write
Detector Type	Max Peak
Reference level	35 dBm
Marker 1	1879.93229 MHz
Marker 2	1880 MHz
Marker 3	1880.06771 MHz

Select in the RF controls window:

Select	Band GSM 1900
	Active UnitTX
	Operation ModeBurst
	RX/TX Channel 661
	TX PA ModeFree
	TX Data TypeAll1

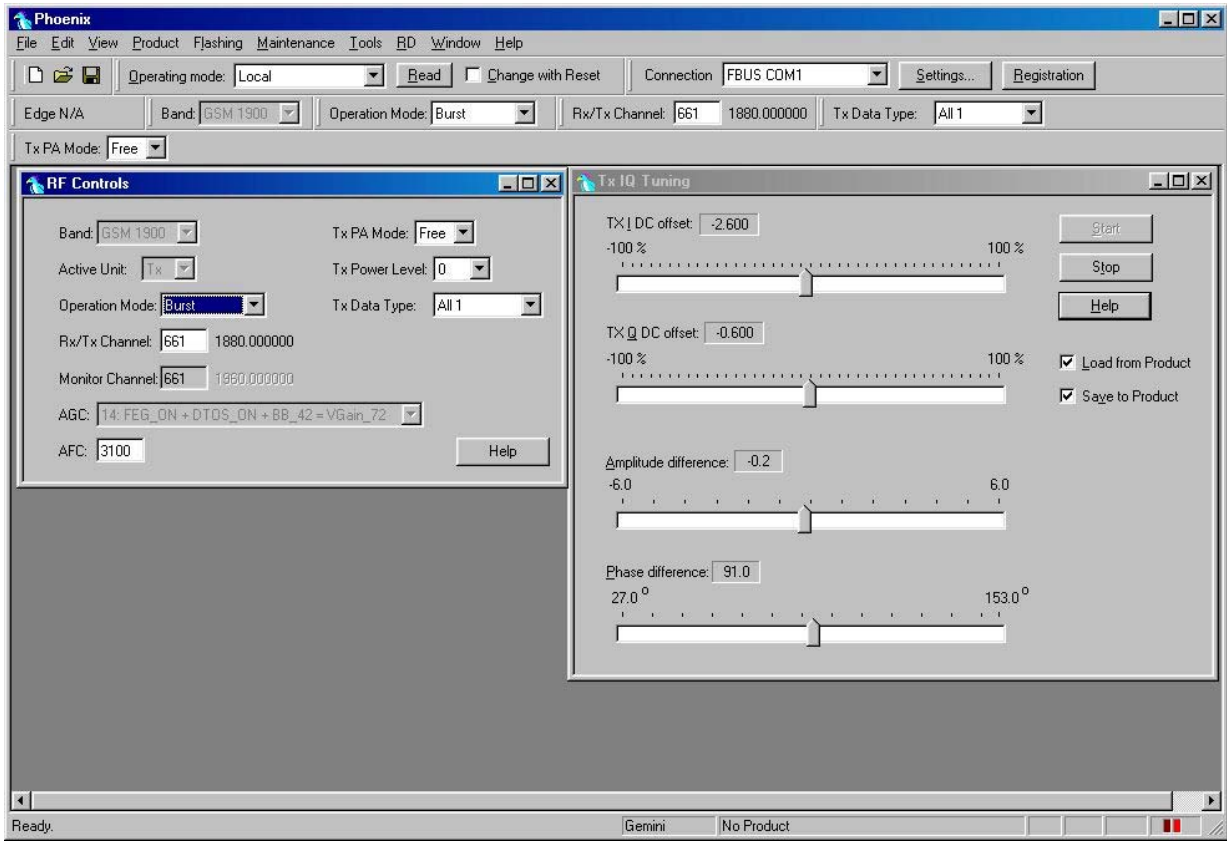
Select in the TX IQ tuning window:

Select	☑ Load from Product
Press	Start

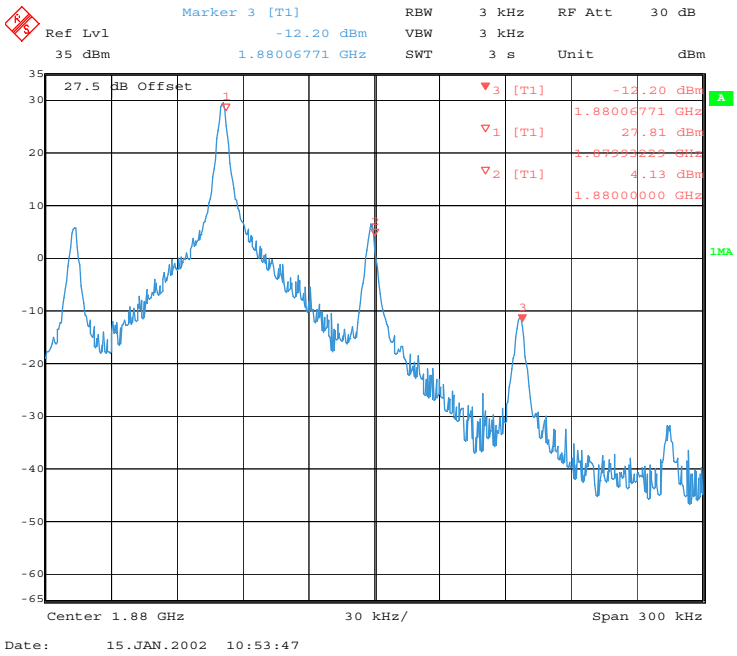
Select again in the RF controls window:

