6(b) RF Troubleshooting

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RF Troubleshooting

Abbreviations in fault finding charts

ASIC	Application Specific Integrated Circuit
BB	Base band
BT	Bluetooth
ESD	Electro Static Discharge
GPRS	General Packed Radio Service
HSCSD	High Speed Circuit Switched Data
LO	Local Oscillator
PA	Power Amplifier
PCS	GSM1900
PLL	Phase Locked Loop
PWB	Printed Wired Board
RF	Radio Frequency
RX	Receiver
SA	Spectrum analyzer
TX	Transmitter
UEM	Universal Energy Management
UHF	Ultra High Frequency
VCO	Voltage controlled oscillator
VHF	Very High Frequency

Introduction

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

- RF measurements shall be done using a Spectrum Analyzer together with a high-frequency probe. (Note, that signal will be significantly attenuated). Correct attenuation can be checked by using a “good” phone board, for example.
- LF (Low frequency) and DC measurements shall be done with a an oscilloscope together with an 10:1 probe.

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

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

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

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

Apart from key-components described in this document there are a lot of discrete components (resistors, inductors and capacitors) for which 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 measurements should be evaluated carefully.

RF Key component placement

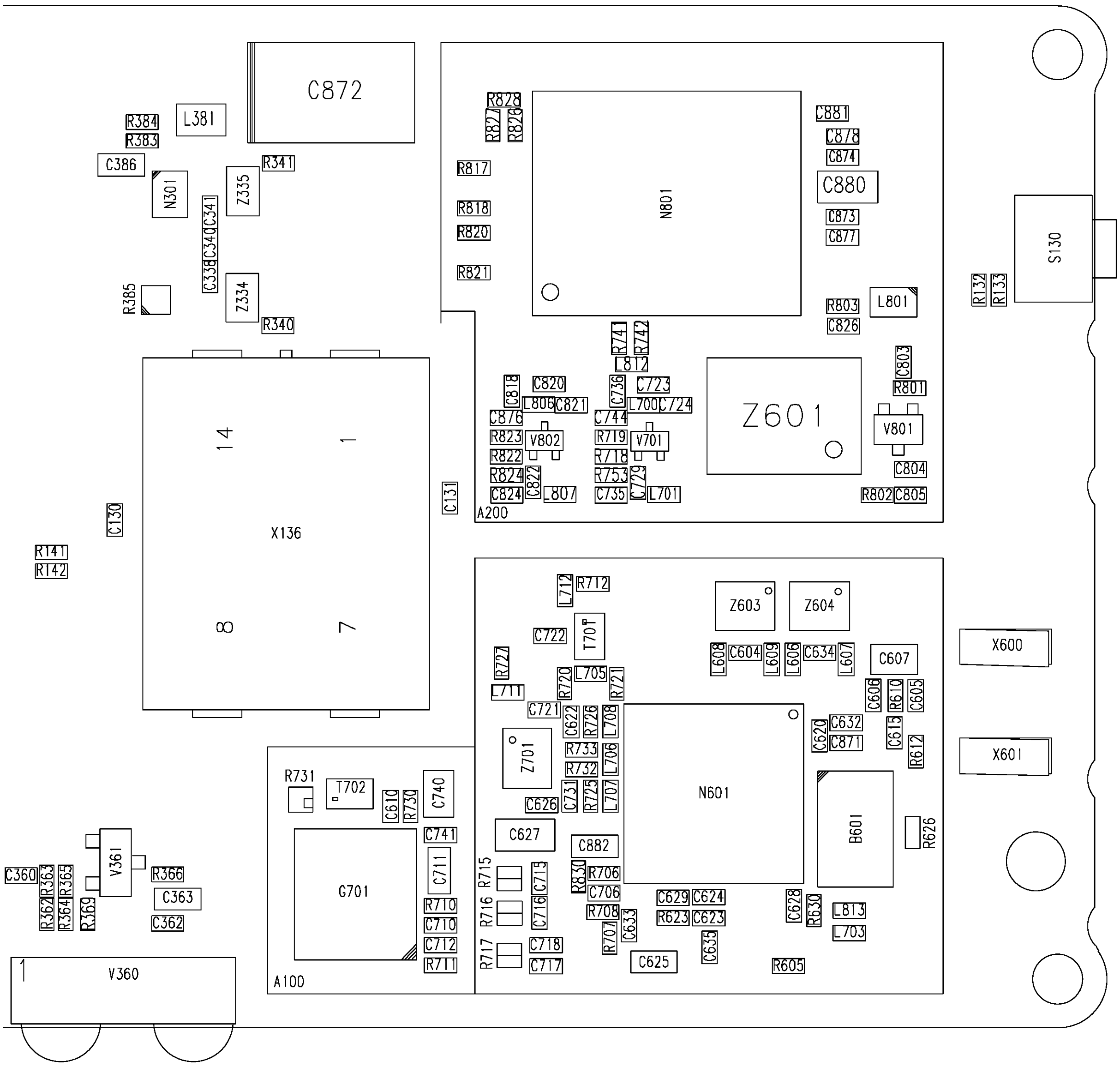

Figure 1: RF key component placement

Reference number	Name	Reference number	Name
N601	Mjoelner RF ASIC	X600	Antenna signal clip
B601	26 MHz Xtal	X601	Antenna ground clip
Z603	GSM1900 RX SAW	X602	RF Connector
Z604	850 RX SAW filter	L801	Directional Coupler
Z701	850 TX SAW filter	V801	Detector Diode
T701	GSM1900 TX Balun	Z601	Antenna switch
V802	850 TX buffer	N801	Power Amplifier
G701	3.7 GHz VCO	V701	1900 TX buffer
T702	VCO Balun		

RF Measurement points

RF Supply points

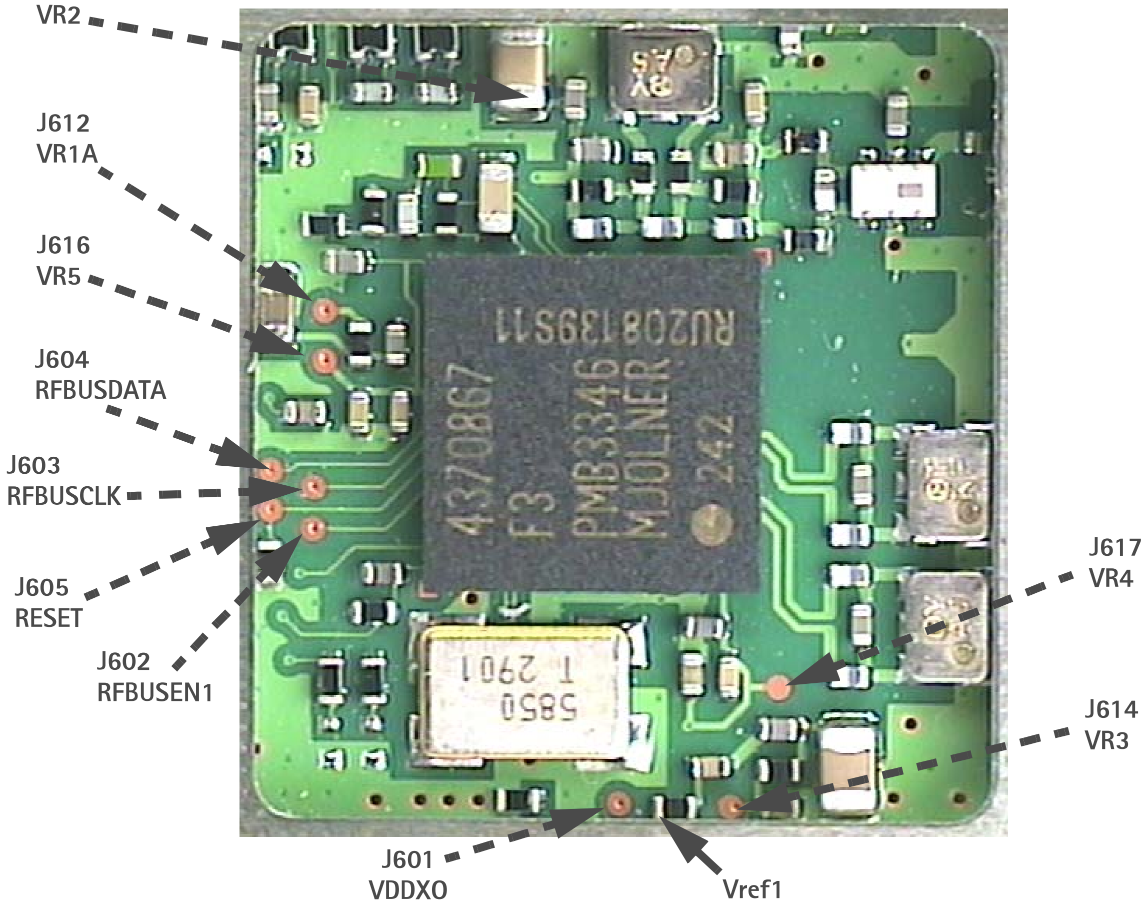

Figure 2: RF Supply points inside Mjoelner can

RF power supplies are generated in the UEM and can be measured either in the Mjoelner can or in the baseband can. Arrows mark the measurement points inside the pictures.

Measurement of VR7 inside Mjoelner can requires removal of RF shielding frame. Therefore, VR7 shall be measured inside baseband can

Measurement points in the receiver

Measurement points are indicated on the picture below.

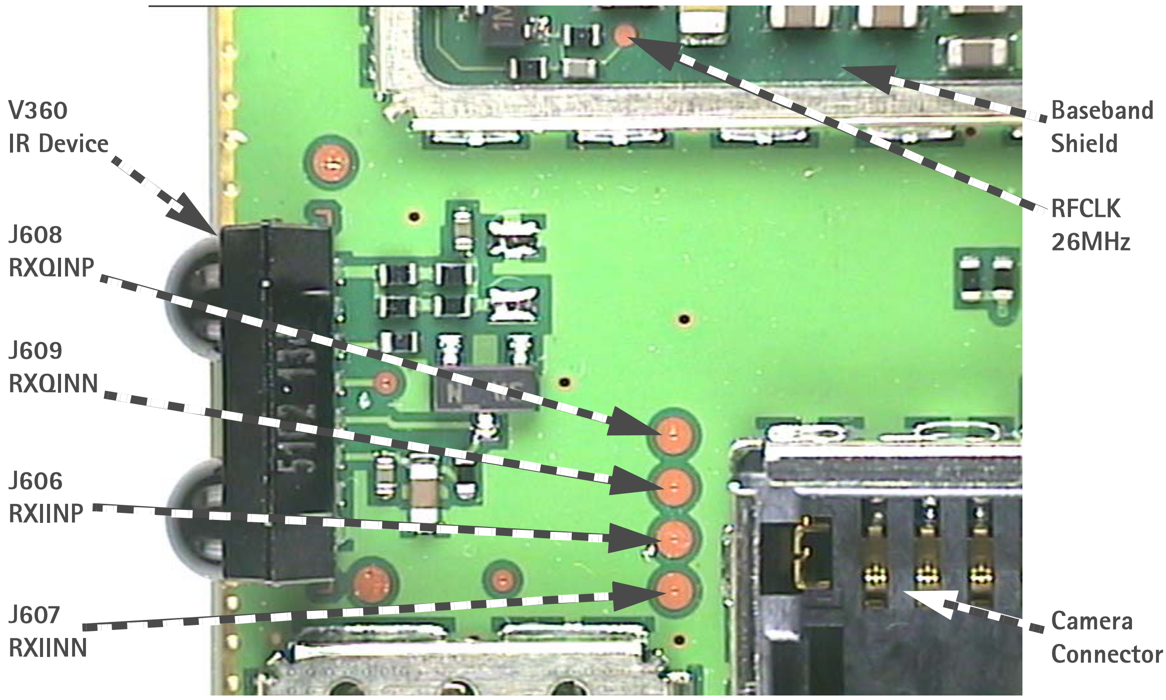

Figure 3: Rx I and Q measurement points

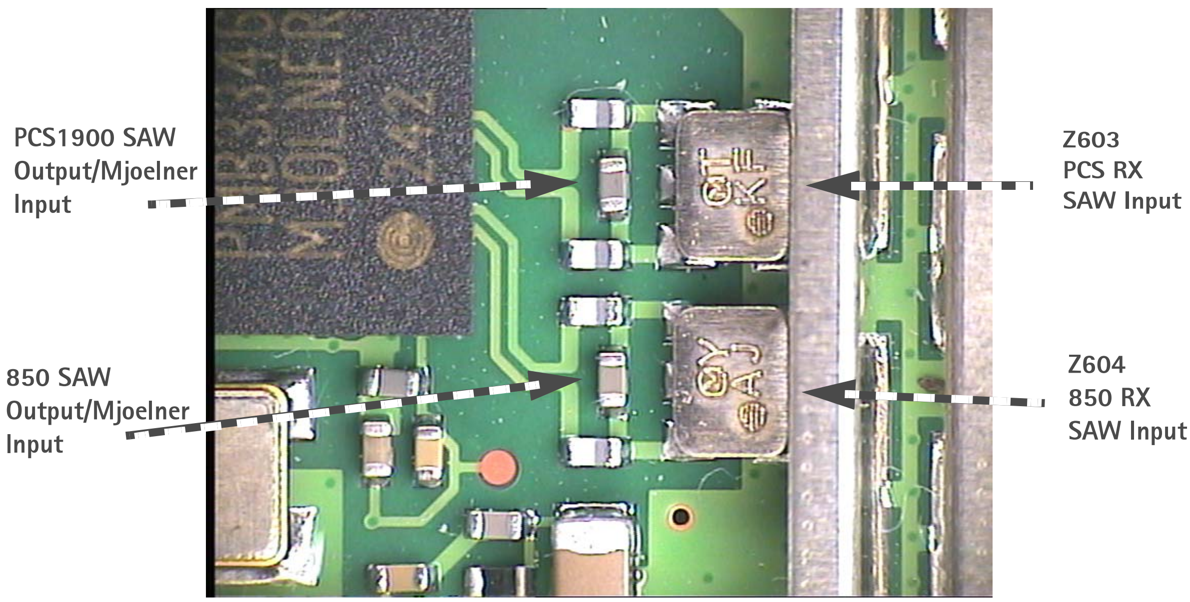

Figure 4: Rx measurement points at Rx SAW filters and Mjoelner RF ASIC

Measurement points in the transmitter

Measurement points are shown in the picture below,

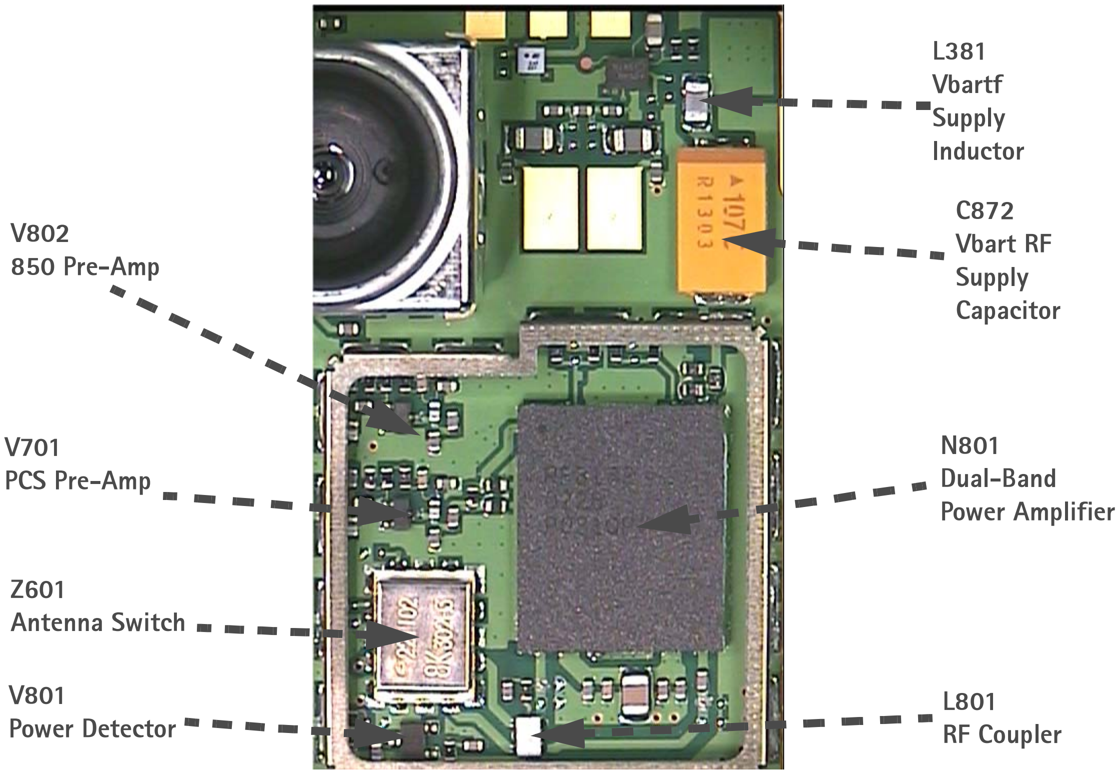

Figure 5: Tx measurement points inside PA can

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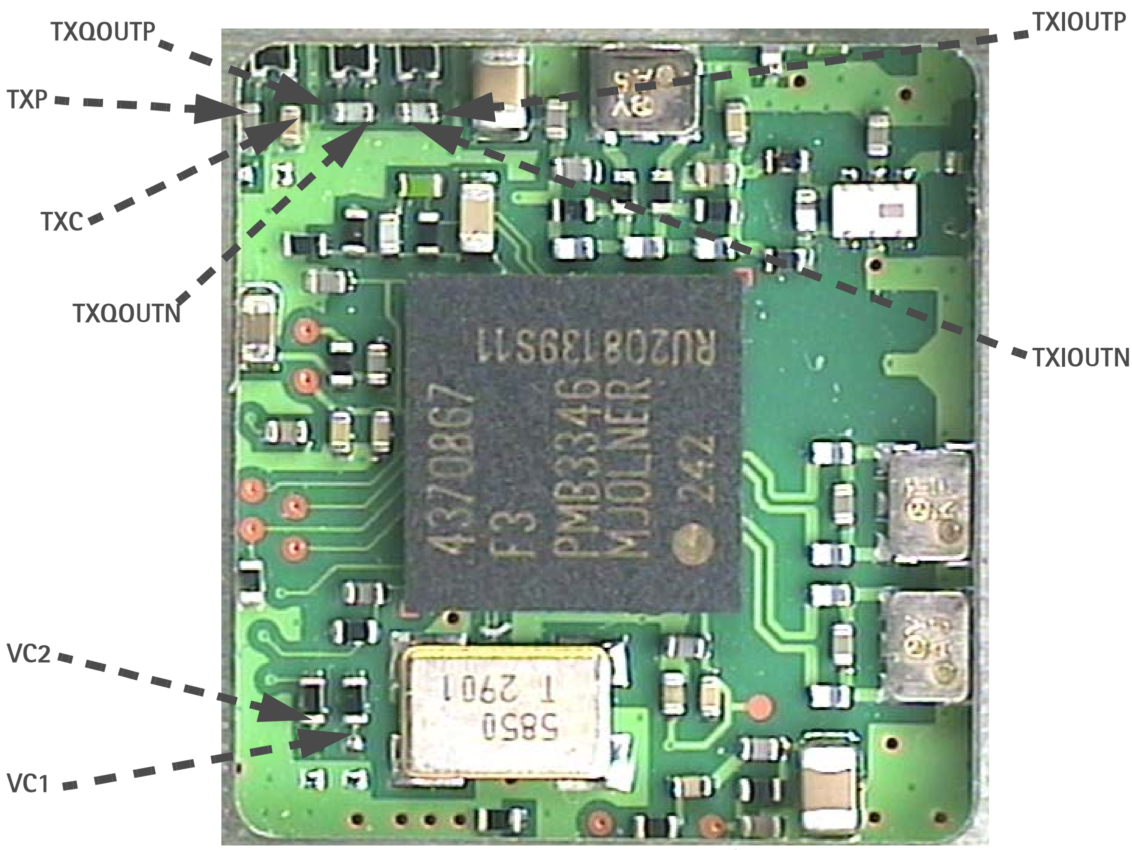


Figure 6: Tx measurement points inside Mjoelner can

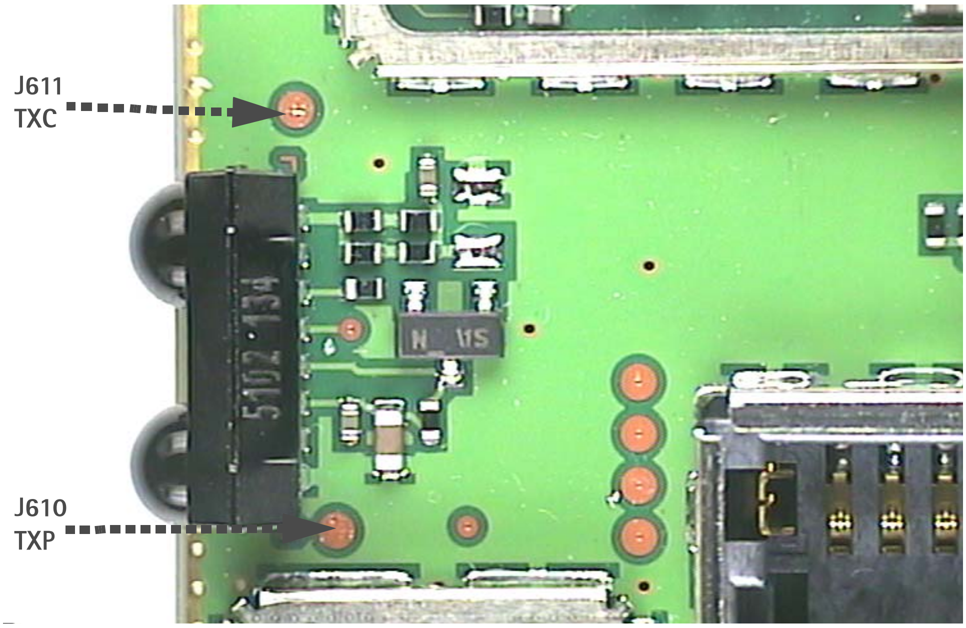


Figure 7: Tx measurement points for TXC, TXP signals

RF in general

The RF part is a multi-band direct conversion transceiver, however, only two bands are used. Using direct conversion no intermediate frequencies are used for up- or down-conversion.

The VCO is set to either twice or four times (depending on the band used) the wanted RX or TX frequency. 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 DC. All up and down-conversion takes place in the RF ASIC named Mjoelner (N601).

Mjoelner RF ASIC also contains PLL and LNAs for all used bands. A DC control section is included in to power and/or control TX buffers, 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 interface between Mjoelner RF ASIC, UPP and Bluetooth uses a 26 MHz reference clock. An external 26 MHz reference clock buffer is used to drive Bluetooth module.

