

Customer Care Solutions

NHL-8 Series Transceivers

6(b) RF Troubleshooting

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RF Troubleshooting

Abbreviations in fault finding charts

BB	Base band
DCS/PCN	GSM1800
PCS	GSM1900
EGSM	Extended GSM900
ESD	Electro Static Discharge
GPRS	General Packed Radio Service
HSCSD	High Speed Circuit Switched Data
LO	Local Oscillator
PA	Power Amplifier
PWB	Printed Wired Board
PLL	Phase Locked Loop
RF	Radio Frequency
RX	Receiver
SA	Spectrum analyzer
TX	Transmitter
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.

In the following both, the name EGSM and EGSM900 will be used for the low band. DCS or PCN and GSM1800 will be used for the mid band. PCS and GSM1900 will be used for the high band.

RF Key component placement

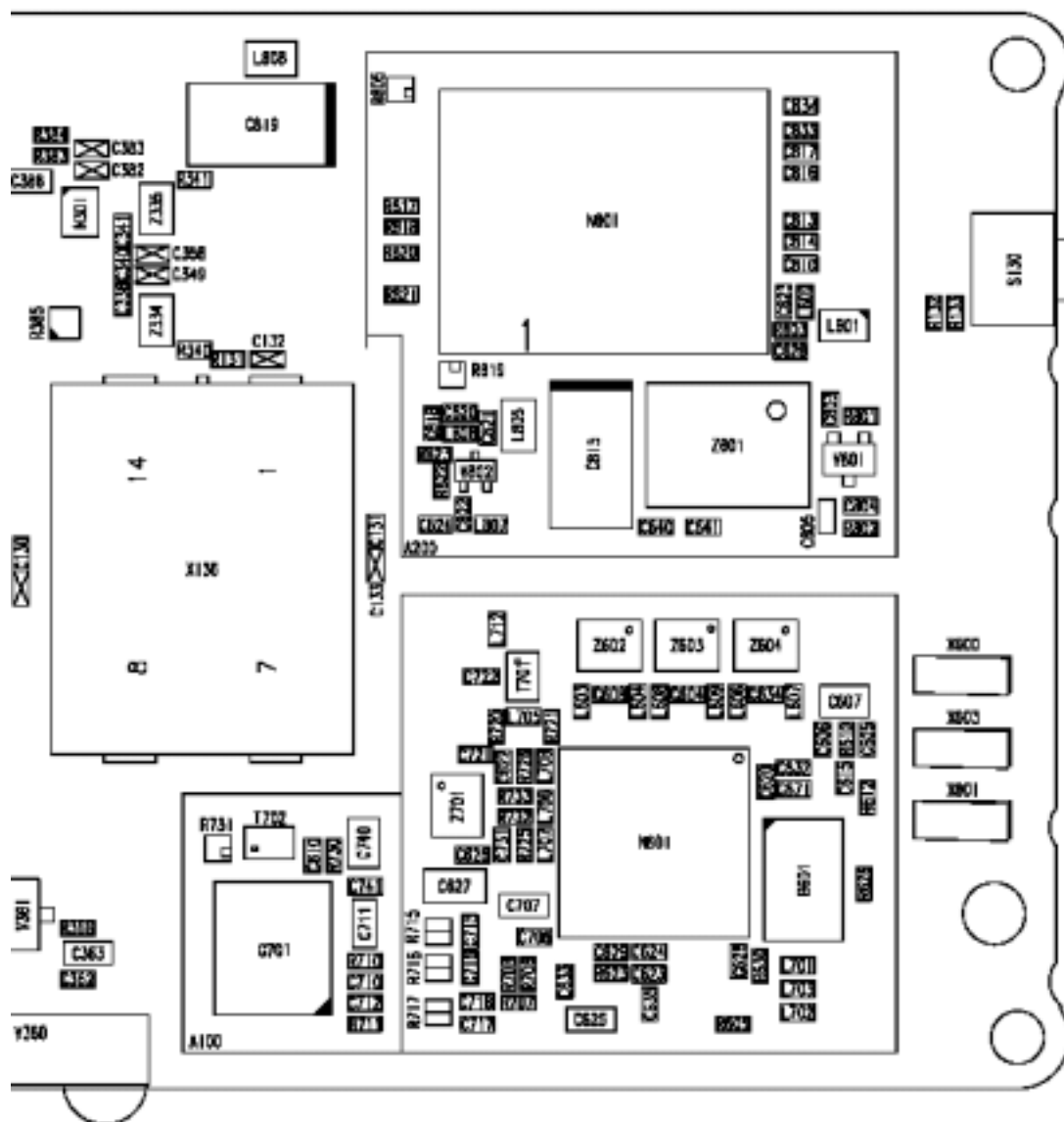


Figure 1: RF key component placement

Reference number	Name	Reference number	Name
N601	Mjoelner RF ASIC	X602	RF Connector
B601	26 MHz Xtal	L801	Directional Coupler
Z602	GSM1800 RX SAW	V801	Detector Diode
Z603	GSM1900 RX SAW	Z601	Antenna switch
Z604	EGSM RX SAW filter	N801	Power Amplifier
Z701	EGSM TX SAW filter		
T701	GSM1800/GSM1900 TX Balun		
V802	EGSM Pre-amplifier		
G701	3.7 GHz VCO		
T702	VCO Balun		
X600	Antenna signal clip		
X601	Antenna ground clip		

RF Measurement points

RF Supply points

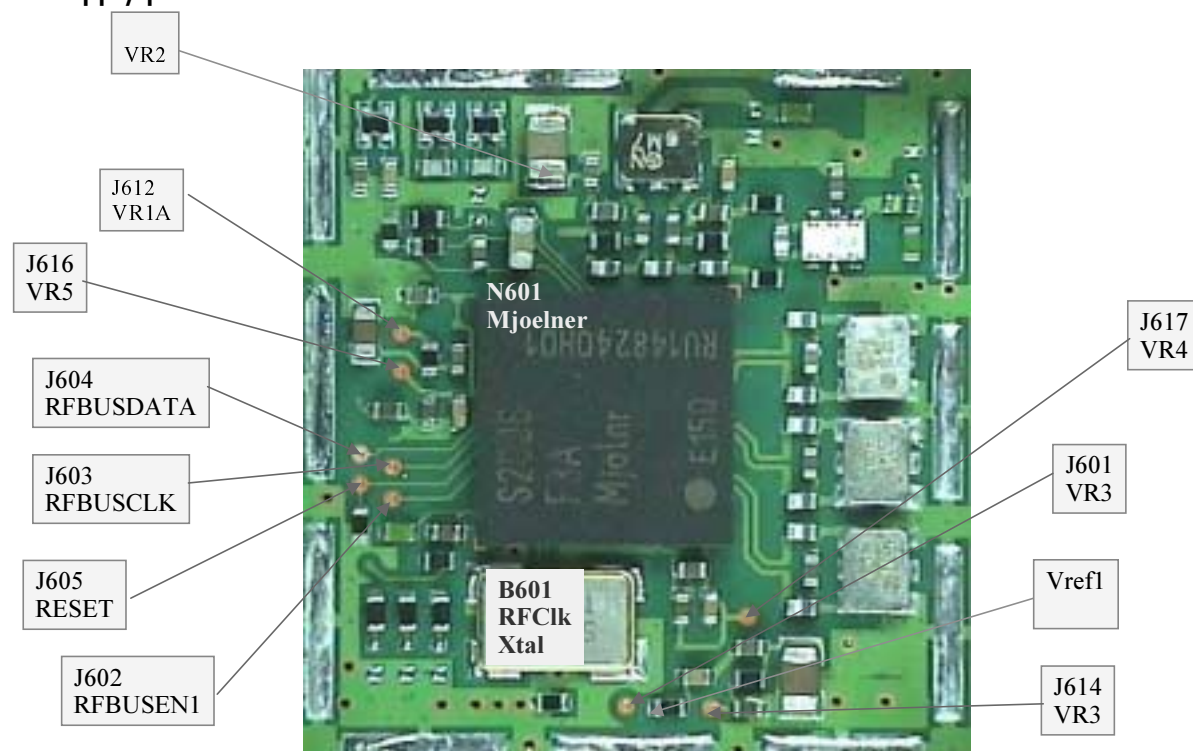


Figure 2: RF Supply points inside Mjoelner can

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.

