# CCS Technical Documentation
# NPM-10 Series Transceivers

# Troubleshooting Instructions RF

Issue 1 03/2003 Confidential

## Contents

**Page No**

# RF Troubleshooting

## Abbreviations in Troubleshooting Charts

| | |
|---|---|
| BB | Base Band |
| DC | Direct Current |
| ESD | ElectroStatic Dicharge |
| LF | Low Frequency |
| LO | Local Oscillator |
| LPF | Low Pass Filter |
| PA | Power Amplifier |
| PLL | Phase Locked Loop |
| PWB | Printed Wiring Board |
| RCT | Radio Communication Tester |
| RF | Radio Frequency |
| RX | Receiver |
| TX | Transmitter |
| UHF | Ultra High Frequency |
| VCO | Voltage Controlled Oscillator |

## Introduction

Two types of measurements are used in the following. It will be specified if the measurement type is "RF" or "LF".

- RF measurements should be done with a Spectrum Analyzer with a high impedance probe. (Note Signal levels can vary depending on measurement setup, therefore it is recommended that a known good phone is used as a benchmark for the measurement technique used. Measurements stated in this section were done with a HP85024 high impedance probe.).

- Note that the test jigs have some losses which must be taken into consideration when calibrating the test system.

- LF (Low frequency) and DC measurements should be done with a 10:1 probe and an oscilloscope. The probe used in the following is 10MΩ/ 8pF passive probe. If using another probe, then bear in mind that the voltages displayed may be slightly different.

Always make sure the measurement set-up is calibrated when measuring RF parameters on the antenna pad. Remember to include the loss in the module test jig when realigning the phone.

**Most RF semiconductors are static-discharge sensitive.** ESD protection must be taken during repair (ground straps and ESD soldering irons). Mjoelner is moisture-sensitive, so parts must be pre-baked prior to soldering.

Apart from key components described in this section, 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 ohmmeter, but be aware that in-circuit measurements should be evaluated carefully.

In the following, both the name GSM and GSM850 will be used for the lower band and both PCS and GSM1900 will be used for the upper band.

## General Description of the RF Circuits

In the following general descriptions, different colors are used in the block diagram. The GSM850 signal route is shown in red, the GSM1900 route in green, and the common signal lines are shown in blue. Control, supply voltage, and unused lines are shown in black.

### Receiver Signal Path

The signal from the antenna pad is routed to the Antenna switch (Z700). If no control voltage is present at VANT2 and VANT1, the switch works as a diplexer for the RX signal: the GSM850 signal passes through the switch to GSM RX and the GSM1900 signal passes through the switch to PCS RX.

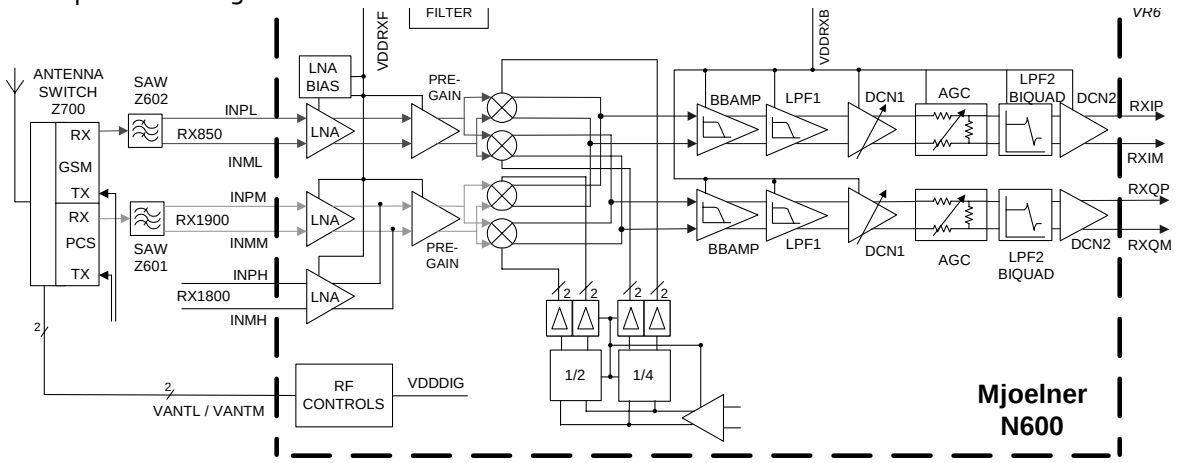



**Figure 1: Receiver signal path**

From the Antenna switch, the GSM850 signal is routed to the SAW filter (Z602). The purpose of the SAW filter is to provide out-of-band blocking immunity and to provide the LNA in Mjoelner (N600) with a balanced signal. The front end of Mjoelner is divided into an LNA and Pre-Gain amplifier before the mixers.

The output from the mixer is fed to the Baseband part of Mjoelner where the signal is amplified in the BBAMP and low pass filtered in LPF1 before the DC compensation circuits in DCN1. The DCN1 output is followed by a controlled attenuator and a second lowpass filter LPF2. The output from LPF2 is DC centered in DCN2 before being fed to the BB for demodulation.

The GSM1900 signal chain is similar to GSM850, the SAW filter numbered Z601.

**Transmitter Signal Path**

The I/Q signal from the BB is routed to the modulators for both 850 MHz and 1900 MHz. The output of the modulators is either terminated in a SAW filter (Z603) for GSM850 or a balun (T602) for GSM1900. Both signals are amplified in buffers, which are operated in a soft compression region to suppress some of the AM contents of the signal and to maintain a certain signal level at the PA inputs. The amplitude limited signal is then amplified in the PA (N700). The detector diode (V700), some discrete components, and the Mjoelner IC (N600) make up the transmitter gain control circuitry. In order to establish the right TX output power level, a sample of the signal is taken in a directional coupler (L709 for GSM850 and L704 for GSM1900) and used in the gain control loop. The TX signal from the couplers is fed to the Antenna switch, which is used to select which signal to route to the antenna.

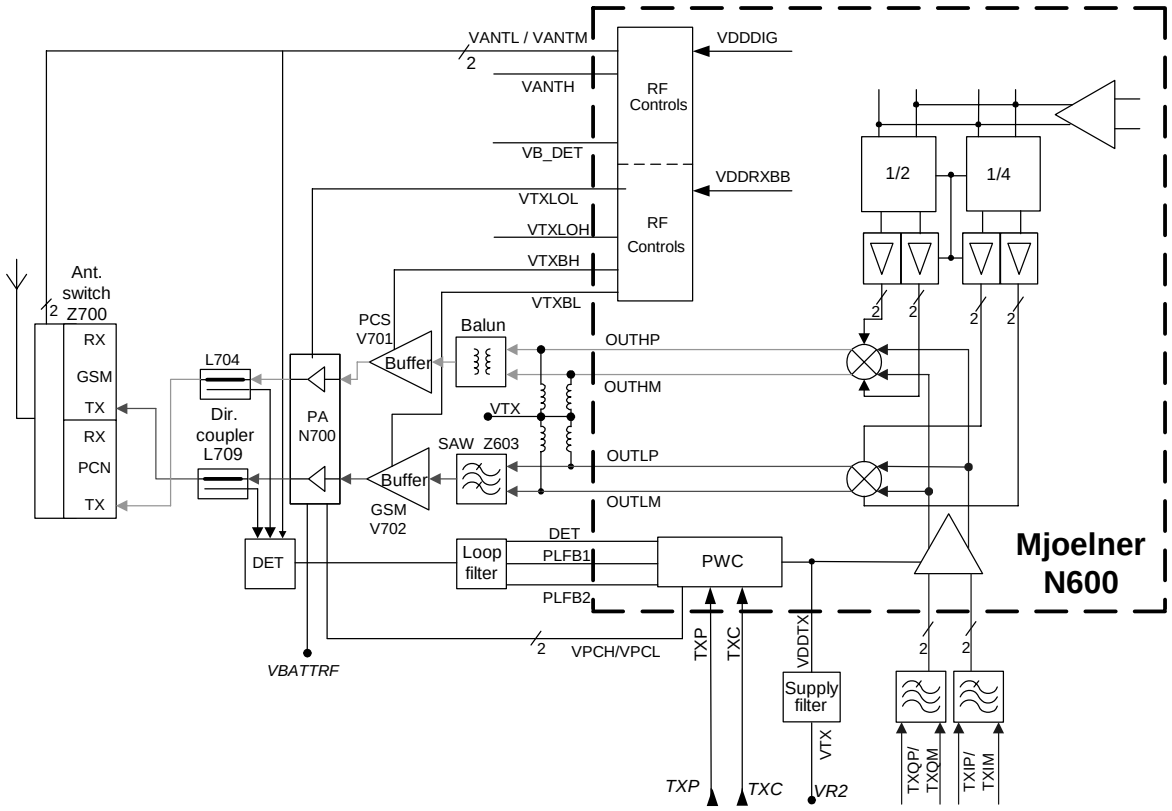



**Figure 2: Transmitter signal path**

## PLL

The PLL supplies Local Oscillator (LO) signals for the RX and TX mixers. In order to be able to generate LO frequencies for the required GSM and PCS channels, a regular Synthesizer circuit is used. All PLL blocks except for the VCO, reference X-tal, and loop filter are located in the Mjoelner IC.

The reference frequency is generated by a 26MHz Voltage Controlled X-tal Oscillator (VCXO), which is located in Mjoelner. Only the X-tal is external. 26MHz is supplied to BB where a divide-by-2 circuit (located in the UPP IC) generates the BB clock at 13MHz. The reference frequency is supplied to the reference divider (RDIV) where the frequency is divided by 65. The output of RDIV (400kHz) is used as reference clock for the Phase Detector (φ).

The PLL is a feedback control system controlling the phase and frequency of the LO signal. Building blocks for the PLL are: Phase detector, Charge Pump, Voltage Controlled Oscillator (VCO), N-divider, and loop filter. As mentioned earlier only the VCO, reference X-tal, and loop filter are external to the Mjoelner IC.

The VCO (G600) is the component that actually generates the LO frequency. Based on the control voltage input, the VCO generates a differential RF output. This signal is fed to the Prescaler and N-divider in Mjoelner, these two blocks will together divide the frequency

by a ratio based on the selected channel. The divider output is supplied to the phase detector, which compares the frequency and phase to the 400kHz reference clock. Based on this comparison, the phase detector controls the charge pump to either charge or discharge the capacitors in the loop filter. By charging/discharging the loop filter, the control voltage to the VCO changes and the LO frequency will change. Therefore, the PLL will make the LO frequency stay locked to the 26MHz VCXO frequency.

The loop filter consists of the following components: C639-C641 and R618-R619.

The PLL is operating at twice the channel center frequency when transmitting or receiving in the PCS band. For the GSM band, the PLL is operating at four times the channel frequency. Therefore, divide-by-2 and divide-by-4 circuits are inserted between the PLL output and LO inputs to the PCS and GSM mixers.

The frequency plan is shown in the table that follows:

**Table 1: PLL Frequency Plan**

| Frequency Band | Channel # | System Frequency Band [MHz] | PLL Frequency Band [MHz] |
|---|---|---|---|
| GSM RX<br>TX | 128 - 251 | 869.2 - 893.8<br>824.2 - 848.8 | 3476.8 - 3575.2<br>3296.8 - 3395.2 |
| PCS RX<br>TX | 512 - 810 | 1930.2 - 1989.8<br>1850.2 - 1909.8 | 3860.4 - 3979.6<br>3700.4 - 3819.6 |

According to the previous table, the PLL must be able to cover the frequency range 3296.8 MHz to 3979.6 MHz.

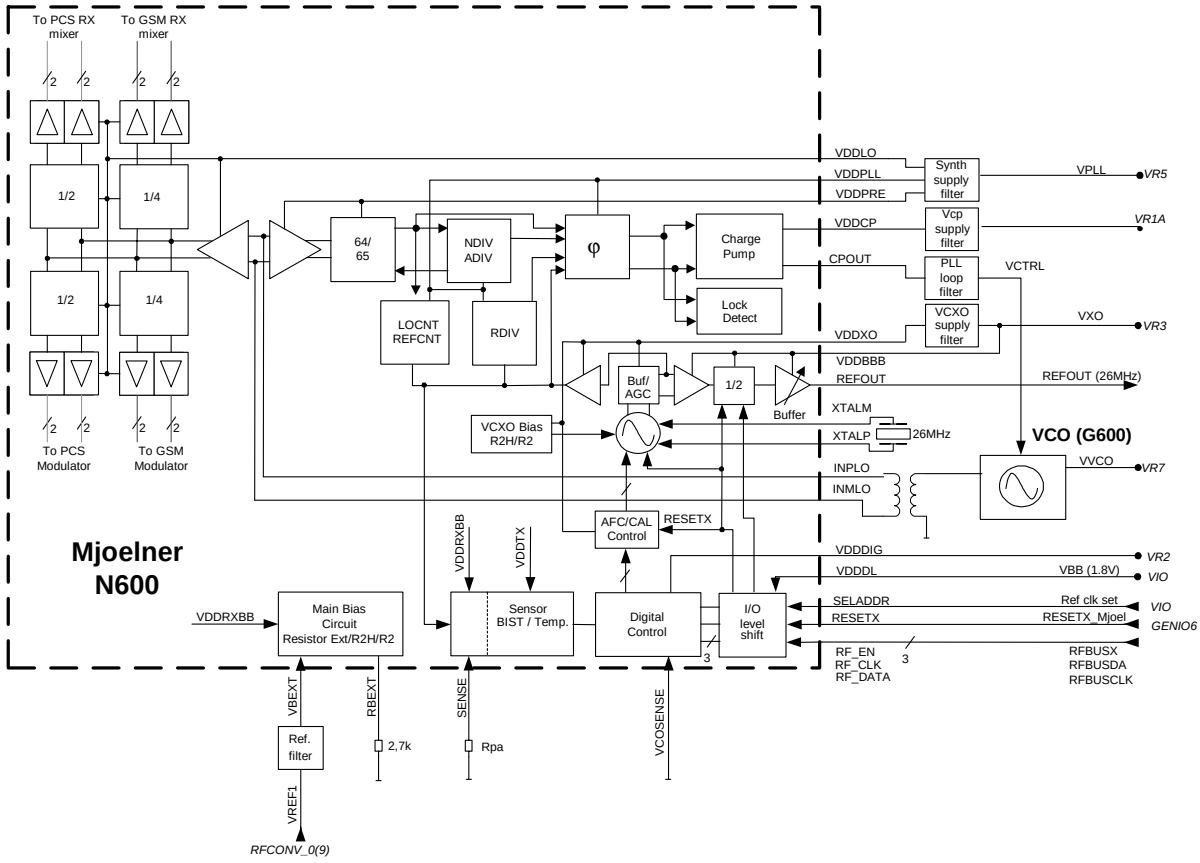



**Figure 3: Synthesizer**

## Key RF Component Placement

The following diagram shows key component locations.

**Table 2: Key Components**

| | |
|---|---|
| N600 | Mjoelner RF IC |
| Z601 | PCS RX SAW |
| Z602 | GSM RX SAW |
| Z603 | GSM TX SAW |
| B600 | 26 MHz crystal |
| G600 | VCO (3.6 GHz UHF VCO) |
| N700 | Power Amplifier (PA) |
| Z700 | Antenna switch |

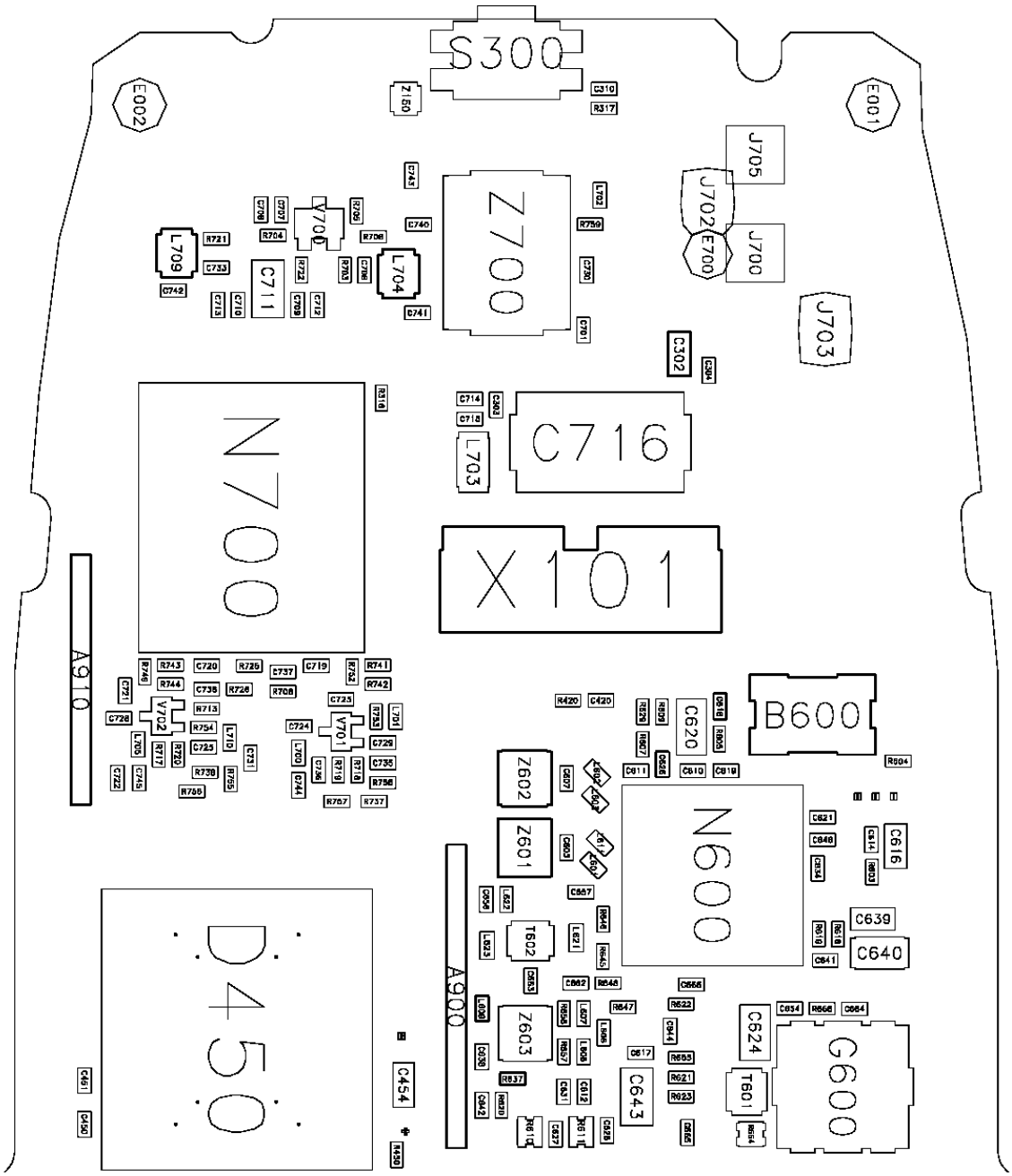



**Figure 4: Key Component Locations**

## Power Supply Configuration

All power supplies for the RF Unit are generated in the UEM IC (D200). All power outputs from this IC have a decoupling capacitor at which the supply voltage can be checked.