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

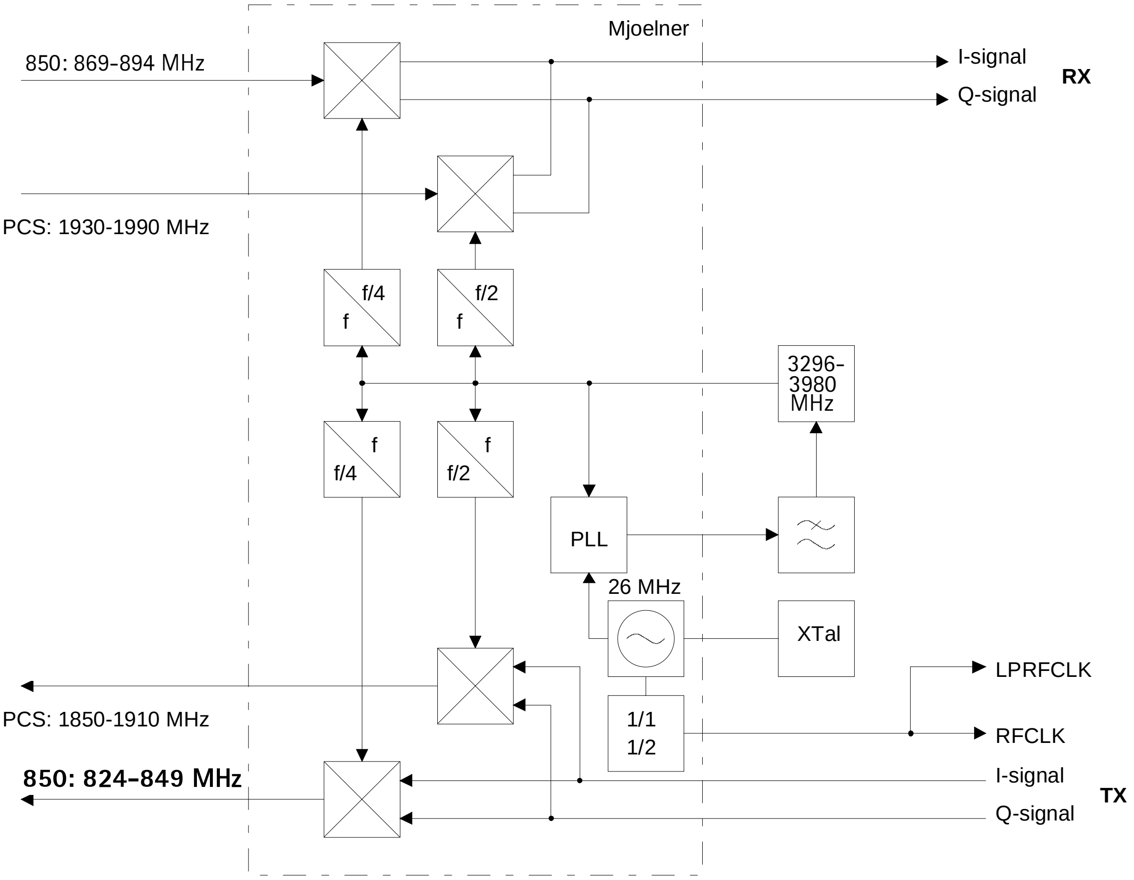


Figure 8: RF frequency plan

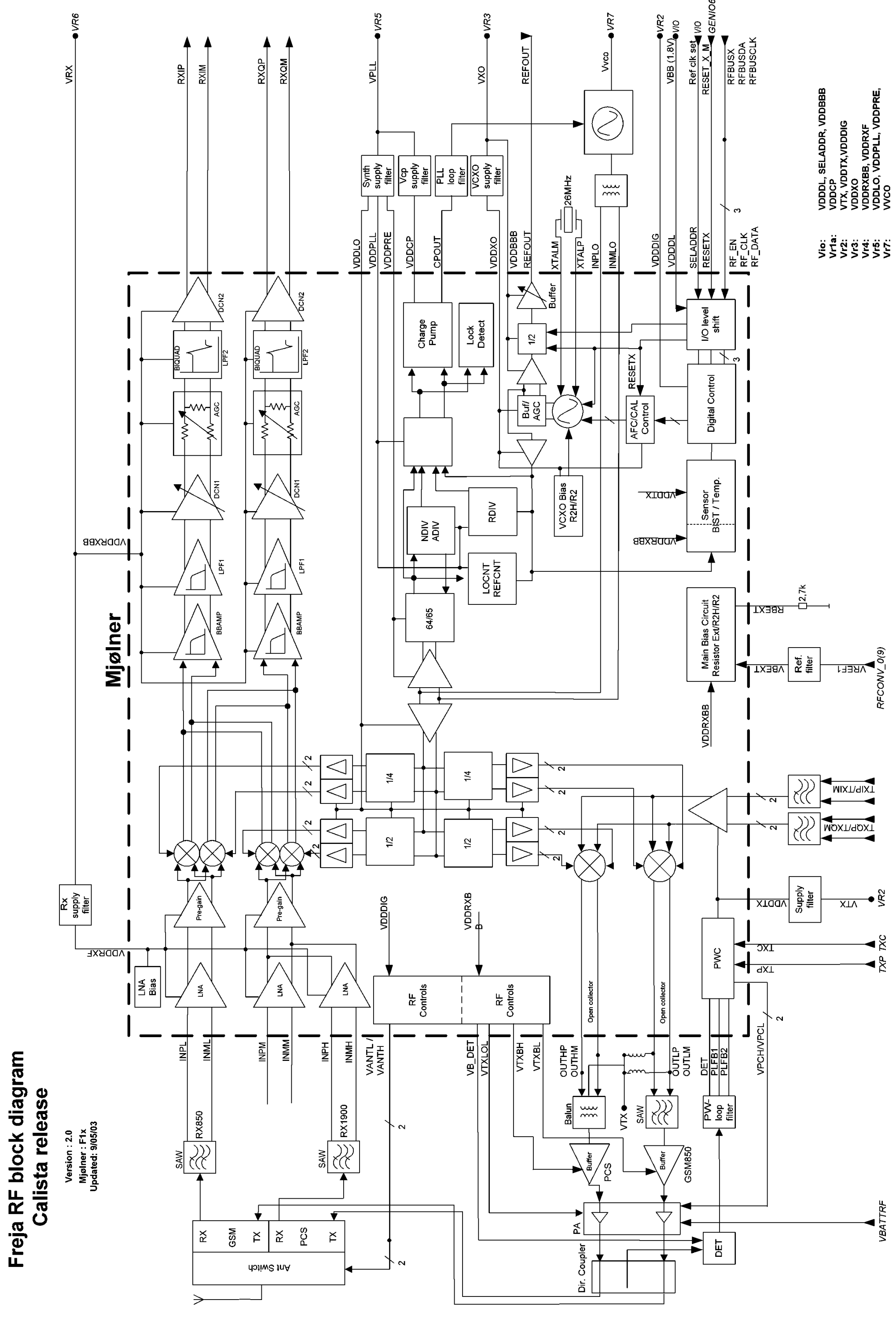


Figure 9: RF Block diagram

RF Power Supply Configuration

All power supplies for the RF Unit are generated in the UEM IC (D200). All RF supplies can be checked either in Mjoelner can or in BB can.

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

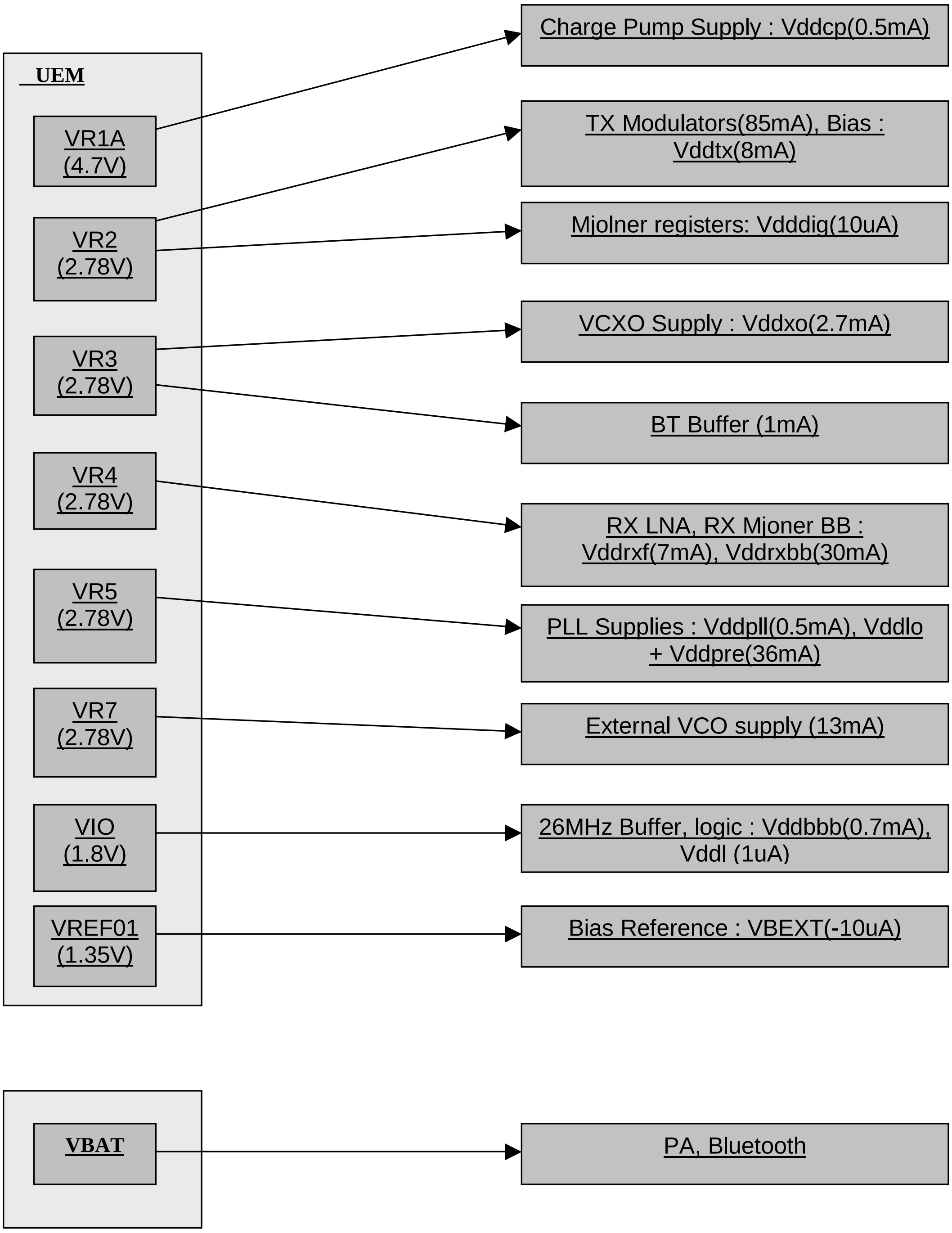
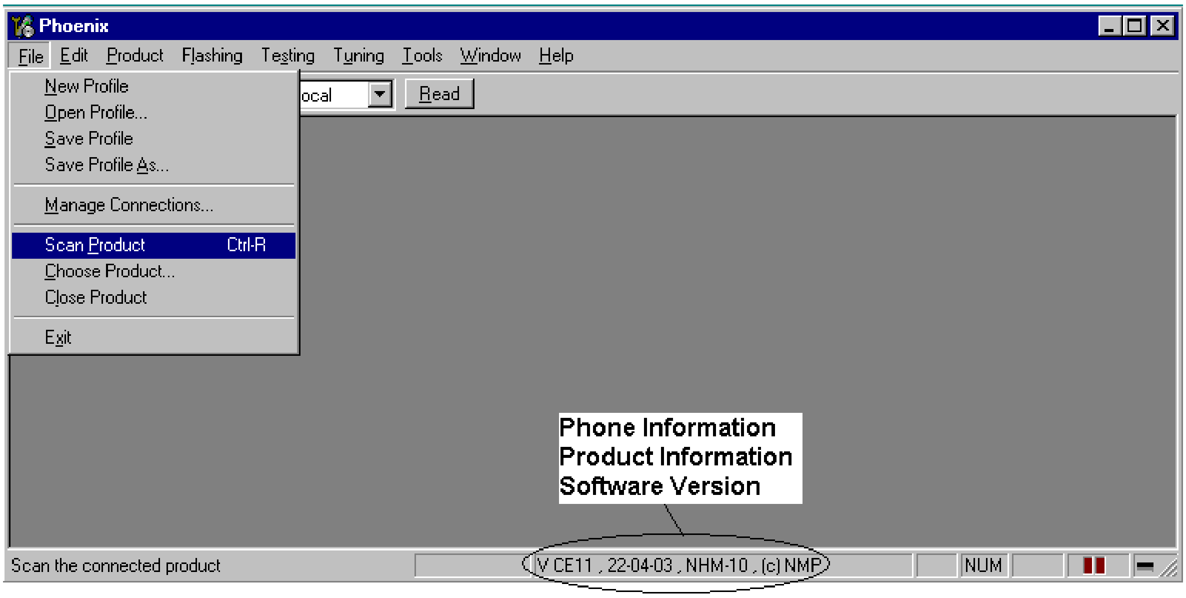
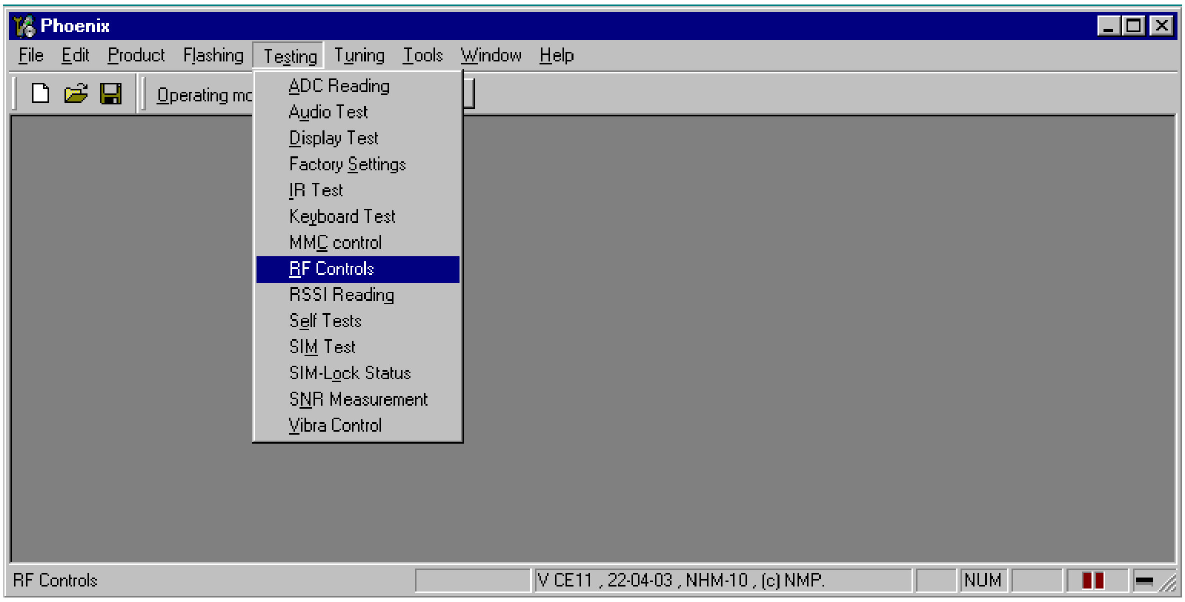


Figure 10: RF Power distribution diagram





Receiver

General instructions for RX troubleshooting

Connect the the phone to a PC with DAU-9S cable and dongle and follow the following instructions:

Measuring RX I/Q signals using RSSI reading

Start Phoenix Service Software

Open the FBUS connection

Select Scan Product Ctrl-R

Wait until phone information shows in the window at the bottom of the screen.

Set operating mode to local mode

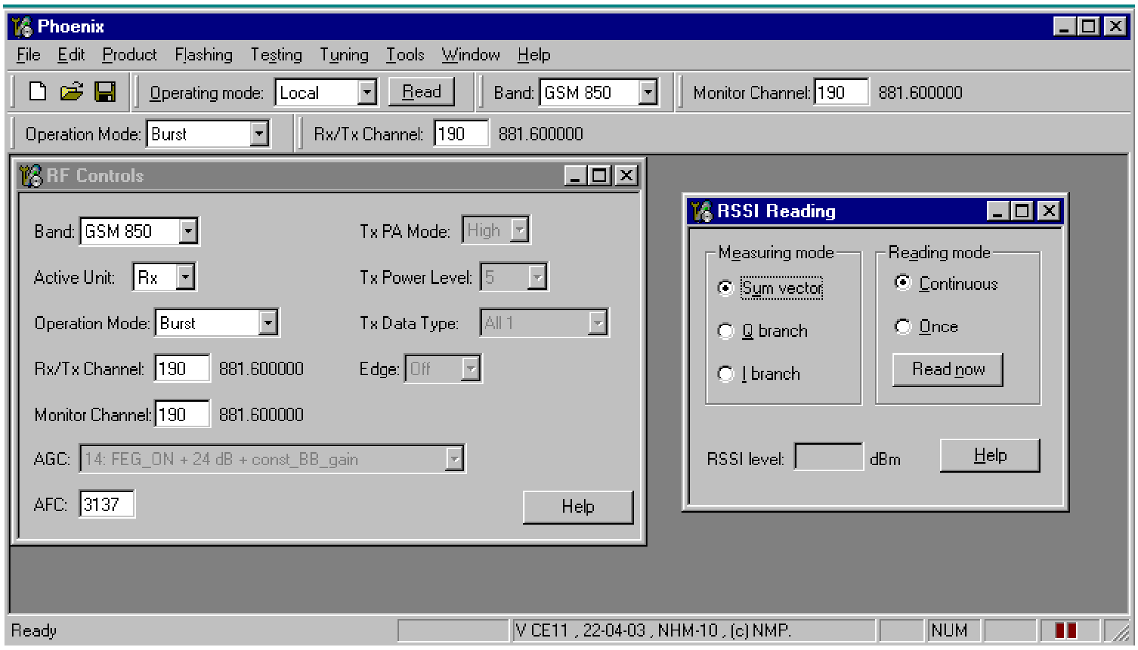
Select	Testing		Alt-S
		RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM 850 or GSM 1900
	Active unit	RX
	Operation mode	Burst
	RX/TX Channel	190 or 661

Select	Testing		Alt-S
		RSSI reading	G

The setup should now look like this:



Apply a signal with a frequency of

GSM 850: 881.667 MHz (channel 190 + 67.710kHz offset)
GSM1900: 1960.067 MHz (channel 661 + 67.710kHz offset)

and a power level of -80dBm to the RF-connector (remember to compensate for cable attenuation).

In RSSI reading click on Read now.

The resulting RSSI level should be –80dBm in each band.

Measuring RX performance using SNR measurement

Start Phoenix Service Software

Open the FBUS connection

Select	Scan Product	Ctrl-R

Wait until phone information is shown in the lower window at the bottom of the screen.

Set operating mode to local mode

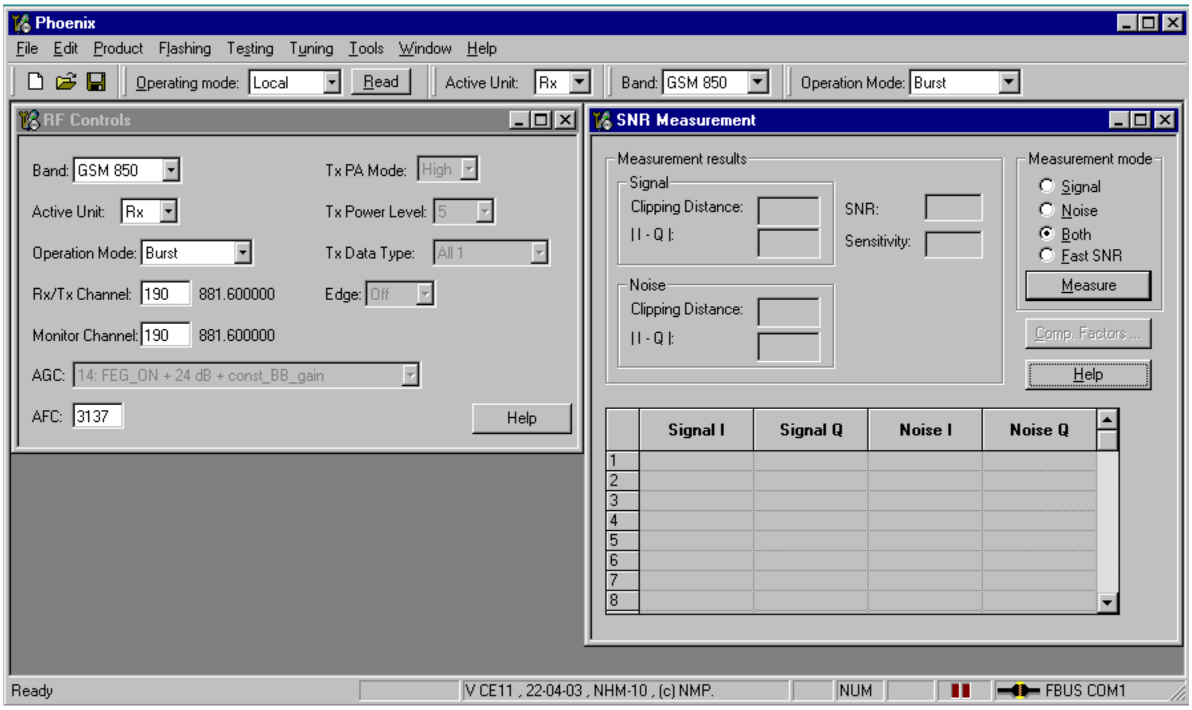
Select	Testing		Alt-S
		RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM 850 or GSM1900
	Active unit	RX
	Operation mode	**Burst**
	RX/TX Channel	190 or 661

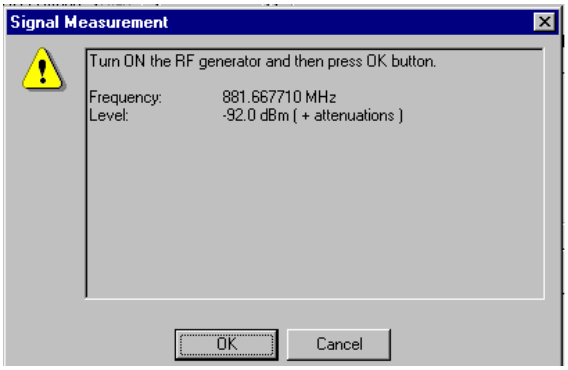
Select	Testing		Alt-S
		SNR Measurement	N
		select Fast SNR	Radio Button

The setup should now look like this:



Choose respective band (GSM850 or GSM1900)

Press measure. A window pops up, e.g. for GSM850 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: GSM850 >20dB
GSM1900 >18dB

Measuring frontend 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

Open the 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	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM 850 or GSM1900
	Active unit	RX
	Operation mode	**Continuous**
	RX/TX Channel	190 or 661

Please refer to the fault finding chart for proper levels at different test points.

Measuring analogue RX I/Q signal voltages using Oscilloscope

Measuring with an oscilloscope on “RXIINN” or “RXQINN” is recommended only if RSSI reading does not provide enough information. No dedicated test points exist for RX I and Q signals, but they can be accessed by probing on via hole plating. Input level = -80dBm

Start Phoenix Service Software

Select	Scan Product	Ctrl-R

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

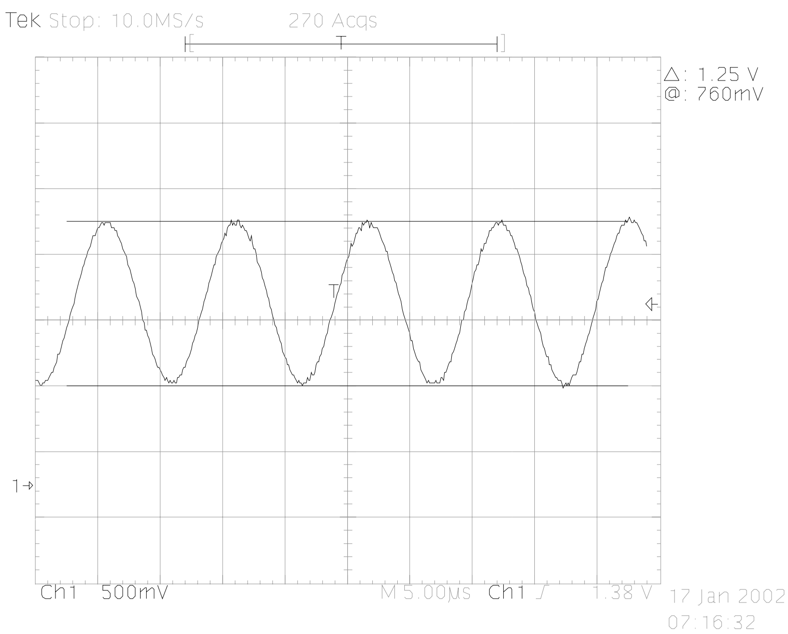
Set operating mode to local mode

Select	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM 850 or GSM1900
	Active unit	RX
	Operation mode	**continuous**
	RX/TX Channel	190 or 661
	AGC	14

Following picture should be seen on a working 850 receiver:



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

Receiver RSSI readings from Phoenix

Open Phoenix and select Fbus connection.

Set up signal generator to 881.668MHz, -80dBm.

Select 'File', 'Scan Product' from pull down menu.

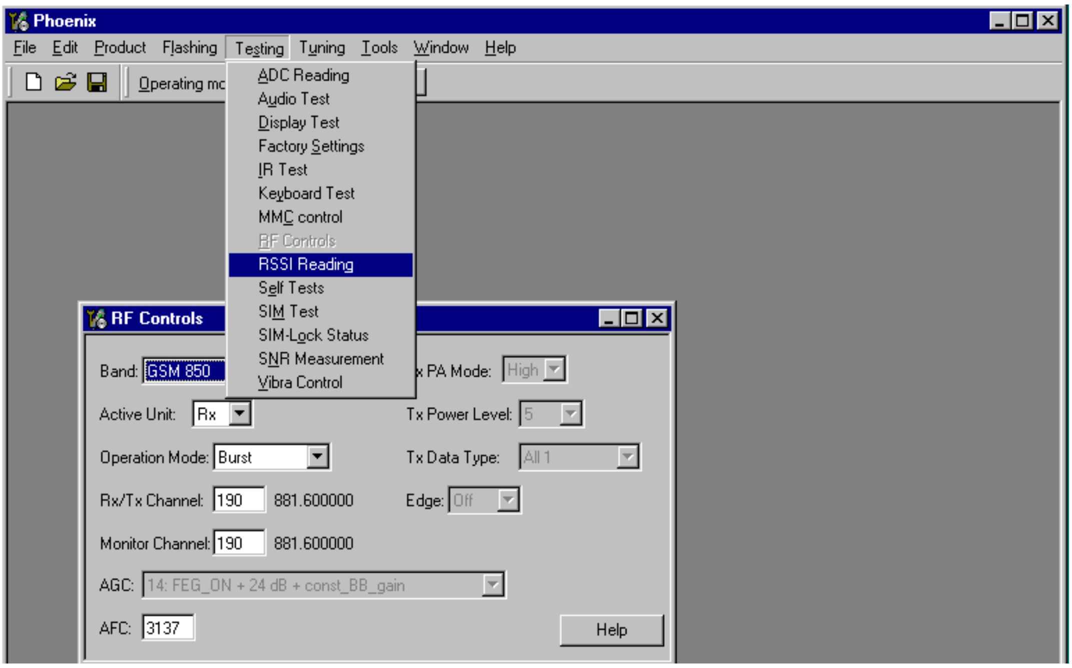
Select 'RF', 'Tuning', 'RF Controls'.