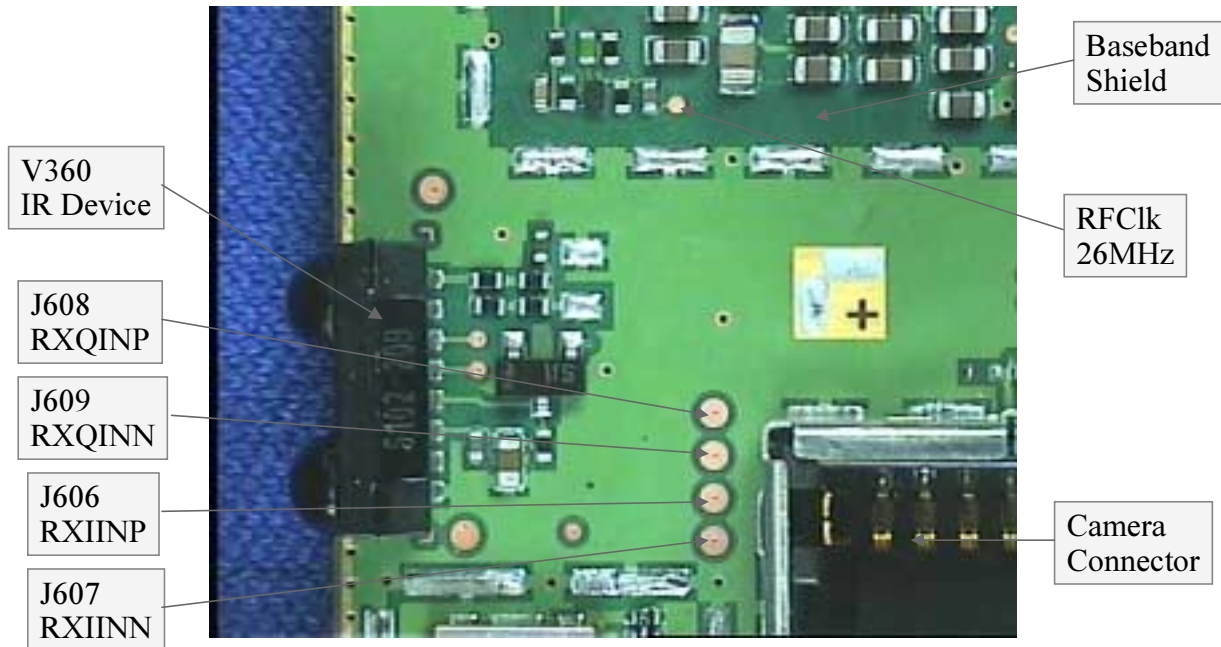


Figure 3: Rx I and Q measurement points

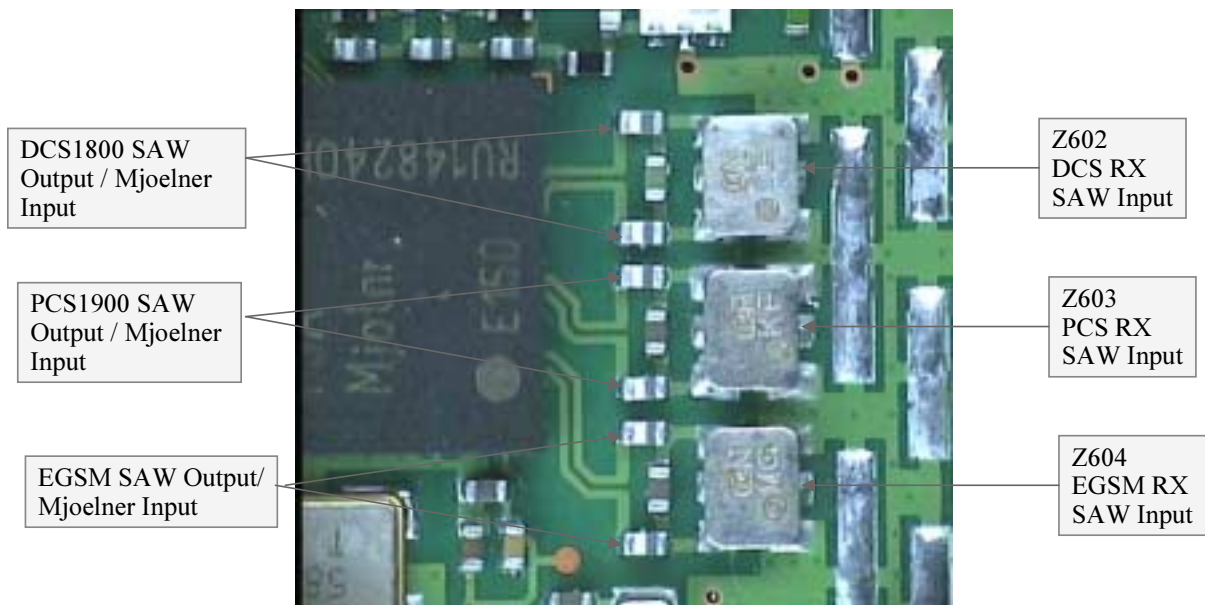


Figure 4: Rx measurement points at Rx SAW filters and Mjoelner RF ASIC

Measurement points in the transmitter

Measurement points are shown in the picture below,

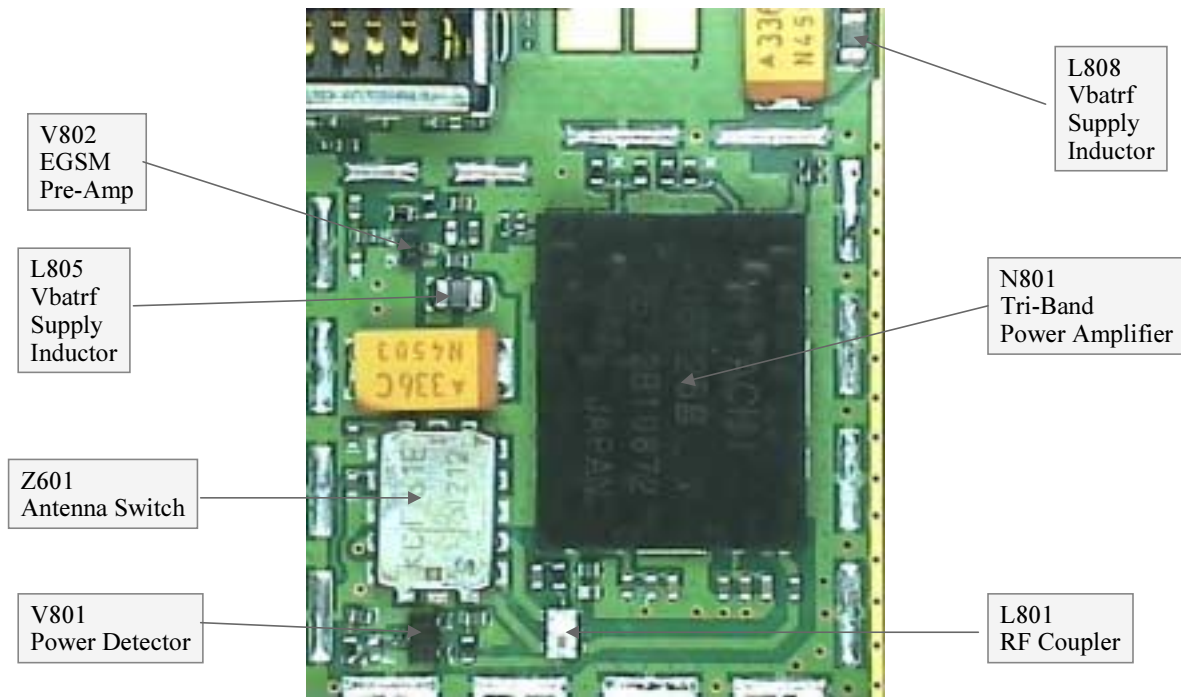