The power supply configuration used in the 3595 phone is shown in the block diagram that follows:

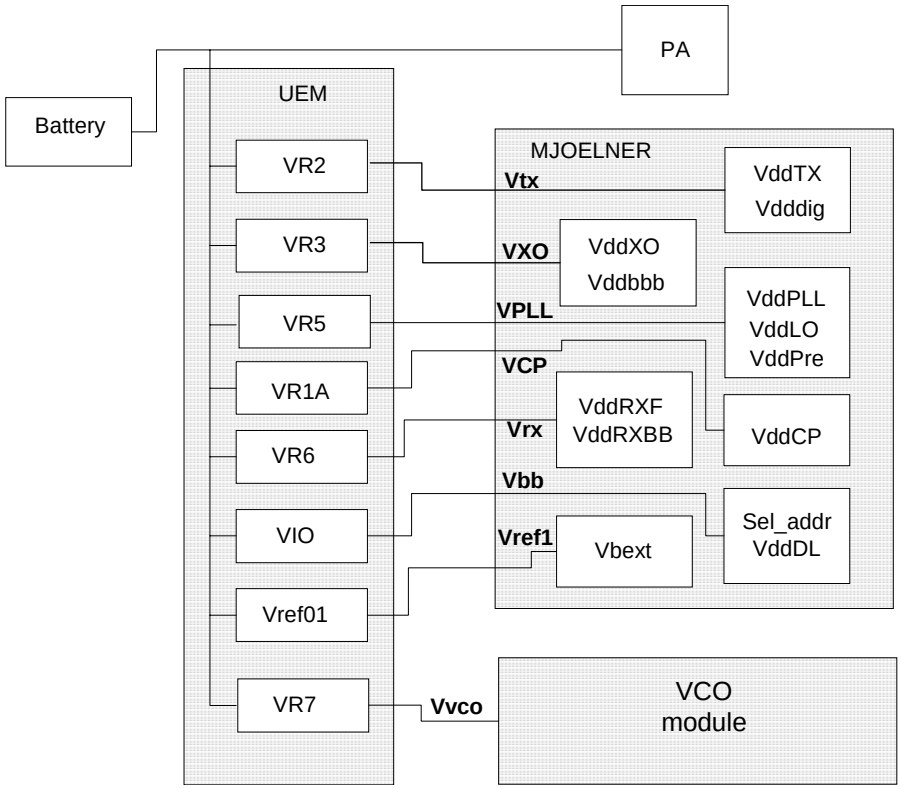



**Figure 5: Power Supply Configuration**

The names in **bold** are signal names which are used on the RF schematic pages. Names in the boxes within the Mjoelner and VCO refer to pin names on the respective ICs (N600, G600).

**Table 3: Power Supply Details**

| Supply name RF | Supply name UEM | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| VTX | VR2 | 2.64 | 2.78 | 2.86 | V |
| VXO | VR3 | 2.64 | 2.78 | 2.86 | V |
| VCP | VR1A | | 4.75 | | V |
| VPLL | VR5 | 2.64 | 2.78 | 2.86 | V |
| VRX | VR6 | 2.64 | 2.78 | 2.86 | V |
| VVCO | VR7 | 2.64 | 2.78 | 2.86 | V |
| VBB | VIO | 1.72 | 1.8 | 1.88 | V |
| VREF2 | VrelRF01 | 1.334 | 1.35 | 1.366 | V |
| VBATT | BATTERY | 3.1 | 3.6 | 5.2 | V |

Please see the following graphic for measuring points at the UEM (D200).

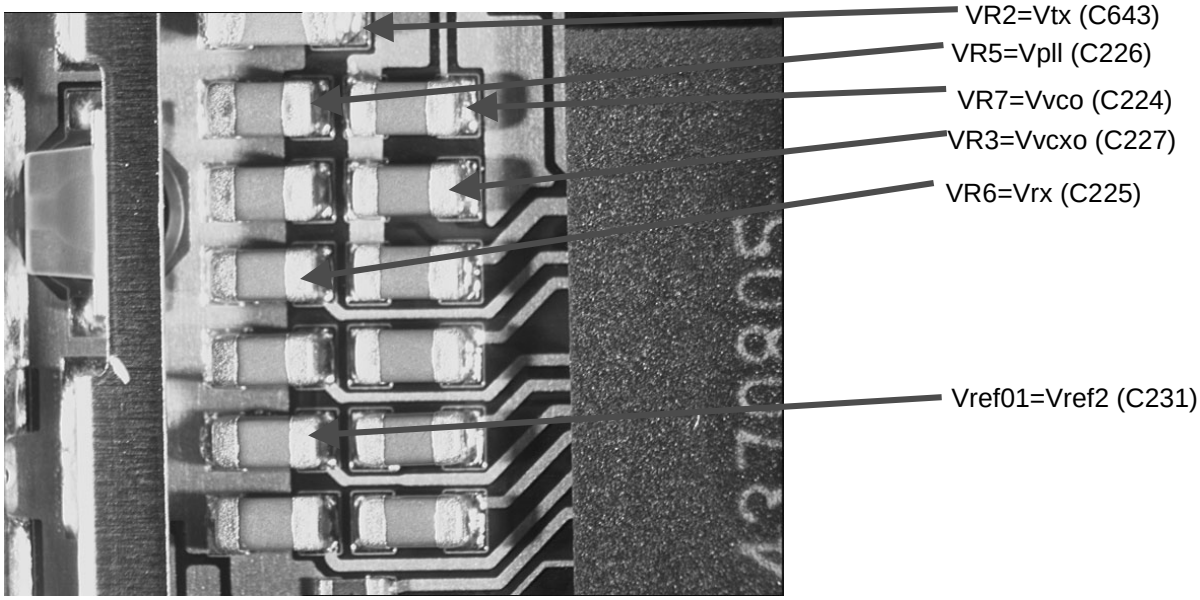



**Figure 6: Supply points at the UEM (D200)**

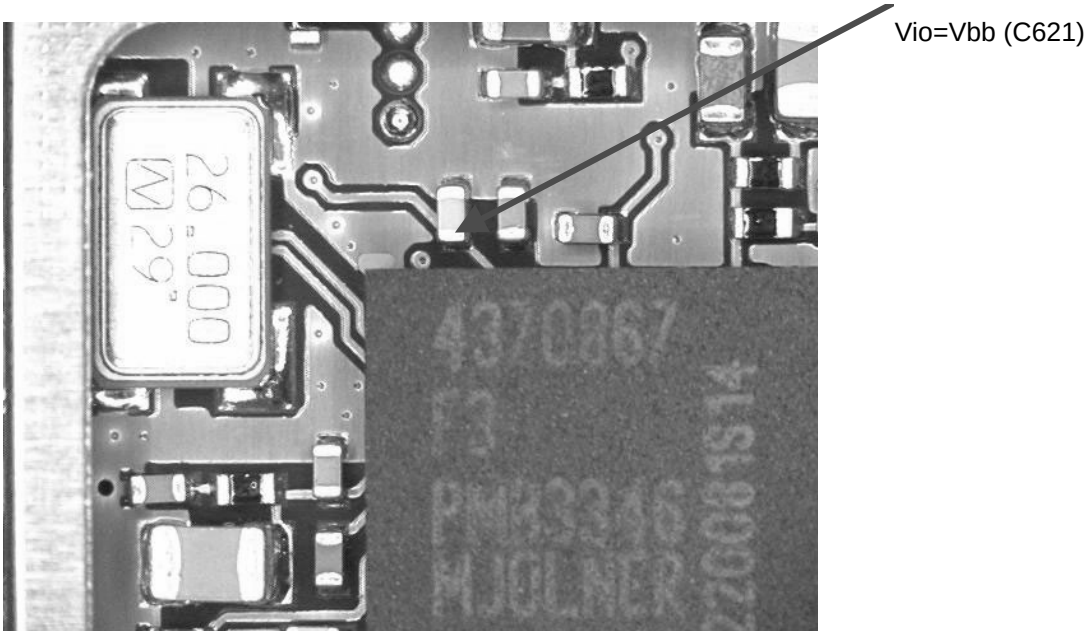



**Figure 7: Supply point at the Mjoelner (N600)**

## Receiver

### General Instructions for GSM850 RX Troubleshooting

Connect the phone to a PC with the module test jig.

Start Phoenix and establish connection to the phone.

Select File

Scan for Product Ctrl-R

Select Maintenance

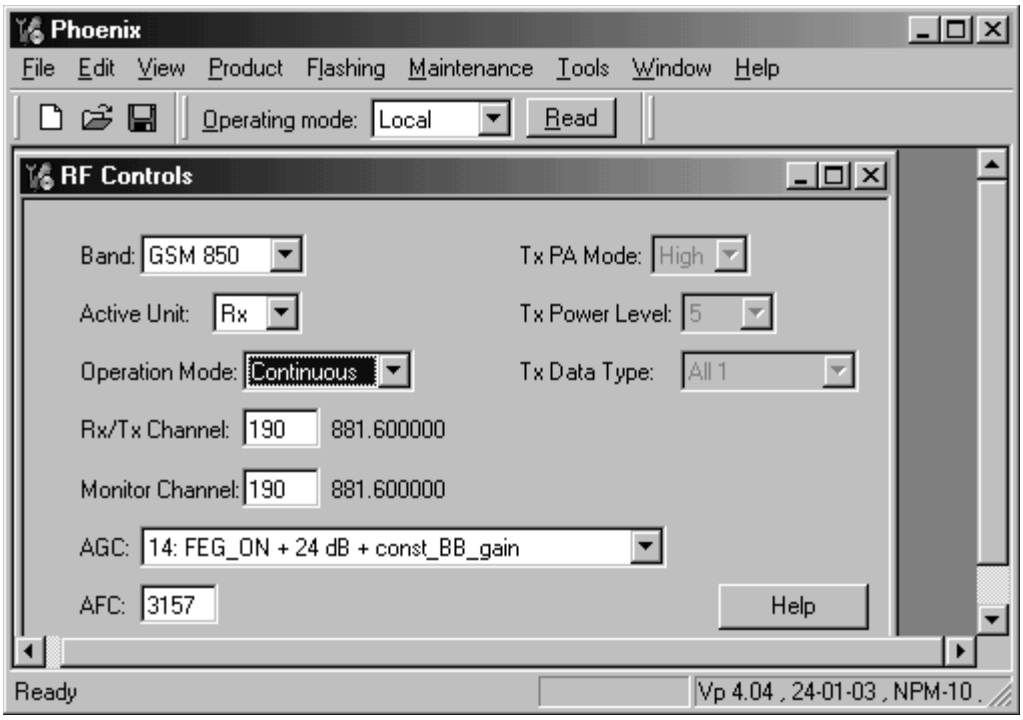
Testing

RF Controls

Select:

| | |
|---|---|
| Band: | GSM850 |
| Active Unit: | RX |
| Operation Mode: | Continuous |
| Rx/Tx Channel: | 190 |
| AGC: | 9 |

The setup should now look like this:



## Troubleshooting Chart for GSM850 Receiver

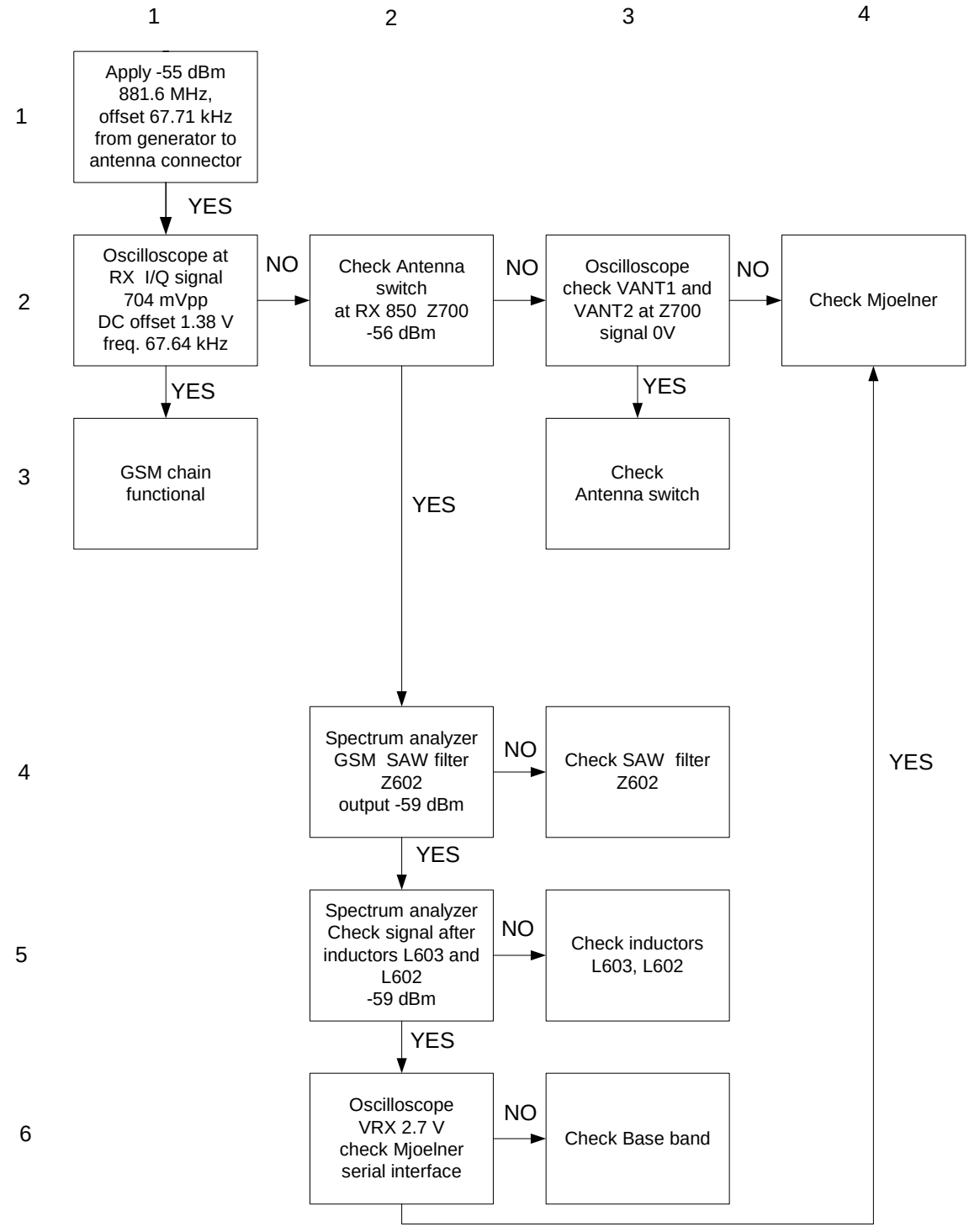



**Figure 8: GSM850 receiver troubleshooting chart**

By measuring with an oscilloscope at RXIP or RXQP on a working GSM850 receiver, the following picture should be seen.

Signal amplitude peak-peak 704 mV

DC offset 1.38 V

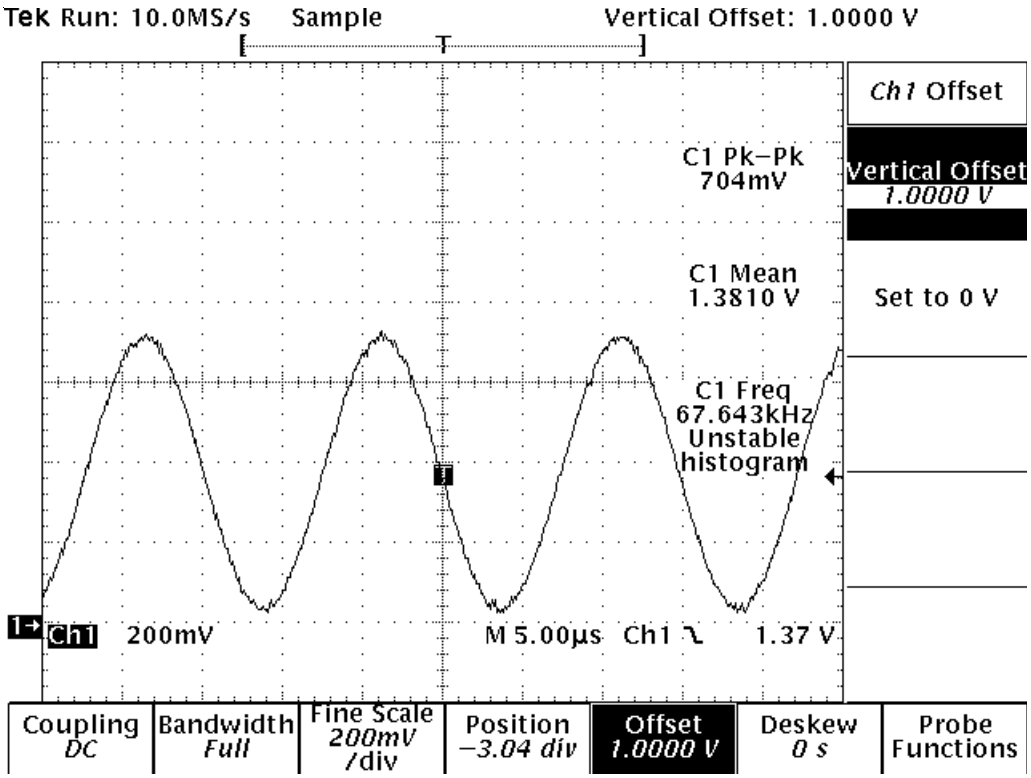



**Figure 9: RX850 I/Q signal waveform**

**General Instructions for GSM1900 RX Troubleshooting**

Connect the phone to a PC with the module test jig.

Start Phoenix and establish connection to the phone.

Select File

Scan for Product Ctrl-R

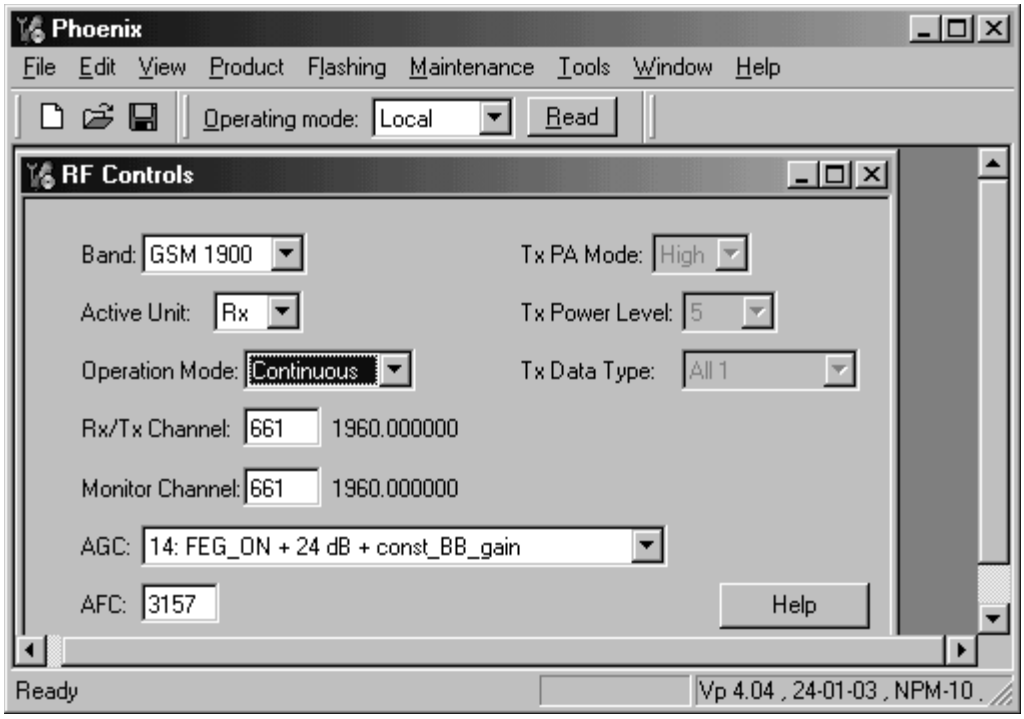
Select Maintenance

Testing

RF Controls

| | |
|---|---|
| Band: | GSM1900 |
| Active Unit: | RX |
| Operation Mode: | Continuous |
| Rx/Tx Channel: | 661 |
| AGC: | 9 |

The setup should now look like this:



## Troubleshooting Chart for PCS Receiver

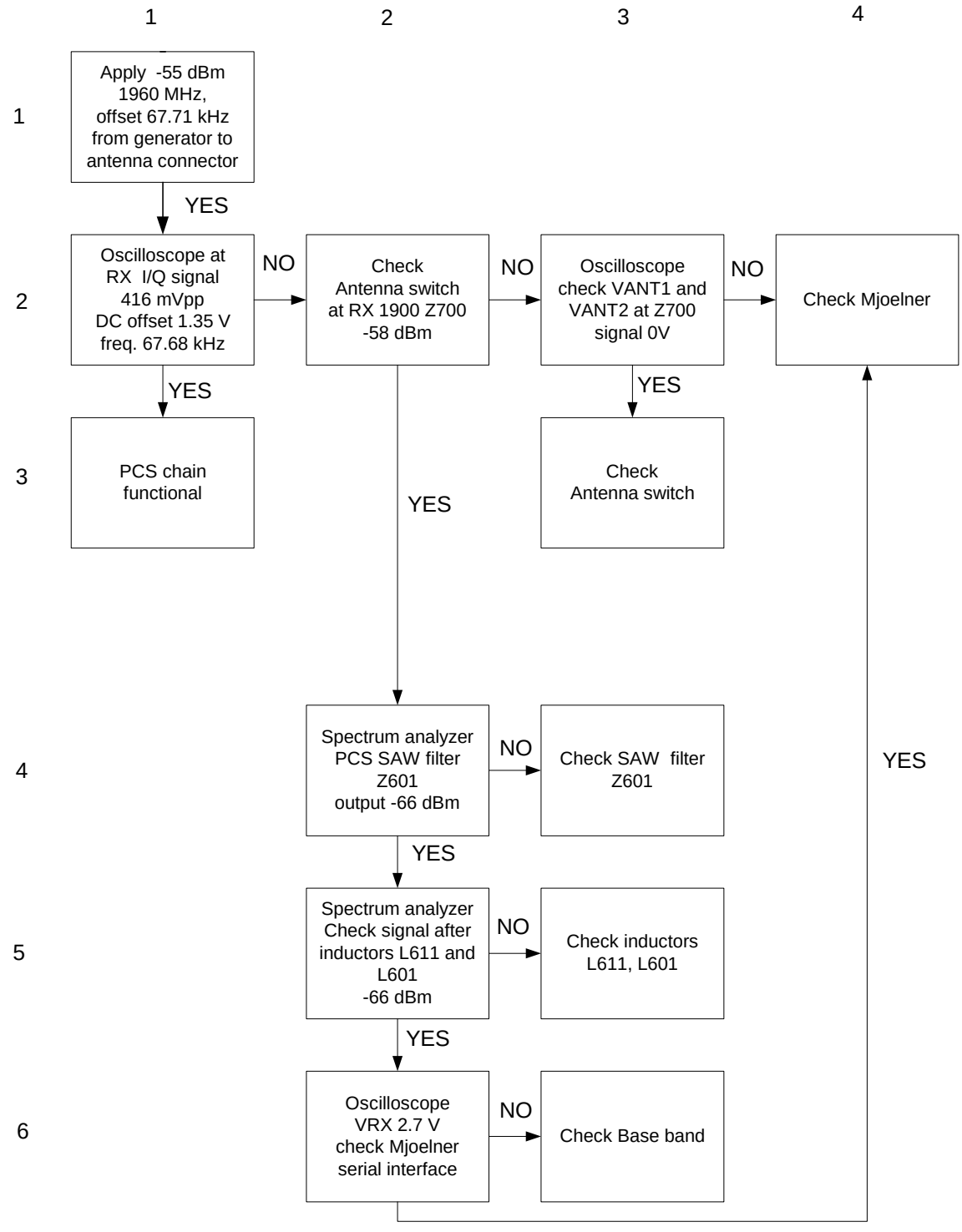



**Figure 10: GSM1900 receiver troubleshooting chart**

By measuring with an oscilloscope at RXIP or RXQP on a working GSM1900 receiver, the following picture should be seen.