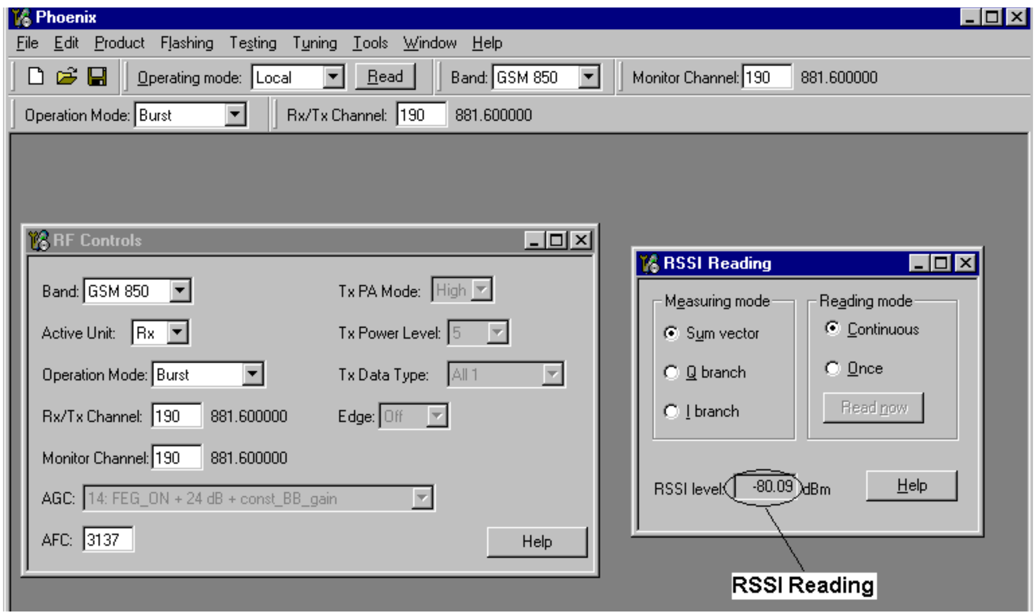
Select 'RF', 'Testing', 'RSSI reading'.

Observe RSSI level in the box.

Change band to GSM 1900 in RF control box and frequency to 1960.0668MHz on signal generator.

Observe RSSI level.





Receiver fault finding

Set up Phoenix as if doing RSSI measurements.

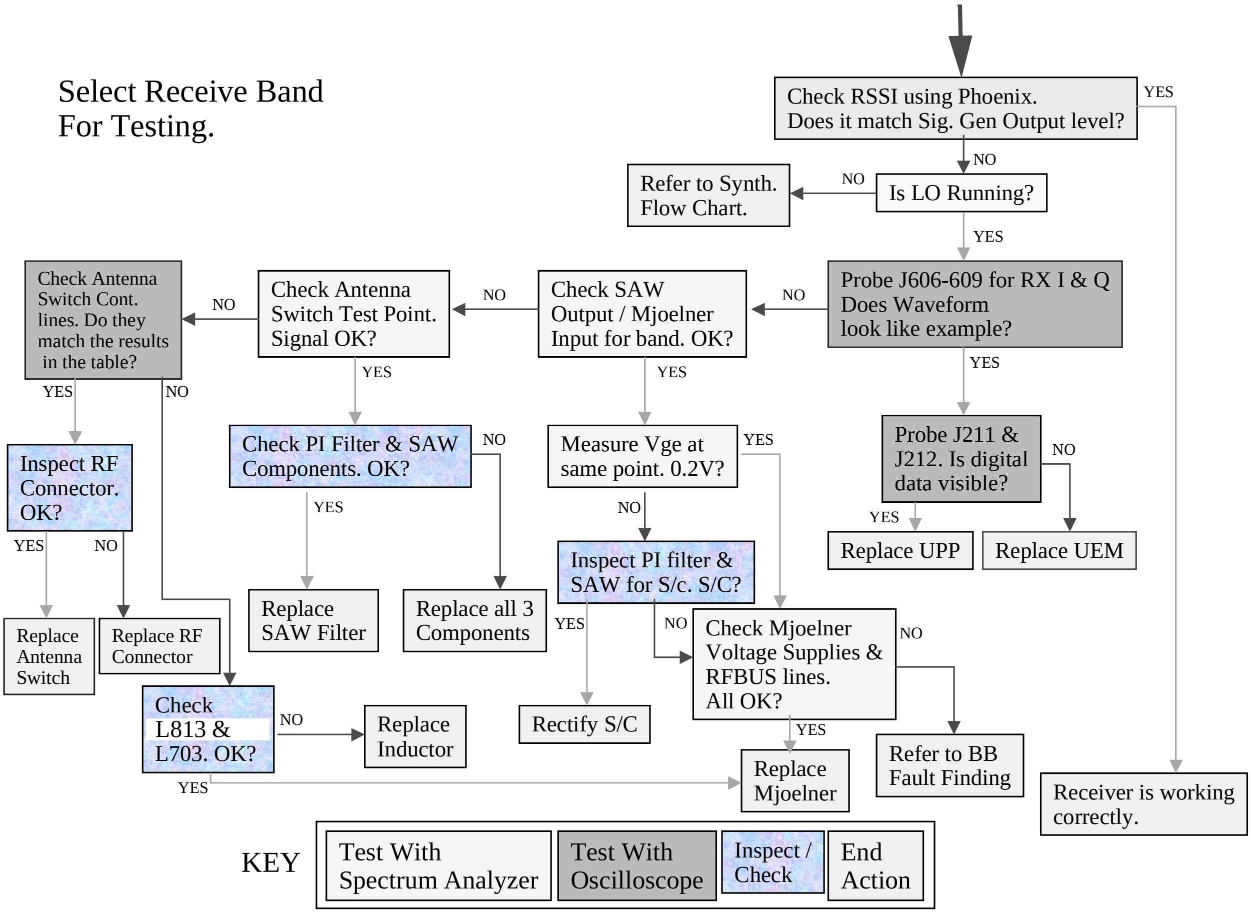
Ascertain which Rx band is faulty.

Refer to Rx fault finding flow chart.

Set signal generator frequency to 881.67MHz for 850 or 1960.07MHz for PCS 1900.

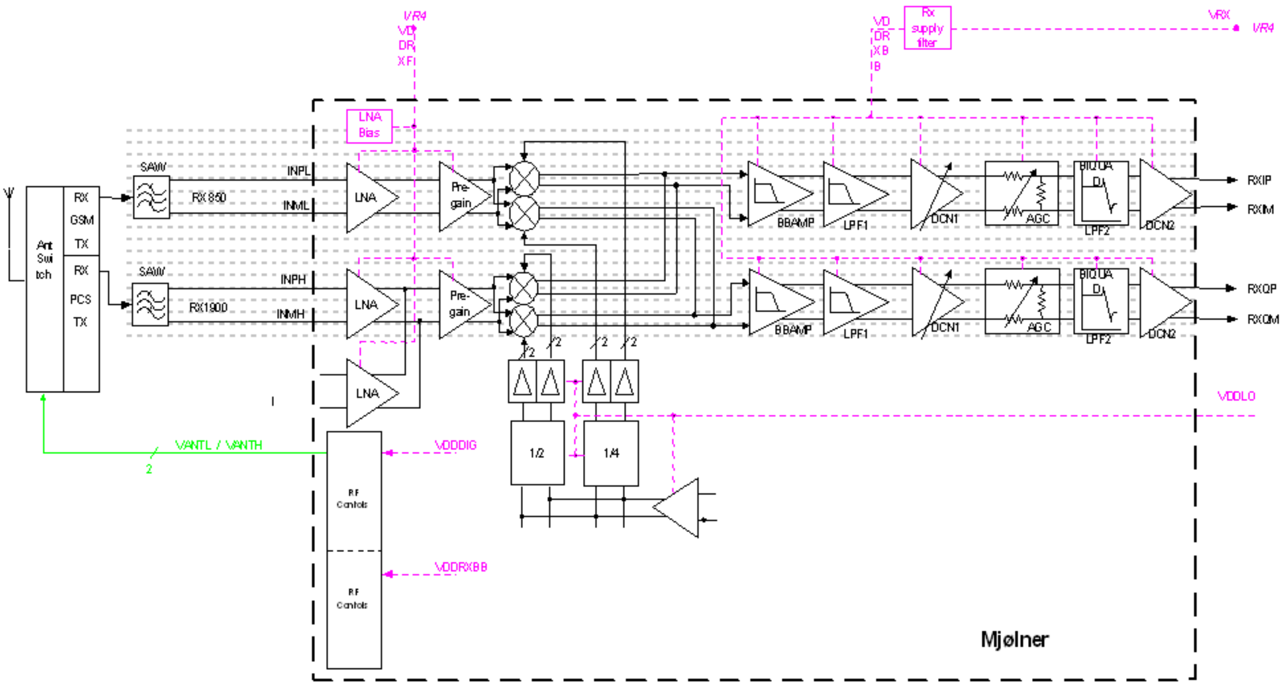
Set signal generator amplitude to -60dBm.

Note: That checking the RF inputs to SAW filters Z603 & Z604 will be extremely difficult with the Mjoelner Can Shield in place. If this is impossible to get to, try checking the test points shown on the antenna switch Z601.



Rx Signal paths

The signal paths of the receiver are shown in following block diagram. Note that the picture shows GSM850 receiver (top) and GSM1900 (PCS) receiver (down).



Antenna switch (RX/TX Switch)

From the antenna-pad (X600) the RF signal is fed through the antenna connector (X602) to the RX/TX switch (Z601). The antenna connector represents a mechanical switch between internal antenna and external antenna feed.

The RX/TX switch (Z601) works as diplexer.

From 850-RX output of the antenna switch the RX signal is routed in the inner layers of the PWB to the GSM850 SAW filter (Z604). From 1900-RX output the RX GSM1900 signal is routed to the GSM1900 SAW filter (Z603).

The RX/TX switch with routed lines has following typical insertion losses:

0.9dB@GSM850 and 1.0dB@GSM1900.

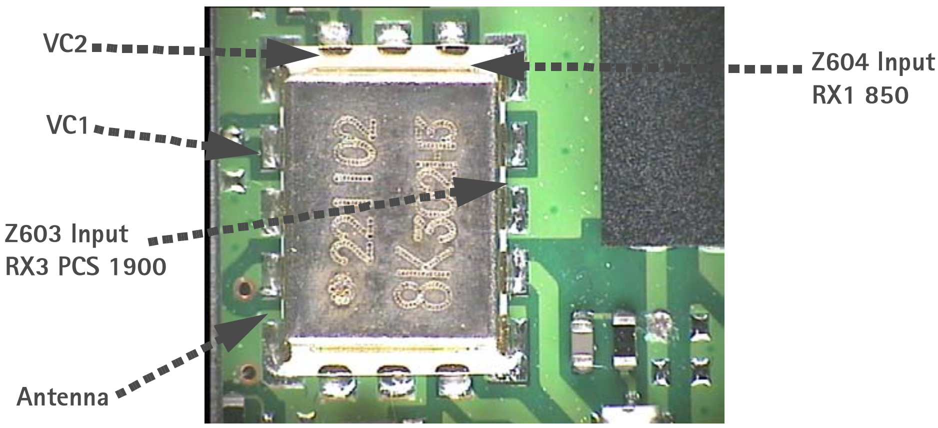


Figure 11: Antenna switch Rx test points

Front-end

The RX front end includes two SAW filters (GSM850 (Z604) and 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@GSM850 and 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 band: GSM850 and GSM1900.
- Two PREGAIN amplifiers, one for GSM850 and one for GSM1900.
- Two passive I/Q mixers (MIX), one for GSM850 and for GSM1900.

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

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

The differential base band outputs are internally DC coupled and 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.

GSM850 Transmitter

General instructions for GSM850 TX troubleshooting

Apply a RF-cable to the RF-connector to allow the transmitted signal to act as normal. RF-cable should be connected to measurement equipment (GSM Test equipment, Powermeter, Spectrum Analyzer, or similar). Be sure to use at least a 10-dB attenuator, otherwise the analyzer may be overloaded.

Connect the phone to a PC with DAU-9P cable and dongle and follow the following instructions:

Connect the phone to a power supply (3.5 ... 4V).

Open Phoenix and select Fbus connection.

Select 'File' and 'Scan Product' from the pull down menus.

Select 'Testing', 'RF controls' from the pull down menu.

Chose Transmit Band for testing, Use the automatically selected channel.

Set Operation Mode to 'Burst'.

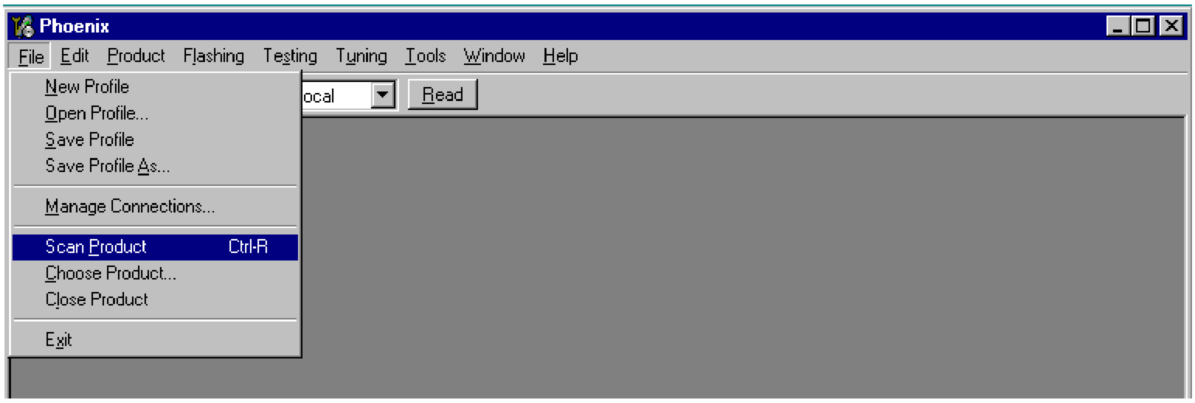
Choose the Power level you want the phone to operate at.

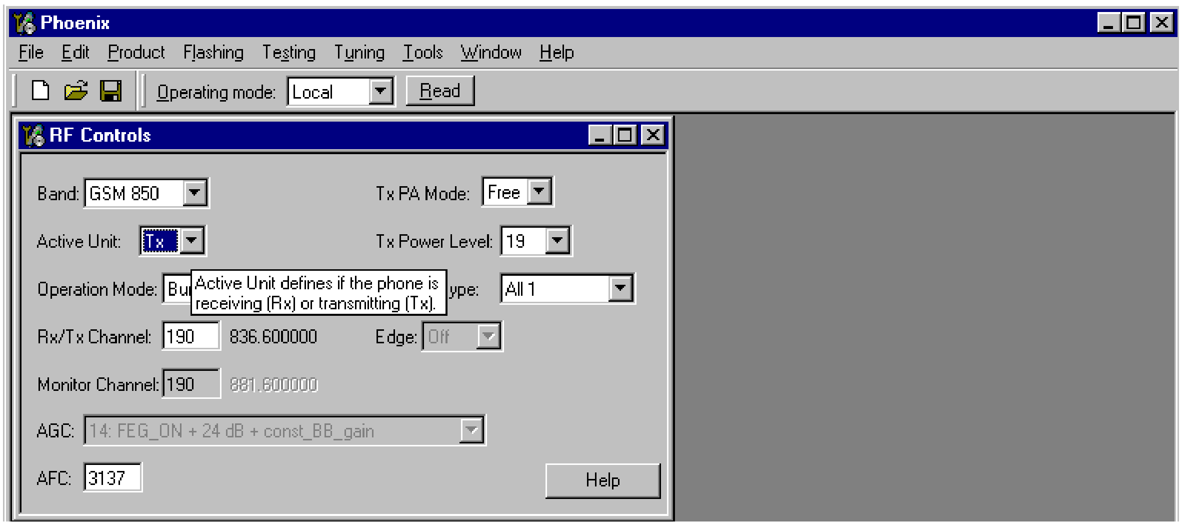
Set spectrum analyzer centre frequency, 836.6MHz for 850 & 1880MHz PCS 1900 and set Span to 1MHz.

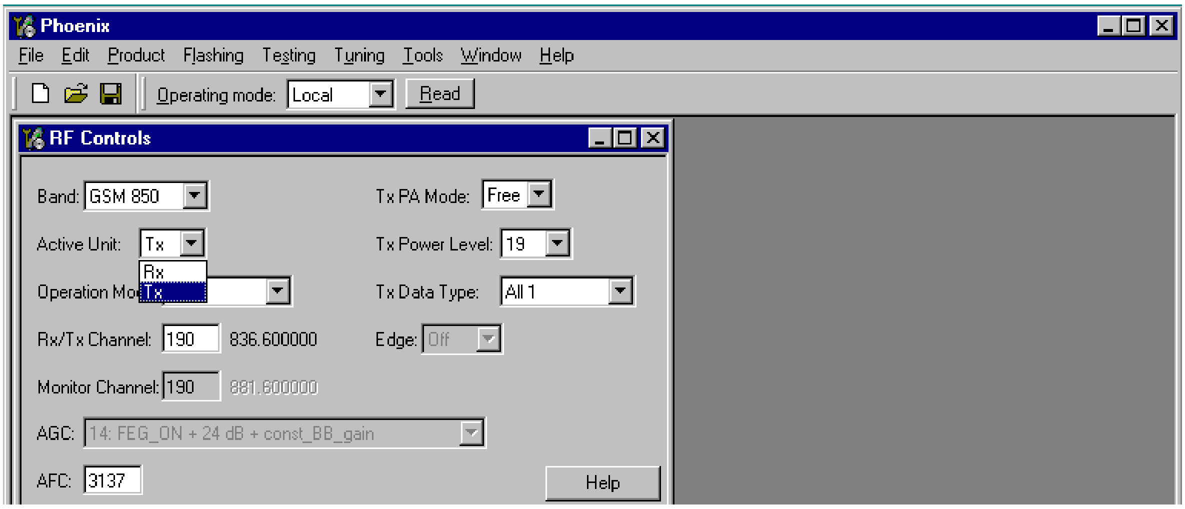
Set Amplitude of spectrum analyzer reference level to one that you can clearly see the transmit pulse according to the kind of test probe you are using.

Diagnose as per fault finding flow chart.

Note: Be careful when selecting the operation mode, if 'Continuous' is selected prolonged transmission may damage the phone




Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local
Read
RF Controls
Band: GSM 850
Tx PA Mode: Free
Active Unit: Tx
Tx Power Level: 19
Operation Mode: Bu
Active Unit defines if the phone is receiving (Rx) or transmitting (Tx).
ype:
All 1
Rx/Tx Channel: 190
836.600000
Edge: Off
Monitor Channel: 190
881.600000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
AFC: 3137
Help


Phoenix
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Operating mode: Local
Read
RF Controls
Band: GSM 850
Tx PA Mode: Free
Active Unit: Tx
Tx Power Level: 19
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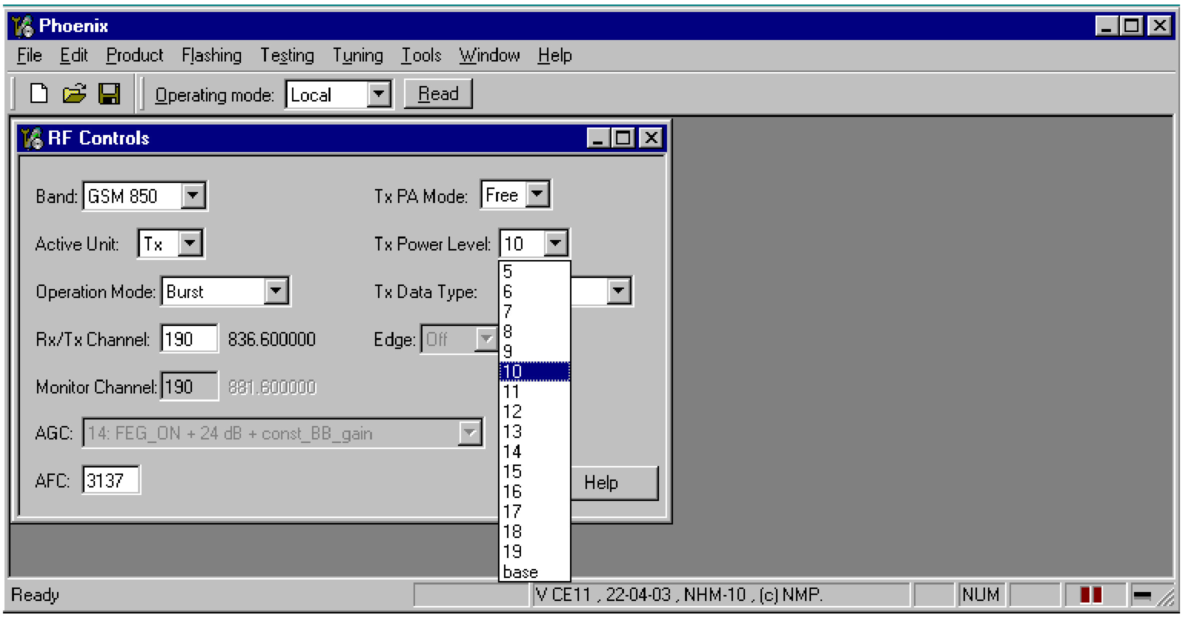
Tx Data Type: All 1
Rx/Tx Channel: 190
836.600000
Edge: Off
Monitor Channel: 190
881.600000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
AFC: 3137
Help


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local
Read
RF Controls
Band: GSM 850
Tx PA Mode: Free
Active Unit: Tx
Tx Power Level: 10
Operation Mode: Burst
Tx Data Type:
Rx/Tx Channel: 190
836.600000
Edge: Off
Monitor Channel: 190
881.600000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
AFC: 3137
5
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base
Help
Ready
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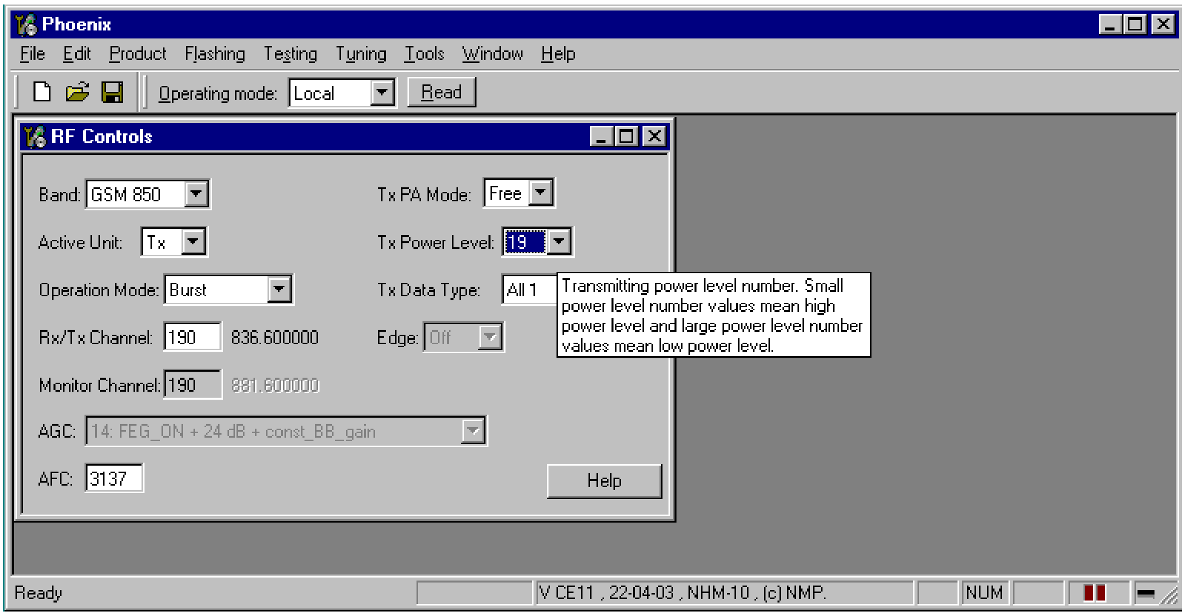
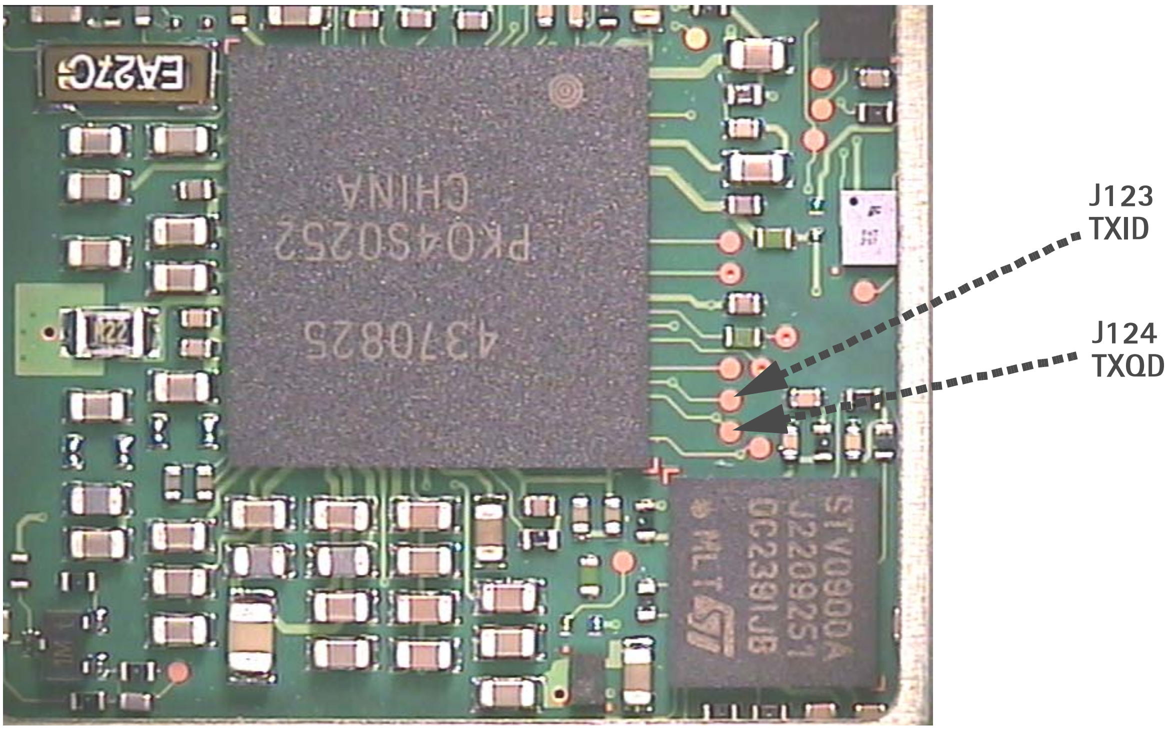
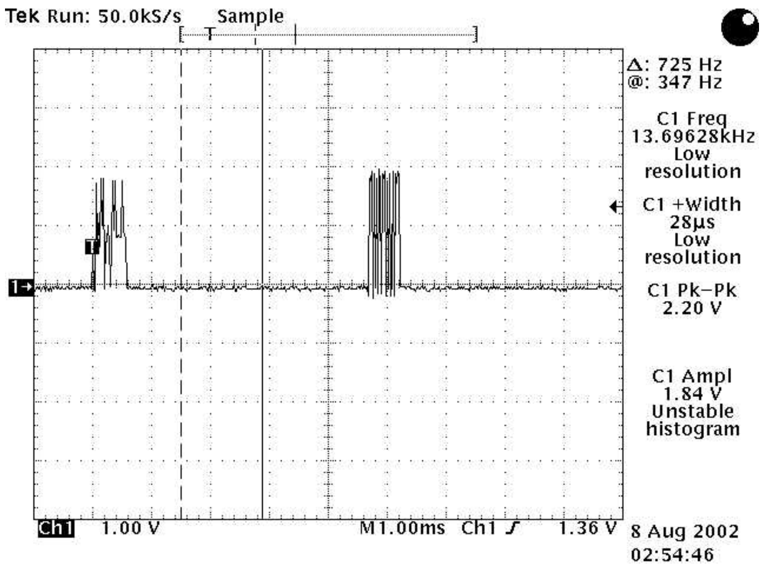
NUM