Figure 5: Tx measurement points inside PA can

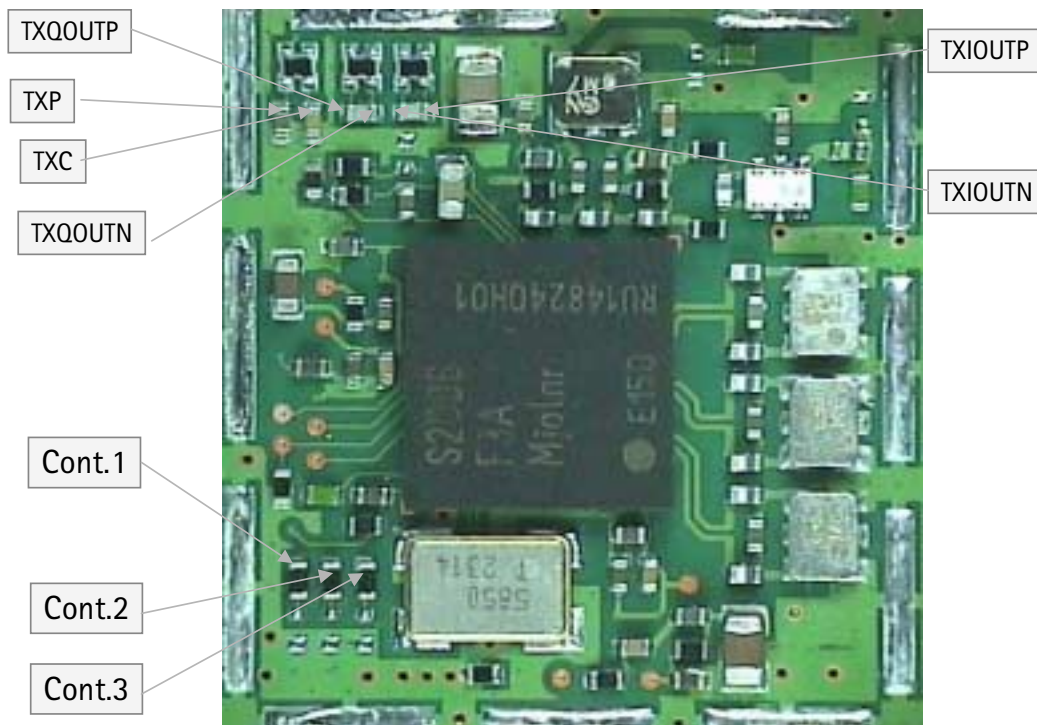


Figure 6: Tx measurement points inside Mjoelner can

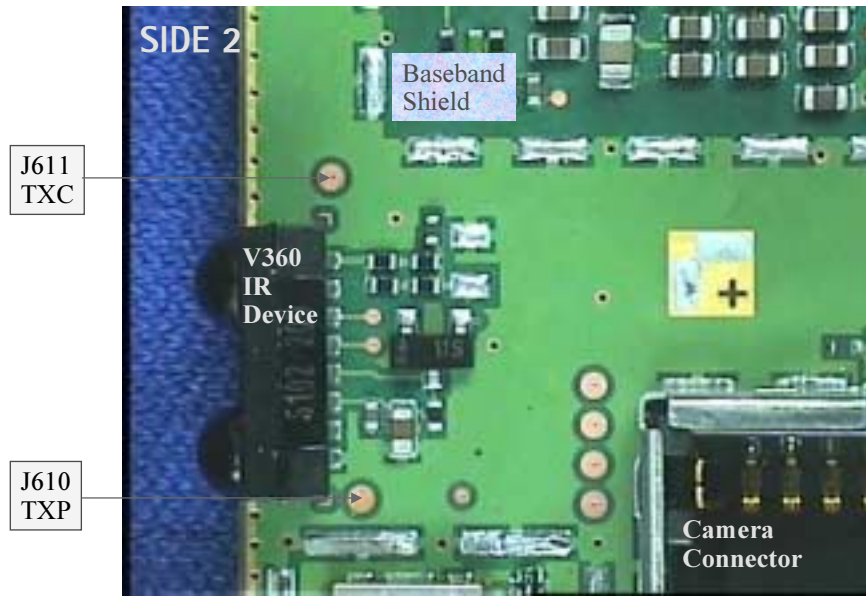


Figure 7: Tx measurement points for TXC, TXP signals

RF in general

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