Signal amplitude peak-peak 416 mV

DC offset 1.35 V

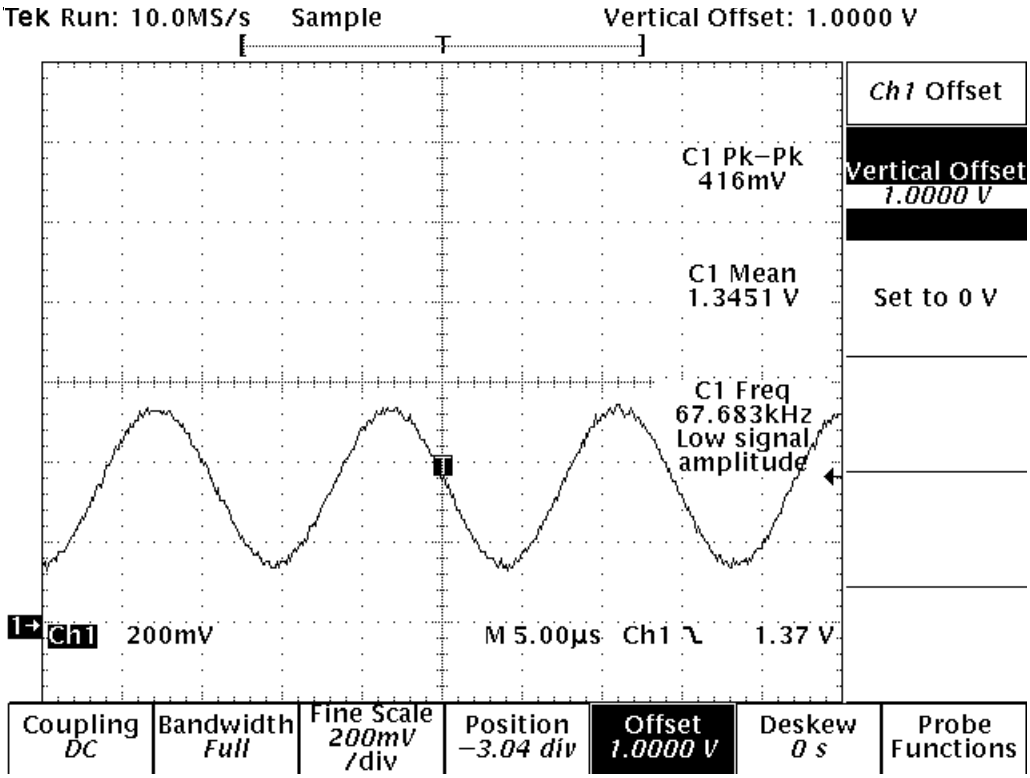



**Figure 11: RX1900 I/Q signal waveform**

## Measurement Points in the Receiver

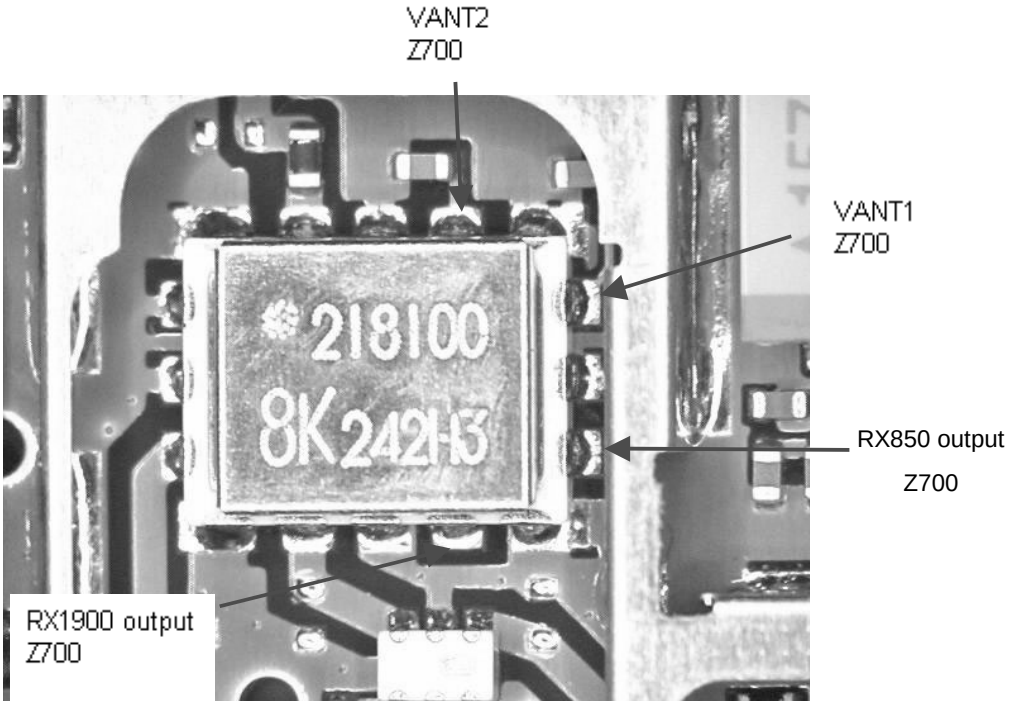



**Figure 12: RX measurements point at the Antenna switch – Z700**

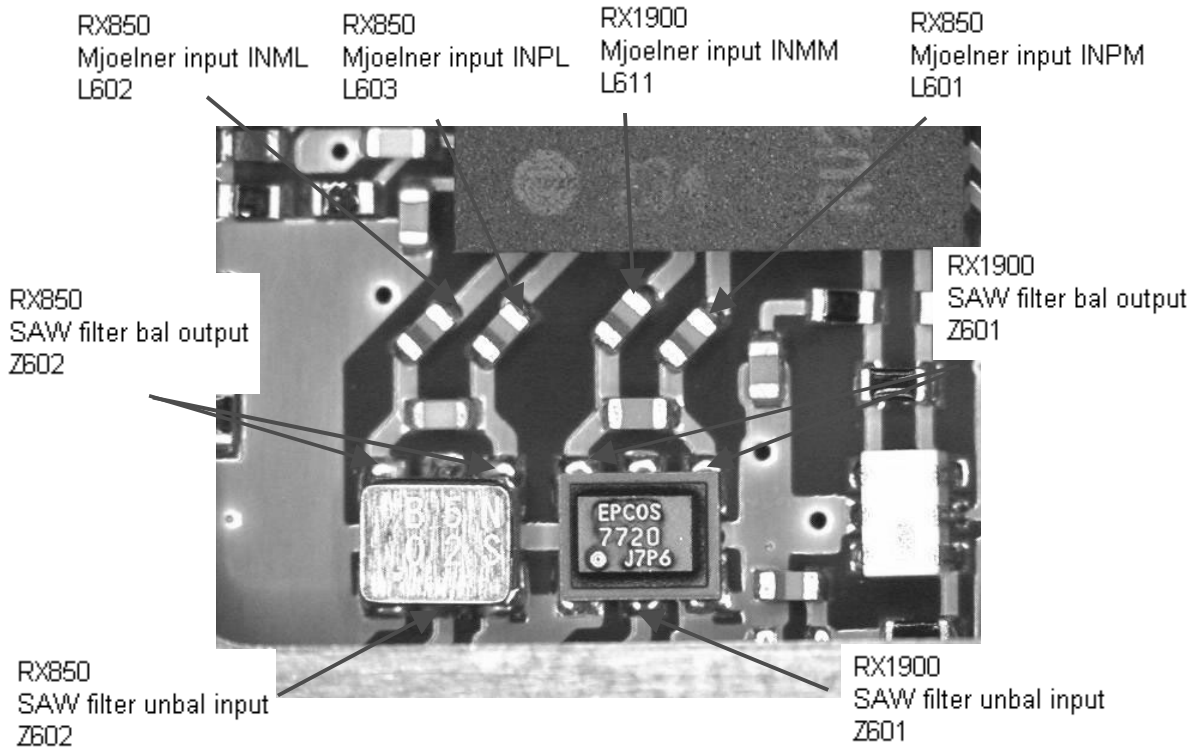



**Figure 13: Measurements points at the RX filters – Z601/Z602**

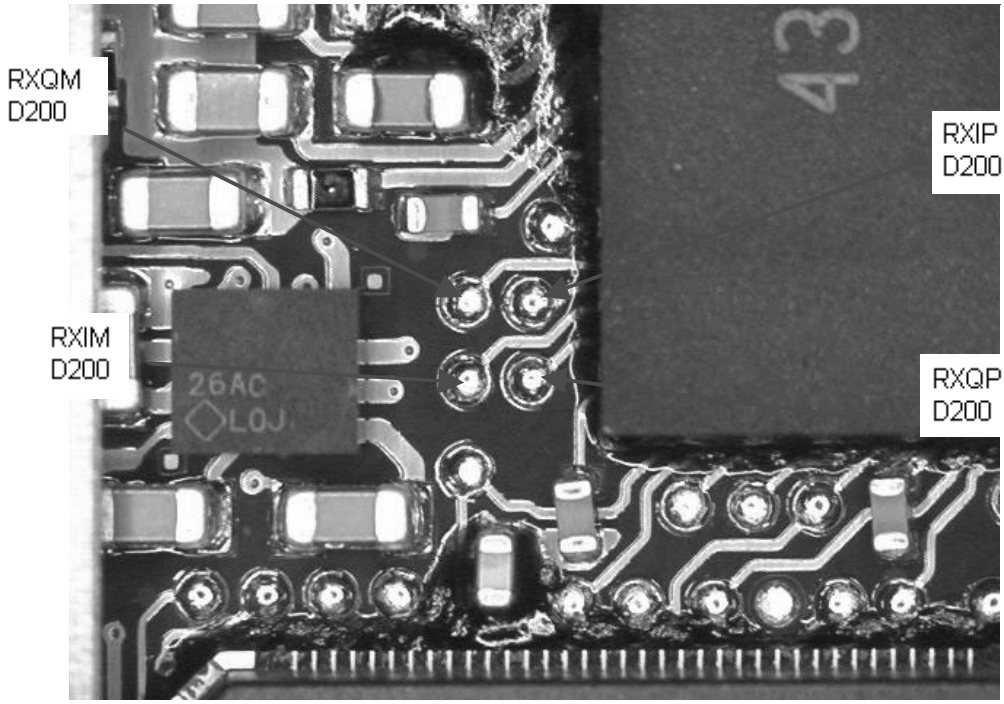



**Figure 14: RX I/Q Signals, Base Band shielding can**

## Transmitter

### Measurement Points for the Transmitter

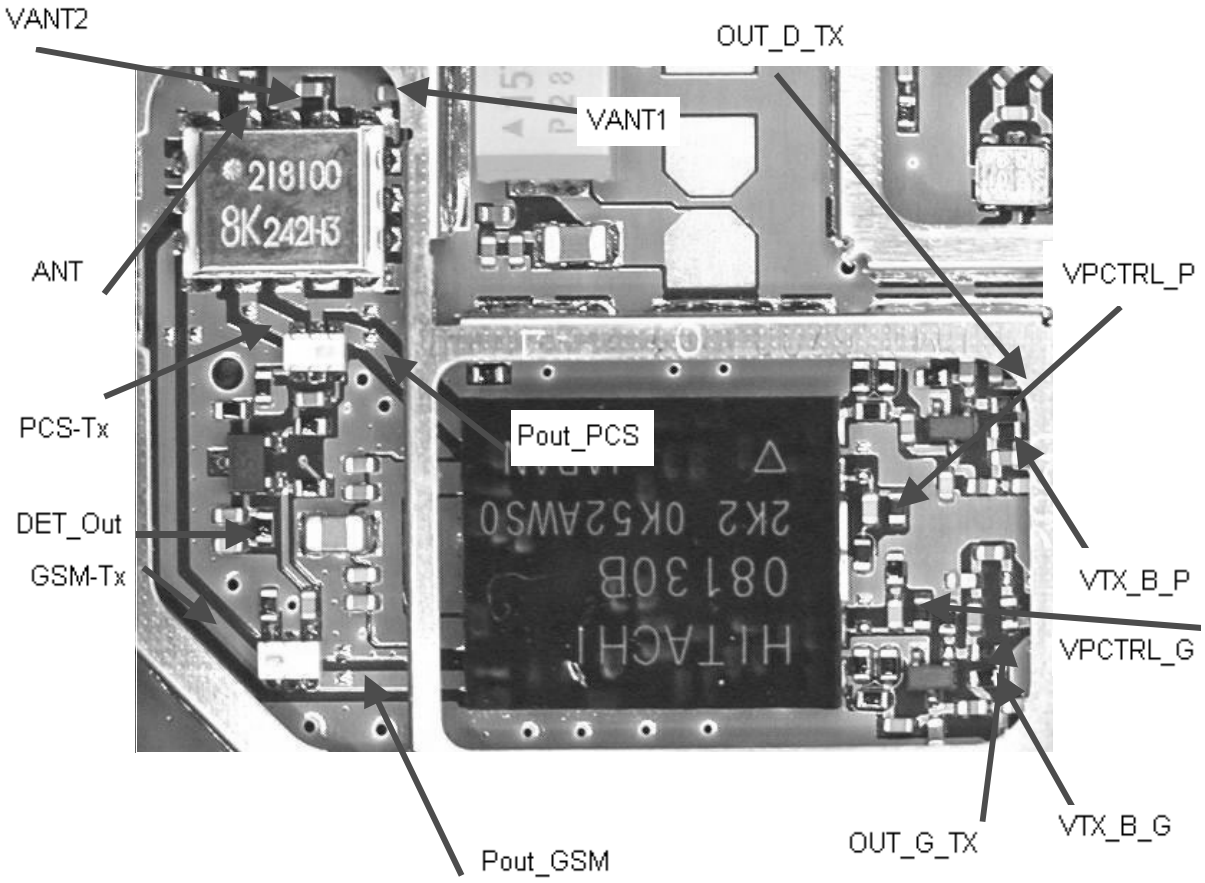



**Figure 15: TX measurement points in the PA ( N700 ) shielding can**

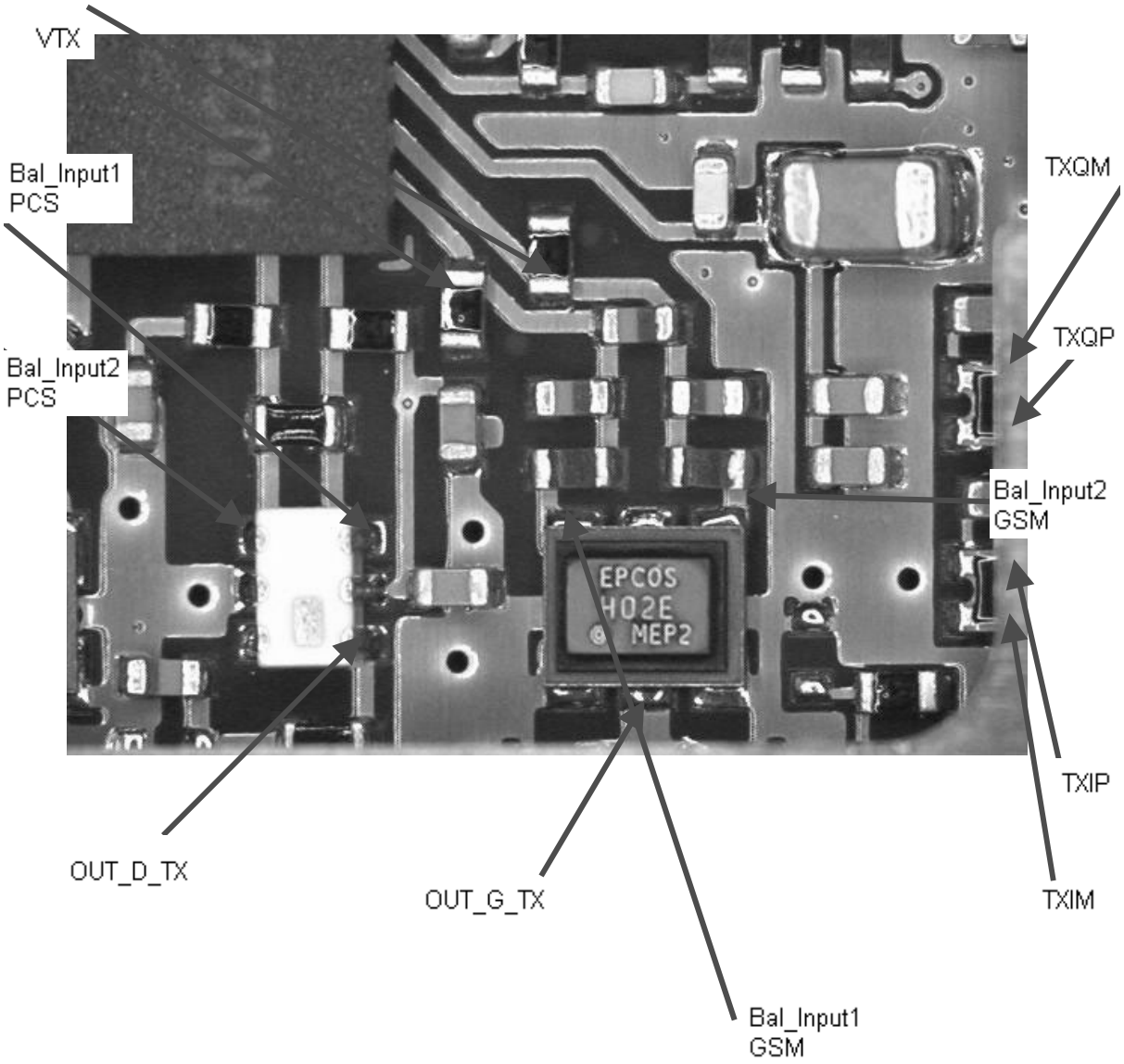



**Figure 16: TX measurement point in Mjolner (N600) shielding can**

### General Instructions for GSM TX Troubleshooting

Apply a RF cable to the test jig's RF connector to allow the transmitted signal to act as normal. The RF cable should be connected to measurement equipment with at least a 10 dB attenuator, or the test equipment may be damaged.