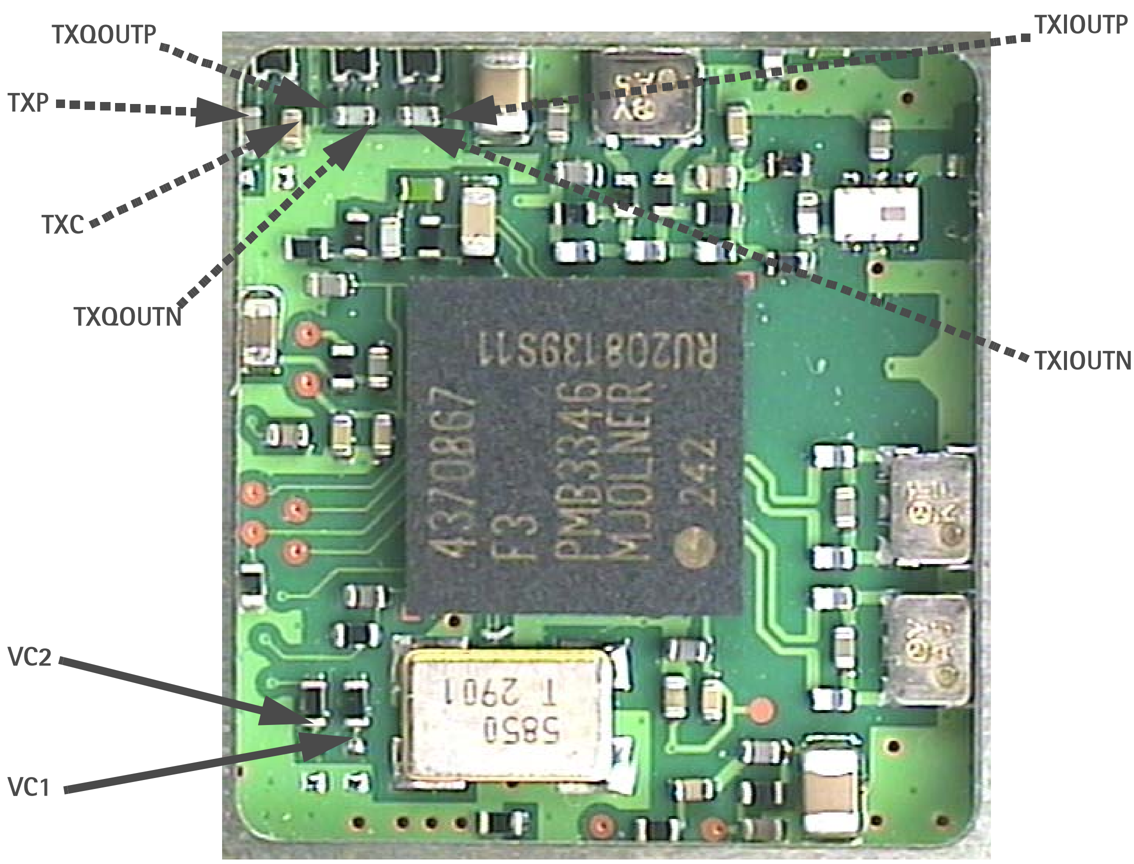
TX Digital I & Test Points



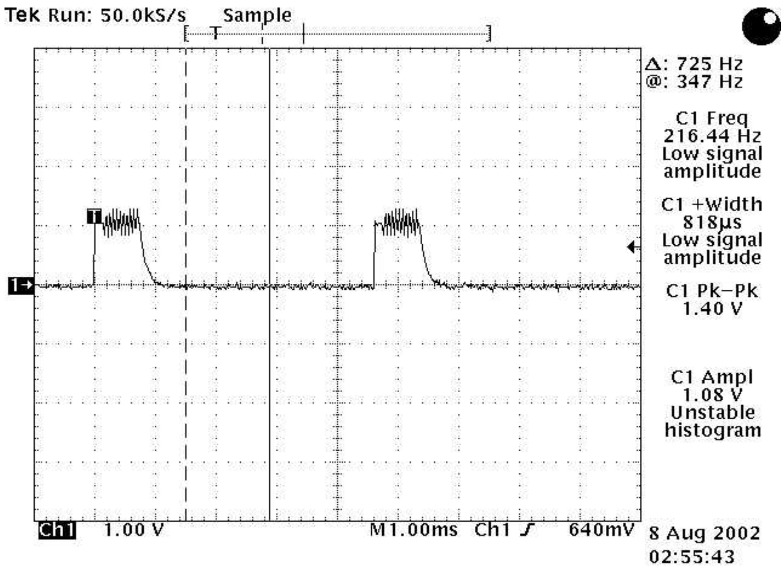
Tx Digital I & Q Data, J123 & 124



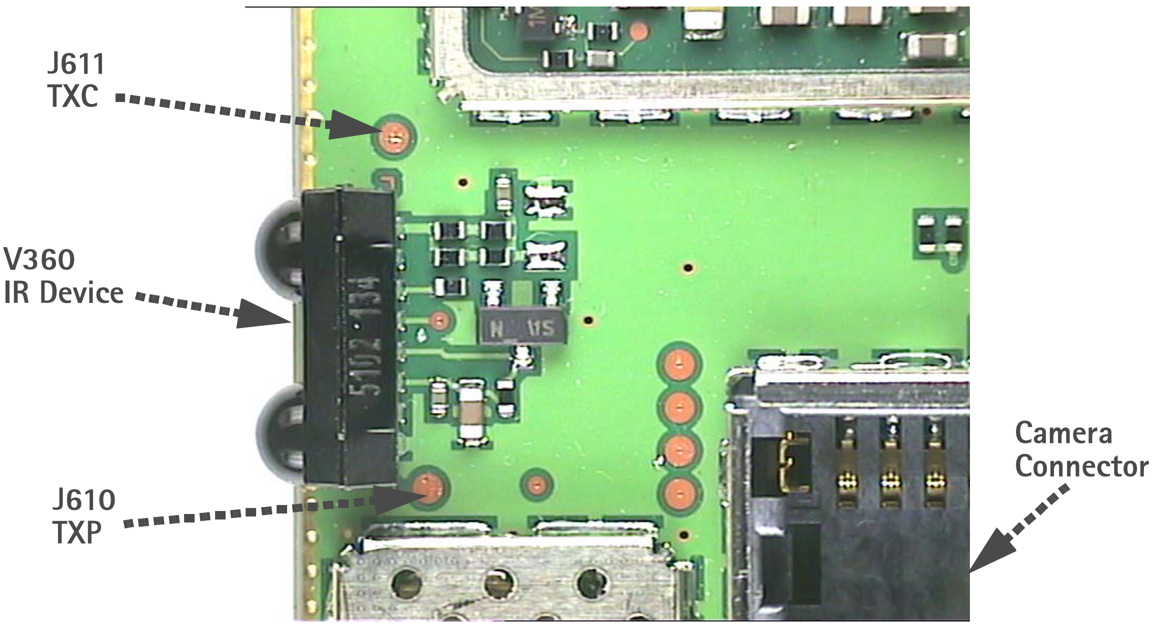
Mjoelner Can Tx Test Points



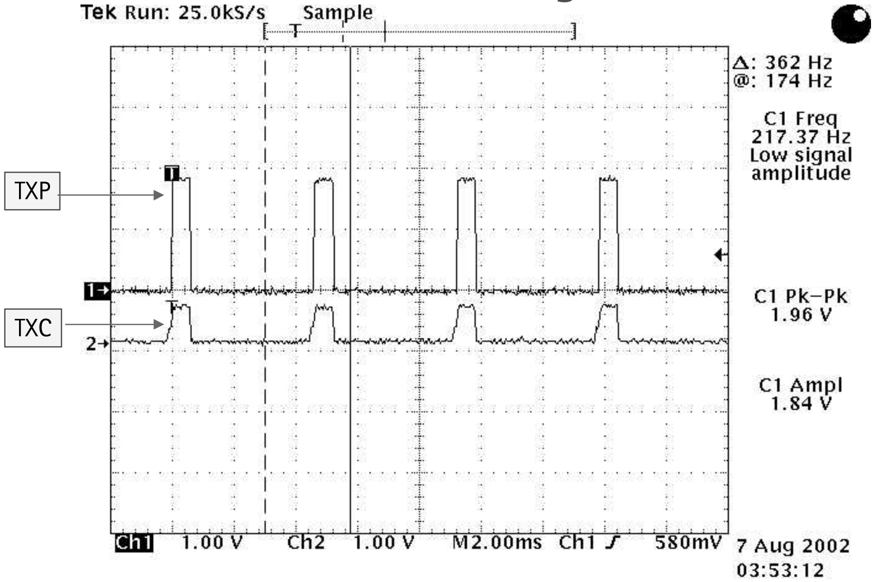
TX Analog I & Q Data, C715 & C716



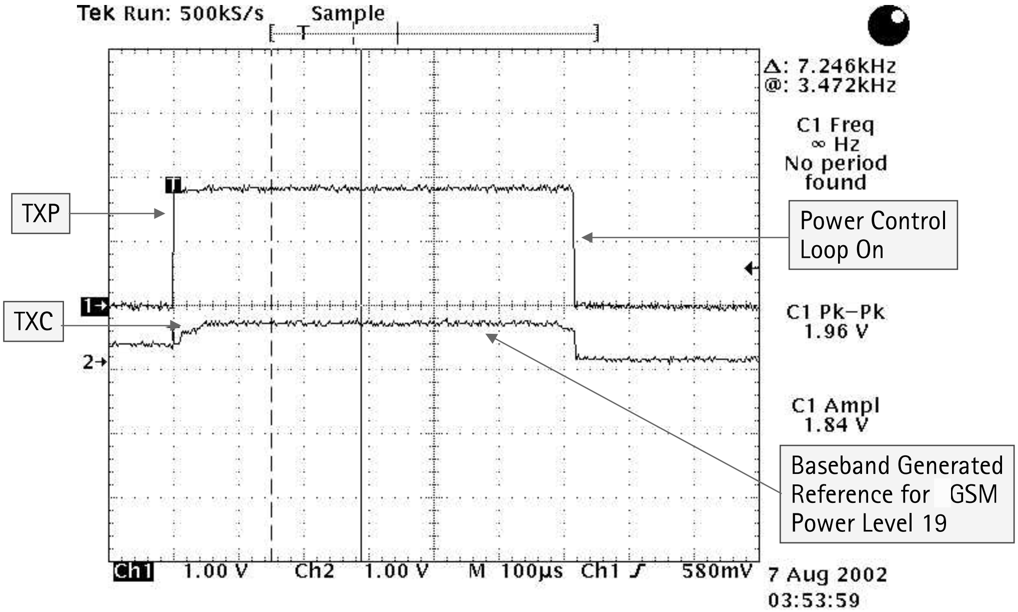
Transmit TXP & TXC Test Points



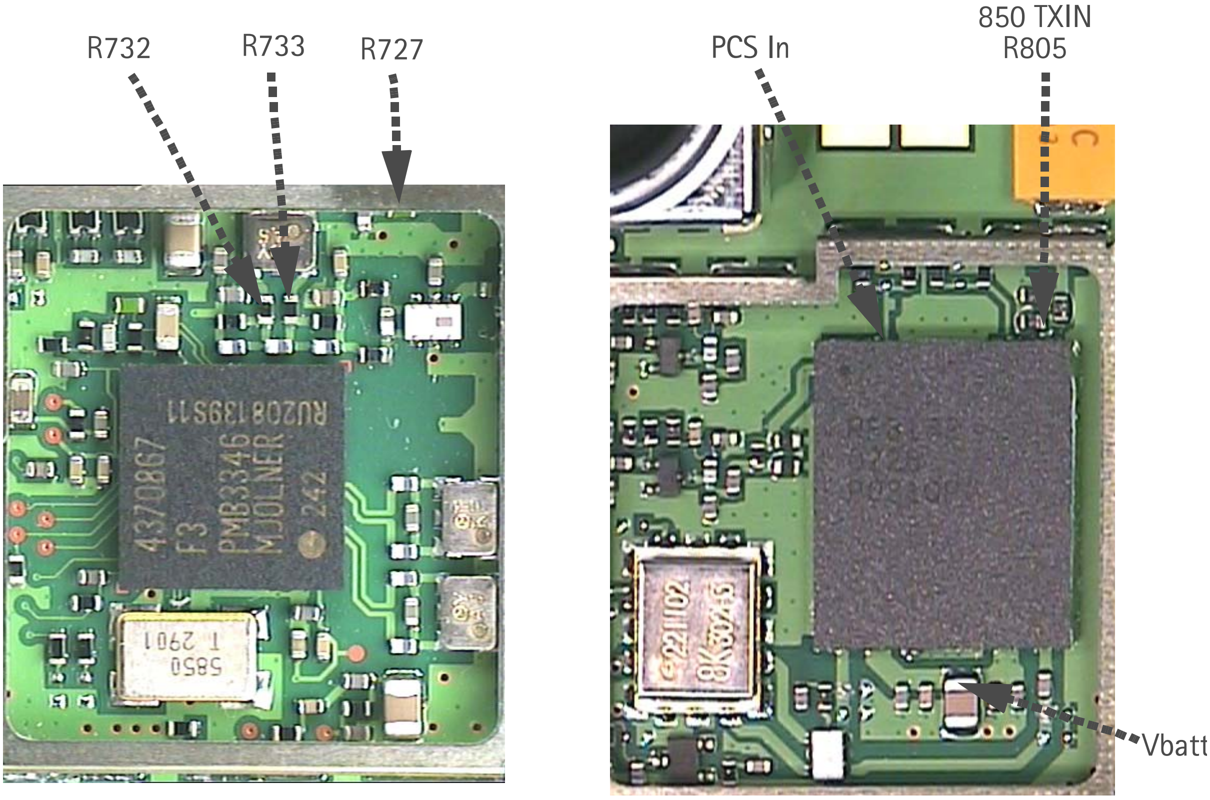
TXP & TXC Lines during Transmission



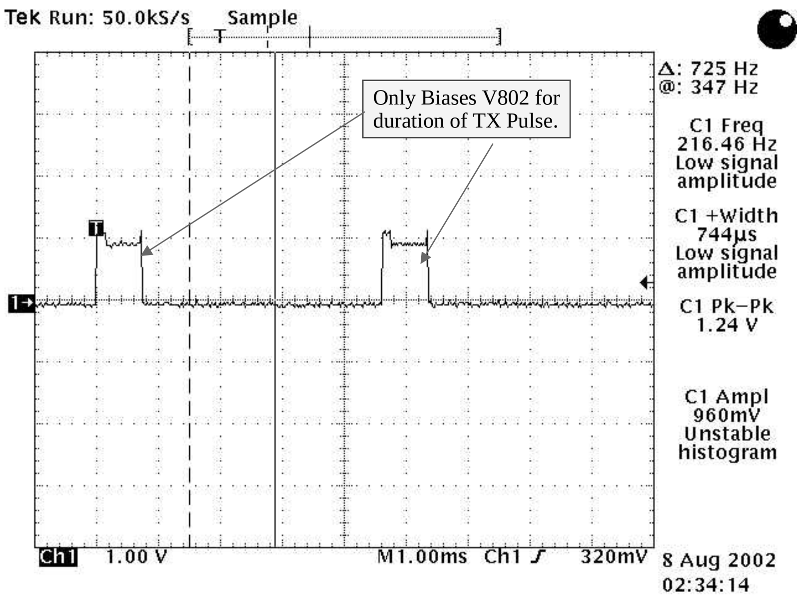
TXP / TXC Mask



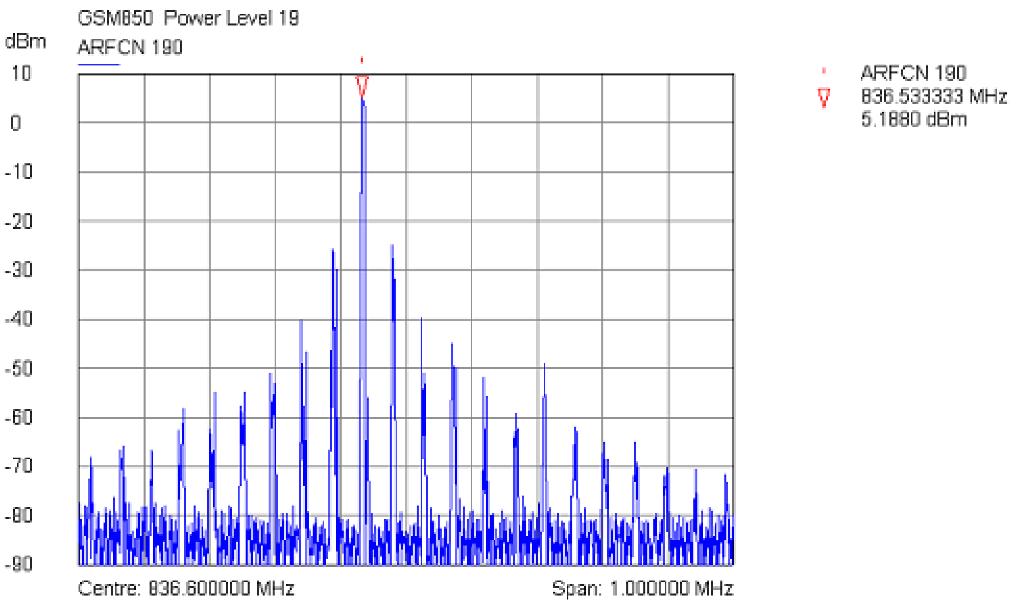
850 TX Can Test Points



VTXB_850 (850 V802 Pre-Amp Biasing Waveform)

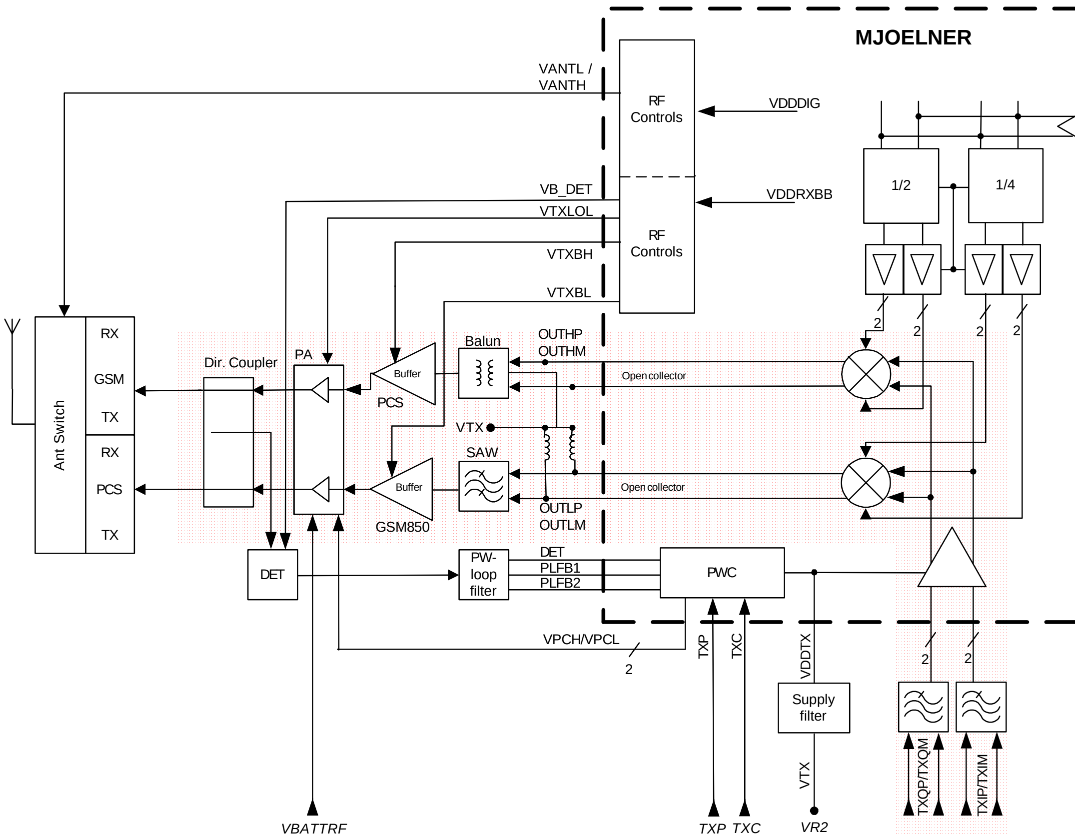


850 Transmit Waveform (Burst, Power Level 19)



TX Path of the transmitted GSM850 signal

For easy error tracing it is important to know the signal path of the GSM850 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the following picture shows both GSM850 transmitter (bottom) and GSM1900 transmitter (top).



GSM850 TX path of Mjoelner RF ASIC

The balanced TX signal is provided by the base band 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 base band signals, one for GSM850 and one for GSM1900. The base band 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 RFASIC the signal is fed through the 850 TX SAW filter (Balanced to single ended), the 850 MHz buffer, and a 10 dB pad to the PA input.

GSM850 TX path of the Power Amplifier (PA)

The PA GSM850 part has a maximum output power of app. 35dBm. Voltage supply is coming directly from the Battery connectors.

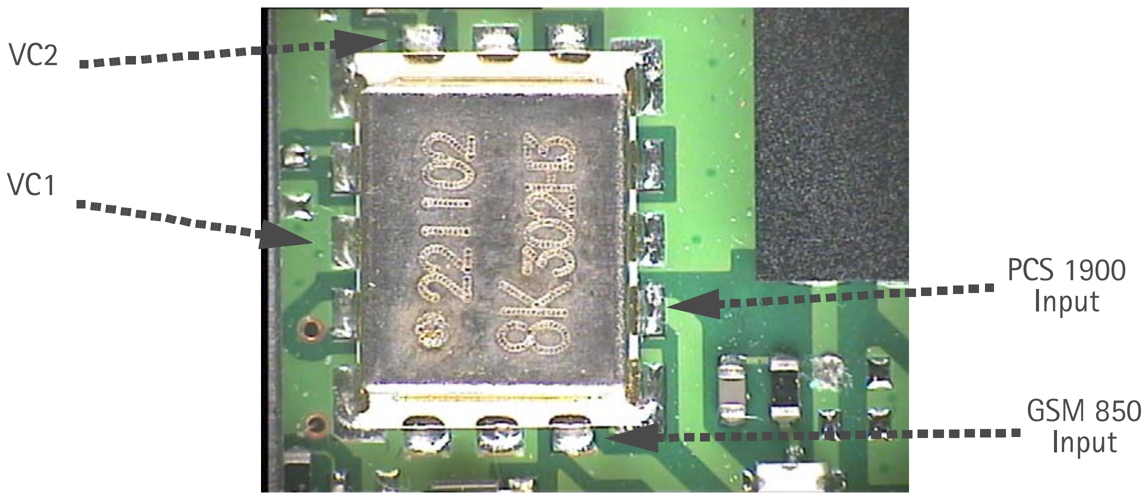
The GSM850 output is controlled by the power control loop. From the GSM850 output of the PA the RF signal is fed through the directional coupler (one of the power control loop components) to the antenna switch.