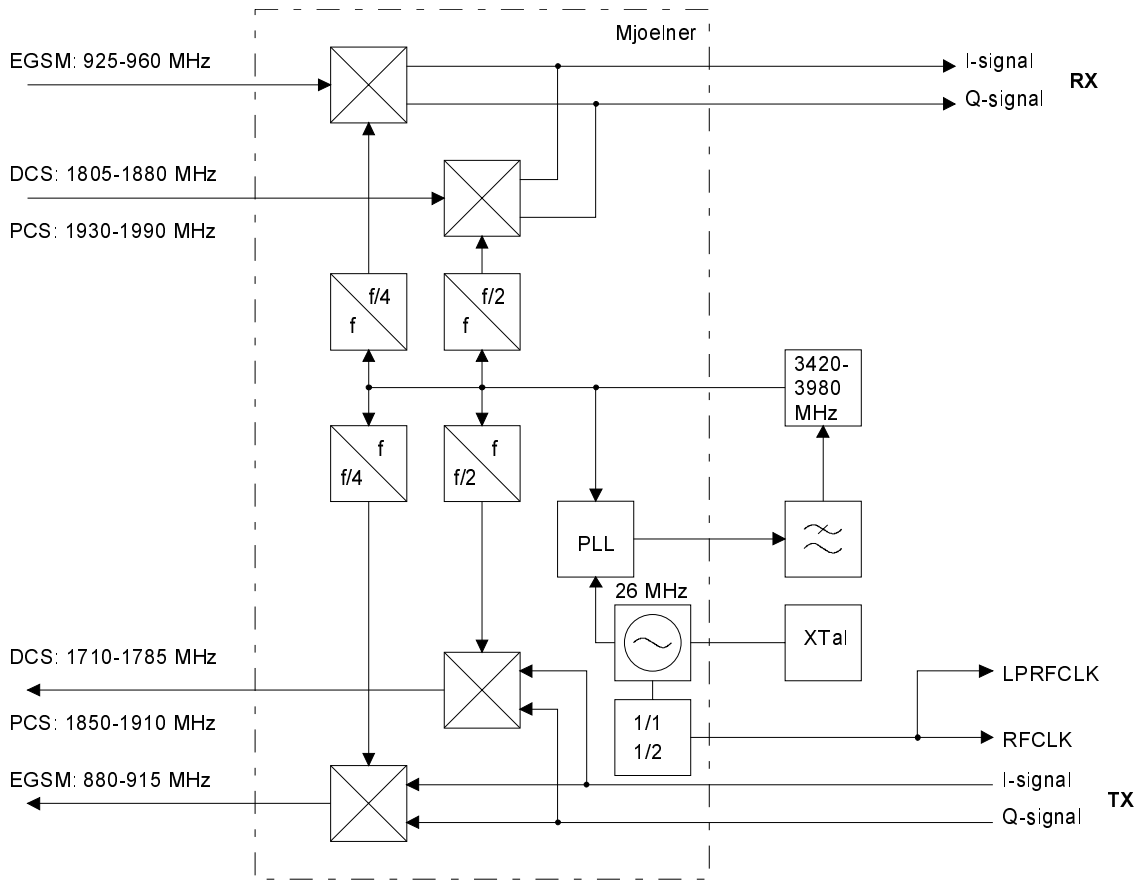


Figure 8: RF frequency plan

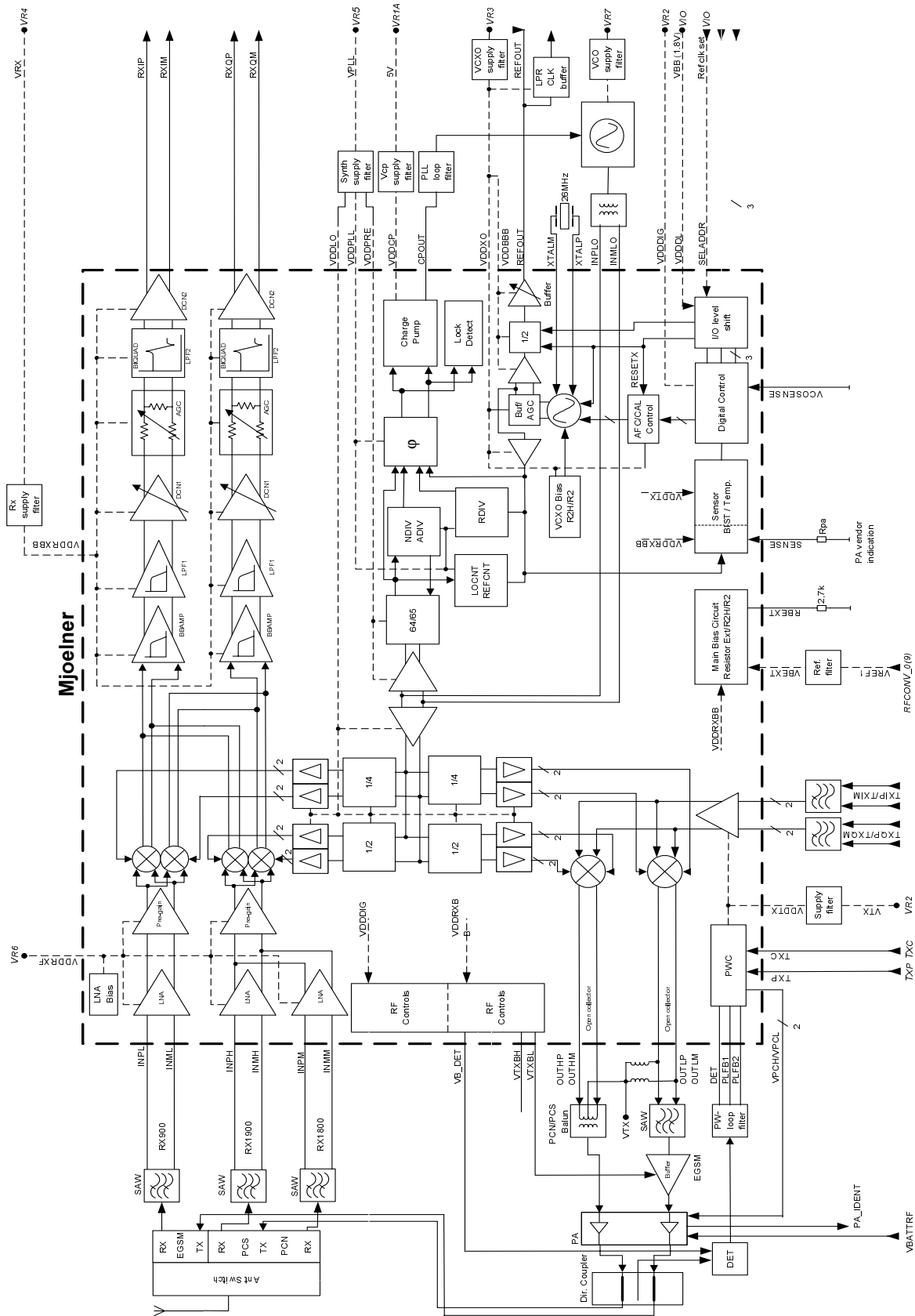


Figure 9: RF Block diagram

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 Mjølner 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.

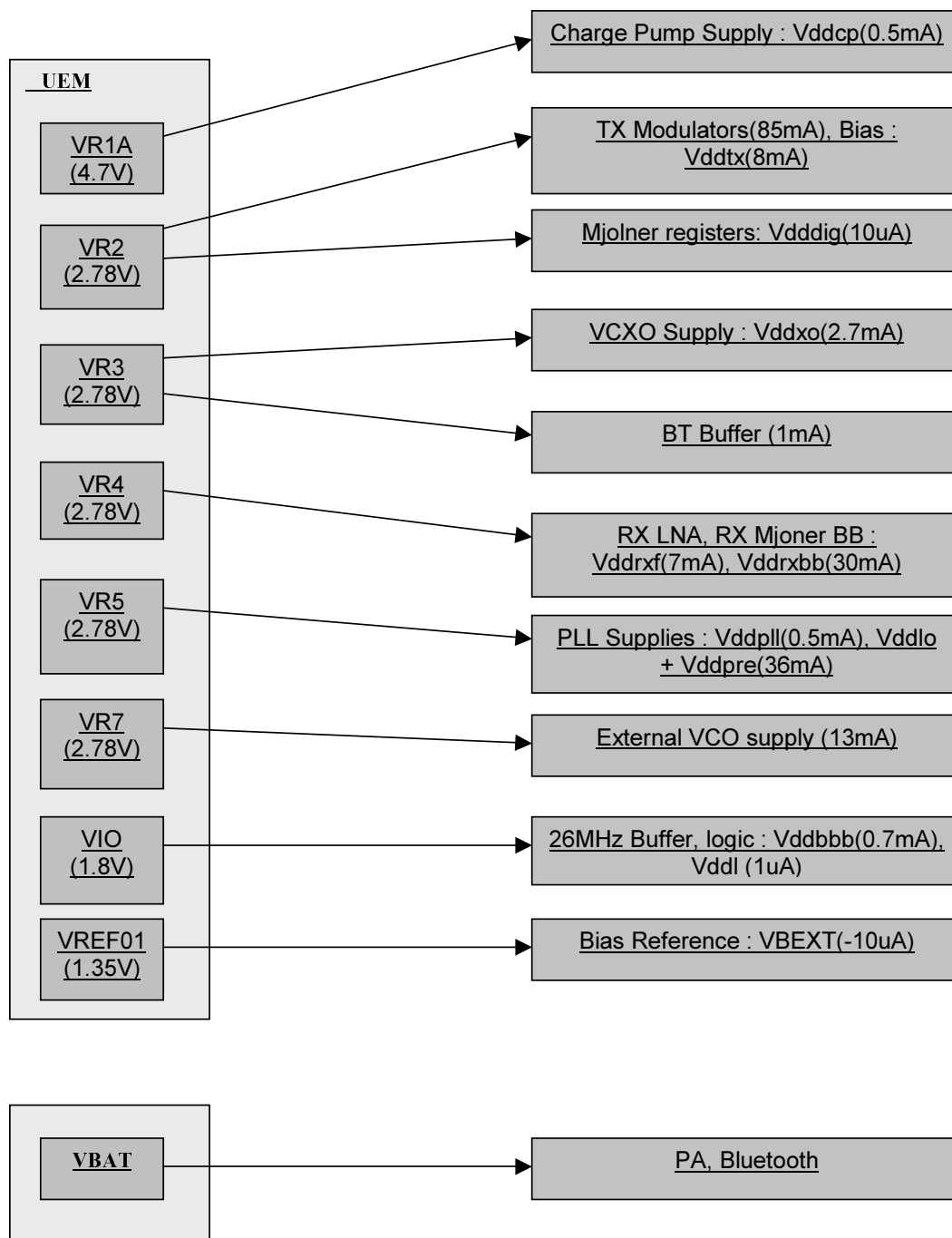
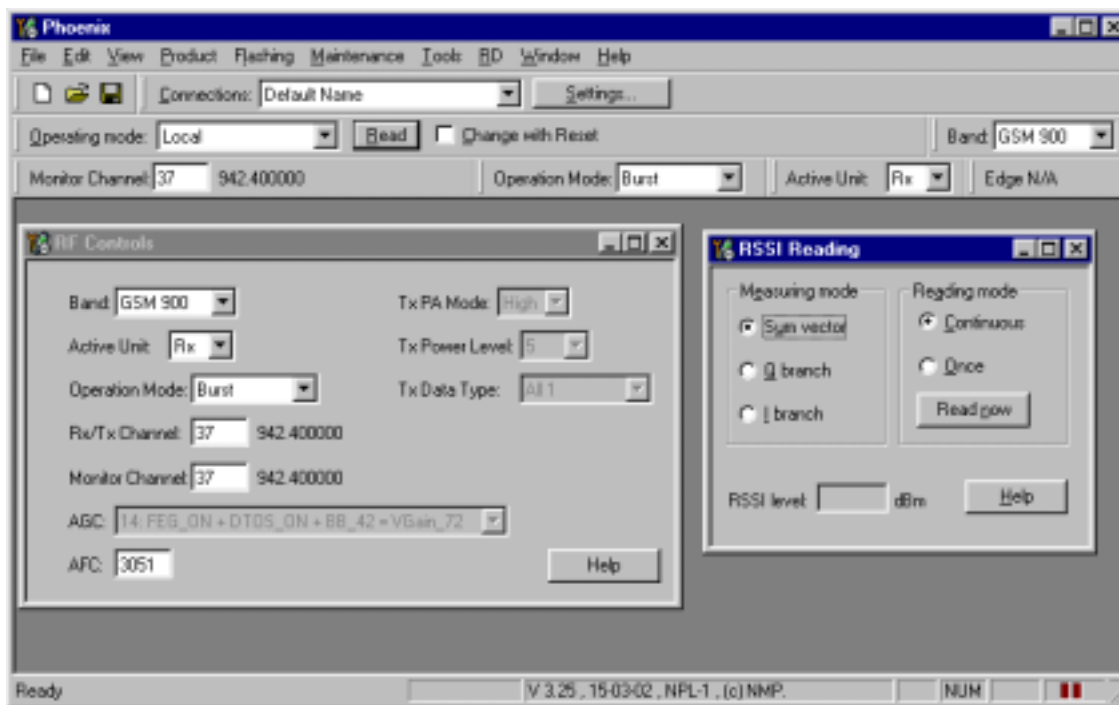