Start Phoenix-Service-Software and:

Establish a connection to the phone e.g. FBUS or MBUS.

Select File

Choose Product

Excelsior

Select: Maintenance

Testing

RF Controls

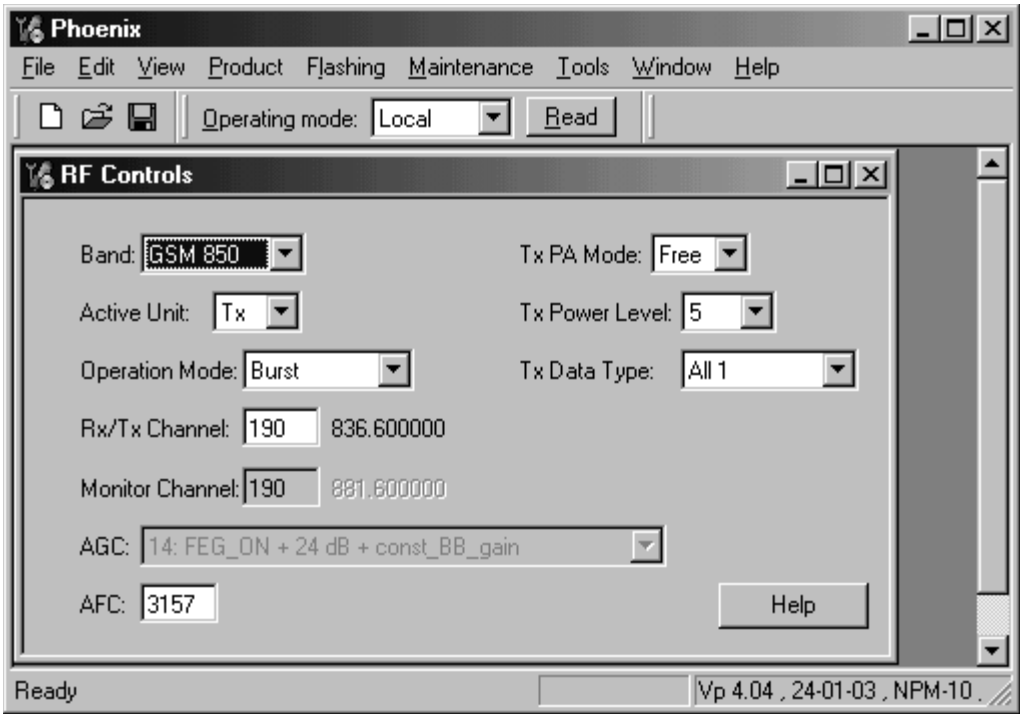
Band: GSM850

Active Unit: TX

Tx Power Level: 5

Tx Data Type: All 1

Your screen should look like:




Measure the output power of the phone; it should be around 32.0 dBm. Remember the loss along the end launch connector in the test jig; which is around 0.3 dB.

**Troubleshooting Chart for GSM850 Transmitter**

Troubleshooting the Output Power

Use a high impedance probe for the spectrum analyzer measurements in the following chart. Since the signal is bursted, set the trace to maxhold.

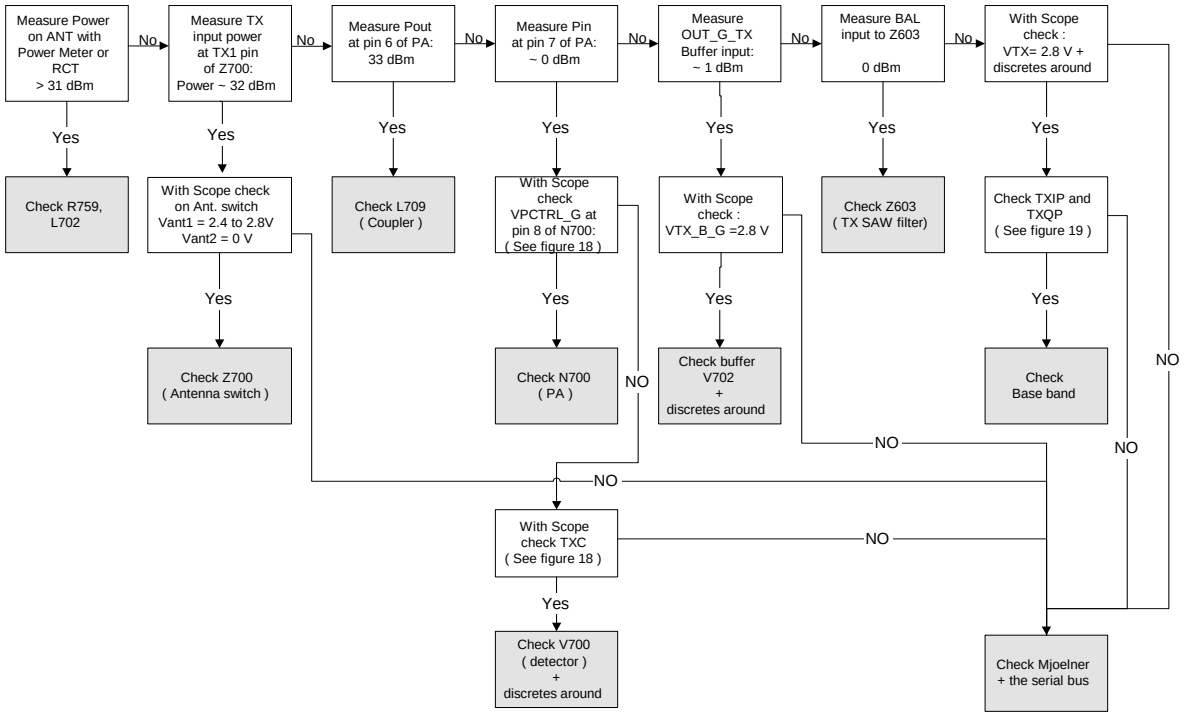
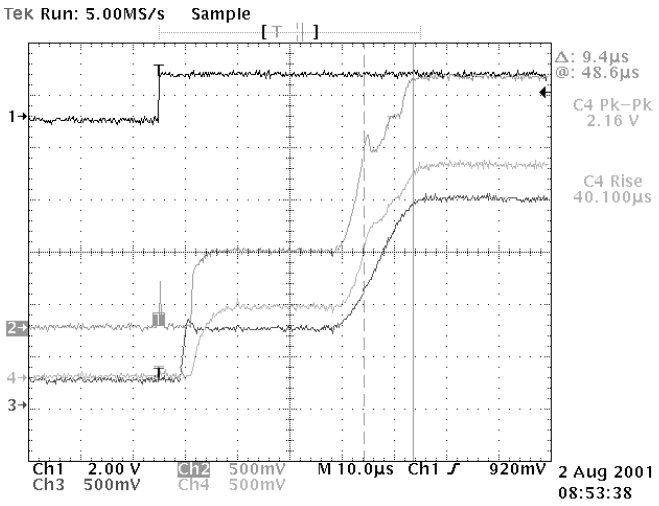



**Figure 17: GSM850 transmitter troubleshooting chart**




GSM850 band, Power level 5, Channel 190

Black trace: Txp

Green trace: Vpctrl @ R713 input

Blue trace: Vpctrl_G @ R713 output

Red trace: TXC

**Figure 18: TXP, VPCTRL_G and TXC**

Troubleshooting the Modulation

The following plots show different situations of TX IQ measurements. Depending on the time the modulation may cause the signal to look differently.

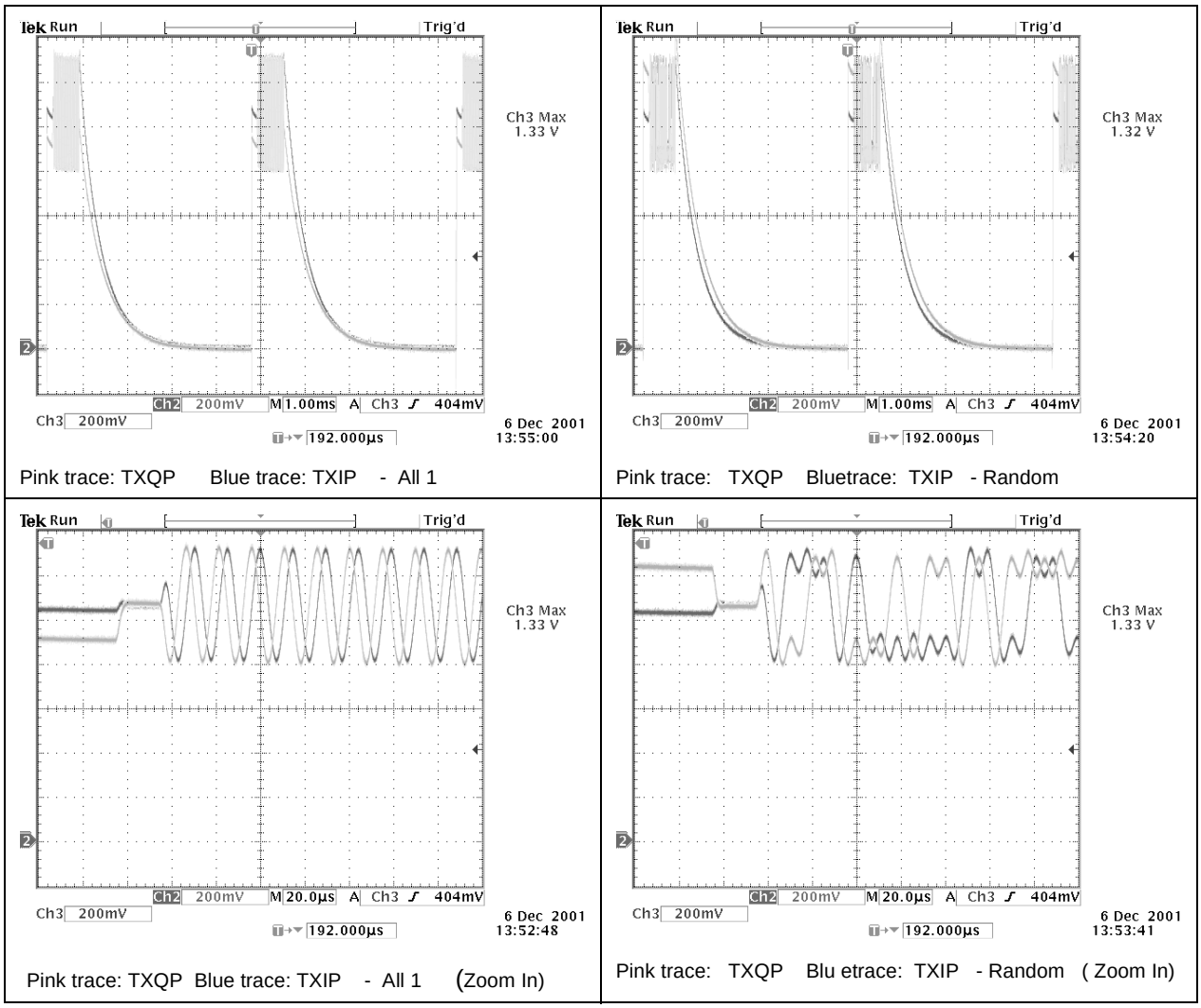



**Figure 19: TX I/Q waveforms**

I/Q signals look almost the same regardless if modulation is by "1" or by "0". There is no significant difference between TXIP and TXIM. The same is valid for TXQP and TXQM.

**General instructions for PCS TX troubleshooting**

Apply an RF cable to the RF connector to allow the transmitted signal act as normal. The RF cable should be connected to measurement equipment or to at least a 10-dB attenuator, otherwise the PA may be damaged.

Start Phoenix-Service-Software and:

Establish a connection to the phone e.g. FBUS.

Select File

Choose Product

Excelsior

Select: Maintenance

Testing

RF Controls

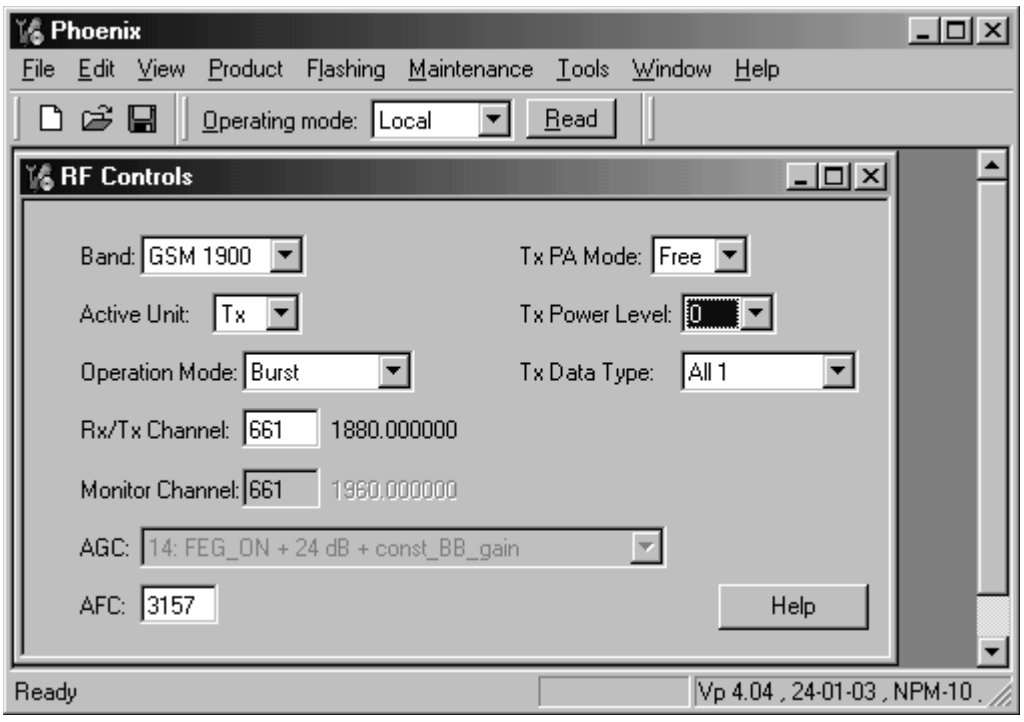
Band: GSM1900

Active Unit: TX

Tx Power Level: 0

Tx Data Type: All 1

Your screen should look like:




Measure the output power of the phone; it should be around 29.5 dBm. Remember the loss in the test jig; around 0.7 dB.

## Troubleshooting chart for PCS transmitter

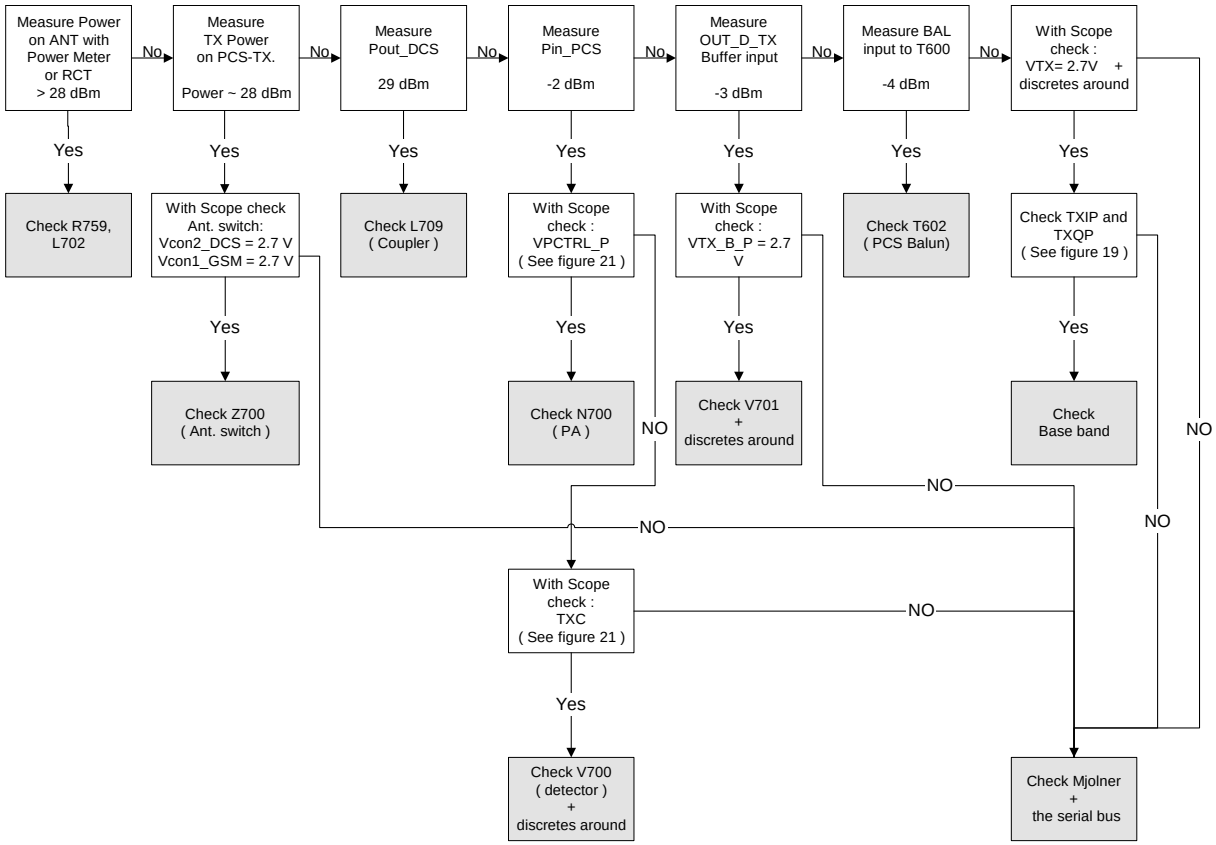
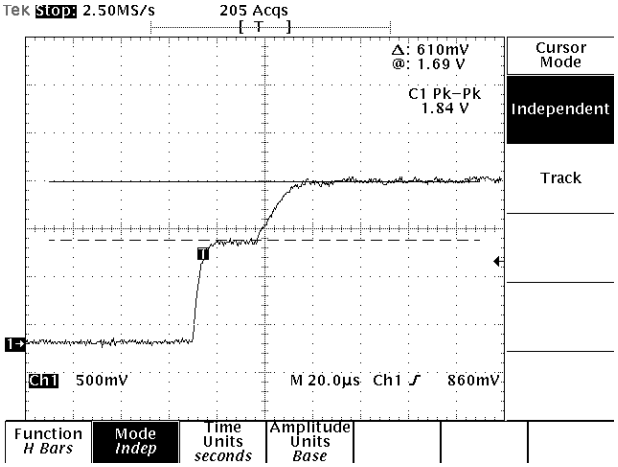



**Figure 20: GSM1900 transmitter troubleshooting chart**




PCS 1900 band, Power level 0, Channel 661

Black trace:Vpctrl_P @ R708 output

**Figure 21: VPCTRL_P**

** TXIQ signals look the same in PCS and GSM

## Synthesizer

There is only one PLL synthesizer generating Local Oscillator frequencies for both RX and TX in both bands (PCS and GSM). The VCO frequency is divided by two for PCS operation or by four for GSM operation inside the Mjoelner IC.