Antenna Switch (TX/RX switch)

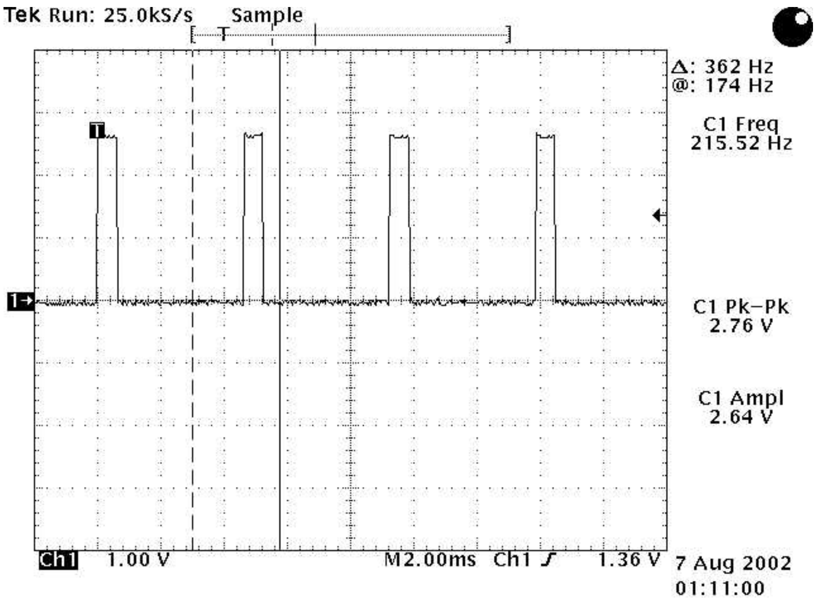
The antenna Switch works as a diplexer for the RX and TX signals. Moreover, it suppresses the TX harmonics generated by the PA. The antenna switch is controlled by the Mjoelner RF ASIC using the control signals VC1and VC2. The following table shows the possible different states.

VC1 [Volt]	VC2 [Volt]	850 Rx	PCS Rx	850 Tx	PCS Tx
0	0	X			
0	0		X		
0	2.7			X	
0	0				
2.7	0				X

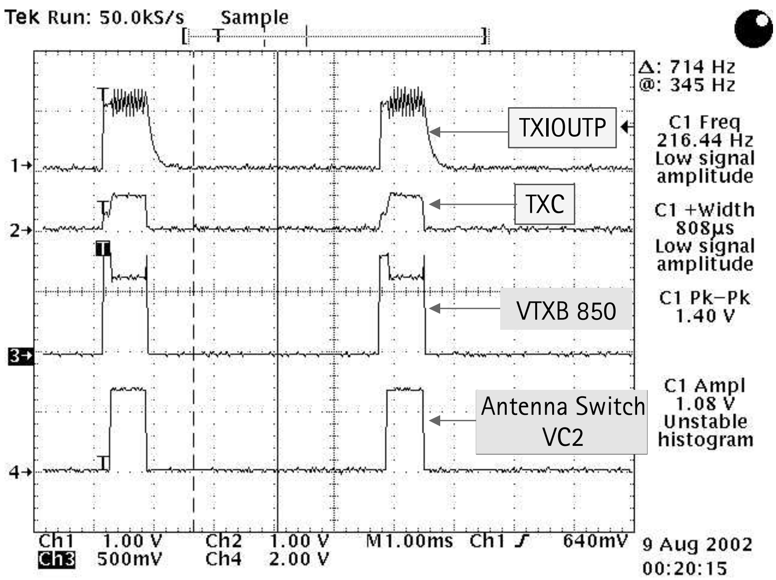
Antenna Switch Test Points



Antenna Switch Control Line During GSM850 Transmission



Transmit Timing

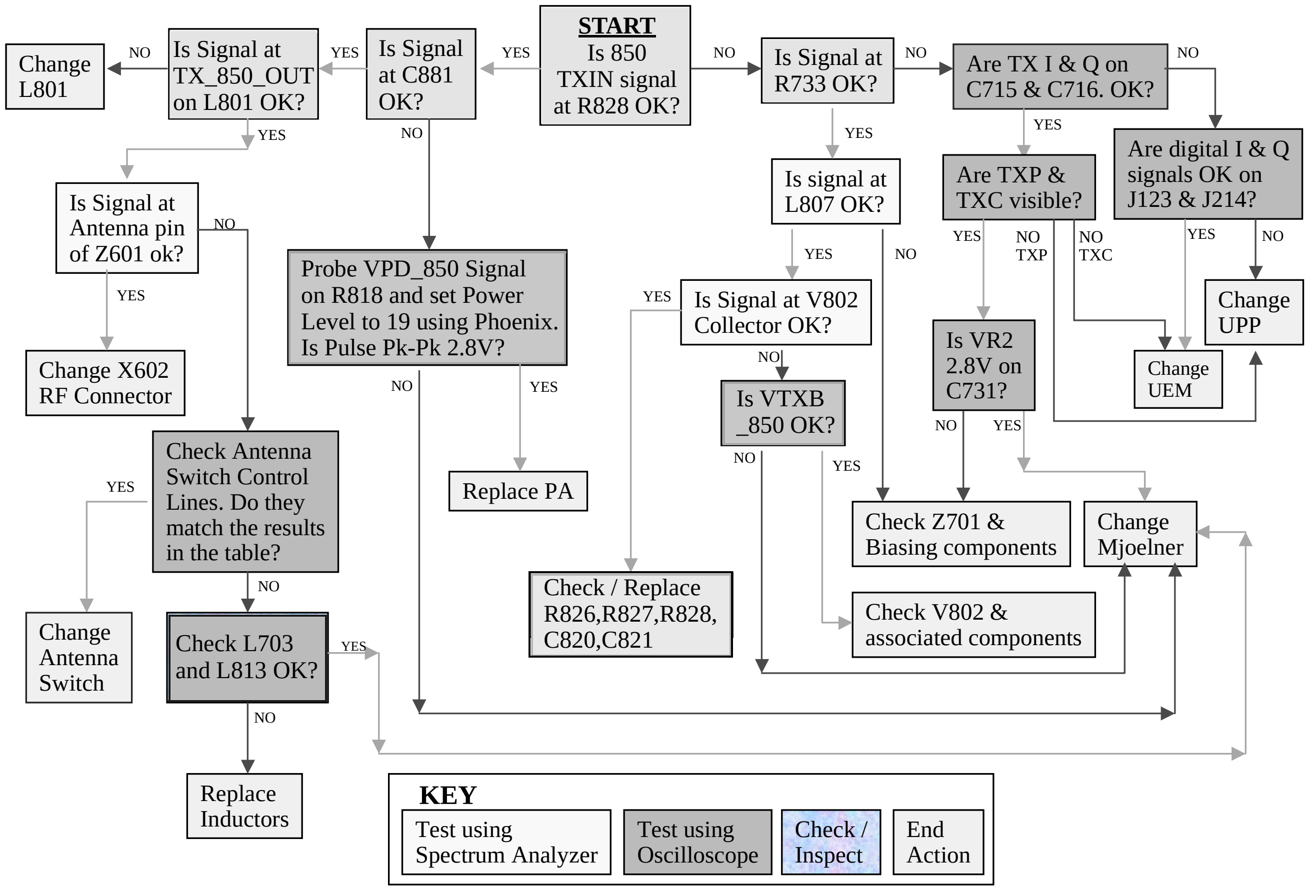


850 Tx fault finding flow chart

The first flow diagram assumes the following:

- Phoenix has been set up as shown in the following screen (the Tx power level may be increased using Phoenix if it makes the Tx pulse easier to see).
- Relevant components have been visually inspected for orientation, placement, etc.
- The transmit signal has been checked with a spectrum analyzer at RF connector, X602 and was found to be too low or non-existent.
- The VCO is running correctly.
- The power amplifier is getting a correct VBATRF suply via L381.

- Mjoelner's supply voltages VR1A, VR2, VR3, VR4, VR5 & VR7 are all working correctly.



GSM1900 Transmitter

General instructions for GSM1900 TX troubleshooting

Apply an RF-cable to the RF-connector to allow the transmitted signal to act as normal. RF-cable should be connected to measurement equipment (GSM Test equipment, Power-meter, Spectrum Analyzer, or similar).

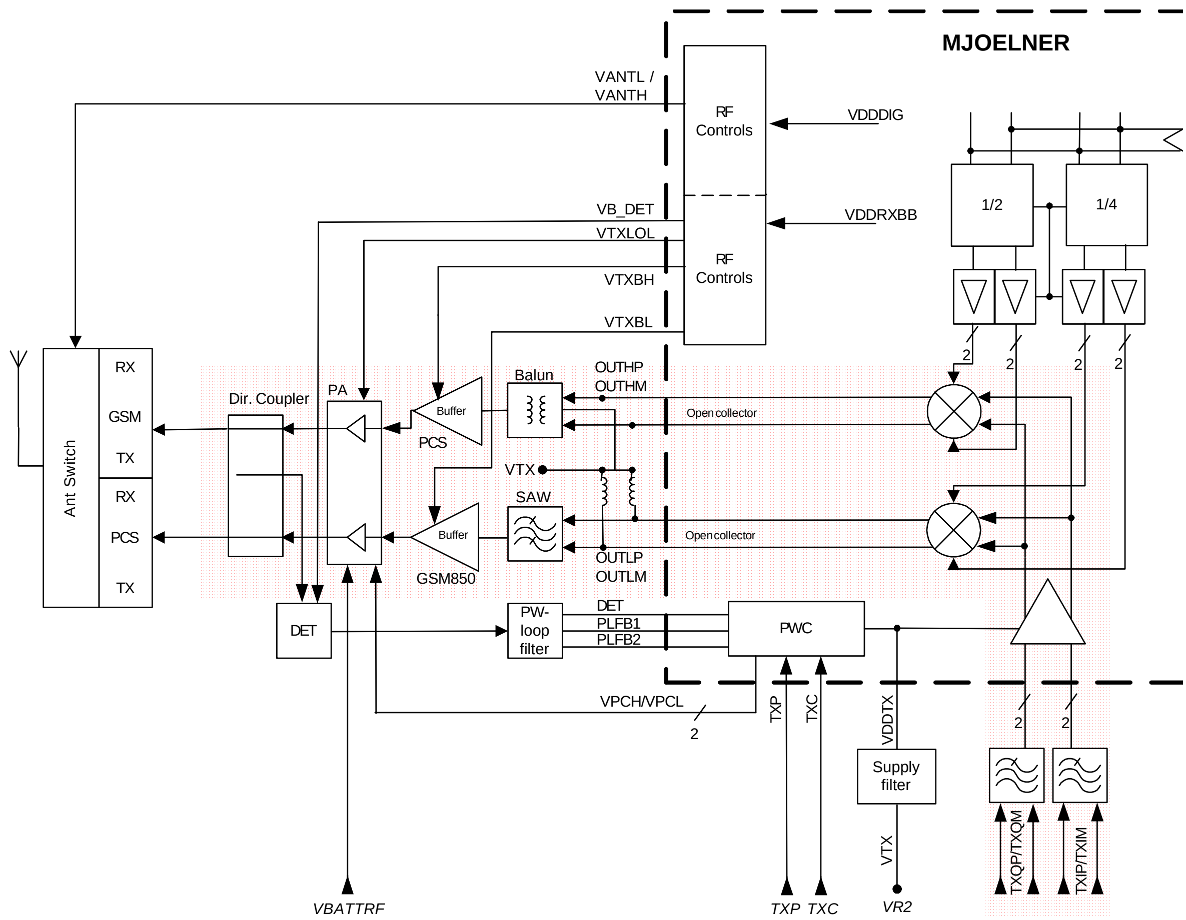
PCS 1900 Tx fault finding flow chart

The following diagram assumes the following:

- Phoenix has been set up as shown previously (selecting PCS 1900 in the RF control box).
- Relevant components have been visually inspected for orientation, placement etc.
- The Transmit Signal has been checked with a Spectrum Analyzer at the RF connector , X602 and was found to be low or non-existent.
- The VCO is running correctly.
- The Power Amplifier is getting a correct VBATRF supply via L381.
- Mjoelner's supply voltages VR1A, VR2, VR3, VR4, VR5 & VR7 are all working correctly.

Path of the transmitted 1900 signal

For easy error tracking it is important to know the signal path of the GSM1900 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the picture shows both 850 transmitter (bottom) and GSM1900 transmitter (top).



The path of Mjoelner RF ASIC

The balanced TX signal from base band is coming to Mjoelner RF ASIC. The GSM1900 path includes a RF modulator for GSM1900. The BB signal is up-converted with the LO signal corresponding to the wanted TX channel. The GSM1900 TX output of Mjoelner is a balanced signal.

From the output of Mjoelner the signal is fed through the Balun T701 (Balanced to single ended), the 1900 buffer, and a 7 dB pad.

The path of the PA

The GSM1900 part of the PA has a maximum output of approximately 33dBm. The supply is coming directly from the Battery connectors.

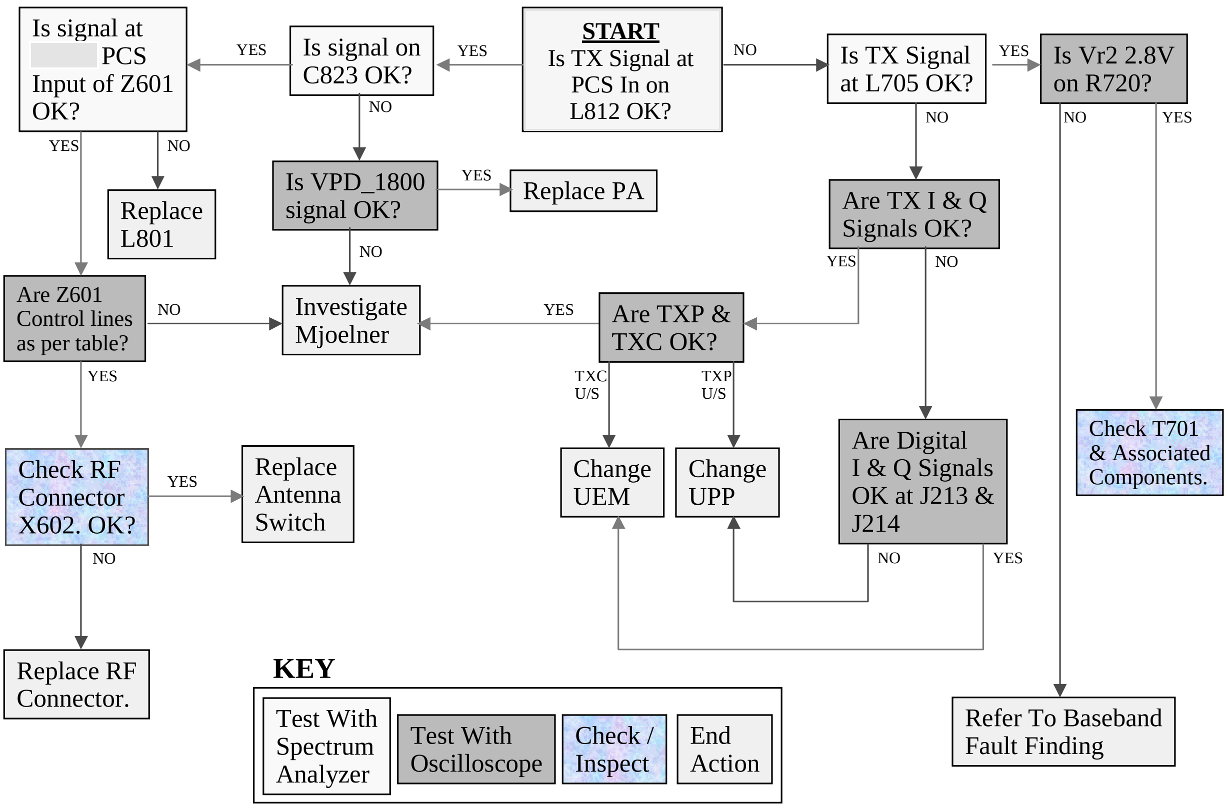
The output is controlled by the power control loop. From the output of the PA the signal goes through the directional coupler (one of the power control loop components) to the Antenna Switch.

Antenna Switch

The Antenna Switch works as a diplexer between RX and TX Bands. Moreover, it partly suppresses the harmonics generated by the PA. Mjoelner RF ASIC controls the antenna switch by two voltages VC1 and VC2. The following table shows the different states.

VC1 [Volt]	VC2 [Volt]	850 Rx	PCS Rx	850 Tx	PCS Tx
0	0	X			
0	0		X		
0	2.7			X	
0	0				
2.7	0				X

Fault finding chart for GSM1900 transmitter

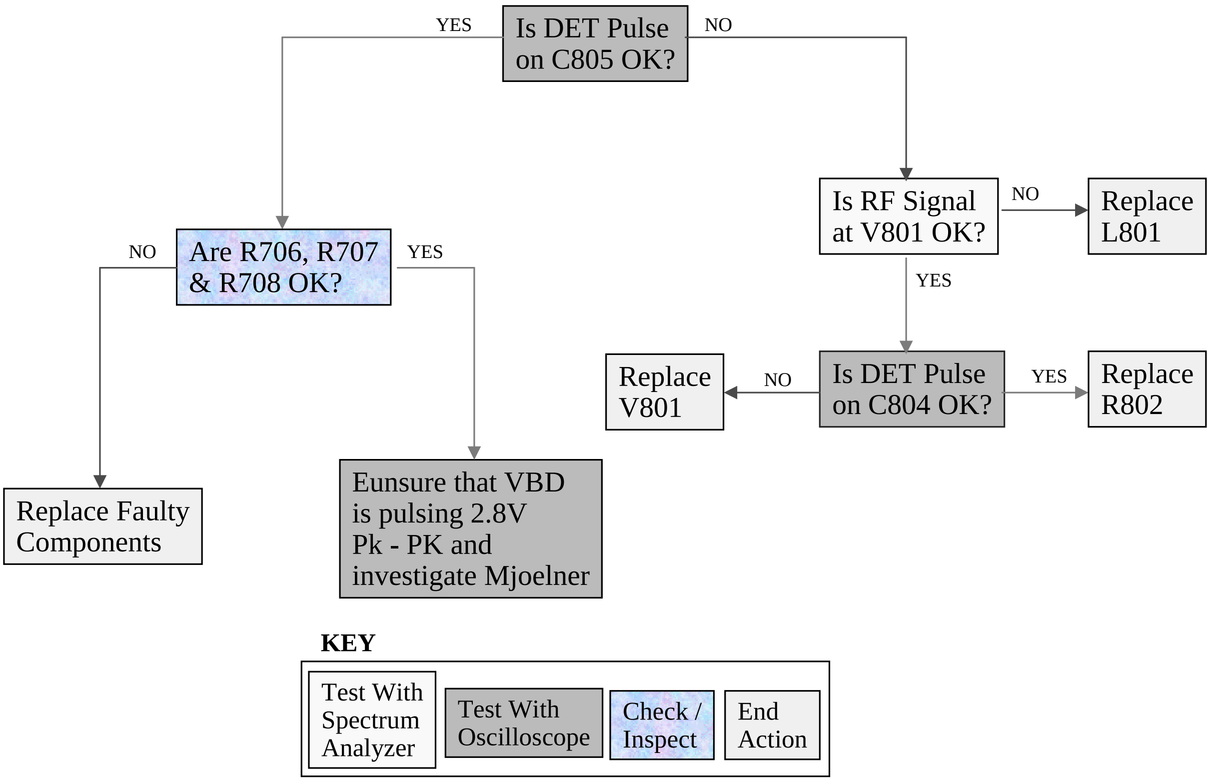


If the Tx output is too high, then it is most likely that there is a problem within the Power Control loop.

Mjoelner is receiving the Reference TXC from Baseband and not getting any feedback from DET to compare with TXC. The result is that Mjoelner drives VDP_850/VPD_1900 high to try and increase the power output so that the DET signal is matching TXC. With a break in the Power Control loop, the DET signal never reaches Mjoelner so it assumes that the PA is not outputting enough power so it tries to compensate by increasing the gain.

When checking the Power Control loop, make sure that VBD is pulsing at 2.8V Peak to Peak. Check the DET pulse at Mjoelner input on R706.

This case is the same for 850 & PCS1900.



NHM-10 Synthesiser

There is only one PLL synthesiser generating frequencies for both Rx and Tx for all three bands. VCO frequency is divided by 2 or by 4 in Mjoelner depending on which band is active.

General instructions for Synthesiser troubleshooting

Connect the the phone to a PC with DAU-9P cable and dongle and follow these instructions:

Start Phoenix Service Software (dongle needed):

Select	Scan Product	Ctrl-R

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

Set operating mode to local mode.

Start RF Control window:

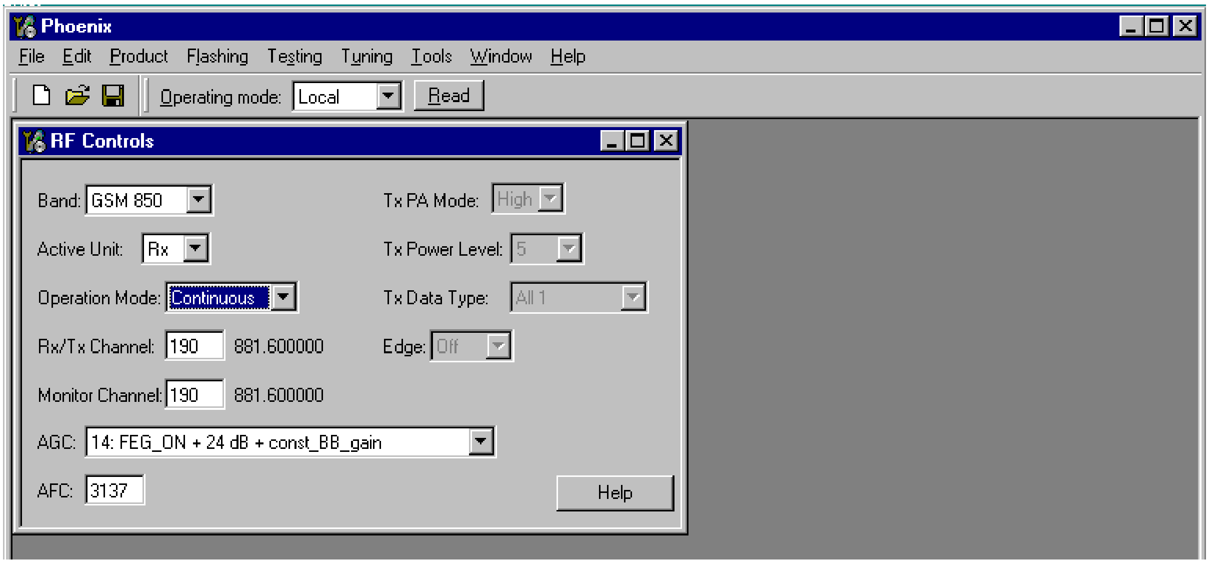
Select	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Set the synthesiser to the following mode:

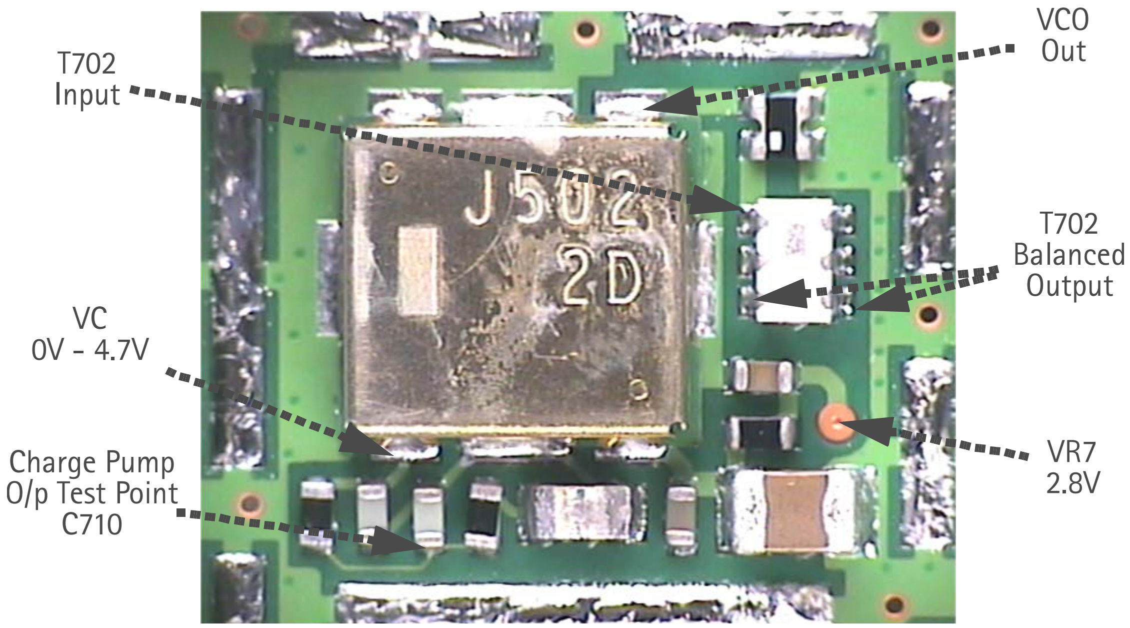
Select	Band	GSM 850
	Active unit	RX
	Operation mode	Continuous
	RX/TX Channel	190

The setup should now look like this:



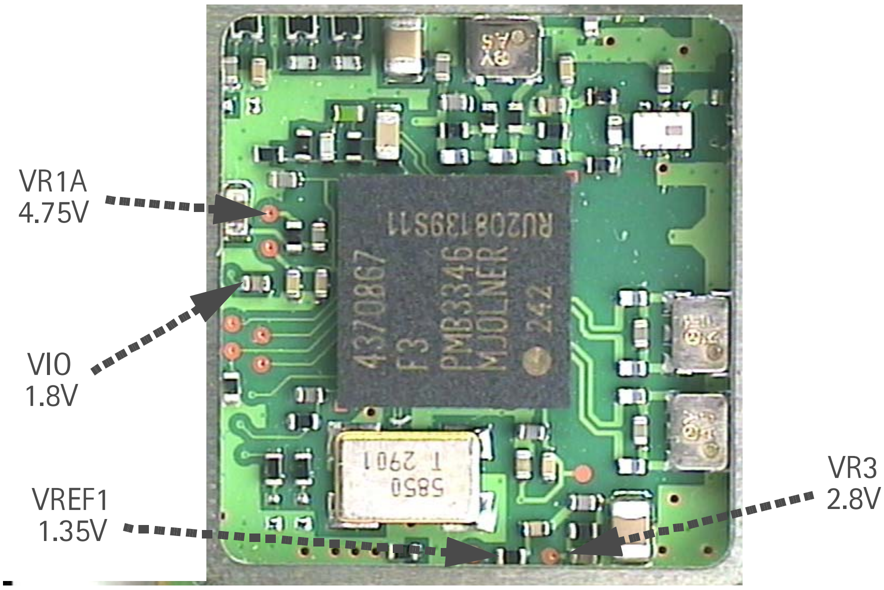
Since VCO chamber is completely shielded, it is not easy to measure frequency of 3526.4MHz at the output of the VCO (G701) using a resistive probe and a spectrum analyzer. It is possible to measure tuning voltage at charge pump output (C710) easily. For f_{VCO} = 3526.4MHz the tuning voltage should be 2.3V_{DC} .. 2.8V_{DC} (Tuning sensitivity of VCO is 240MHz/V typ.).