Figure 10: RF Power distribution diagram



Apply a signal with a frequency of

EGSM : 942.467 MHz (channel 37 + 67.710kHz offset)

GSM1800: 1842.867 MHz (channel 700 + 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 right corner of the screen.

Set operating mode to local mode

Select	RF	Alt-M
	Tuning	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 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 (500hm 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	RF	Alt-M
	Tuning	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 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

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

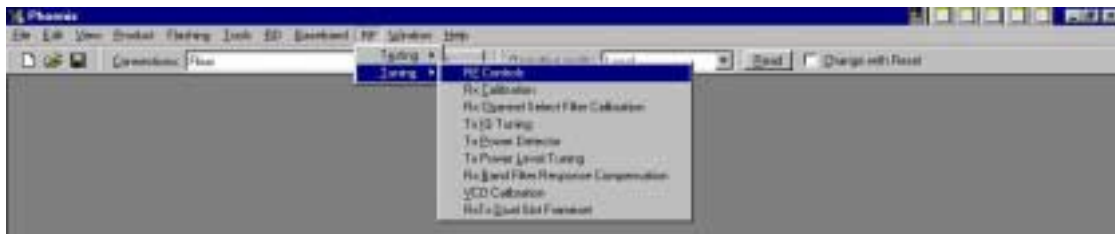
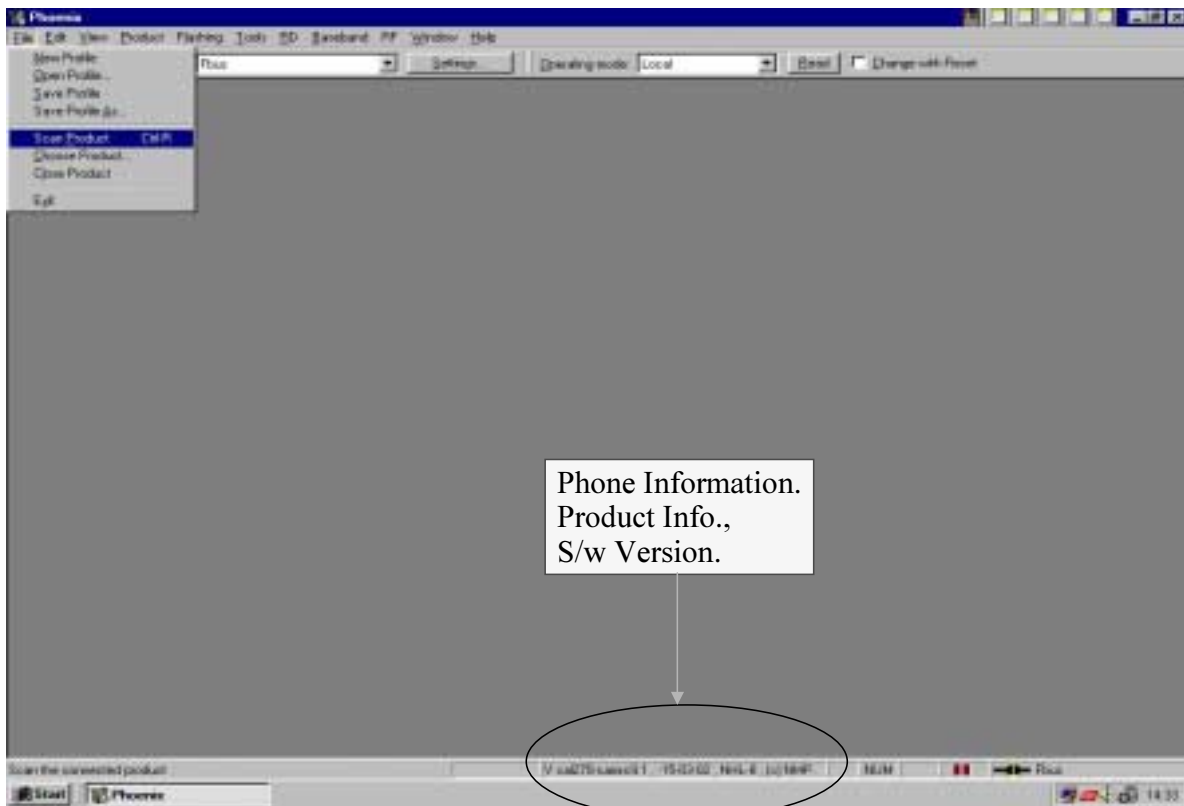
Observe RSSI level in the box.

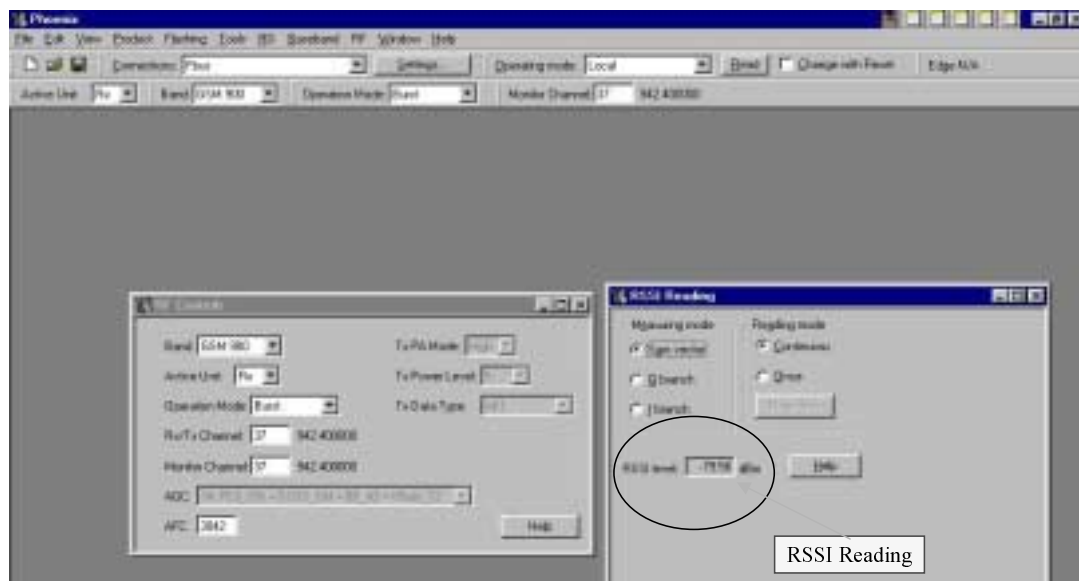
Change band to GSM 1800 in RF control box and frequency to 1842.8MHz on signal generator.

Observe RSSI level.

Change band to GSM 1900 in RF control box and frequency to 1960MHz on signal generator.

Observe RSSI level.





Receiver fault finding

Set up Phoenix as if doing RSSI measurements.

Ascertain which Rx band is faulty.