### General Instructions for Synthesizer Troubleshooting

Start the Phoenix-Service-Software and

Select: Product NPM-10

Select: Maintenance

Testing

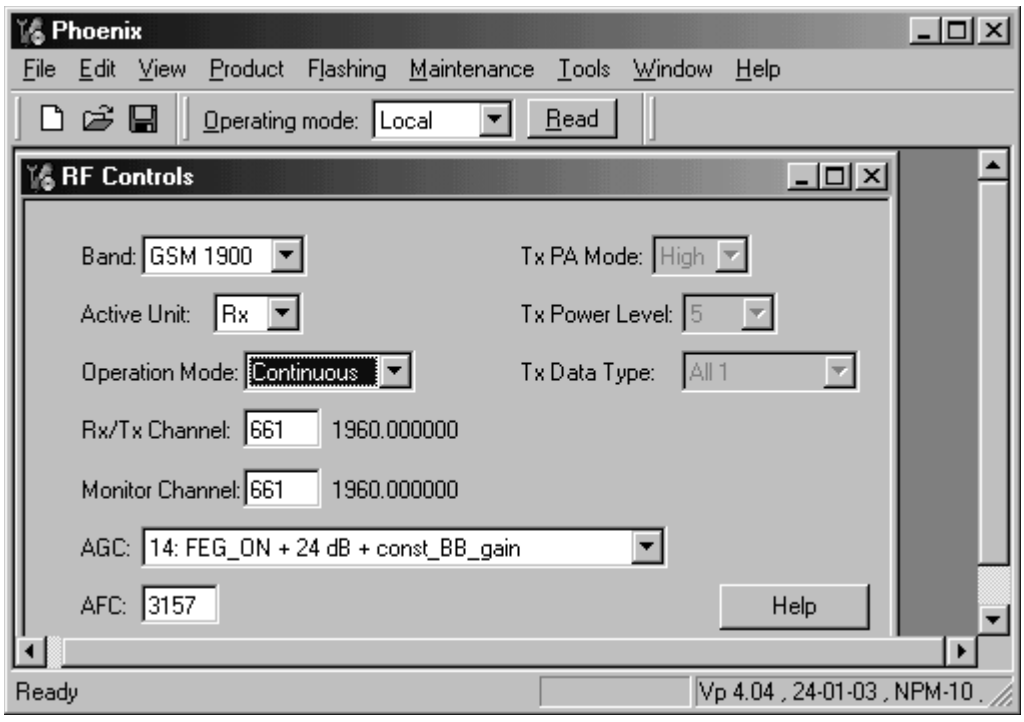
RF Controls

Band GSM1900

Active Unit RX

Operation Mode Continuous

RX/TX Channel 661




It is not possible to measure the output of the VCO (G600) directly as this component is placed underneath a shielding can without detachable lid. However, with spectrum ana-

lyzer and high impedance probe it is possible to get an indication if the VCO outputs the correct frequency. To do this, probe R656, C654 – the frequency should be 3920 MHz and the power should be around –50 dBm.

### 26 MHz Reference Oscillator ( VCXO )

The 26 MHz oscillator is located in the Mjoelner IC (N600). The coarse frequency for this oscillator is set by an external crystal (B600). The reference oscillator is used as a reference frequency for the PLL synthesizer and as the system clock for Baseband. The 26 MHz signal is divided by two to achieve 13 MHz inside the UPP IC (D400). The 26 MHz signal from the VCXO can be measured by probing R420 (must be measured on the UPP side of R420; i.e., the end **not** connected to C420). The level at this point is approx. 700mVpp. Frequency of this oscillator is adjusted by changing the AFC-register inside the Mjoelner IC. This is done via the Mjoelner serial interface.

Example Signal Measured at VCXO output (R420)

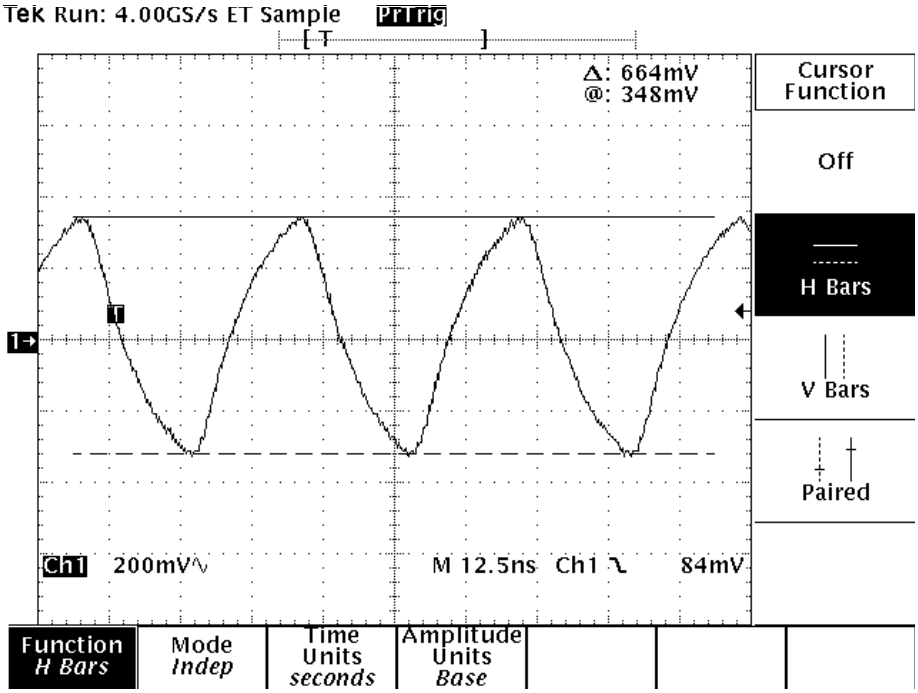



**Figure 22: VCXO 26 MHz waveform**

### VCO

The VCO is generating frequencies in the range of 3296.8 MHz – 3979.6 MHz when the PLL is running. The output frequency from the VCO is led to the Local oscillator input of the Mjoelner IC (N600), where the frequency is divided by two or four so that they can generate all channels in GSM and PCS respectively. Frequency of the VCO is controlled by a DC-voltage ( Vctrl ) coming from the loop filter. The loop filter consists of the components R618, R619 and C639-C641. Range of the Vctrl when the PLL is running (locked) is 0.4V – 2.4V. Even if the PLL is not in locked state (Vctrl out of range) there is some frequency at the output of the VCO (G600) which is between 3 and 4 GHz. This is of course only true if the VCO is working and if the VCO power supply is present (2.7V).

## Troubleshooting Chart for PLL Synthesizer

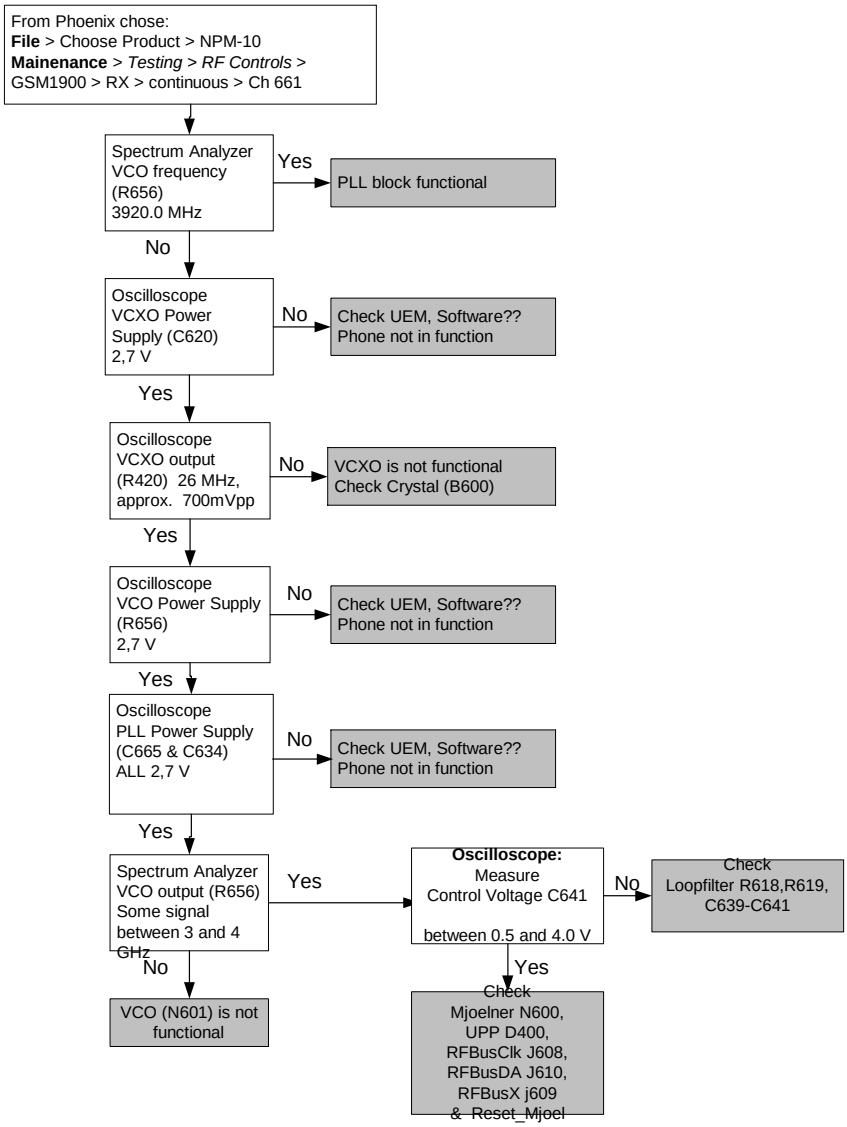



**Figure 23: PLL troubleshooting chart**

If the phone stops working a short time after the power is turned ON, a possible reason for this might be that the 26 MHz system clock signal is not getting to the UPP clock-input in Baseband. In this case, check the following:

Turn on the phone and check

VCXO Power supply (C620) = 2.7V

VCXO output (R420 – end **not** connected to C420) is 26MHz and approx. 700mVpp

If this is not the case check the reference crystal (B600), Mjoelner (N600), R420, R426, C420, and C426.