PLL Synthesizer Test Points



If this is not the case, then go to Fault finding chart in this document for troubleshooting.

Mjoelner Can Test Points



26 MHz reference oscillator (VCXO)

The 26 MHz reference oscillator (VCXO) is part of Mjoelner RF-ASIC (N601). It needs only an external 26 MHz Xtal (B601) as external circuitry.

The reference oscillator has three functions:

- Reference frequency for the PLL synthesiser.

- System clock for BB (RFClk_I = 26 MHz).
- 26 MHz Reference clock (LPRFClk_I) for Bluetooth Module (N430) via buffer V601.

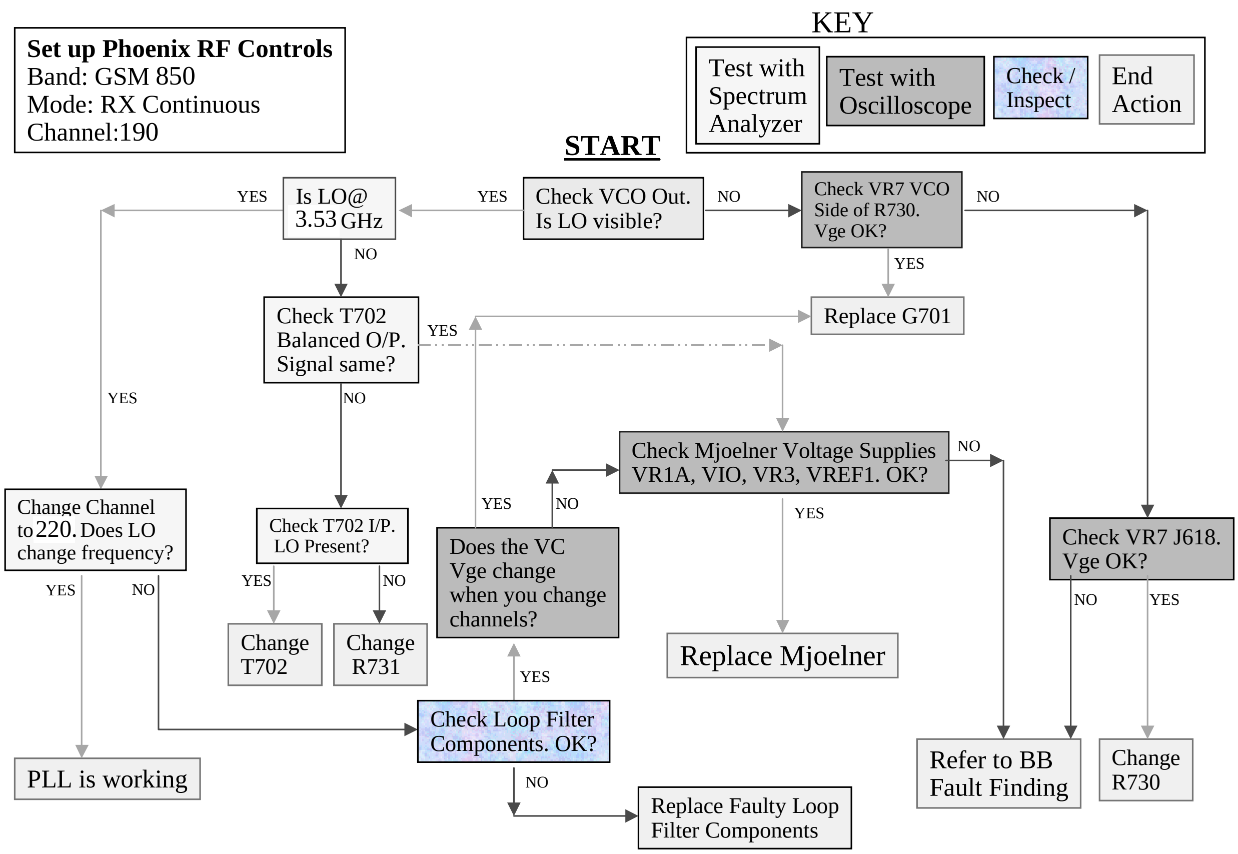
For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a **VCXO-calibration (cal)** value is written via the serial Bus into the RefOSCCAL register of Mjoelner and an additional bit in the RefOSCCntl register of the Mjoelner. That is necessary for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

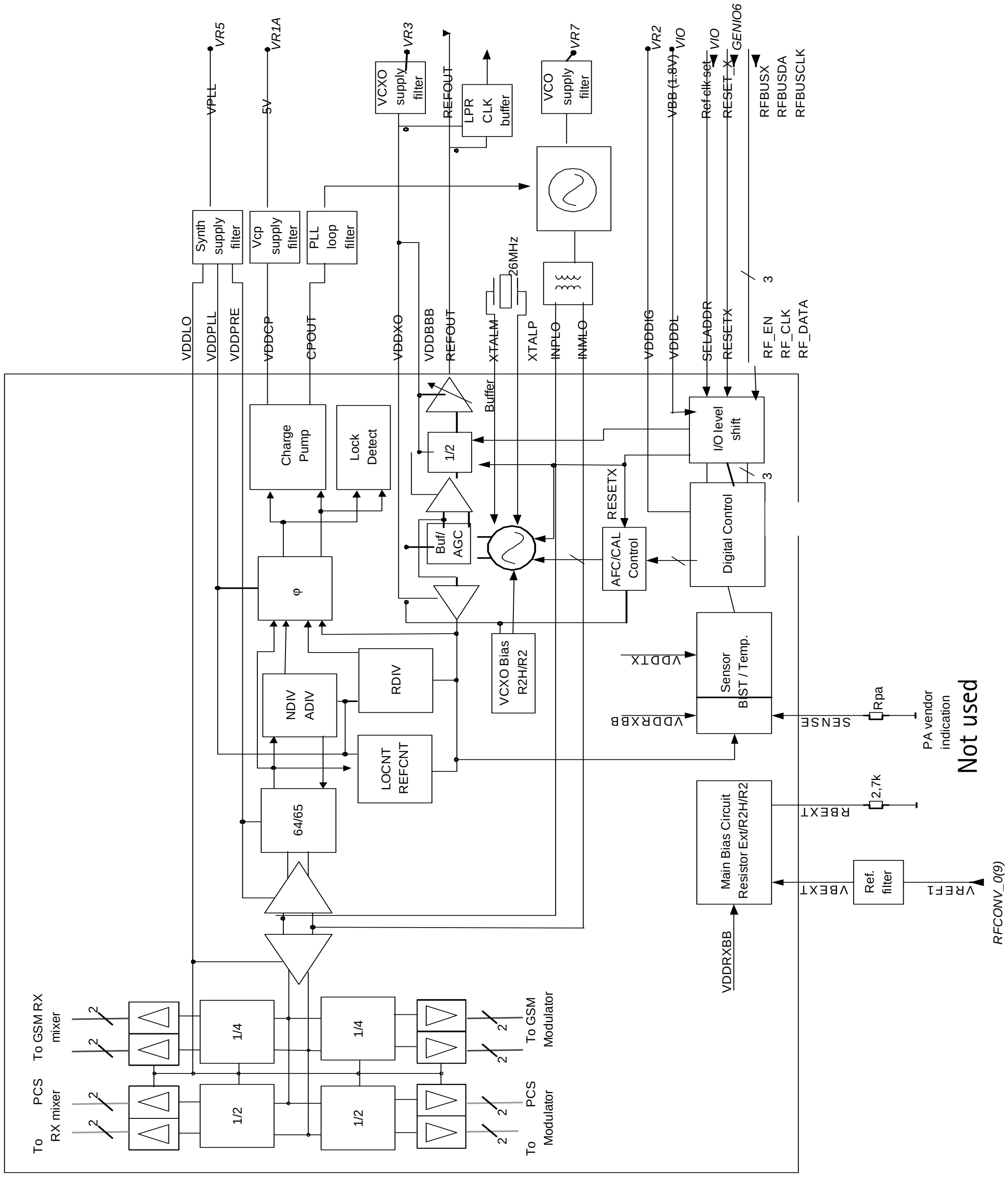
The VCO is able to generate frequencies in the range from 3290MHz to 3980MHz when PLL is in function. The frequency of the VCO signal is divided by 2 or by 4 in Mjoelner RF-ASIC. So it is possible to generate the frequency of all channels in GSM850 and GSM1900 (both RX and TX). Frequency of the VCO is controlled by DC voltage (Vc) coming from the PLL loop filter. Range of Vc when PLL is in function is 0.7V– 3.8V. Typical tuning sensitivity of the VCO is 250MHz/V. Even if PLL is not working (Vc out of range) there is a frequency at the output of the VCO, which is between 3 and 4 GHz (if the VCO itself is ok).

Fault finding chart for PLL Synthesiser

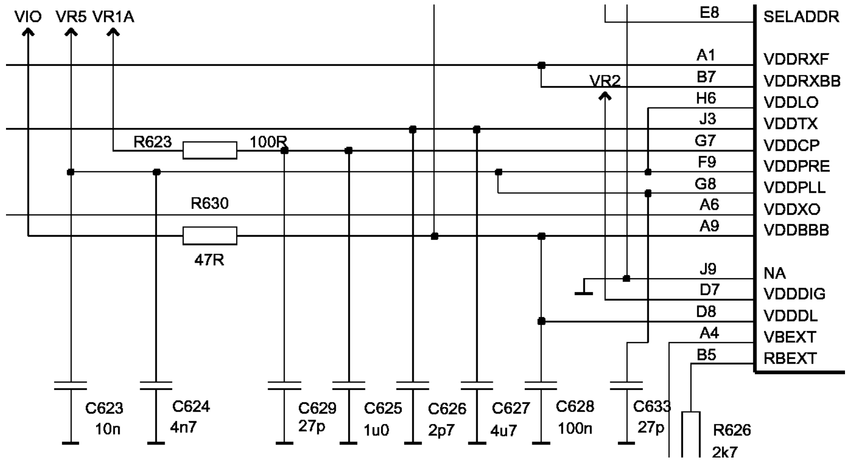


It is important to say that power supply for VCXO (VR3) is only switched 'OFF' in the so-called 'Deep Sleep Mode' and power supply for VCO (G701 VR7) is switched 'OFF' in so-called 'Sleep Mode'.

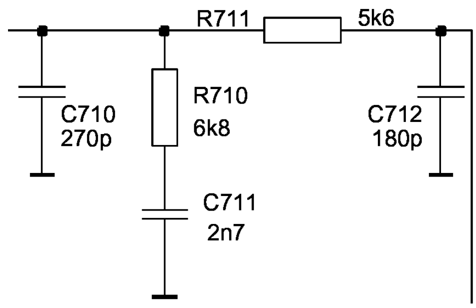
PLL Blockdiagram



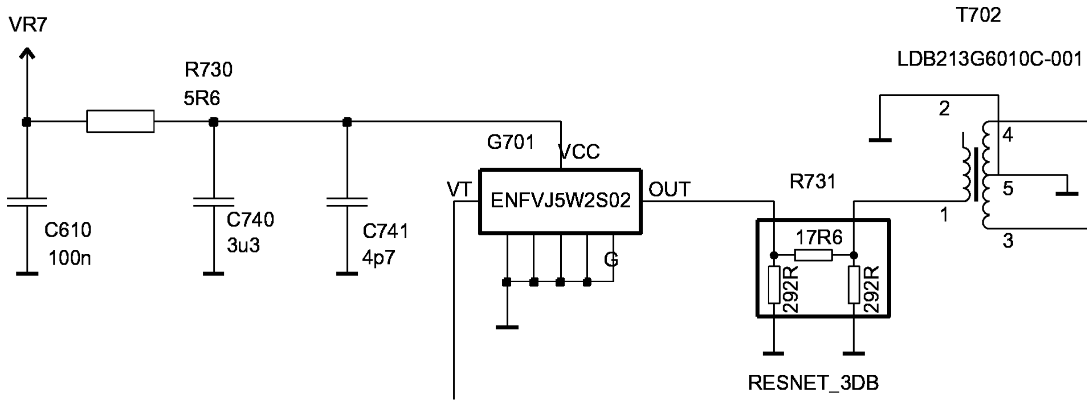
PLL power supply



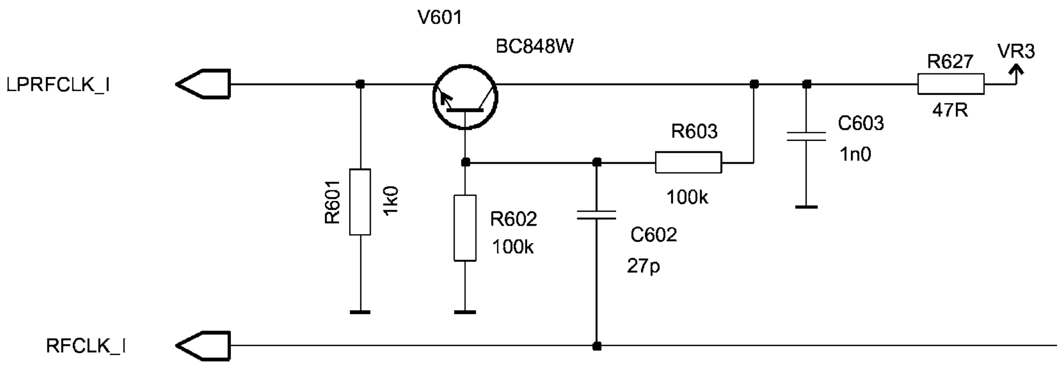
Loop Filter



VCO and power supply



26MHz Bluetooth buffer



Phoenix tuning

Before any tuning the phone should synchronised with the PC.

Connect the phone to a PC with DAU-9P cable and dongle and follow the following instructions:

Provide the phone with power supply

Start Phoenix Service Software and open FBUS connection

Select File Scan Product

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 understood well.

- In general repairs in the TX part will require "TX Power Level Tuning" and "TX IQ Tuning".
- In general repairs in the RX part or PLL part always require "RX Calibration", "Rx Band Filter Response 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 (incl. VCXO Calibration)

The "RX calibration" is used to determine 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.

RX-calibration in GSM850 combines two tunings, VCXO-calibration and AGC-calibration:

Calibration of GSM1900 band only determines AGC values.

The **VCXO-calibration** finds out a calibration value for VCXO control, an AFC initial value and 3 AFC-slope coefficients.

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

AGC-calibration:

The AGC-calibration finds the gain values of the RX-gain system.
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.

VCXO-calibration:

The VCXO-calibration ensures the function of an **initial** synchronization (before location update is done) when the mobile station 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.

Also the DSP algorithm determines 3 AFC slope coefficients **Slope C1...3** during VCXO calibration. One AFC slope value is not sufficient for Mjoelner **F3**, because the AFC slope is non-linear in this chip.

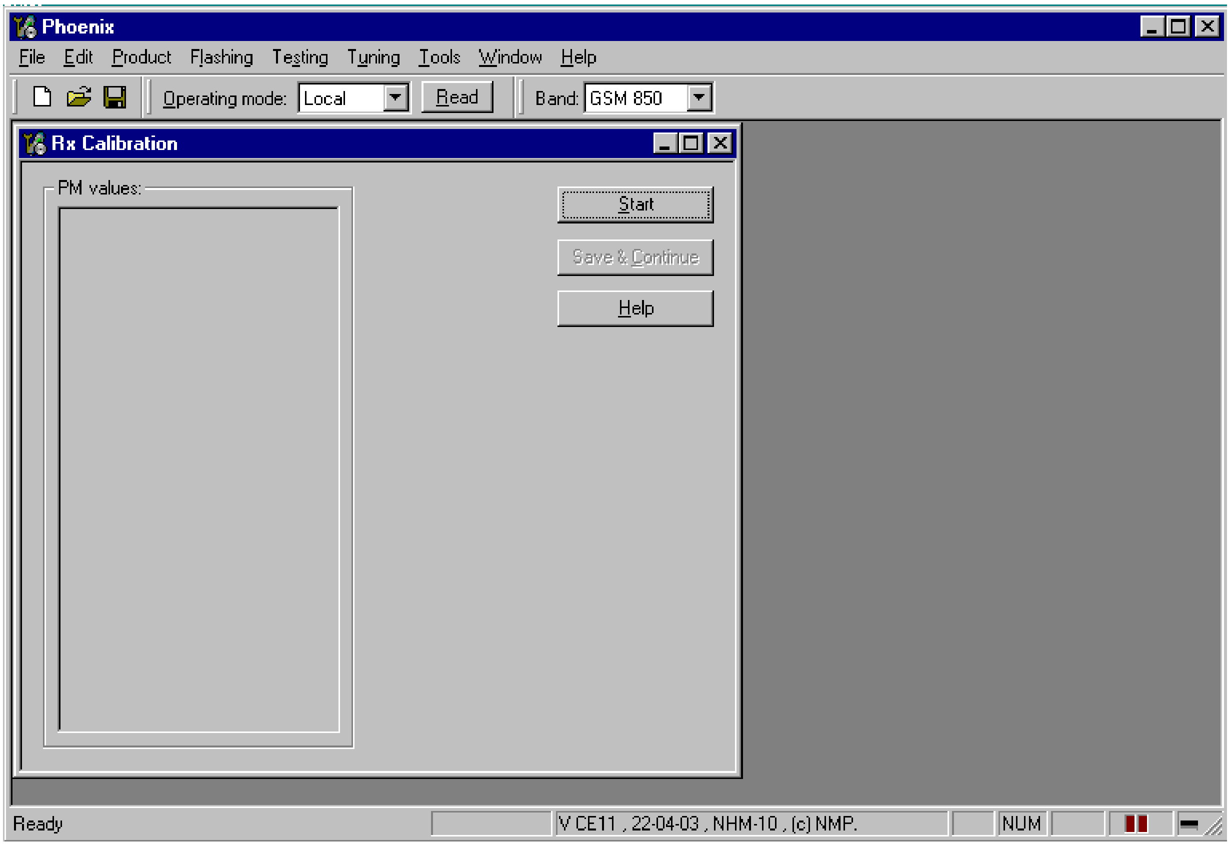
GSM 850

Set operating mode to local mode

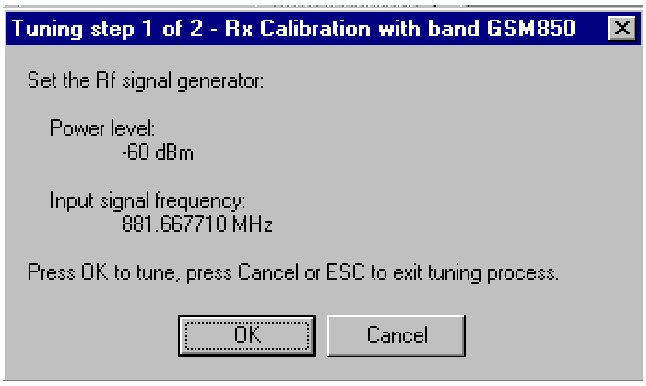
Select	Tuning		Alt U
		RX Calibration	C

Wait until the RX Calibration window pops up.

The setup should now look like this:



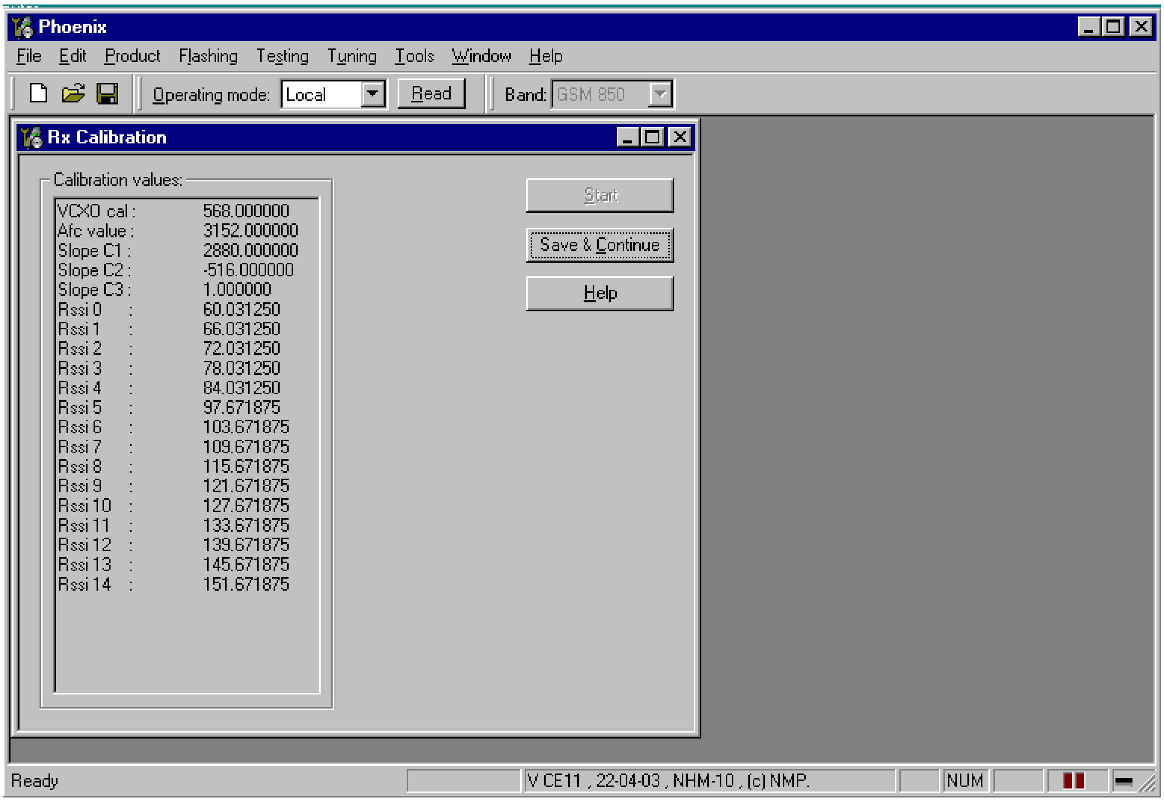
Press Start and a window pops up:



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.

Press OK and the window closes.