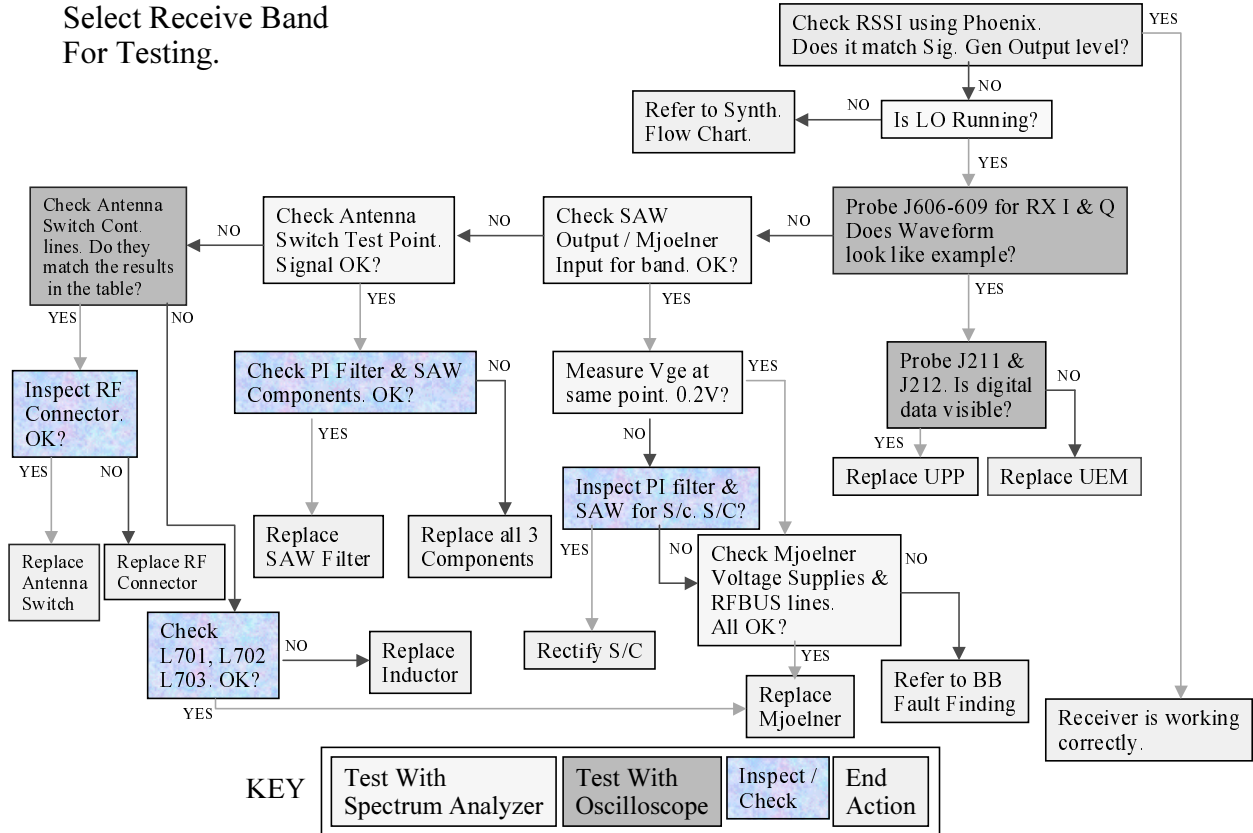
Refer to Rx fault finding flow chart.

Set signal generator frequency to 942.47MHz for EGSM, 1842.87MHz for DCS 1800 or 1960.07MHz for PCS 1900.

Set signal generator amplitude to -60dBm.

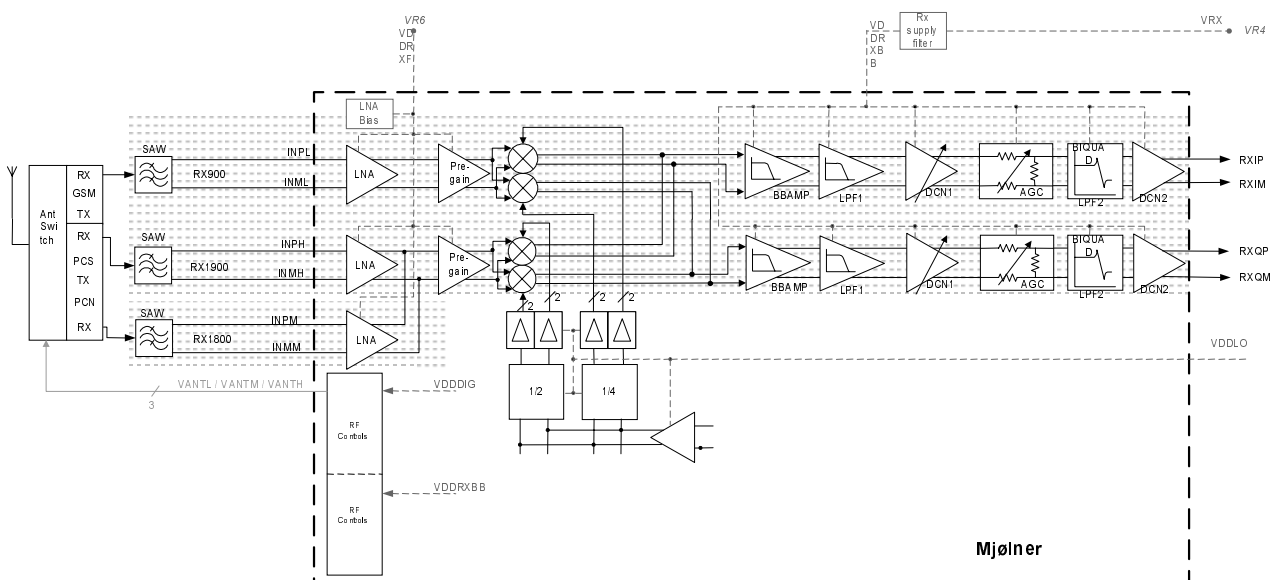
Note: That checking the RF inputs to SAW filters Z602, Z603 & Z604 will be extremely difficult with the Mjoelner Can Shield in place. If this is impossible to get to, try checking the test points shown on the antenna switch Z601.

Select Receive Band For Testing.



Rx Signal paths

The signal paths of the receiver are shown in following block diagram. Note that the picture shows EGSM900 (EGSM) receiver (top), GSM1900 (PCS) receiver (middle) and GSM1800 (DCS/PCN) 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. 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 in the inner layers of the PWB 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 RX/TX switch with routed lines has following typical insertion losses:

1.3dB@EGSM900, 1.6dB@GSM1800 and 1.6dB@GFSM1900.

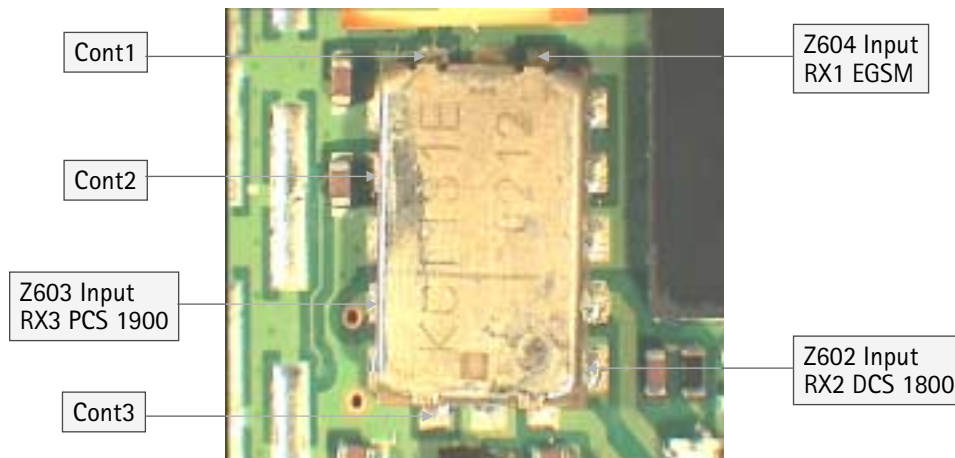


Figure 11: Antenna switch Rx test points

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 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 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:

- 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.