## Measurement Points for the PLL

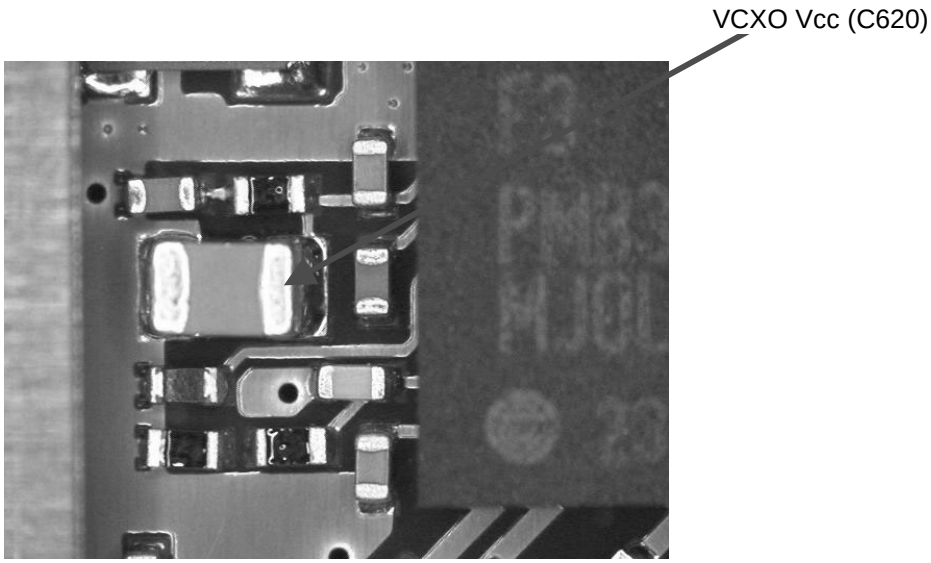



**Figure 24: Measurement point for VCXO supply**

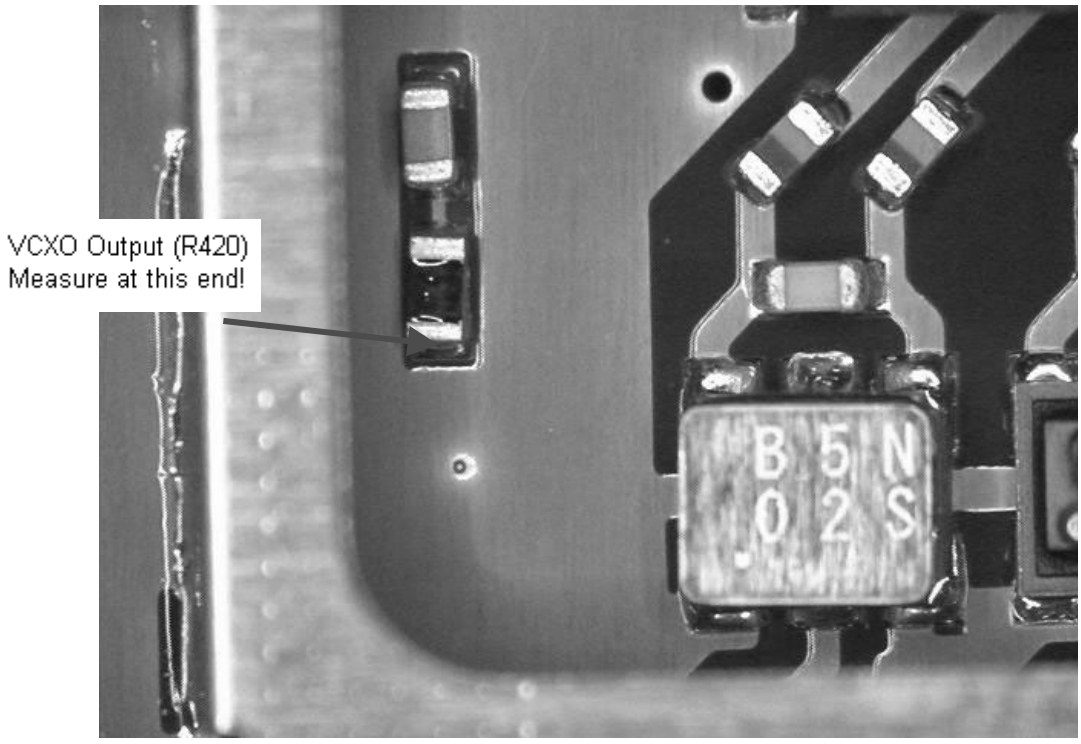



**Figure 25: Measurement point for VCXO output**

Measurement Points at the PLL/VCO

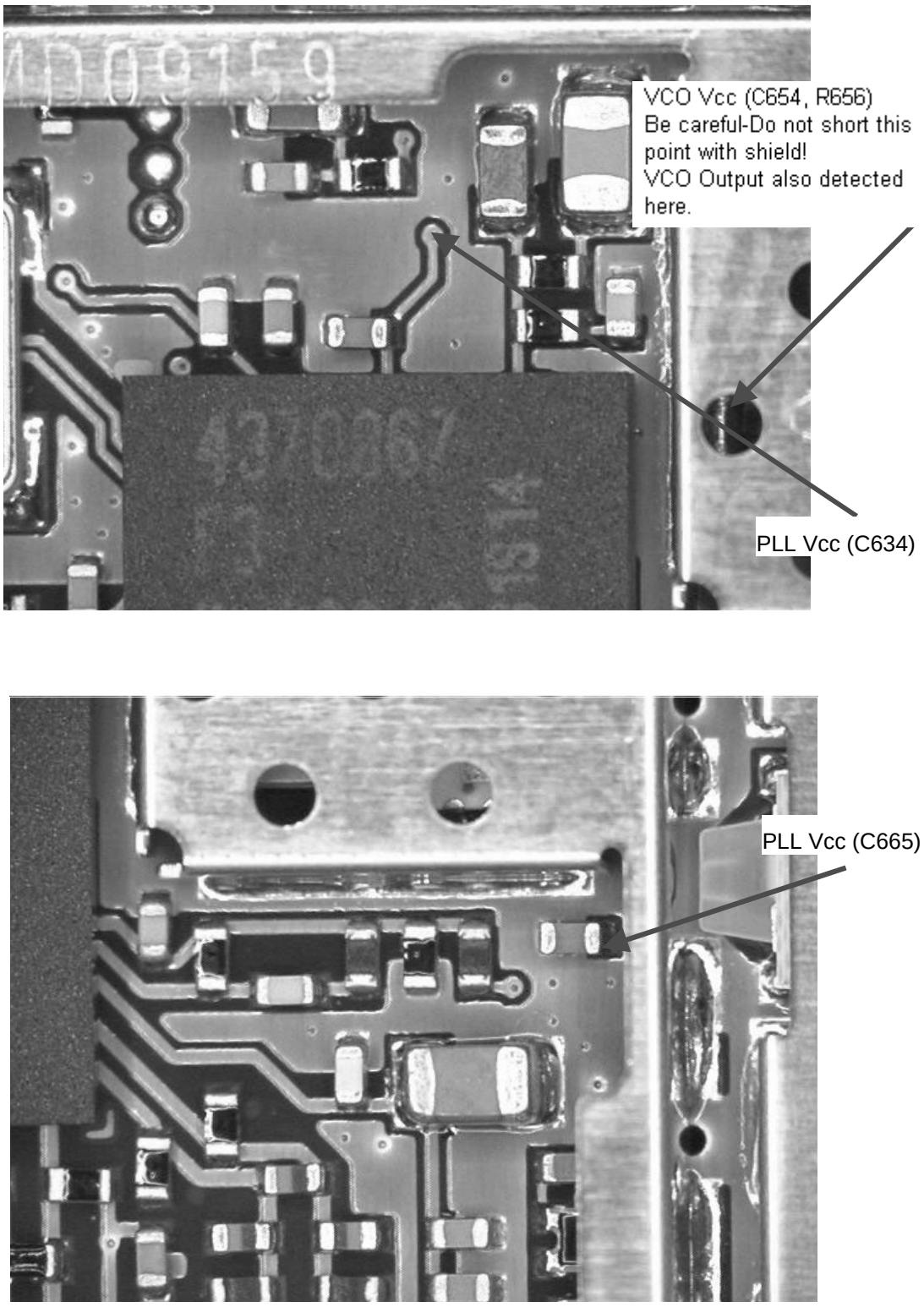



**Figure 26: Measurement points for PLL**

## Frequency Lists

GSM850

| Ch | TX | RX | VCO TX | VCO RX | Ch | TX | RX | VCO TX | VCO RX | Ch | TX | RX | VCO TX | VCO RX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 128 | 824.2 | 869.2 | 3296.8 | 3476.8 | 170 | 832.6 | 877.6 | 3330.4 | 3510.4 | 210 | 840.6 | 885.6 | 3362.4 | 3542.4 |
| 129 | 824.4 | 869.4 | 3297.6 | 3477.6 | 171 | 832.8 | 877.8 | 3331.2 | 3511.2 | 211 | 840.8 | 885.8 | 3363.2 | 3543.2 |
| 130 | 824.6 | 869.6 | 3298.4 | 3478.4 | 172 | 833 | 878 | 3332 | 3512 | 212 | 841 | 886 | 3364 | 3544 |
| 131 | 824.8 | 869.8 | 3299.2 | 3479.2 | 173 | 833.2 | 878.2 | 3332.8 | 3512.8 | 213 | 841.2 | 886.2 | 3364.8 | 3544.8 |
| 132 | 825 | 870 | 3300 | 3480 | 174 | 833.4 | 878.4 | 3333.6 | 3513.6 | 214 | 841.4 | 886.4 | 3365.6 | 3545.6 |
| 133 | 825.2 | 870.2 | 3300.8 | 3480.8 | 175 | 833.6 | 878.6 | 3334.4 | 3514.4 | 215 | 841.6 | 886.6 | 3366.4 | 3546.4 |
| 134 | 825.4 | 870.4 | 3301.6 | 3481.6 | 176 | 833.8 | 878.8 | 3335.2 | 3515.2 | 216 | 841.8 | 886.8 | 3367.2 | 3547.2 |
| 135 | 825.6 | 870.6 | 3302.4 | 3482.4 | 177 | 834 | 879 | 3336 | 3516 | 217 | 842 | 887 | 3368 | 3548 |
| 136 | 825.8 | 870.8 | 3303.2 | 3483.2 | 178 | 834.2 | 879.2 | 3336.8 | 3516.8 | 218 | 842.2 | 887.2 | 3368.8 | 3548.8 |
| 137 | 826 | 871 | 3304 | 3484 | 179 | 834.4 | 879.4 | 3337.6 | 3517.6 | 219 | 842.4 | 887.4 | 3369.6 | 3549.6 |
| 138 | 826.2 | 871.2 | 3304.8 | 3484.8 | 180 | 834.6 | 879.6 | 3338.4 | 3518.4 | 220 | 842.6 | 887.6 | 3370.4 | 3550.4 |
| 139 | 826.4 | 871.4 | 3305.6 | 3485.6 | 181 | 834.8 | 879.8 | 3339.2 | 3519.2 | 221 | 842.8 | 887.8 | 3371.2 | 3551.2 |
| 140 | 826.6 | 871.6 | 3306.4 | 3486.4 | 182 | 835 | 880 | 3340 | 3520 | 222 | 843 | 888 | 3372 | 3552 |
| 141 | 826.8 | 871.8 | 3307.2 | 3487.2 | 183 | 835.2 | 880.2 | 3340.8 | 3520.8 | 223 | 843.2 | 888.2 | 3372.8 | 3552.8 |
| 142 | 827 | 872 | 3308 | 3488 | 184 | 835.4 | 880.4 | 3341.6 | 3521.6 | 224 | 843.4 | 888.4 | 3373.6 | 3553.6 |
| 143 | 827.2 | 872.2 | 3308.8 | 3488.8 | 185 | 835.6 | 880.6 | 3342.4 | 3522.4 | 225 | 843.6 | 888.6 | 3374.4 | 3554.4 |
| 144 | 827.4 | 872.4 | 3309.6 | 3489.6 | 186 | 835.8 | 880.8 | 3343.2 | 3523.2 | 226 | 843.8 | 888.8 | 3375.2 | 3555.2 |
| 145 | 827.6 | 872.6 | 3310.4 | 3490.4 | 187 | 836 | 881 | 3344 | 3524 | 227 | 844 | 889 | 3376 | 3556 |
| 146 | 827.8 | 872.8 | 3311.2 | 3491.2 | 188 | 836.2 | 881.2 | 3344.8 | 3524.8 | 228 | 844.2 | 889.2 | 3376.8 | 3556.8 |
| 147 | 828 | 873 | 3312 | 3492 | 189 | 836.4 | 881.4 | 3345.6 | 3525.6 | 229 | 844.4 | 889.4 | 3377.6 | 3557.6 |
| 148 | 828.2 | 873.2 | 3312.8 | 3492.8 | 190 | 836.6 | 881.6 | 3346.4 | 3526.4 | 230 | 844.6 | 889.6 | 3378.4 | 3558.4 |
| 149 | 828.4 | 873.4 | 3313.6 | 3493.6 | 191 | 836.8 | 881.8 | 3347.2 | 3527.2 | 231 | 844.8 | 889.8 | 3379.2 | 3559.2 |
| 150 | 828.6 | 873.6 | 3314.4 | 3494.4 | 192 | 837 | 882 | 3348 | 3528 | 232 | 845 | 890 | 3380 | 3560 |
| 151 | 828.8 | 873.8 | 3315.2 | 3495.2 | 193 | 837.2 | 882.2 | 3348.8 | 3528.8 | 233 | 845.2 | 890.2 | 3380.8 | 3560.8 |
| 152 | 829 | 874 | 3316 | 3496 | 194 | 837.4 | 882.4 | 3349.6 | 3529.6 | 234 | 845.4 | 890.4 | 3381.6 | 3561.6 |
| 153 | 829.2 | 874.2 | 3316.8 | 3496.8 | 195 | 837.6 | 882.6 | 3350.4 | 3530.4 | 235 | 845.6 | 890.6 | 3382.4 | 3562.4 |
| 154 | 829.4 | 874.4 | 3317.6 | 3497.6 | 196 | 837.8 | 882.8 | 3351.2 | 3531.2 | 236 | 845.8 | 890.8 | 3383.2 | 3563.2 |
| 155 | 829.6 | 874.6 | 3318.4 | 3498.4 | 197 | 838 | 883 | 3352 | 3532 | 237 | 846 | 891 | 3384 | 3564 |
| 156 | 829.8 | 874.8 | 3319.2 | 3499.2 | 198 | 838.2 | 883.2 | 3352.8 | 3532.8 | 238 | 846.2 | 891.2 | 3384.8 | 3564.8 |
| 157 | 830 | 875 | 3320 | 3500 | 199 | 838.4 | 883.4 | 3353.6 | 3533.6 | 239 | 846.4 | 891.4 | 3385.6 | 3565.6 |
| 158 | 830.2 | 875.2 | 3320.8 | 3500.8 | 200 | 838.6 | 883.6 | 3354.4 | 3534.4 | 240 | 846.6 | 891.6 | 3386.4 | 3566.4 |
| 159 | 830.4 | 875.4 | 3321.6 | 3501.6 | 201 | 838.8 | 883.8 | 3355.2 | 3535.2 | 241 | 846.8 | 891.8 | 3387.2 | 3567.2 |
| 160 | 830.6 | 875.6 | 3322.4 | 3502.4 | 202 | 839 | 884 | 3356 | 3536 | 242 | 847 | 892 | 3388 | 3568 |
| 161 | 830.8 | 875.8 | 3323.2 | 3503.2 | 203 | 839.2 | 884.2 | 3356.8 | 3536.8 | 243 | 847.2 | 892.2 | 3388.8 | 3568.8 |
| 162 | 831 | 876 | 3324 | 3504 | 204 | 839.4 | 884.4 | 3357.6 | 3537.6 | 244 | 847.4 | 892.4 | 3389.6 | 3569.6 |
| 163 | 831.2 | 876.2 | 3324.8 | 3504.8 | 205 | 839.6 | 884.6 | 3358.4 | 3538.4 | 245 | 847.6 | 892.6 | 3390.4 | 3570.4 |
| 164 | 831.4 | 876.4 | 3325.6 | 3505.6 | 206 | 839.8 | 884.8 | 3359.2 | 3539.2 | 246 | 847.8 | 892.8 | 3391.2 | 3571.2 |
| 165 | 831.6 | 876.6 | 3326.4 | 3506.4 | 207 | 840 | 885 | 3360 | 3540 | 247 | 848 | 893 | 3392 | 3572 |
| 166 | 831.8 | 876.8 | 3327.2 | 3507.2 | 208 | 840.2 | 885.2 | 3360.8 | 3540.8 | 248 | 848.2 | 893.2 | 3392.8 | 3572.8 |
| 167 | 832 | 877 | 3328 | 3508 | 209 | 840.4 | 885.4 | 3361.6 | 3541.6 | 249 | 848.4 | 893.4 | 3393.6 | 3573.6 |
| 168 | 832.2 | 877.2 | 3328.8 | 3508.8 | | | | | | 250 | 848.6 | 893.6 | 3394.4 | 3574.4 |
| 169 | 832.4 | 877.4 | 3329.6 | 3509.6 | | | | | | 251 | 848.8 | 893.8 | 3395.2 | 3575.2 |

PCS1900

| 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 | 612 | 1870.2 | 1950.2 | 3740.4 | 3900.4 | 712 | 1890.2 | 1970.2 | 3780.4 | 3940.4 |
| 513 | 1850.4 | 1930.4 | 3700.8 | 3860.8 | 613 | 1870.4 | 1950.4 | 3740.8 | 3900.8 | 713 | 1890.4 | 1970.4 | 3780.8 | 3940.8 |
| 514 | 1850.6 | 1930.6 | 3701.2 | 3861.2 | 614 | 1870.6 | 1950.6 | 3741.2 | 3901.2 | 714 | 1890.6 | 1970.6 | 3781.2 | 3941.2 |
| 515 | 1850.8 | 1930.8 | 3701.6 | 3861.6 | 615 | 1870.8 | 1950.8 | 3741.6 | 3901.6 | 715 | 1890.8 | 1970.8 | 3781.6 | 3941.6 |
| 516 | 1851 | 1931 | 3702 | 3862 | 616 | 1871 | 1951 | 3742 | 3902 | 716 | 1891 | 1971 | 3782 | 3942 |
| 517 | 1851.2 | 1931.2 | 3702.4 | 3862.4 | 617 | 1871.2 | 1951.2 | 3742.4 | 3902.4 | 717 | 1891.2 | 1971.2 | 3782.4 | 3942.4 |
| 518 | 1851.4 | 1931.4 | 3702.8 | 3862.8 | 618 | 1871.4 | 1951.4 | 3742.8 | 3902.8 | 718 | 1891.4 | 1971.4 | 3782.8 | 3942.8 |
| 519 | 1851.6 | 1931.6 | 3703.2 | 3863.2 | 619 | 1871.6 | 1951.6 | 3743.2 | 3903.2 | 719 | 1891.6 | 1971.6 | 3783.2 | 3943.2 |
| 520 | 1851.8 | 1931.8 | 3703.6 | 3863.6 | 620 | 1871.8 | 1951.8 | 3743.6 | 3903.6 | 720 | 1891.8 | 1971.8 | 3783.6 | 3943.6 |
| 521 | 1852 | 1932 | 3704 | 3864 | 621 | 1872 | 1952 | 3744 | 3904 | 721 | 1892 | 1972 | 3784 | 3944 |
| 522 | 1852.2 | 1932.2 | 3704.4 | 3864.4 | 622 | 1872.2 | 1952.2 | 3744.4 | 3904.4 | 722 | 1892.2 | 1972.2 | 3784.4 | 3944.4 |
| 523 | 1852.4 | 1932.4 | 3704.8 | 3864.8 | 623 | 1872.4 | 1952.4 | 3744.8 | 3904.8 | 723 | 1892.4 | 1972.4 | 3784.8 | 3944.8 |
| 524 | 1852.6 | 1932.6 | 3705.2 | 3865.2 | 624 | 1872.6 | 1952.6 | 3745.2 | 3905.2 | 724 | 1892.6 | 1972.6 | 3785.2 | 3945.2 |
| 525 | 1852.8 | 1932.8 | 3705.6 | 3865.6 | 625 | 1872.8 | 1952.8 | 3745.6 | 3905.6 | 725 | 1892.8 | 1972.8 | 3785.6 | 3945.6 |
| 526 | 1853 | 1933 | 3706 | 3866 | 626 | 1873 | 1953 | 3746 | 3906 | 726 | 1893 | 1973 | 3786 | 3946 |
| 527 | 1853.2 | 1933.2 | 3706.4 | 3866.4 | 627 | 1873.2 | 1953.2 | 3746.4 | 3906.4 | 727 | 1893.2 | 1973.2 | 3786.4 | 3946.4 |
| 528 | 1853.4 | 1933.4 | 3706.8 | 3866.8 | 628 | 1873.4 | 1953.4 | 3746.8 | 3906.8 | 728 | 1893.4 | 1973.4 | 3786.8 | 3946.8 |
| 529 | 1853.6 | 1933.6 | 3707.2 | 3867.2 | 629 | 1873.6 | 1953.6 | 3747.2 | 3907.2 | 729 | 1893.6 | 1973.6 | 3787.2 | 3947.2 |
| 530 | 1853.8 | 1933.8 | 3707.6 | 3867.6 | 630 | 1873.8 | 1953.8 | 3747.6 | 3907.6 | 730 | 1893.8 | 1973.8 | 3787.6 | 3947.6 |
| 531 | 1854 | 1934 | 3708 | 3868 | 631 | 1874 | 1954 | 3748 | 3908 | 731 | 1894 | 1974 | 3788 | 3948 |
| 532 | 1854.2 | 1934.2 | 3708.4 | 3868.4 | 632 | 1874.2 | 1954.2 | 3748.4 | 3908.4 | 732 | 1894.2 | 1974.2 | 3788.4 | 3948.4 |
| 533 | 1854.4 | 1934.4 | 3708.8 | 3868.8 | 633 | 1874.4 | 1954.4 | 3748.8 | 3908.8 | 733 | 1894.4 | 1974.4 | 3788.8 | 3948.8 |
| 534 | 1854.6 | 1934.6 | 3709.2 | 3869.2 | 634 | 1874.6 | 1954.6 | 3749.2 | 3909.2 | 734 | 1894.6 | 1974.6 | 3789.2 | 3949.2 |
| 535 | 1854.8 | 1934.8 | 3709.6 | 3869.6 | 635 | 1874.8 | 1954.8 | 3749.6 | 3909.6 | 735 | 1894.8 | 1974.8 | 3789.6 | 3949.6 |
| 536 | 1855 | 1935 | 3710 | 3870 | 636 | 1875 | 1955 | 3750 | 3910 | 736 | 1895 | 1975 | 3790 | 3950 |
| 537 | 1855.2 | 1935.2 | 3710.4 | 3870.4 | 637 | 1875.2 | 1955.2 | 3750.4 | 3910.4 | 737 | 1895.2 | 1975.2 | 3790.4 | 3950.4 |
| 538 | 1855.4 | 1935.4 | 3710.8 | 3870.8 | 638 | 1875.4 | 1955.4 | 3750.8 | 3910.8 | 738 | 1895.4 | 1975.4 | 3790.8 | 3950.8 |
| 539 | 1855.6 | 1935.6 | 3711.2 | 3871.2 | 639 | 1875.6 | 1955.6 | 3751.2 | 3911.2 | 739 | 1895.6 | 1975.6 | 3791.2 | 3951.2 |
| 540 | 1855.8 | 1935.8 | 3711.6 | 3871.6 | 640 | 1875.8 | 1955.8 | 3751.6 | 3911.6 | 740 | 1895.8 | 1975.8 | 3791.6 | 3951.6 |
| 541 | 1856 | 1936 | 3712 | 3872 | 641 | 1876 | 1956 | 3752 | 3912 | 741 | 1896 | 1976 | 3792 | 3952 |
| 542 | 1856.2 | 1936.2 | 3712.4 | 3872.4 | 642 | 1876.2 | 1956.2 | 3752.4 | 3912.4 | 742 | 1896.2 | 1976.2 | 3792.4 | 3952.4 |
| 543 | 1856.4 | 1936.4 | 3712.8 | 3872.8 | 643 | 1876.4 | 1956.4 | 3752.8 | 3912.8 | 743 | 1896.4 | 1976.4 | 3792.8 | 3952.8 |
| 544 | 1856.6 | 1936.6 | 3713.2 | 3873.2 | 644 | 1876.6 | 1956.6 | 3753.2 | 3913.2 | 744 | 1896.6 | 1976.6 | 3793.2 | 3953.2 |
| 545 | 1856.8 | 1936.8 | 3713.6 | 3873.6 | 645 | 1876.8 | 1956.8 | 3753.6 | 3913.6 | 745 | 1896.8 | 1976.8 | 3793.6 | 3953.6 |
| 546 | 1857 | 1937 | 3714 | 3874 | 646 | 1877 | 1957 | 3754 | 3914 | 746 | 1897 | 1977 | 3794 | 3954 |
| 547 | 1857.2 | 1937.2 | 3714.4 | 3874.4 | 647 | 1877.2 | 1957.2 | 3754.4 | 3914.4 | 747 | 1897.2 | 1977.2 | 3794.4 | 3954.4 |
| 548 | 1857.4 | 1937.4 | 3714.8 | 3874.8 | 648 | 1877.4 | 1957.4 | 3754.8 | 3914.8 | 748 | 1897.4 | 1977.4 | 3794.8 | 3954.8 |
| 549 | 1857.6 | 1937.6 | 3715.2 | 3875.2 | 649 | 1877.6 | 1957.6 | 3755.2 | 3915.2 | 749 | 1897.6 | 1977.6 | 3795.2 | 3955.2 |
| 550 | 1857.8 | 1937.8 | 3715.6 | 3875.6 | 650 | 1877.8 | 1957.8 | 3755.6 | 3915.6 | 750 | 1897.8 | 1977.8 | 3795.6 | 3955.6 |
| 551 | 1858 | 1938 | 3716 | 3876 | 651 | 1878 | 1958 | 3756 | 3916 | 751 | 1898 | 1978 | 3796 | 3956 |
| 552 | 1858.2 | 1938.2 | 3716.4 | 3876.4 | 652 | 1878.2 | 1958.2 | 3756.4 | 3916.4 | 752 | 1898.2 | 1978.2 | 3796.4 | 3956.4 |
| 553 | 1858.4 | 1938.4 | 3716.8 | 3876.8 | 653 | 1878.4 | 1958.4 | 3756.8 | 3916.8 | 753 | 1898.4 | 1978.4 | 3796.8 | 3956.8 |
| 554 | 1858.6 | 1938.6 | 3717.2 | 3877.2 | 654 | 1878.6 | 1958.6 | 3757.2 | 3917.2 | 754 | 1898.6 | 1978.6 | 3797.2 | 3957.2 |
| 555 | 1858.8 | 1938.8 | 3717.6 | 3877.6 | 655 | 1878.8 | 1958.8 | 3757.6 | 3917.6 | 755 | 1898.8 | 1978.8 | 3797.6 | 3957.6 |
| 556 | 1859 | 1939 | 3718 | 3878 | 656 | 1879 | 1959 | 3758 | 3918 | 756 | 1899 | 1979 | 3798 | 3958 |
| 557 | 1859.2 | 1939.2 | 3718.4 | 3878.4 | 657 | 1879.2 | 1959.2 | 3758.4 | 3918.4 | 757 | 1899.2 | 1979.2 | 3798.4 | 3958.4 |
| 558 | 1859.4 | 1939.4 | 3718.8 | 3878.8 | 658 | 1879.4 | 1959.4 | 3758.8 | 3918.8 | 758 | 1899.4 | 1979.4 | 3798.8 | 3958.8 |
| 559 | 1859.6 | 1939.6 | 3719.2 | 3879.2 | 659 | 1879.6 | 1959.6 | 3759.2 | 3919.2 | 759 | 1899.6 | 1979.6 | 3799.2 | 3959.2 |
| 560 | 1859.8 | 1939.8 | 3719.6 | 3879.6 | 660 | 1879.8 | 1959.8 | 3759.6 | 3919.6 | 760 | 1899.8 | 1979.8 | 3799.6 | 3959.6 |
| 561 | 1860 | 1940 | 3720 | 3880 | 661 | 1880 | 1960 | 3760 | 3920 | 761 | 1900 | 1980 | 3800 | 3960 |