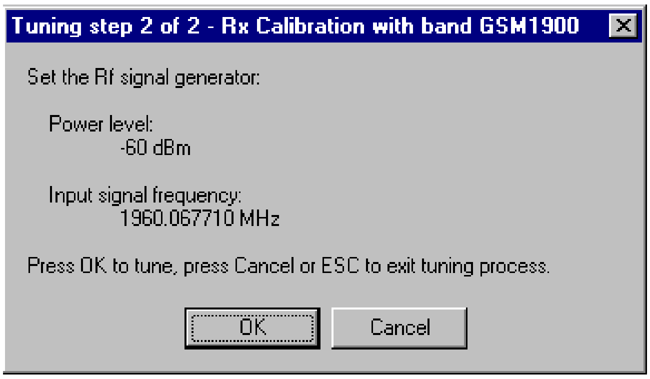
A typical result will look like this:



Press Save and Continue in the RX Calibration window:

GSM1900 (PCS)

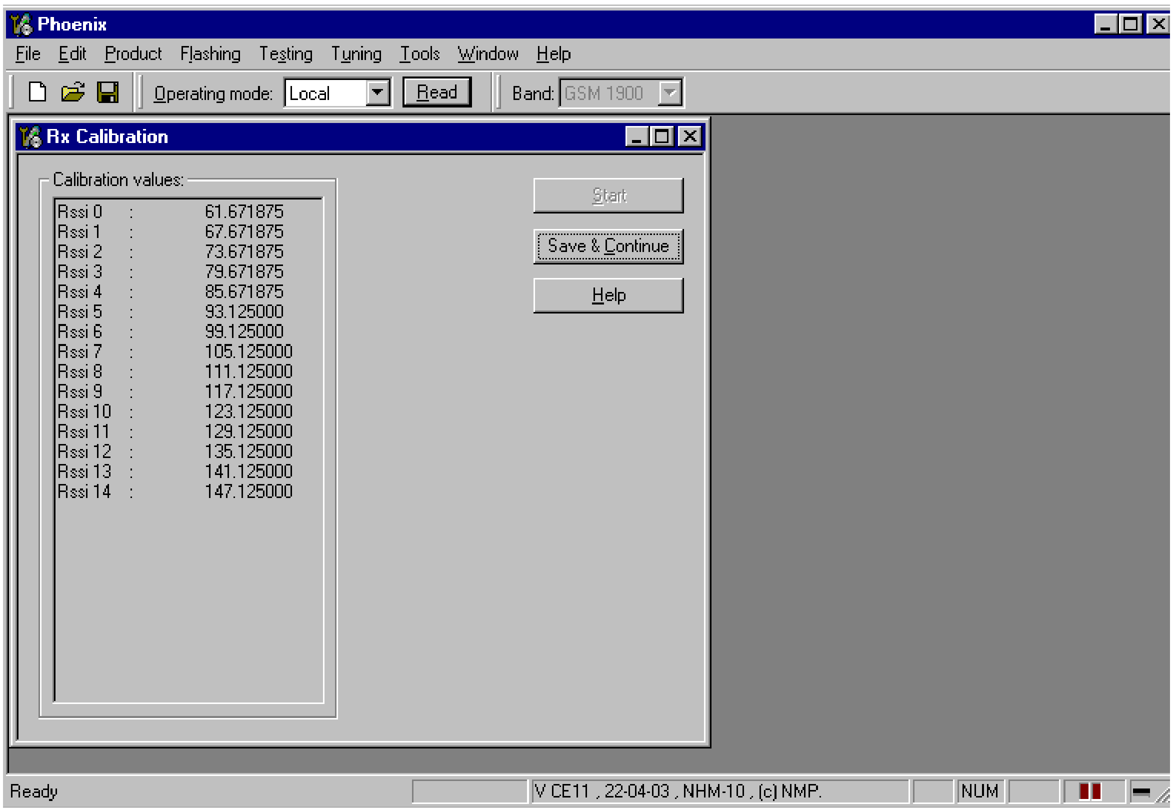
A window pops up:



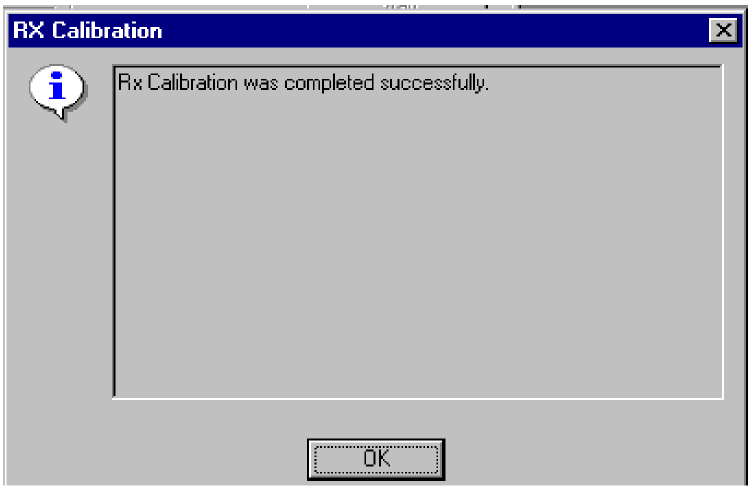
Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses.

Press OK and the window closes.

A typical result will look like this:



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



Press OK and the RX Calibration is finished.

RX AGC limits

The Rx calibration is only valid if it is within certain limits.

For the most recent limits see NHM-10 Production Testing Requirements,

If calibration is not within limits, there is a fault in the RX chain.

Below the values for RSSI4 and RSSI7 are given:

RSSI4:(Rx A5)

band	min	typ	max
GSM850	81	85	91
GSM1900	79	87	89

RSSI7:(Rx A8)

band	min	typ	max
GSM850	103	109	113
GSM1900	100	105	110

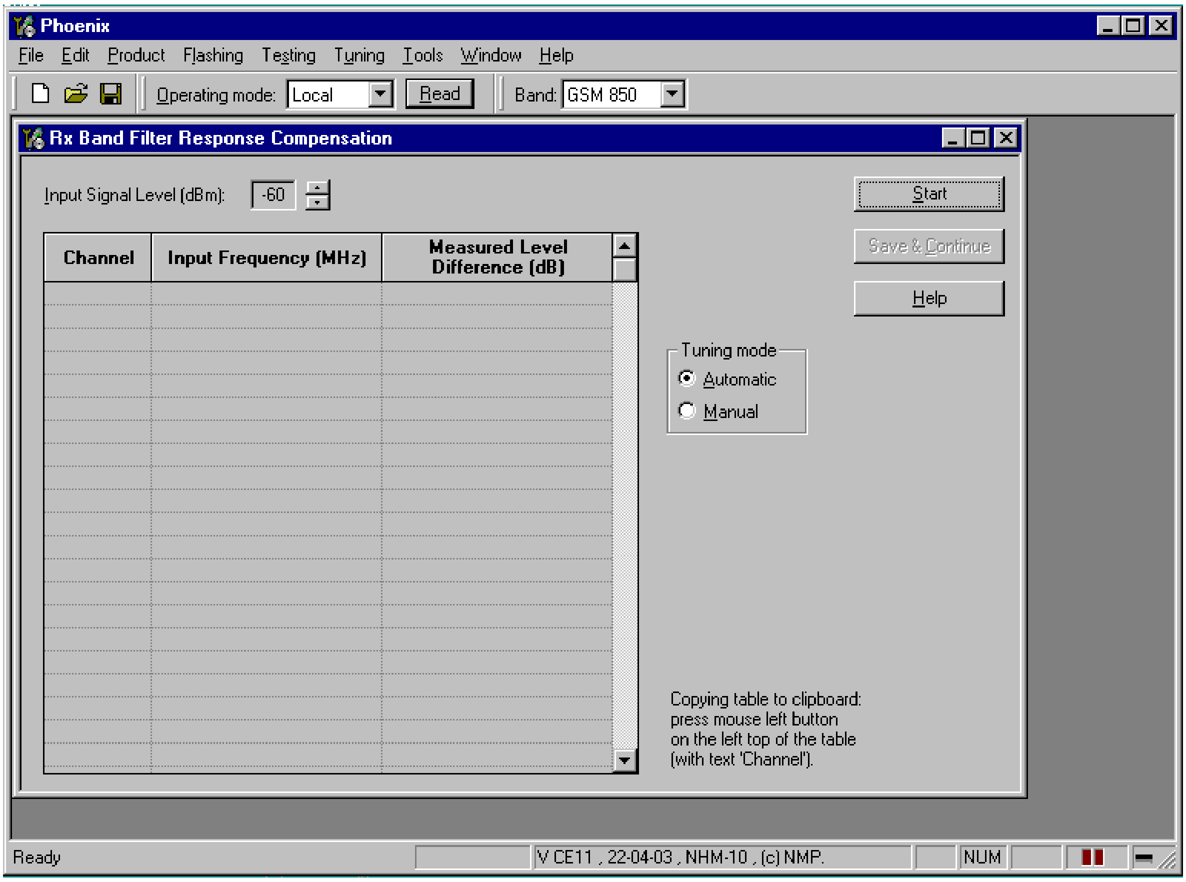
RX Band Filter Response Compensation

GSM850

Set operating mode to local mode

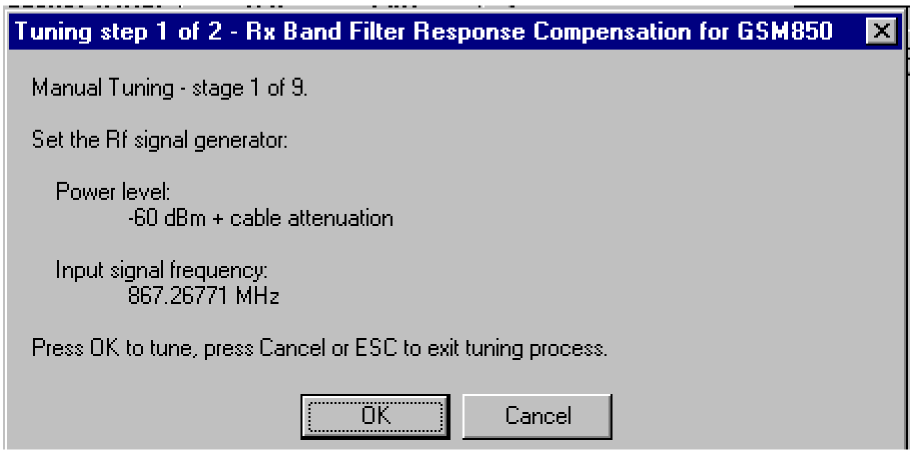
Select	Tuning	Alt U
	RX Band Filter Response Compensation	B

The setup should now look like this:



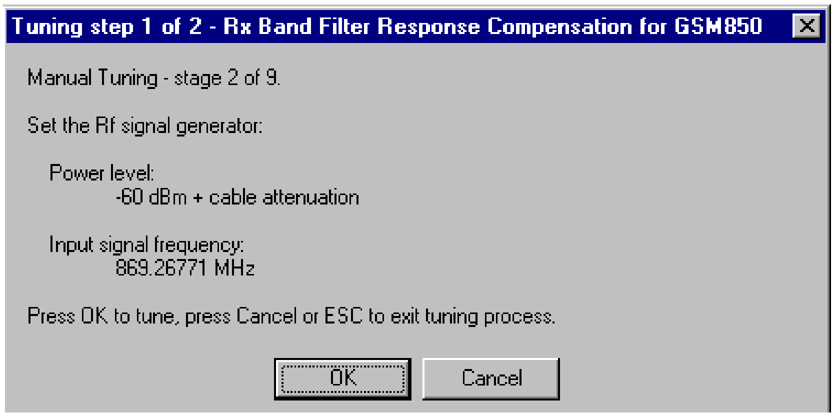
Manual Tuning

Press Manual Tuning and Start 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.

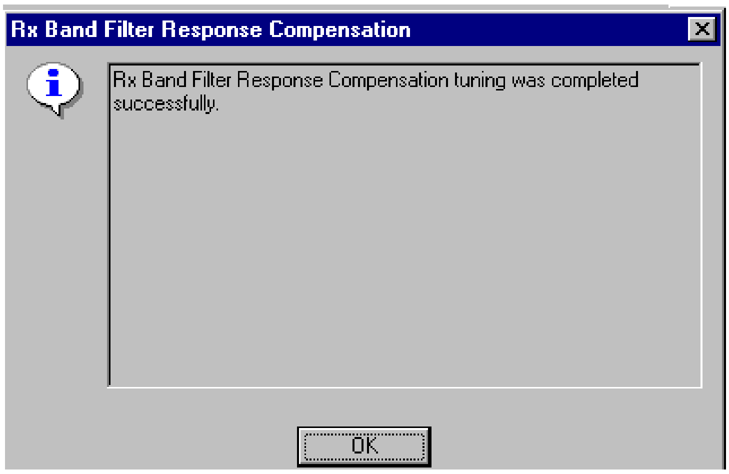
Press OK and a new window pops up:



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 Save and Continue and repeat the process for the 1900 band.

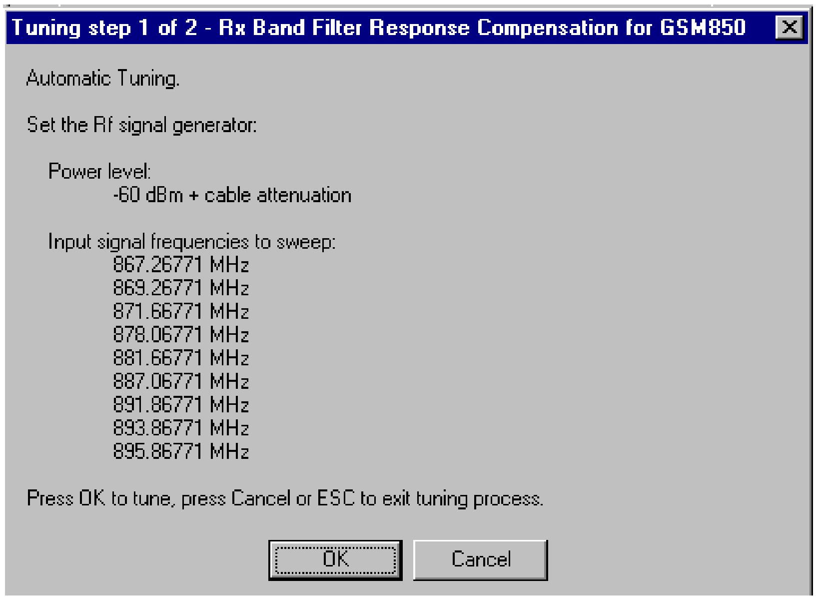


Auto Tuning

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.

Press Auto Tuning and Start.

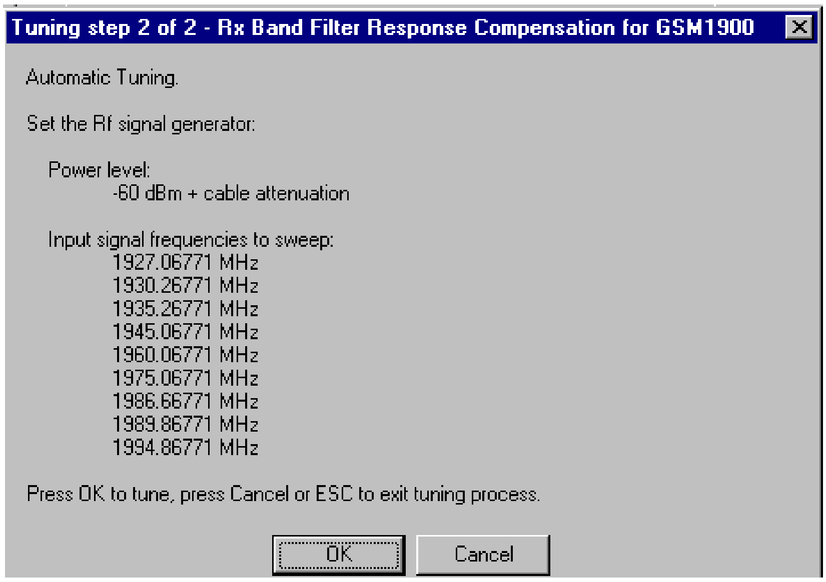
Program the signal generator to the list of frequencies that are visible in the column "frequencies to sweep" .



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 Save and Continue and a window pops up for 1900 band:



Press OK and Repeat, the process for the 1900 band..

RX Channel Select Filter Calibration

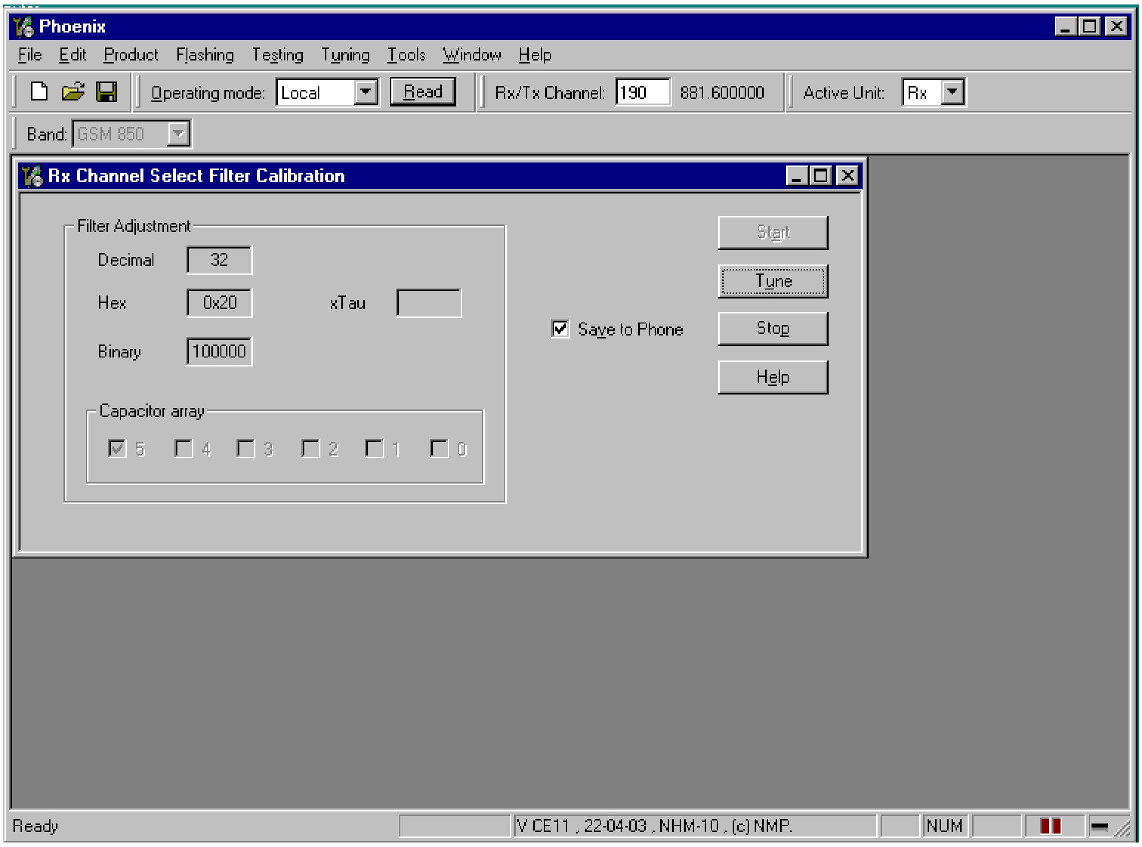
This calibration is calibrating the Base band filter inside Mjoelner. It is done by internally measuring a prototype filter, for this reason the calibration is done once, not separately in 2 bands.

Set operating mode to local mode

Select	Tuning	Alt U
	RX Channel Select filter Calibration	H

The RX Channel Select Filter Calibration window pops up.

The setup should now look like this:



Press Tune and the optimal values are found.

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

TX Power tuning

This tuning must be done in both 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.

GSM850

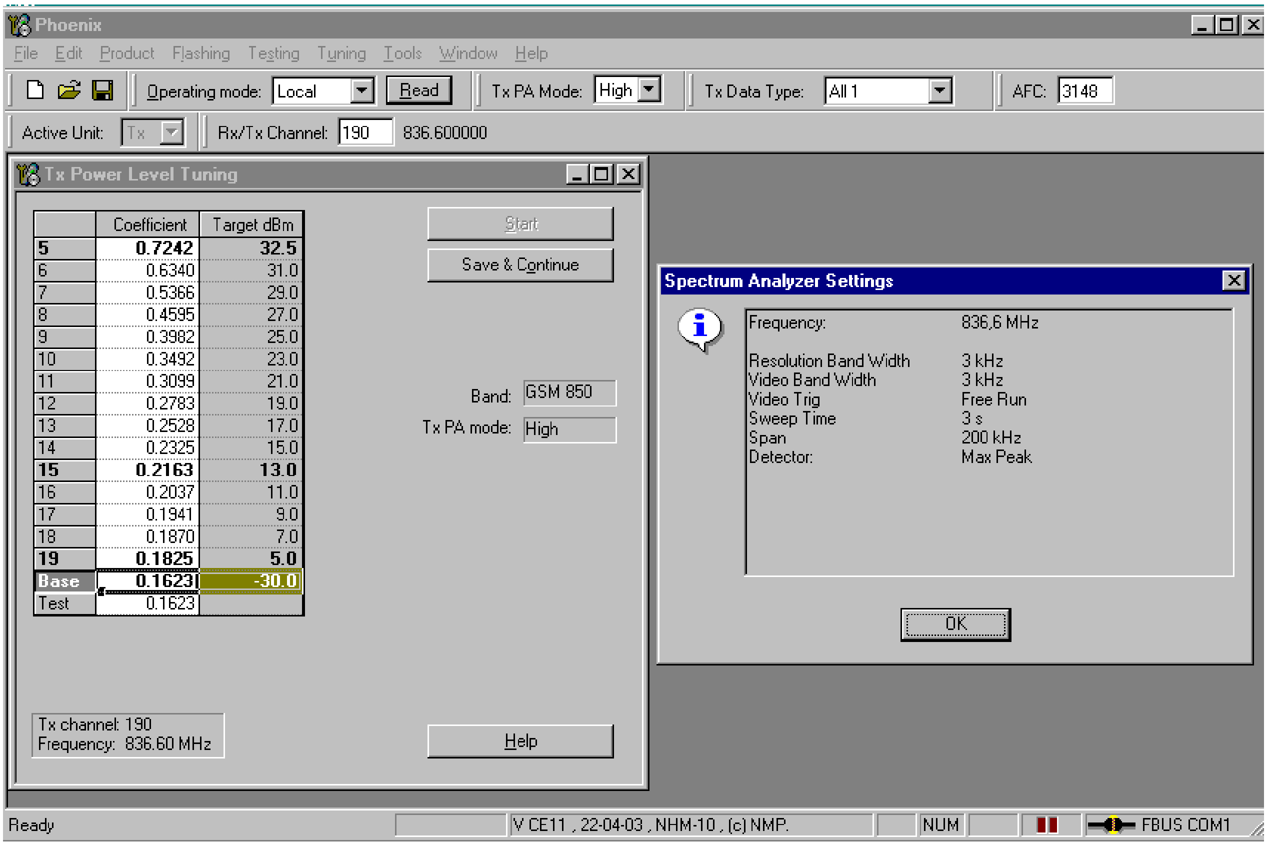
Set operating mode to local mode

Select RF Tuning TX Power Level Tuning

Wait until the TX Power Level Tuning window pops up.

Connect a **calibrated** powermeter or spectrum analyser to the RF connector of the phone.

Press Start and a window pops up:



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 Target values. The Power levels may differ from Phoenix mentioned target power levels.

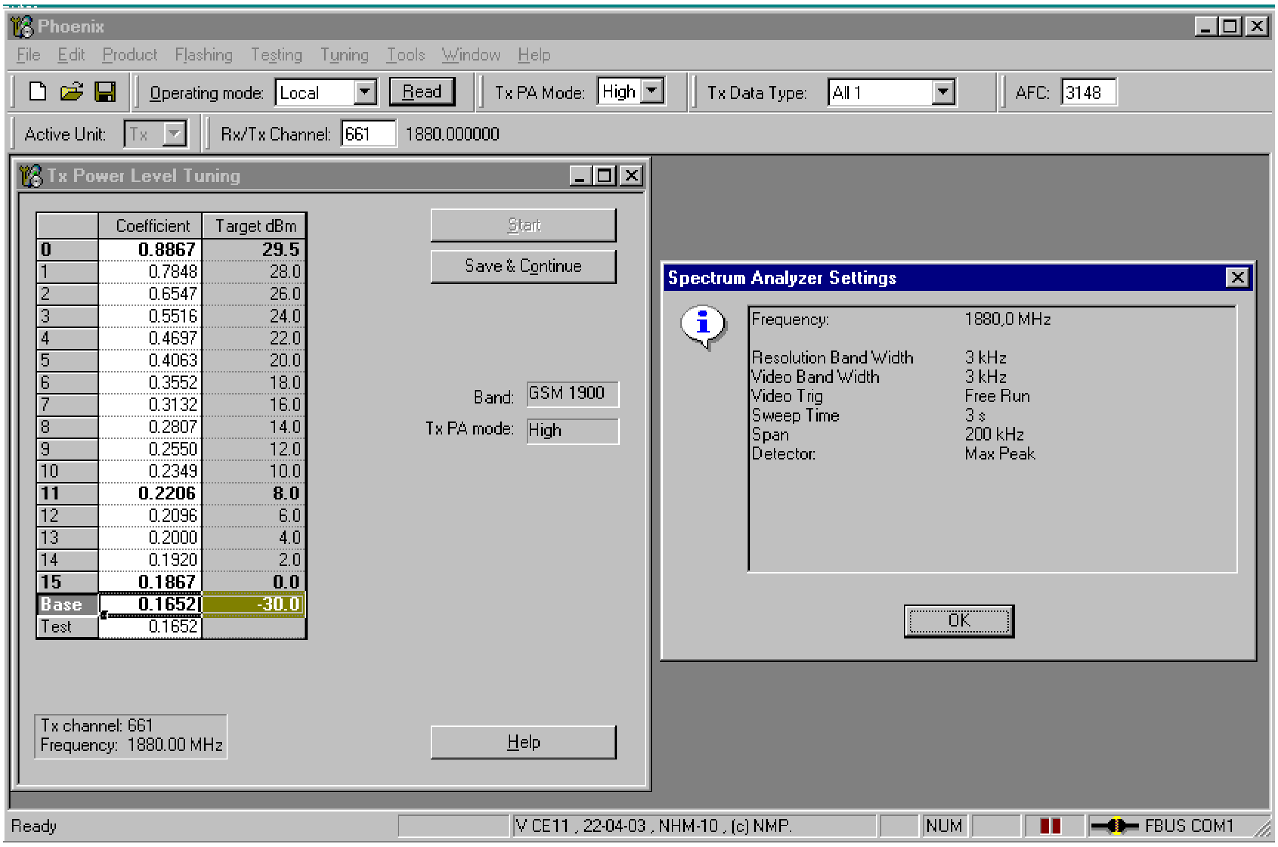
Press Save and Continue.

<u>Ignore table for low PA mode.</u>

Press Save and Continue.

GSM1900 (PCS)

The setup should now look like this:



Press 'OK'

Tune Base level to –27 dBm.

Adjust DAC Values for Power Level 0 (29.5 dBm), 11 (8.2 dBm) and 15 (1 dBm). The Power levels may differ from Phoenix mentioned target power levels.

Press Save and Continue.

The TX Power Level Tuning is finished.

TX I/Q Tuning

This tuning must be done in both bands.