EGSM (EGSM900) Transmitter

General instructions for EGSM 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 results may be incorrect.

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 'RF', 'Tuning', 'RF controls' from the pull down menu.

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

Set Operation Mode to 'Burst'.

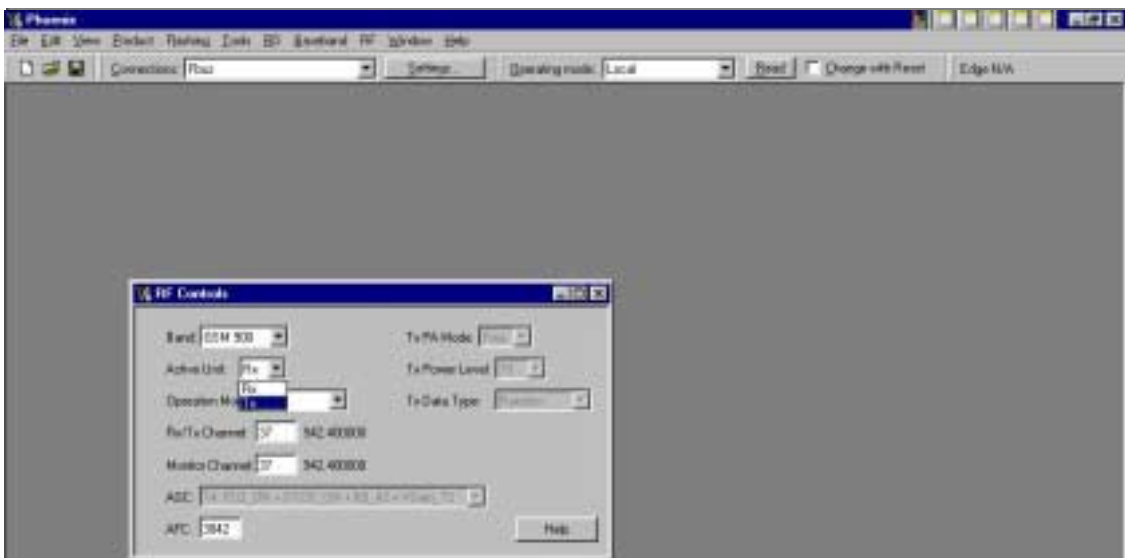
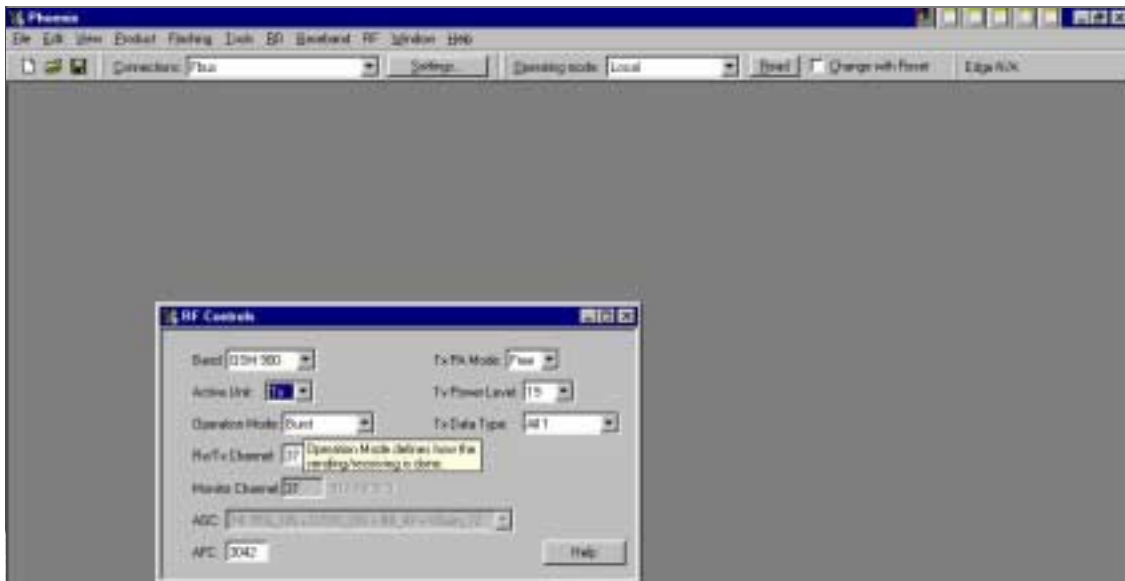
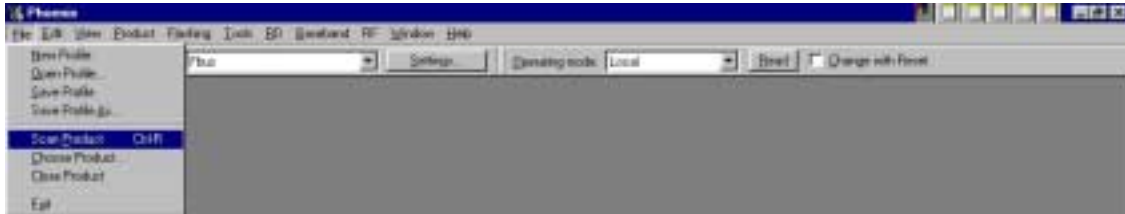
Choose the Power level you want the phone to operate at.

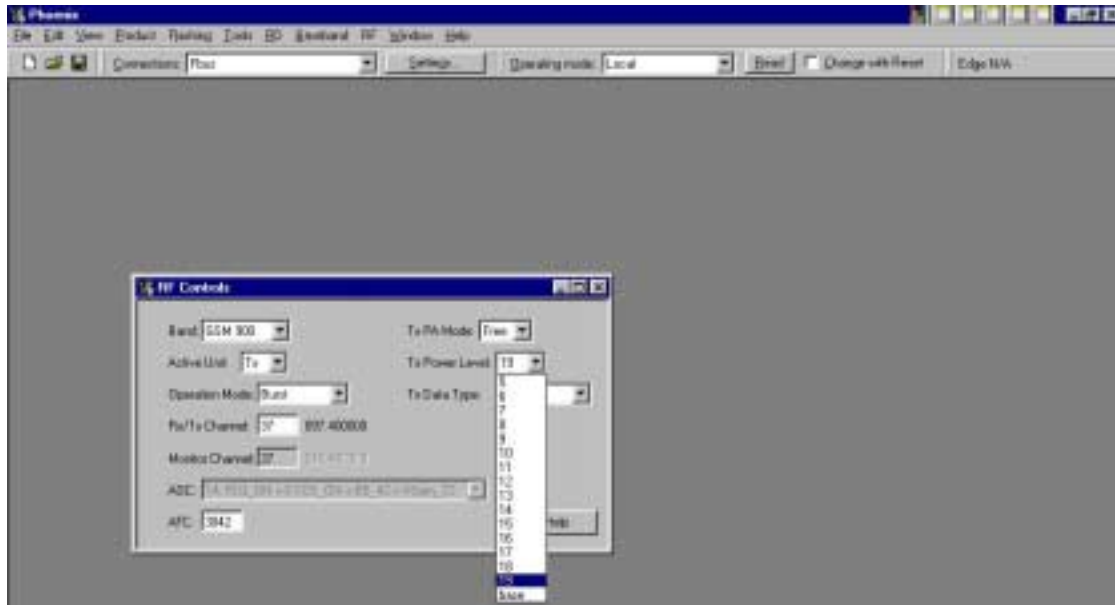
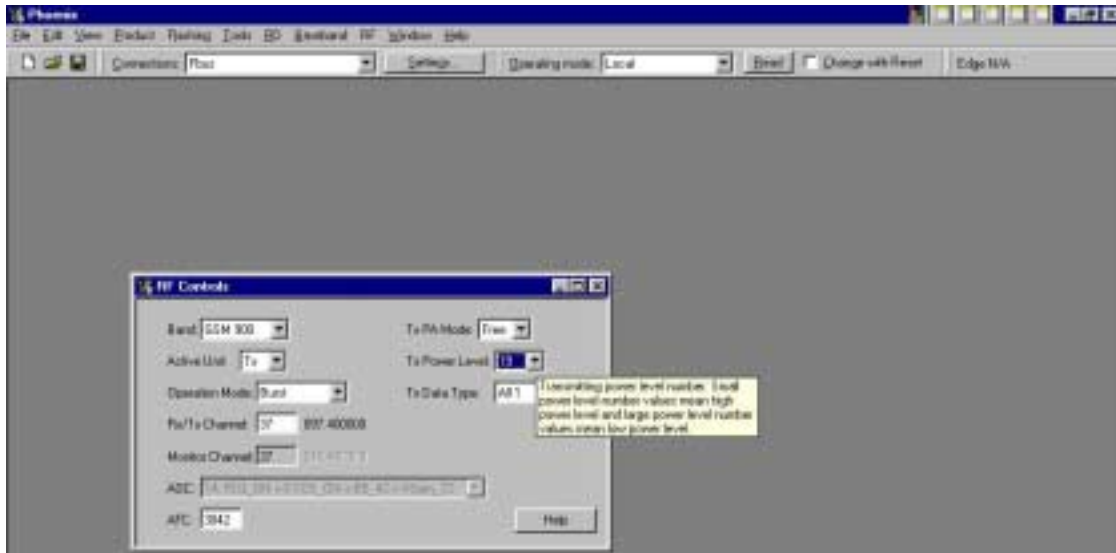
Set spectrum analyzer centre frequency, 897.4MHz for EGSM, 1747.8MHz for PCN 1800 & 1880MHz PCS 1900 and set Span to 1MHz.