| Ch | TX | RX | VCO TX | VCO RX | Ch | TX | RX | VCO TX | VCO RX | Ch | TX | RX | VCO TX | VCO RX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 562 | 1860.2 | 1940.2 | 3720.4 | 3880.4 | 662 | 1880.2 | 1960.2 | 3760.4 | 3920.4 | 762 | 1900.2 | 1980.2 | 3800.4 | 3960.4 |
| 563 | 1860.4 | 1940.4 | 3720.8 | 3880.8 | 663 | 1880.4 | 1960.4 | 3760.8 | 3920.8 | 763 | 1900.4 | 1980.4 | 3800.8 | 3960.8 |
| 564 | 1860.6 | 1940.6 | 3721.2 | 3881.2 | 664 | 1880.6 | 1960.6 | 3761.2 | 3921.2 | 764 | 1900.6 | 1980.6 | 3801.2 | 3961.2 |
| 565 | 1860.8 | 1940.8 | 3721.6 | 3881.6 | 665 | 1880.8 | 1960.8 | 3761.6 | 3921.6 | 765 | 1900.8 | 1980.8 | 3801.6 | 3961.6 |
| 566 | 1861 | 1941 | 3722 | 3882 | 666 | 1881 | 1961 | 3762 | 3922 | 766 | 1901 | 1981 | 3802 | 3962 |
| 567 | 1861.2 | 1941.2 | 3722.4 | 3882.4 | 667 | 1881.2 | 1961.2 | 3762.4 | 3922.4 | 767 | 1901.2 | 1981.2 | 3802.4 | 3962.4 |
| 568 | 1861.4 | 1941.4 | 3722.8 | 3882.8 | 668 | 1881.4 | 1961.4 | 3762.8 | 3922.8 | 768 | 1901.4 | 1981.4 | 3802.8 | 3962.8 |
| 569 | 1861.6 | 1941.6 | 3723.2 | 3883.2 | 669 | 1881.6 | 1961.6 | 3763.2 | 3923.2 | 769 | 1901.6 | 1981.6 | 3803.2 | 3963.2 |
| 570 | 1861.8 | 1941.8 | 3723.6 | 3883.6 | 670 | 1881.8 | 1961.8 | 3763.6 | 3923.6 | 770 | 1901.8 | 1981.8 | 3803.6 | 3963.6 |
| 571 | 1862 | 1942 | 3724 | 3884 | 671 | 1882 | 1962 | 3764 | 3924 | 771 | 1902 | 1982 | 3804 | 3964 |
| 572 | 1862.2 | 1942.2 | 3724.4 | 3884.4 | 672 | 1882.2 | 1962.2 | 3764.4 | 3924.4 | 772 | 1902.2 | 1982.2 | 3804.4 | 3964.4 |
| 573 | 1862.4 | 1942.4 | 3724.8 | 3884.8 | 673 | 1882.4 | 1962.4 | 3764.8 | 3924.8 | 773 | 1902.4 | 1982.4 | 3804.8 | 3964.8 |
| 574 | 1862.6 | 1942.6 | 3725.2 | 3885.2 | 674 | 1882.6 | 1962.6 | 3765.2 | 3925.2 | 774 | 1902.6 | 1982.6 | 3805.2 | 3965.2 |
| 575 | 1862.8 | 1942.8 | 3725.6 | 3885.6 | 675 | 1882.8 | 1962.8 | 3765.6 | 3925.6 | 775 | 1902.8 | 1982.8 | 3805.6 | 3965.6 |
| 576 | 1863 | 1943 | 3726 | 3886 | 676 | 1883 | 1963 | 3766 | 3926 | 776 | 1903 | 1983 | 3806 | 3966 |
| 577 | 1863.2 | 1943.2 | 3726.4 | 3886.4 | 677 | 1883.2 | 1963.2 | 3766.4 | 3926.4 | 777 | 1903.2 | 1983.2 | 3806.4 | 3966.4 |
| 578 | 1863.4 | 1943.4 | 3726.8 | 3886.8 | 678 | 1883.4 | 1963.4 | 3766.8 | 3926.8 | 778 | 1903.4 | 1983.4 | 3806.8 | 3966.8 |
| 579 | 1863.6 | 1943.6 | 3727.2 | 3887.2 | 679 | 1883.6 | 1963.6 | 3767.2 | 3927.2 | 779 | 1903.6 | 1983.6 | 3807.2 | 3967.2 |
| 580 | 1863.8 | 1943.8 | 3727.6 | 3887.6 | 680 | 1883.8 | 1963.8 | 3767.6 | 3927.6 | 780 | 1903.8 | 1983.8 | 3807.6 | 3967.6 |
| 581 | 1864 | 1944 | 3728 | 3888 | 681 | 1884 | 1964 | 3768 | 3928 | 781 | 1904 | 1984 | 3808 | 3968 |
| 582 | 1864.2 | 1944.2 | 3728.4 | 3888.4 | 682 | 1884.2 | 1964.2 | 3768.4 | 3928.4 | 782 | 1904.2 | 1984.2 | 3808.4 | 3968.4 |
| 583 | 1864.4 | 1944.4 | 3728.8 | 3888.8 | 683 | 1884.4 | 1964.4 | 3768.8 | 3928.8 | 783 | 1904.4 | 1984.4 | 3808.8 | 3968.8 |
| 584 | 1864.6 | 1944.6 | 3729.2 | 3889.2 | 684 | 1884.6 | 1964.6 | 3769.2 | 3929.2 | 784 | 1904.6 | 1984.6 | 3809.2 | 3969.2 |
| 585 | 1864.8 | 1944.8 | 3729.6 | 3889.6 | 685 | 1884.8 | 1964.8 | 3769.6 | 3929.6 | 785 | 1904.8 | 1984.8 | 3809.6 | 3969.6 |
| 586 | 1865 | 1945 | 3730 | 3890 | 686 | 1885 | 1965 | 3770 | 3930 | 786 | 1905 | 1985 | 3810 | 3970 |
| 587 | 1865.2 | 1945.2 | 3730.4 | 3890.4 | 687 | 1885.2 | 1965.2 | 3770.4 | 3930.4 | 787 | 1905.2 | 1985.2 | 3810.4 | 3970.4 |
| 588 | 1865.4 | 1945.4 | 3730.8 | 3890.8 | 688 | 1885.4 | 1965.4 | 3770.8 | 3930.8 | 788 | 1905.4 | 1985.4 | 3810.8 | 3970.8 |
| 589 | 1865.6 | 1945.6 | 3731.2 | 3891.2 | 689 | 1885.6 | 1965.6 | 3771.2 | 3931.2 | 789 | 1905.6 | 1985.6 | 3811.2 | 3971.2 |
| 590 | 1865.8 | 1945.8 | 3731.6 | 3891.6 | 690 | 1885.8 | 1965.8 | 3771.6 | 3931.6 | 790 | 1905.8 | 1985.8 | 3811.6 | 3971.6 |
| 591 | 1866 | 1946 | 3732 | 3892 | 691 | 1886 | 1966 | 3772 | 3932 | 791 | 1906 | 1986 | 3812 | 3972 |
| 592 | 1866.2 | 1946.2 | 3732.4 | 3892.4 | 692 | 1886.2 | 1966.2 | 3772.4 | 3932.4 | 792 | 1906.2 | 1986.2 | 3812.4 | 3972.4 |
| 593 | 1866.4 | 1946.4 | 3732.8 | 3892.8 | 693 | 1886.4 | 1966.4 | 3772.8 | 3932.8 | 793 | 1906.4 | 1986.4 | 3812.8 | 3972.8 |
| 594 | 1866.6 | 1946.6 | 3733.2 | 3893.2 | 694 | 1886.6 | 1966.6 | 3773.2 | 3933.2 | 794 | 1906.6 | 1986.6 | 3813.2 | 3973.2 |
| 595 | 1866.8 | 1946.8 | 3733.6 | 3893.6 | 695 | 1886.8 | 1966.8 | 3773.6 | 3933.6 | 795 | 1906.8 | 1986.8 | 3813.6 | 3973.6 |
| 596 | 1867 | 1947 | 3734 | 3894 | 696 | 1887 | 1967 | 3774 | 3934 | 796 | 1907 | 1987 | 3814 | 3974 |
| 597 | 1867.2 | 1947.2 | 3734.4 | 3894.4 | 697 | 1887.2 | 1967.2 | 3774.4 | 3934.4 | 797 | 1907.2 | 1987.2 | 3814.4 | 3974.4 |
| 598 | 1867.4 | 1947.4 | 3734.8 | 3894.8 | 698 | 1887.4 | 1967.4 | 3774.8 | 3934.8 | 798 | 1907.4 | 1987.4 | 3814.8 | 3974.8 |
| 599 | 1867.6 | 1947.6 | 3735.2 | 3895.2 | 699 | 1887.6 | 1967.6 | 3775.2 | 3935.2 | 799 | 1907.6 | 1987.6 | 3815.2 | 3975.2 |
| 600 | 1867.8 | 1947.8 | 3735.6 | 3895.6 | 700 | 1887.8 | 1967.8 | 3775.6 | 3935.6 | 800 | 1907.8 | 1987.8 | 3815.6 | 3975.6 |
| 601 | 1868 | 1948 | 3736 | 3896 | 701 | 1888 | 1968 | 3776 | 3936 | 801 | 1908 | 1988 | 3816 | 3976 |
| 602 | 1868.2 | 1948.2 | 3736.4 | 3896.4 | 702 | 1888.2 | 1968.2 | 3776.4 | 3936.4 | 802 | 1908.2 | 1988.2 | 3816.4 | 3976.4 |
| 603 | 1868.4 | 1948.4 | 3736.8 | 3896.8 | 703 | 1888.4 | 1968.4 | 3776.8 | 3936.8 | 803 | 1908.4 | 1988.4 | 3816.8 | 3976.8 |
| 604 | 1868.6 | 1948.6 | 3737.2 | 3897.2 | 704 | 1888.6 | 1968.6 | 3777.2 | 3937.2 | 804 | 1908.6 | 1988.6 | 3817.2 | 3977.2 |
| 605 | 1868.8 | 1948.8 | 3737.6 | 3897.6 | 705 | 1888.8 | 1968.8 | 3777.6 | 3937.6 | 805 | 1908.8 | 1988.8 | 3817.6 | 3977.6 |
| 606 | 1869 | 1949 | 3738 | 3898 | 706 | 1889 | 1969 | 3778 | 3938 | 806 | 1909 | 1989 | 3818 | 3978 |
| 607 | 1869.2 | 1949.2 | 3738.4 | 3898.4 | 707 | 1889.2 | 1969.2 | 3778.4 | 3938.4 | 807 | 1909.2 | 1989.2 | 3818.4 | 3978.4 |
| 608 | 1869.4 | 1949.4 | 3738.8 | 3898.8 | 708 | 1889.4 | 1969.4 | 3778.8 | 3938.8 | 808 | 1909.4 | 1989.4 | 3818.8 | 3978.8 |
| 609 | 1869.6 | 1949.6 | 3739.2 | 3899.2 | 709 | 1889.6 | 1969.6 | 3779.2 | 3939.2 | 809 | 1909.6 | 1989.6 | 3819.2 | 3979.2 |
| 610 | 1869.8 | 1949.8 | 3739.6 | 3899.6 | 710 | 1889.8 | 1969.8 | 3779.6 | 3939.6 | 810 | 1909.8 | 1989.8 | 3819.6 | 3979.6 |
| 611 | 1870 | 1950 | 3740 | 3900 | 711 | 1890 | 1970 | 3780 | 3940 | | | | | |

## Alignment

### 3595 Manual Align with Phoenix

In Phoenix, select connection FBUS and Product Excelsior. If you power up the board before selecting FBUS, it works without any error messages. Use Test jig or other device for RF and bus connection. Attenuation in test jig RF connector alone is 0.3dB for 850 and 0.7dB for 1900. Use a RCT (radio communication tester), spectrum analzyer, or another suitable device for tuning or testing the phone. The default channels are 190 for GSM850 and 661 for GSM1900. **The alignments and calibrations must be performed**

**in the order shown to give reliable results.**

The way to save data to the phone and to load data from the phone is different in the various tuning procedures. Always look at what is shown in the windows regarding these issues and act accordingly.

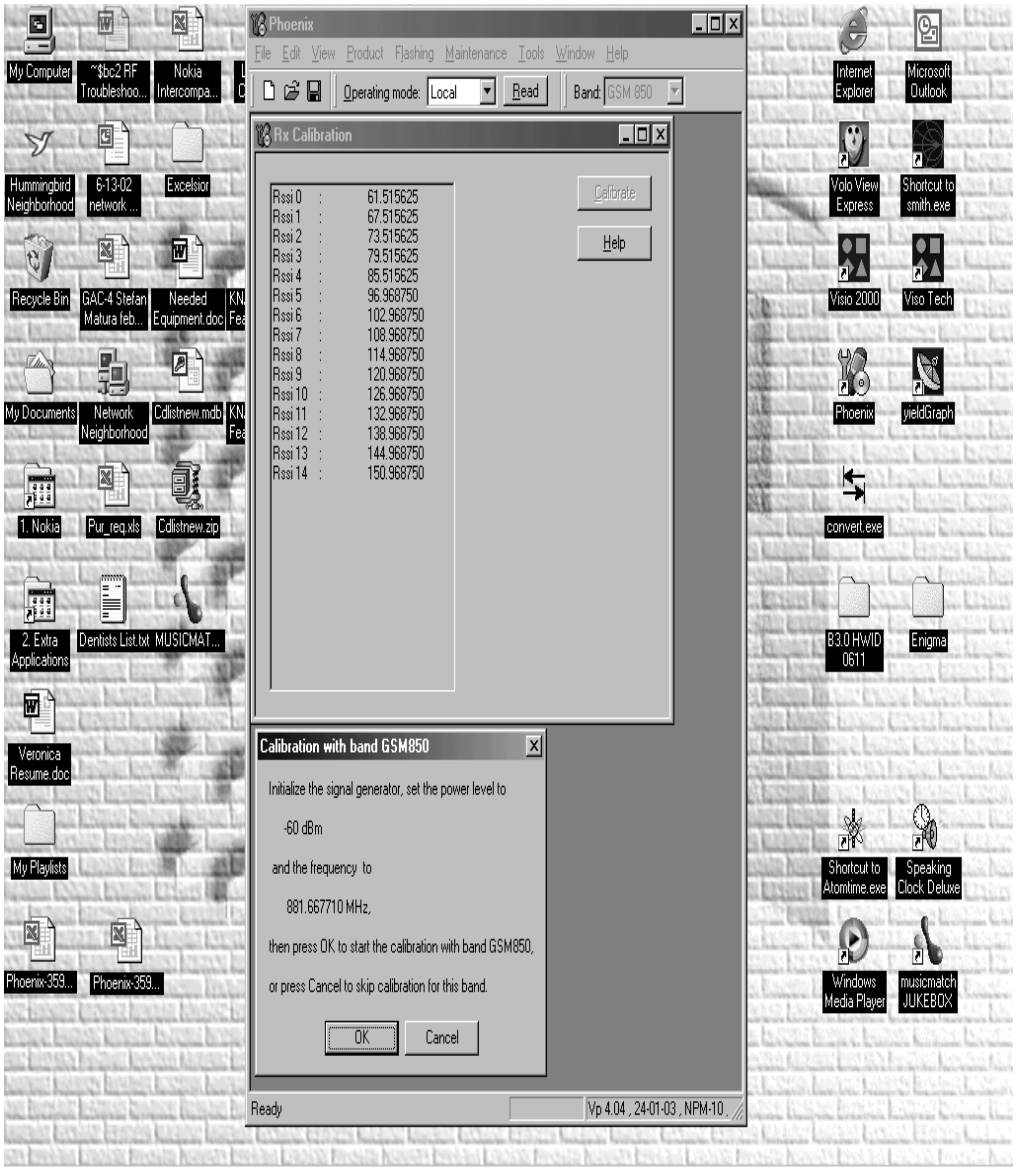
To vary a selected parameter you can use + and – key or in some cases directly type the new value. + and – steps the value for every press. Repeat function seems not to work. In I/Q you can use the side arrows.

## RX Calibration

Select Maintenance, Tuning, RX Calibration

Select Band GSM850. Note that GSM850 must be calibrated before PCS1900.

The result should be as shown:



Select Calibrate.

The current values stored in Permanent Memory are shown.

Set sig. gen. settings to the freq. and amplitude specified in the popup window.

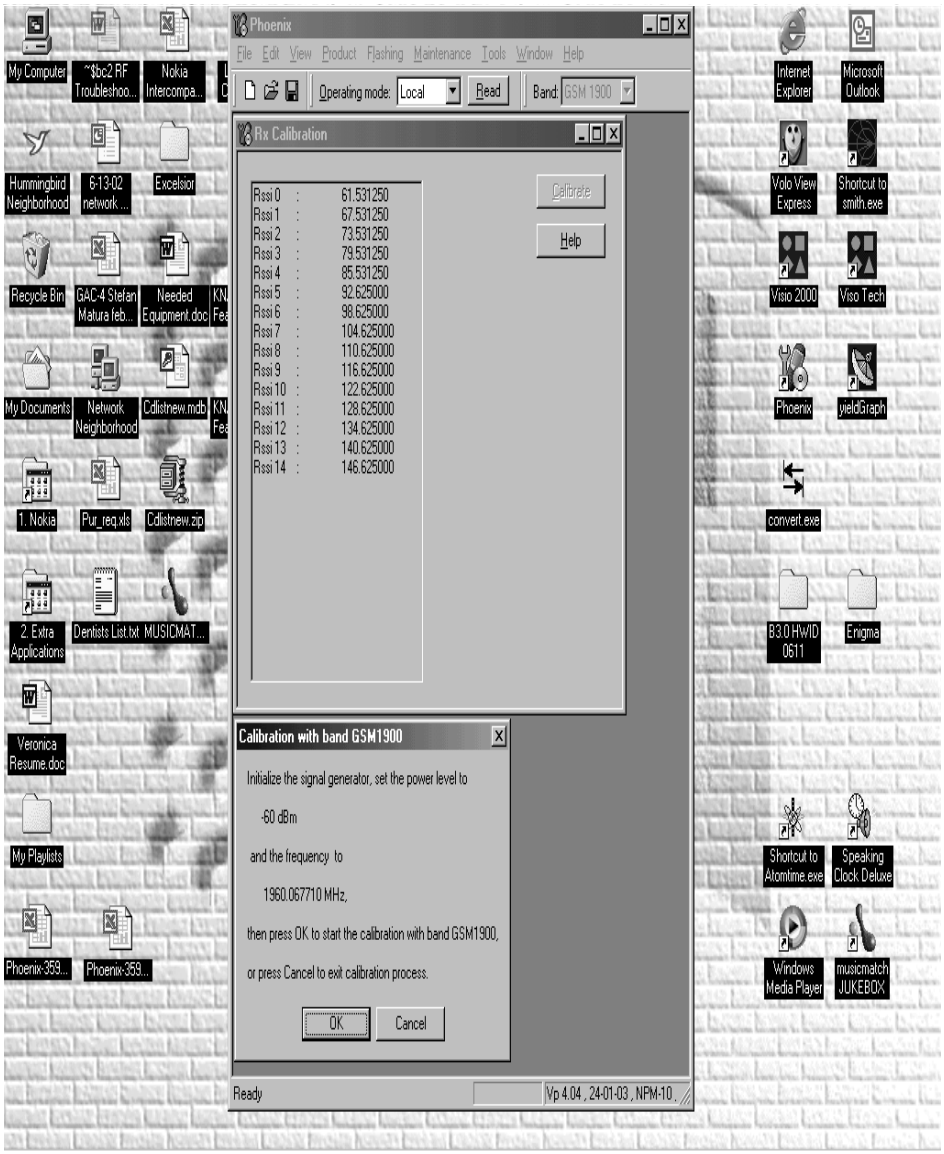
Select OK,  850 band will be calibrated and automatically stored in PM.

Phoenix will then prompt for 1900MHz calibration while displaying the current values in PM.

Again set up sig. gen. settings as shown and select OK.

New RSSI values will be calculated and stored in PM.

RX cal is now complete.



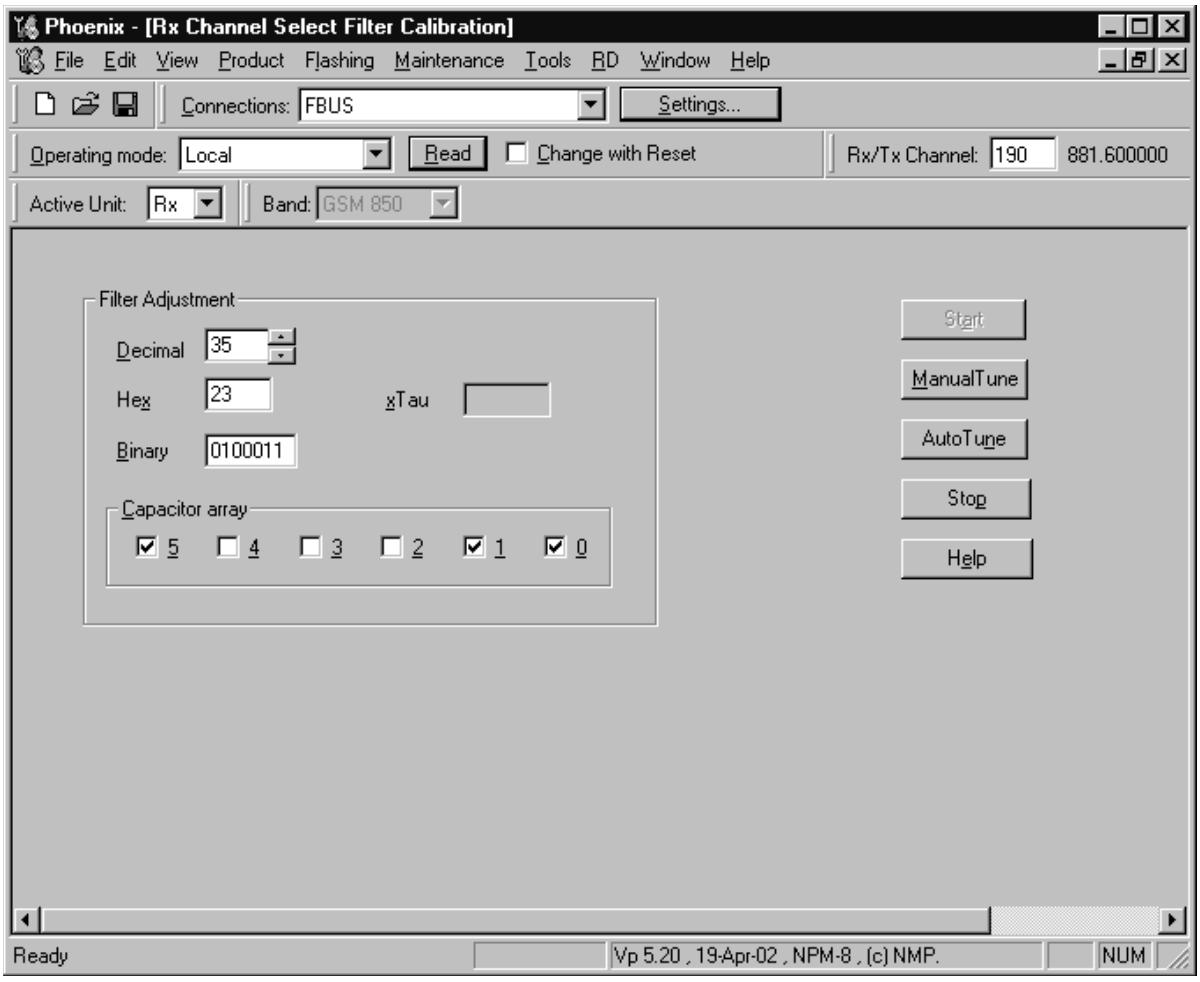
**RX Channel Select Filter**

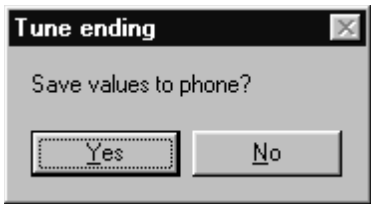
Select Maintenance, Tuning, Rx Channel Select Filter Calibration