Select TX Power Level 4

The setup should now look like this:



The Spectrum Analyzer now shows a plot like this:

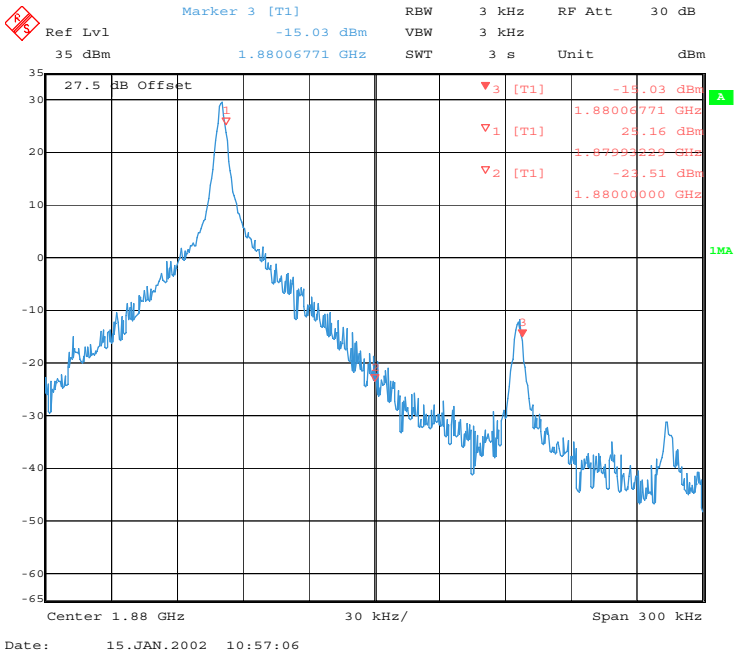


The purpose of this alignment is to tune the carrier signal (at marker 2) and the +67kHz signal (at marker 3) to a minimum level.

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (marker 2). Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 2 and the peak levels at marker 1 must exceed 40dB.

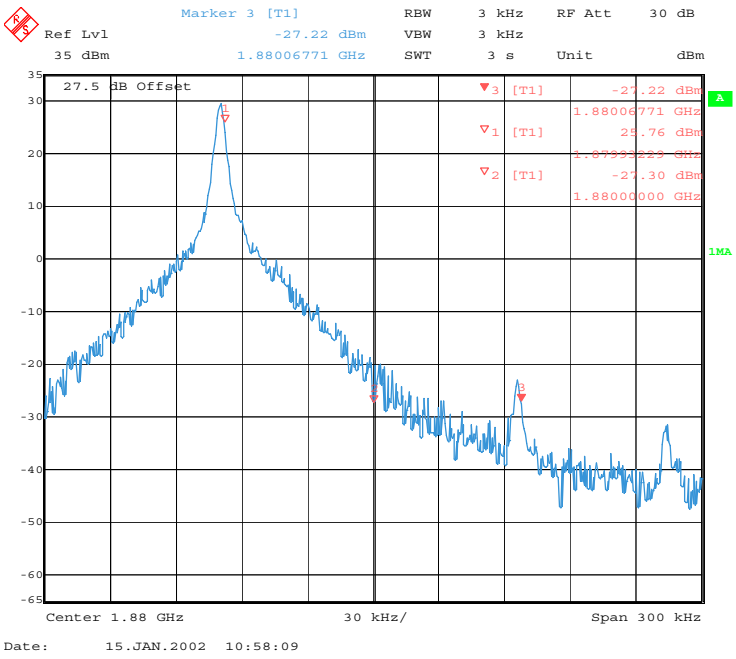
The Spectrum Analyzer now shows a plot like this:



Use the variables 'Amplitude difference' and 'Phase difference' to adjust the +67kHz signal to a minimum level (Marker 3). Tuning is possible by using the arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

After tuning to the minimum the level difference between marker 3 and the peak level at marker 1 must exceed 40dB.

The Spectrum Analyzer now shows a plot like this:



Check the results in the TX IQ Tuning Window against the limits:

Value	Typical	Limit min.	Limit max.
TX I DC offset	0.2	-6	6
TX Q DC offset	-0.1	-6	6
Amplitude difference	0	-1	1
Phase difference	89.0	80	100

Select in the TX IQ tuning window:

Select ☑ Save to Product

Press Stop

and the values are stored in the phone. The GSM1800 TX IQ Tuning is now finished.

Note: The optimum values for "TX I and Q Offset" and "Amplitude and Phase Difference" vary from phone to phone.