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

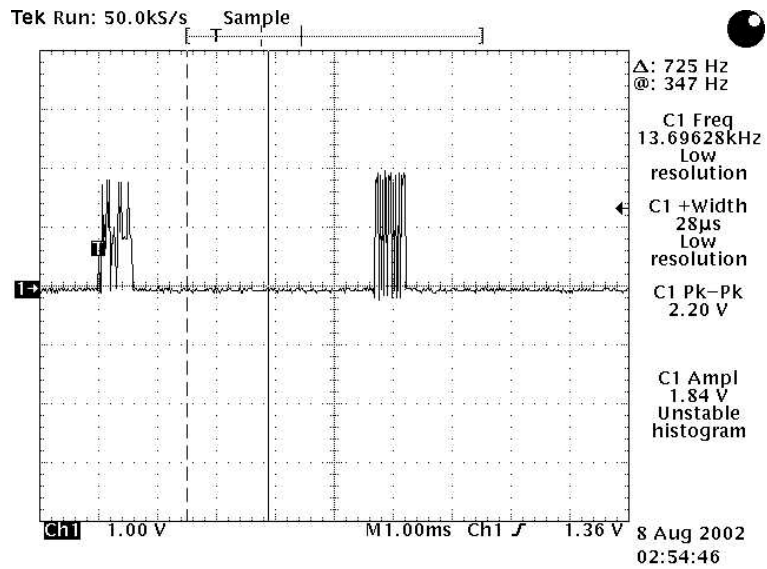




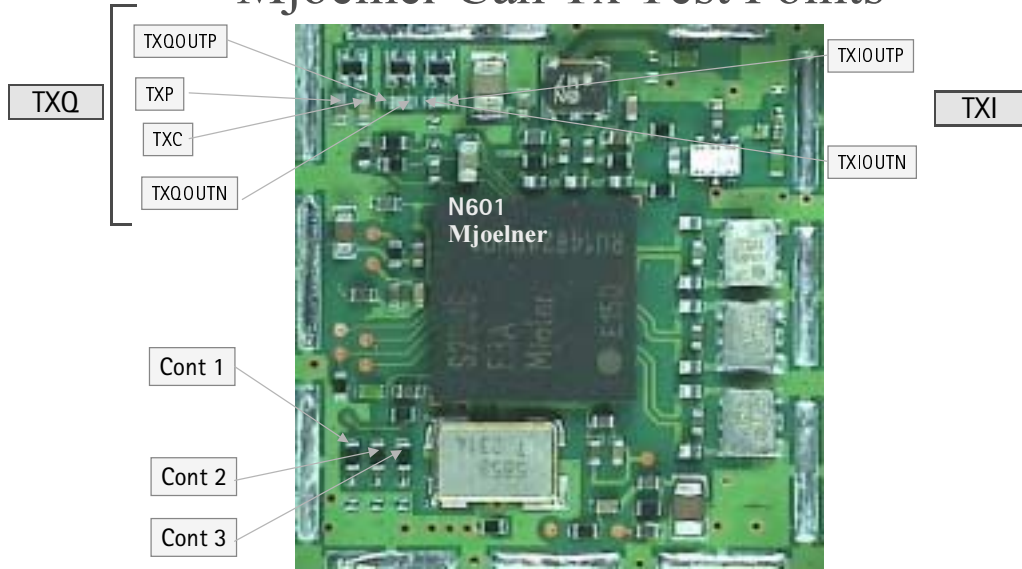
TX Digital I & Q Test Points



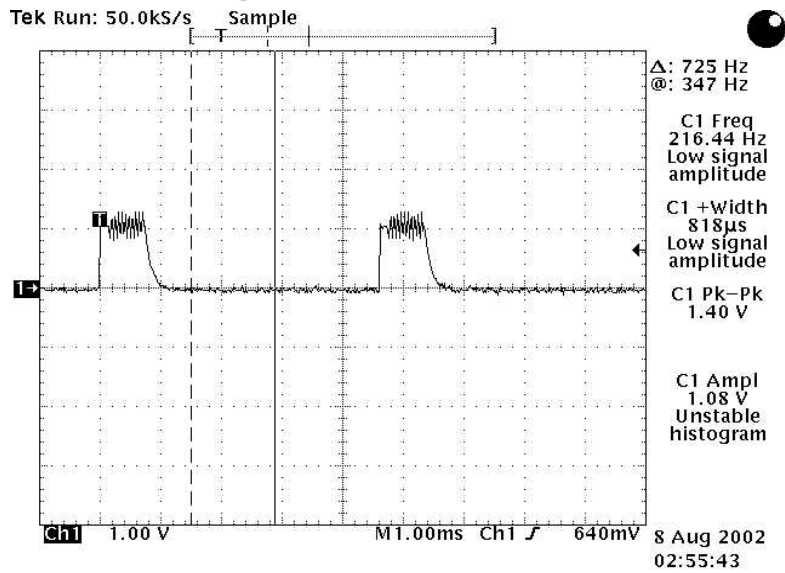
TX Digital I & Q Data, J123 & 214



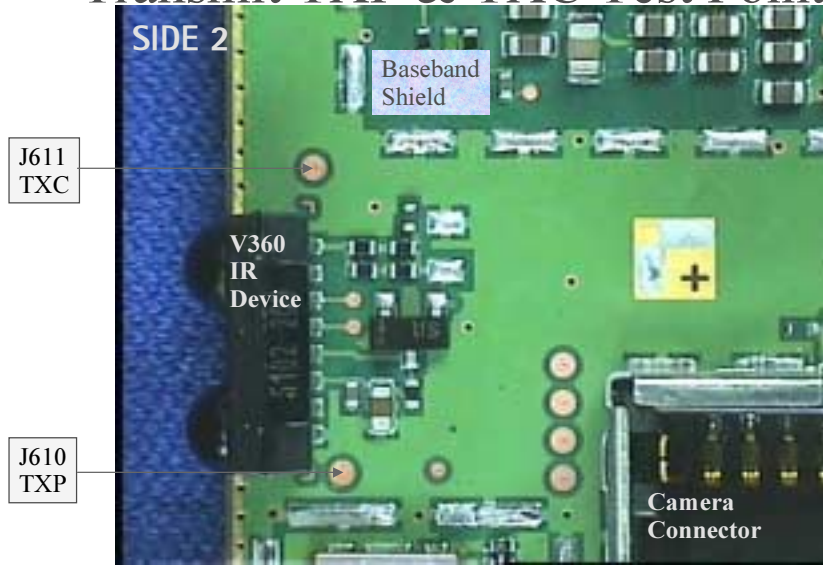
Mjoelner Can Tx Test Points



TX Analog I & Q Data, C715 & C716



Transmit TXP & TXC Test Points



TXP & TXC Lines during Transmission