GSM850

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

PC/Phone operation:

Set operating mode to local mode

Select Tuning Alt U
TX IQ Tuning I

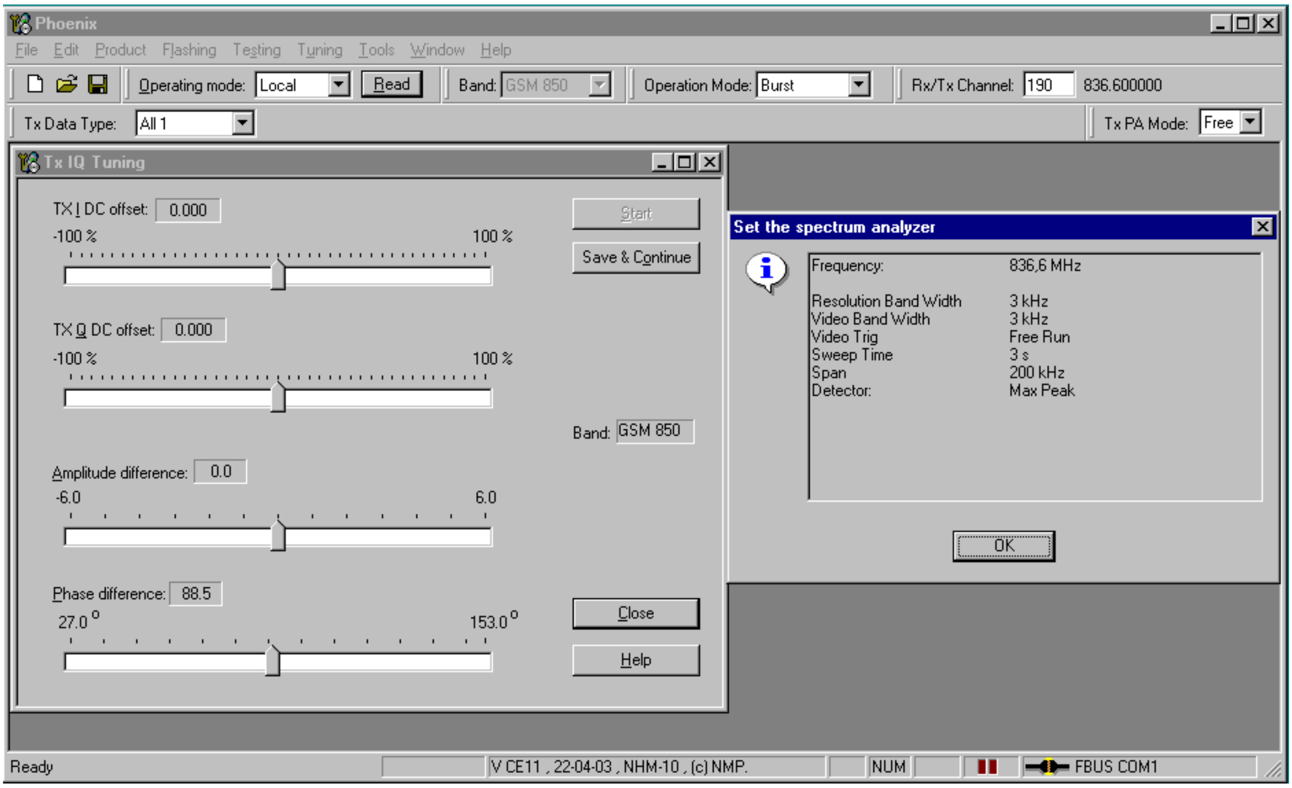
Wait until the TX IQ Tuning window pops up.

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

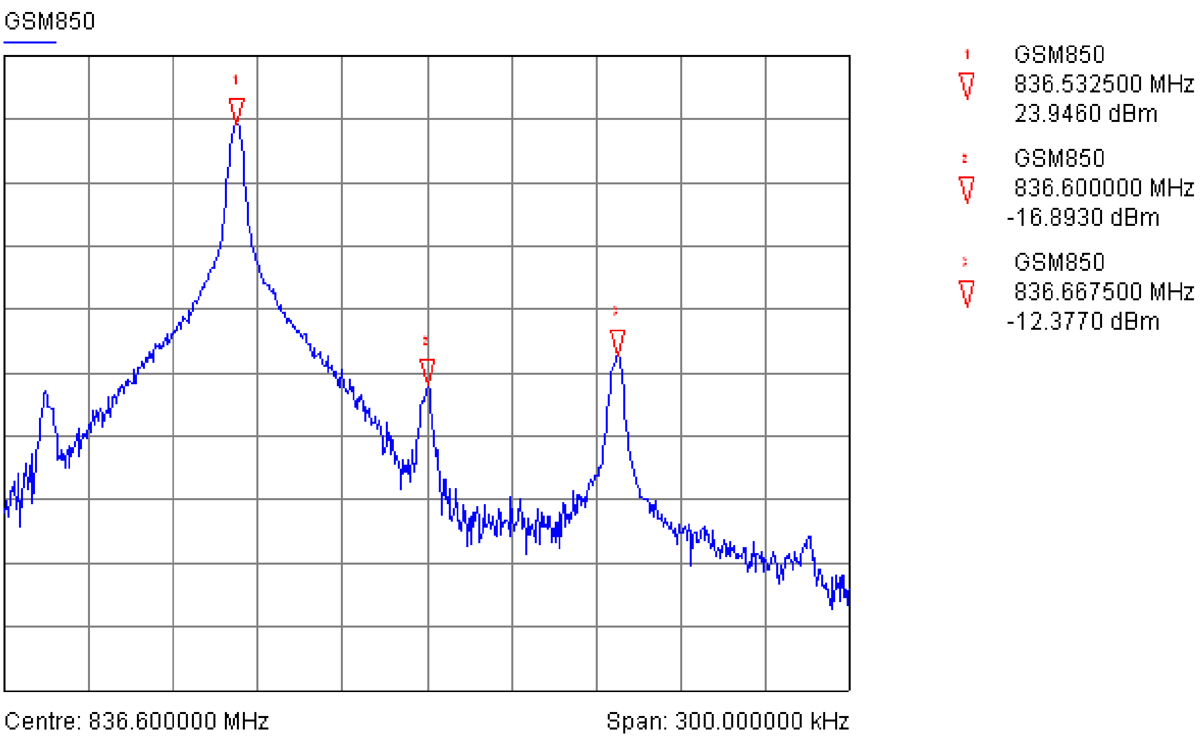
If a spectrum analyzer is used then use the following settings.

	GSM850
Center Frequency	836.6 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
	EGSM/EGSM900
Marker 1	836.6 -67 KHz
Marker 2	836.6 MHz
Marker 3	836.6 +67 KHz

The setup should now look like this:



The Spectrum Analyzer now shows a plot like this:



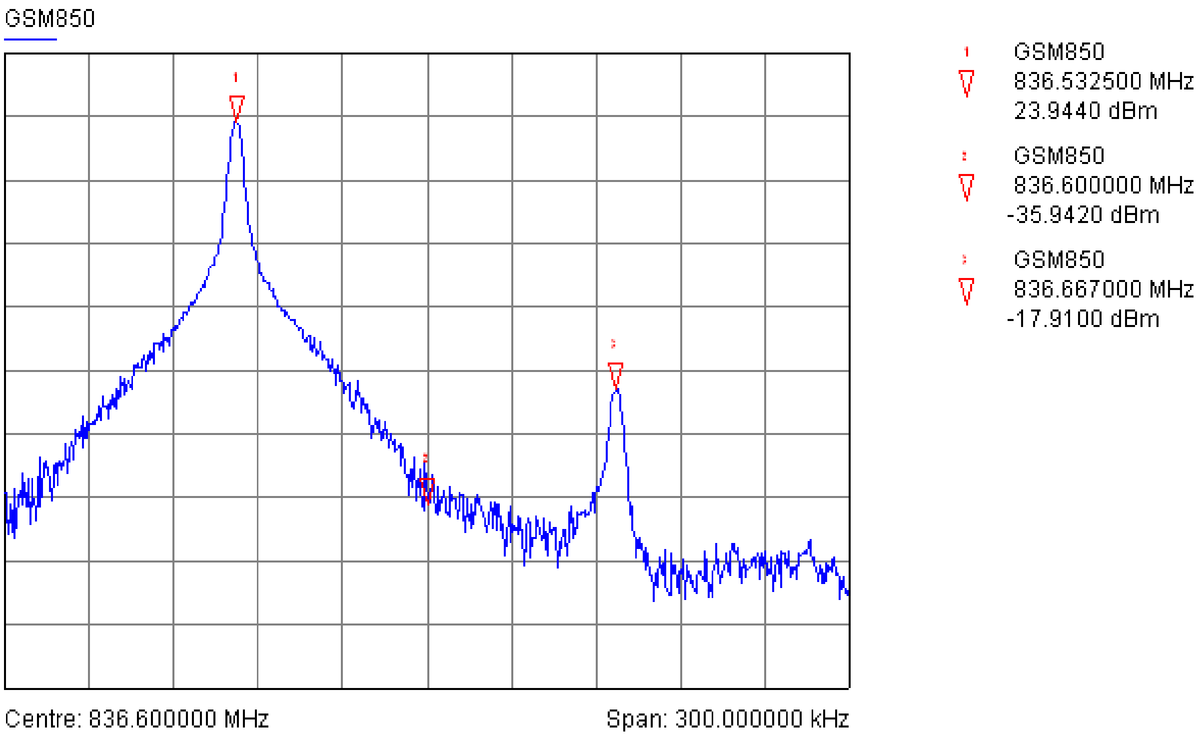
The purpose of this tuning is to tune the carrier signal and the +67kHz signal to a minimum level (Marker 2 and 3).

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (Marker 2).

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

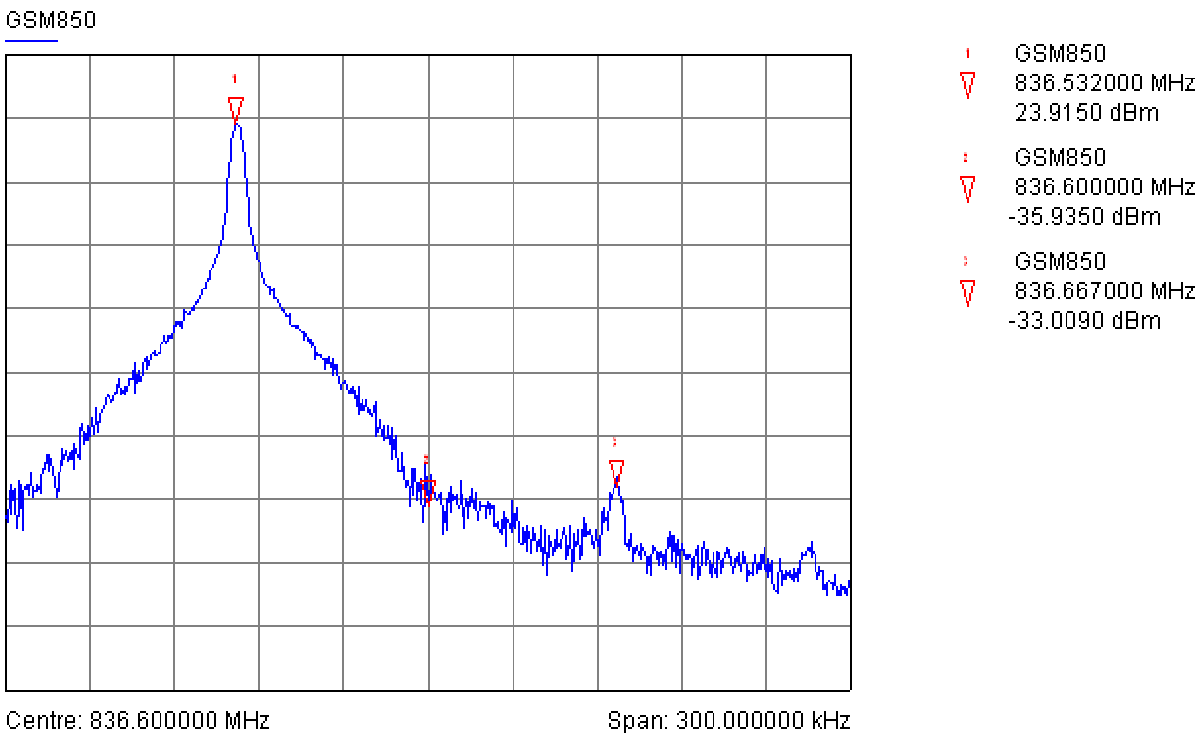
Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

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). After tuning to the minimum the level difference between the peak levels at marker 1 and 3 must exceed 40dB. Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

The Spectrum Analyzer now shows a plot like this:



Select "Save and Continue"

Press Stop and the values are stored in the phone.

The 850 TX IQ Tuning is now finished.

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

GSM1900 (PCS)

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

Wait until the RF Controls window pops up.

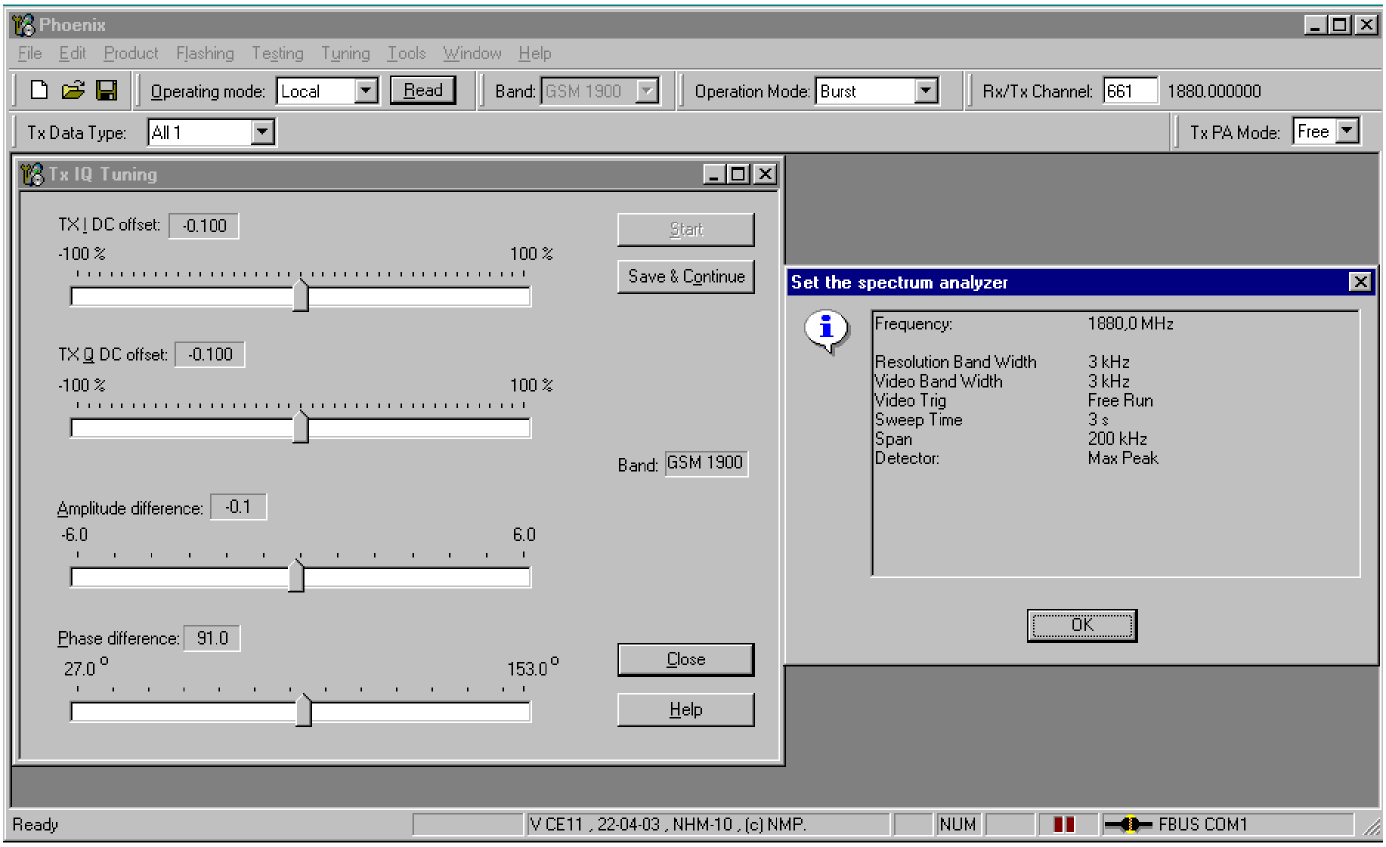
Connect a Spectrum Analyzer or GSM tester with the option *Narrow Spectrum' to the RF connector of the phone.

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

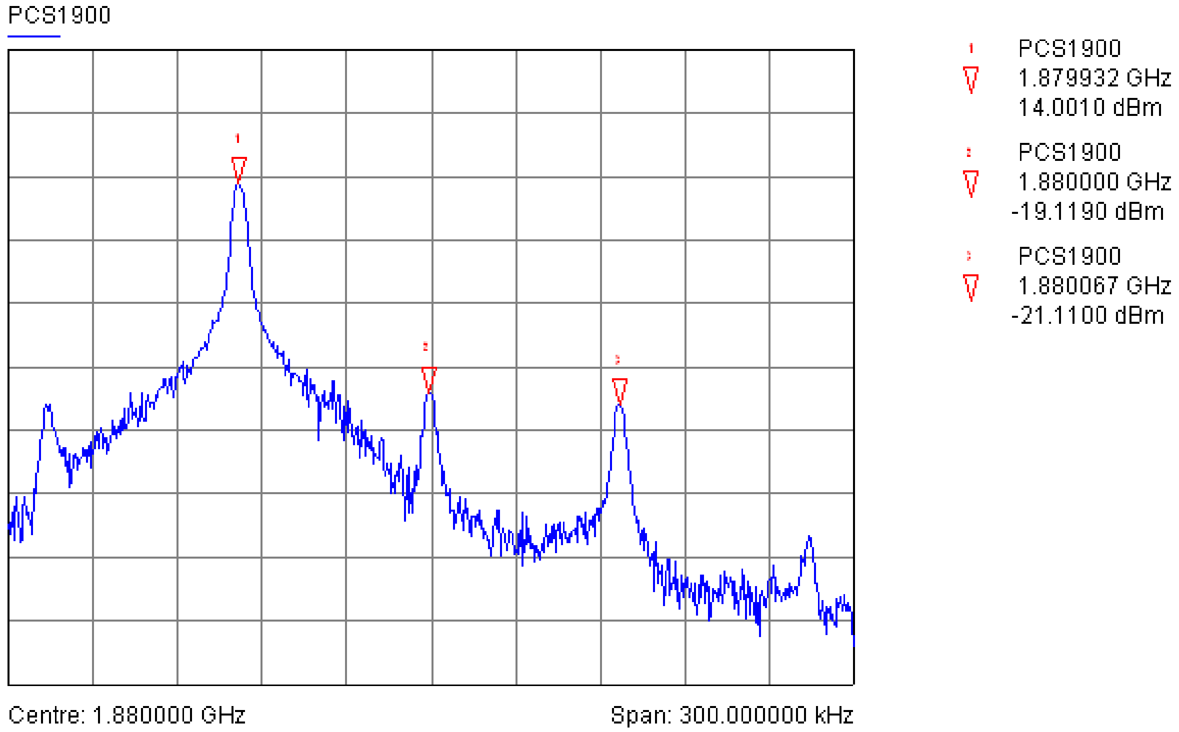
	GSM1900
Center Frequency	1880MHz
Frequency Span	300 kHz

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	1880 -67 KHz
Marker 2	1880 MHz
Marker 3	1880 +67 KHz

The setup should now look like this:



The Spectrum Analyzer now shows a plot like this:



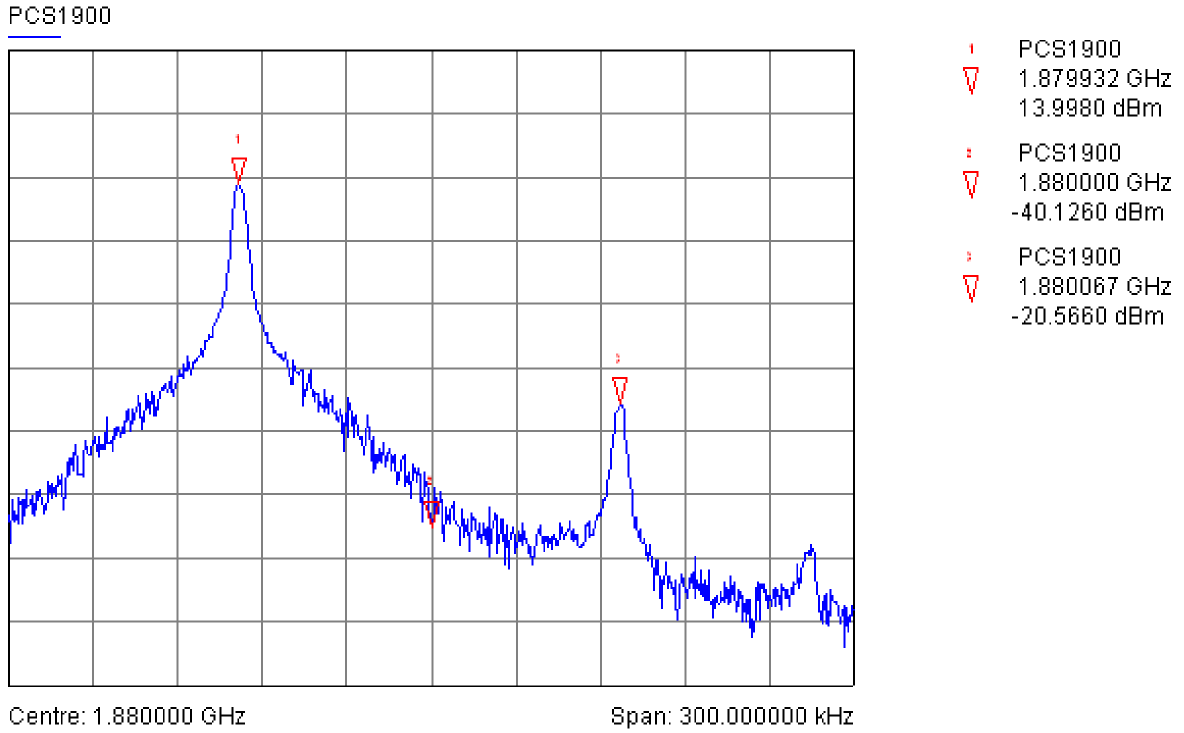
The purpose of this tuning is to tune the carrier signal and the +67kHz signal to a minimum level (Marker 2 and 3).

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (Marker 2).

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

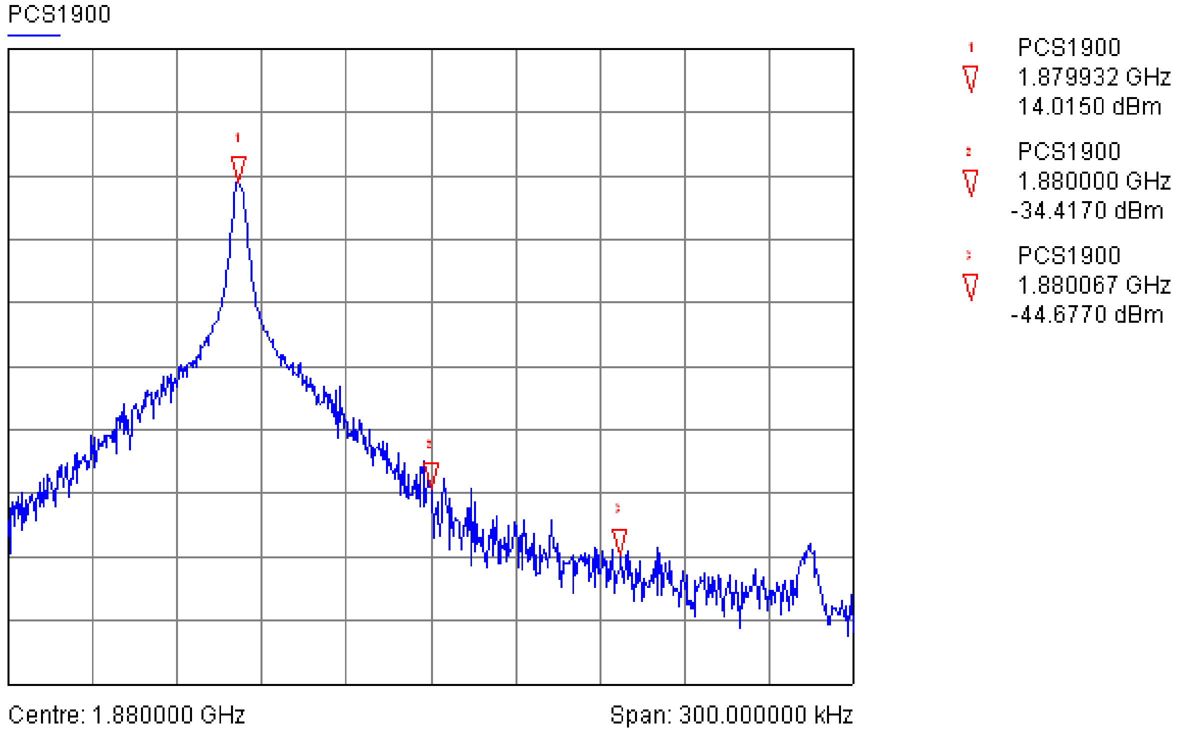
Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

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). After tuning to the minimum the level difference between the peak levels at marker 1 and 3 must exceed 40dB, Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible'

The Spectrum Analyzer now shows a plot like this:



Press Save and Continue in the TX IQ Tuning Window and the values are stored in the phone.

The TX IQ Tuning is now finished.

Note: The optimal values for “TX I and Q Offset” and “Amplitude and Phase Difference” vary from phone to phone.

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