Next, select to load values from the phone or not

Press AutoTune

Press Stop and you can select to save values to the phone or not




Note: This calibration requires no input signal

**RX Band Filter Response**

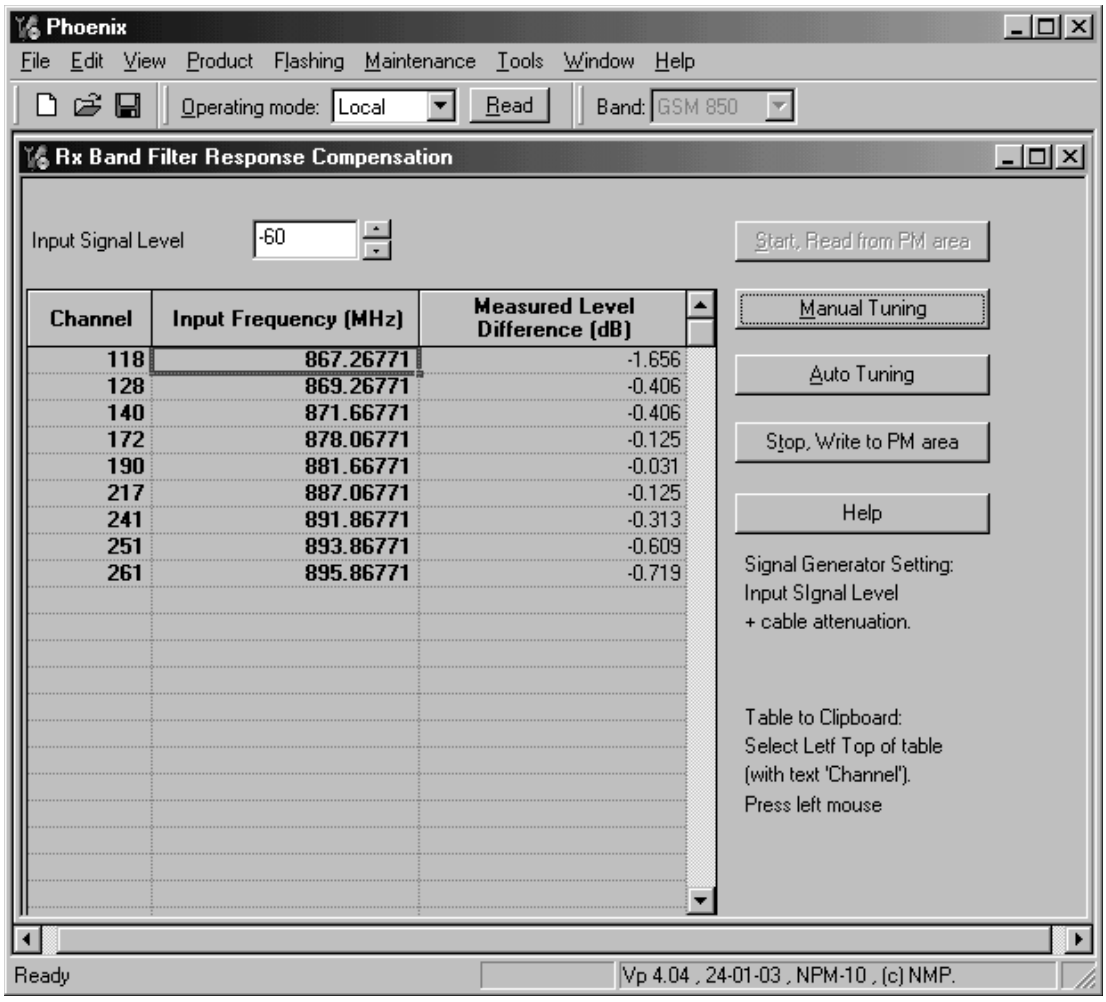
Select Maintenance, Tuning, Rx Band Filter Response Compensation

Press Start, Read from PM area and you can select to load values from the phone or not

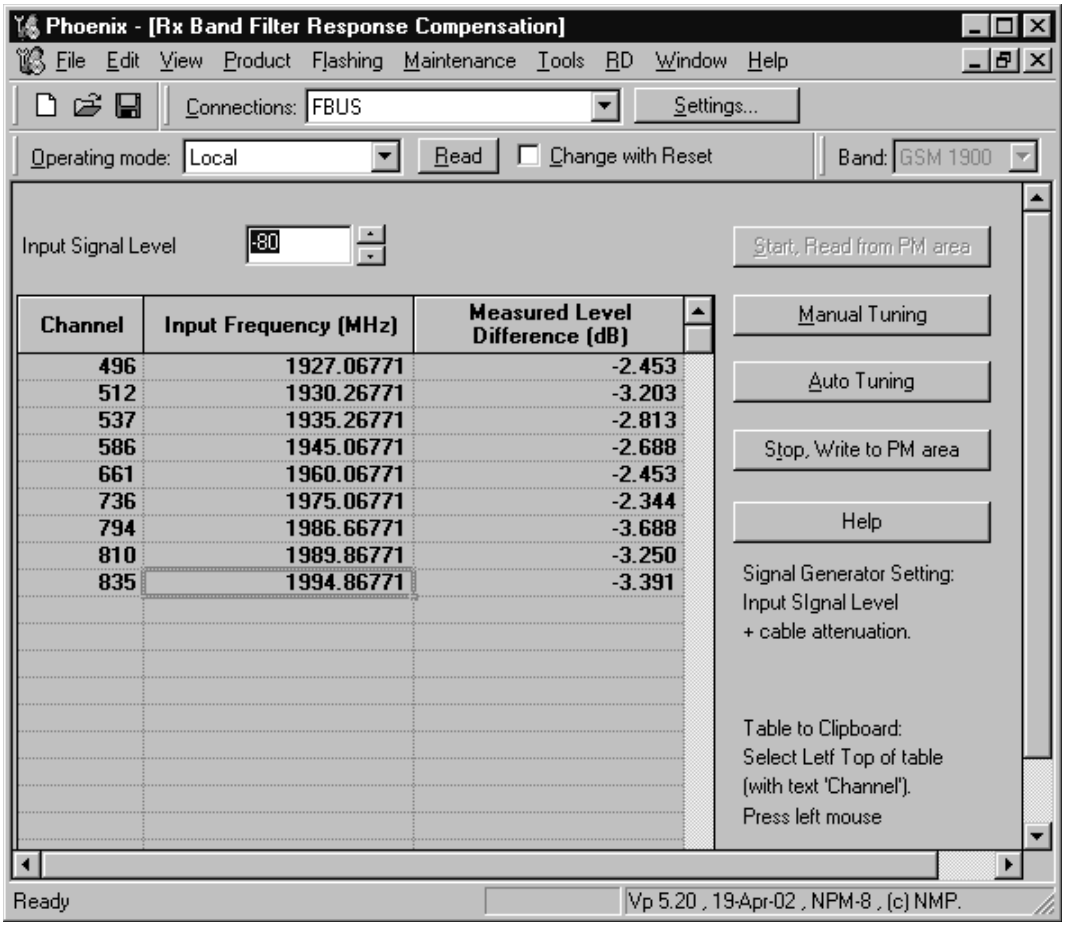
Press Manual Tuning

Set the Signal generator according to the pop-up windows

When finished press Stop, Write to PM area and you can select to save values to the phone or not



Repeat for GSM1900




Note: This calibration requires a lot of different frequencies from the generator. If you have a signal generator with a frequency list option you can with advantage use Auto Tuning (Dwell should be around 10 ms).

## Tx Tuning

Phoenix menu: Select Maintenance, Tuning,Tx Power Level Tuning

Settings and considerations for tuning with a spectrum analyzer:

A DC block and at least 10 dB attenuator should be used on the RF input port to protect the spectrum analyzer.

The burst power should be measured, so a span of 0 Hertz is used.

Span: 0 Hertz

Resolution Bandwidth 1 MHz

Video Bandwidth 1 MHz

Sweeptime 10 msec

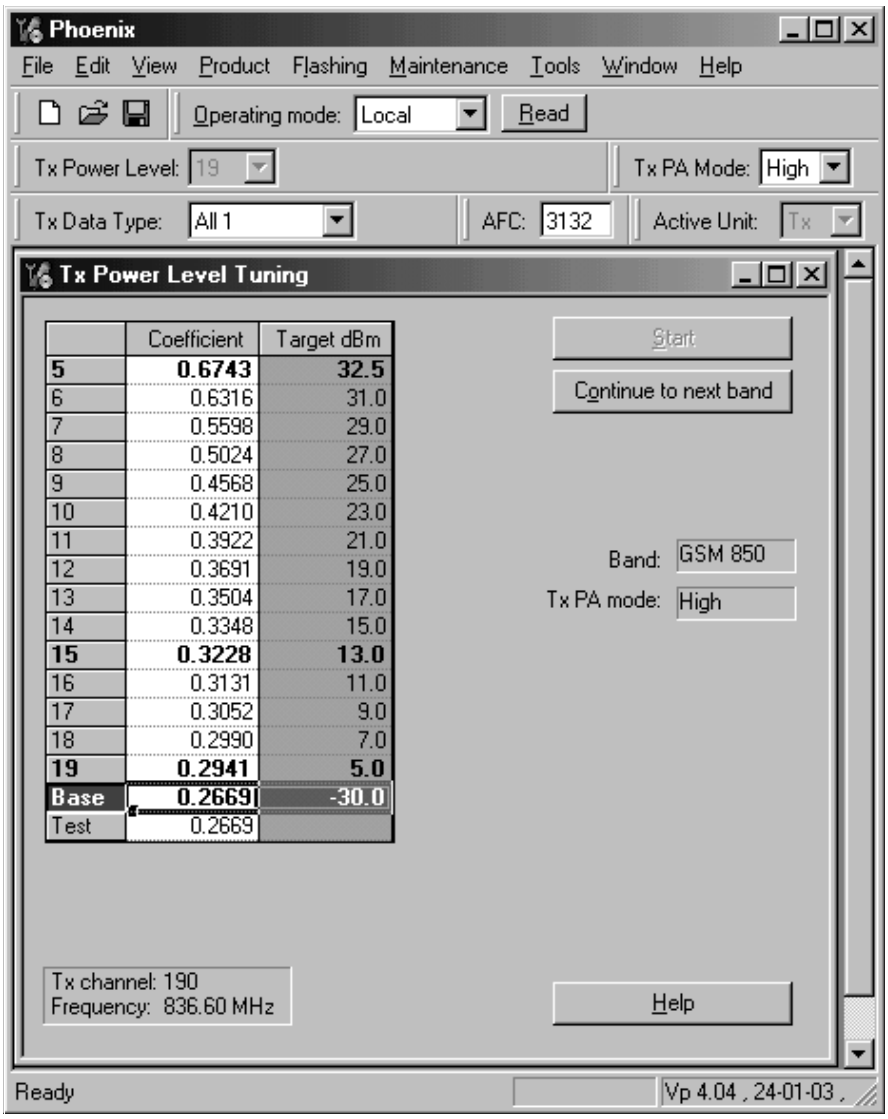
RF Attenuation: 30 dB

Reference level: if you set this to 40 dBm, you can tune both the low band (target output power of 32.0 dBm for power level 5) and highband (target output power of 29.5 dBm for power level 0) at the maximum output levels. The reference level must be reduced, to say 0 dB level when tuning the base level.

Trigger: Video. Set the level to 0 dbm. This must be lowered when you are setting the base level (Base level target output power of -30 dBm). If you don't lower the video trigger level to below –30 dBm when tuning the base level, the spectrum analyzer will not be triggered when you are tuning the base level.

Center Frequency: 836.6 MHz (For GSM 850 band, channel 190 is used for Tx output power tuning). For GSM 1900, Center frequency is 1880 MHz (mid Channel 661) for Tx output power tuning.

**TX Power Tuning GSM850**




Entering TX Pwr Lvl tuning will bring you to the screen shown above. Phoenix automatically loads the coefficients currently stored in PM. DUT should be transmitting at the channel and frequency shown in the lower left corner of the active screen.

Select the modulation 1, 0 or random in Tx Data Type. Select random if a GSM tester is used. Then it can be synchronised to the burst.

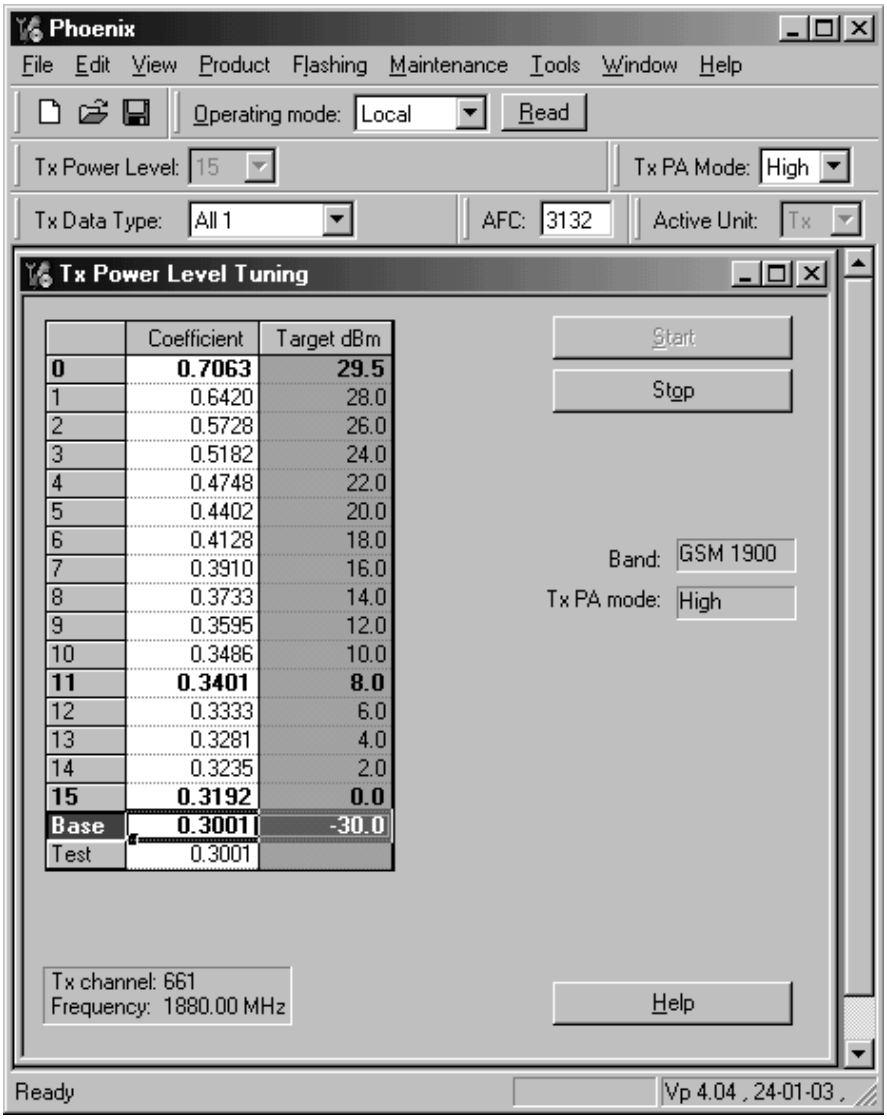
Select Tx PA Mode High. Note that Low PA Mode tuning is not to be used.

First power tuning should be setting base level to –30dBm.

Tune the highlighted values (in **BOLD**) to the target value highlighted in blue (Use average burst power) also *Note: PL5 target value is 32dBm not 32.5dBm*.

After tuning the bold power levels, select "Continue to next band". Phoenix will then calculate the coefficients for the remaining power levels, save them to permanent memory, and will proceed to 1900MHz power level tuning.

**TX Power Tuning PCS1900**




Repeat the procedure for 1900MHz. After the bolded power levels are tuned, select OK. Phoenix will then calculate the coefficients for the remaining power levels and save them to permanent memory.

Tx power level tuning is complete.

## TX I/Q Tuning

Phoenix Menu: Select Maintenance, Tuning, Tx IQ tuning

Settings for spectrum analyzer for I/Q tuning:

Same center frequencies are used for GSM 850 (Ch190 = 836.6 MHz) and 1900 (Ch661 = 1880 MHz) as in Tx output power tuning.

Span 200 kHz

RBW 10 kHz

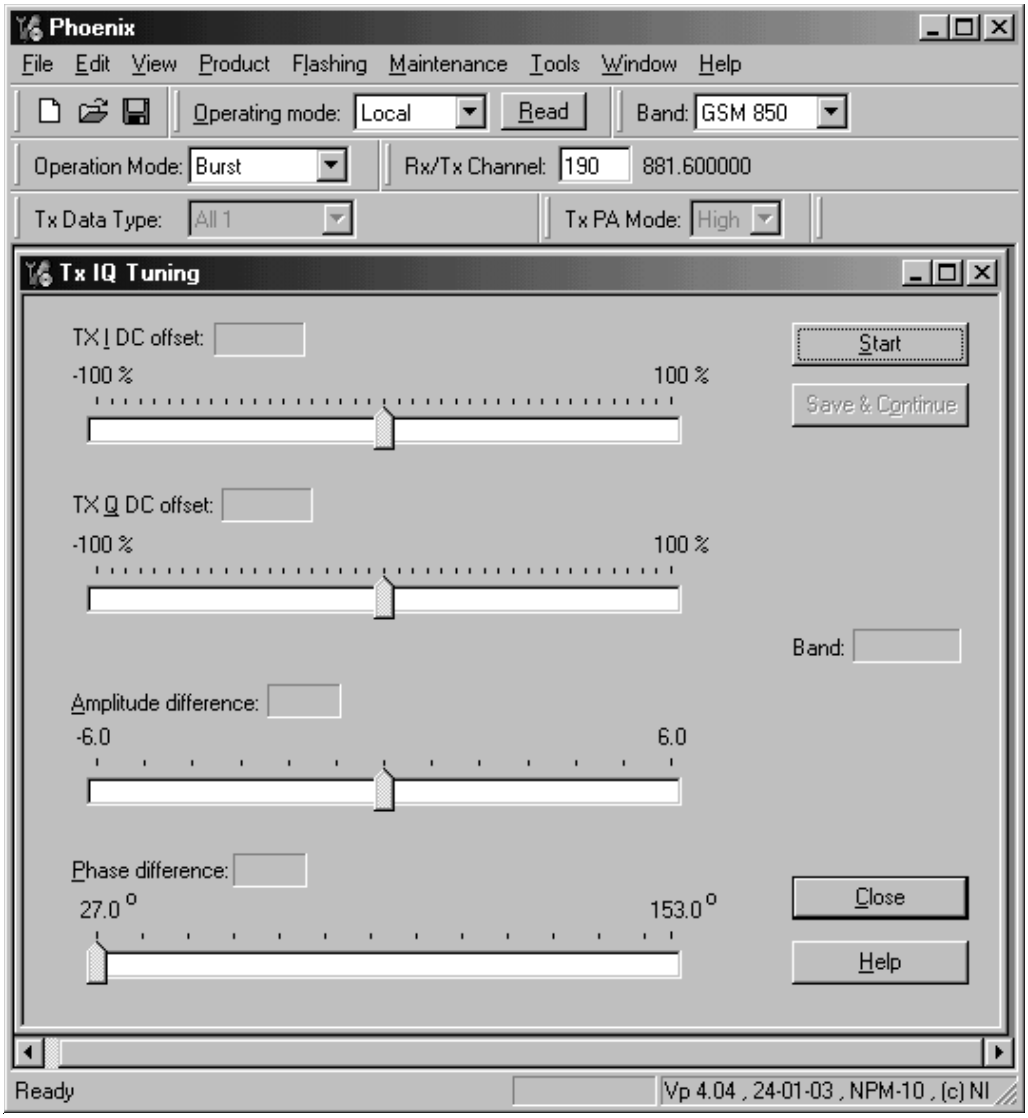
VBW 1 kHz

Sweeptime .5 seconds

RF attenuation 20 dB

Reference level 30 dBm

Trigger: free run



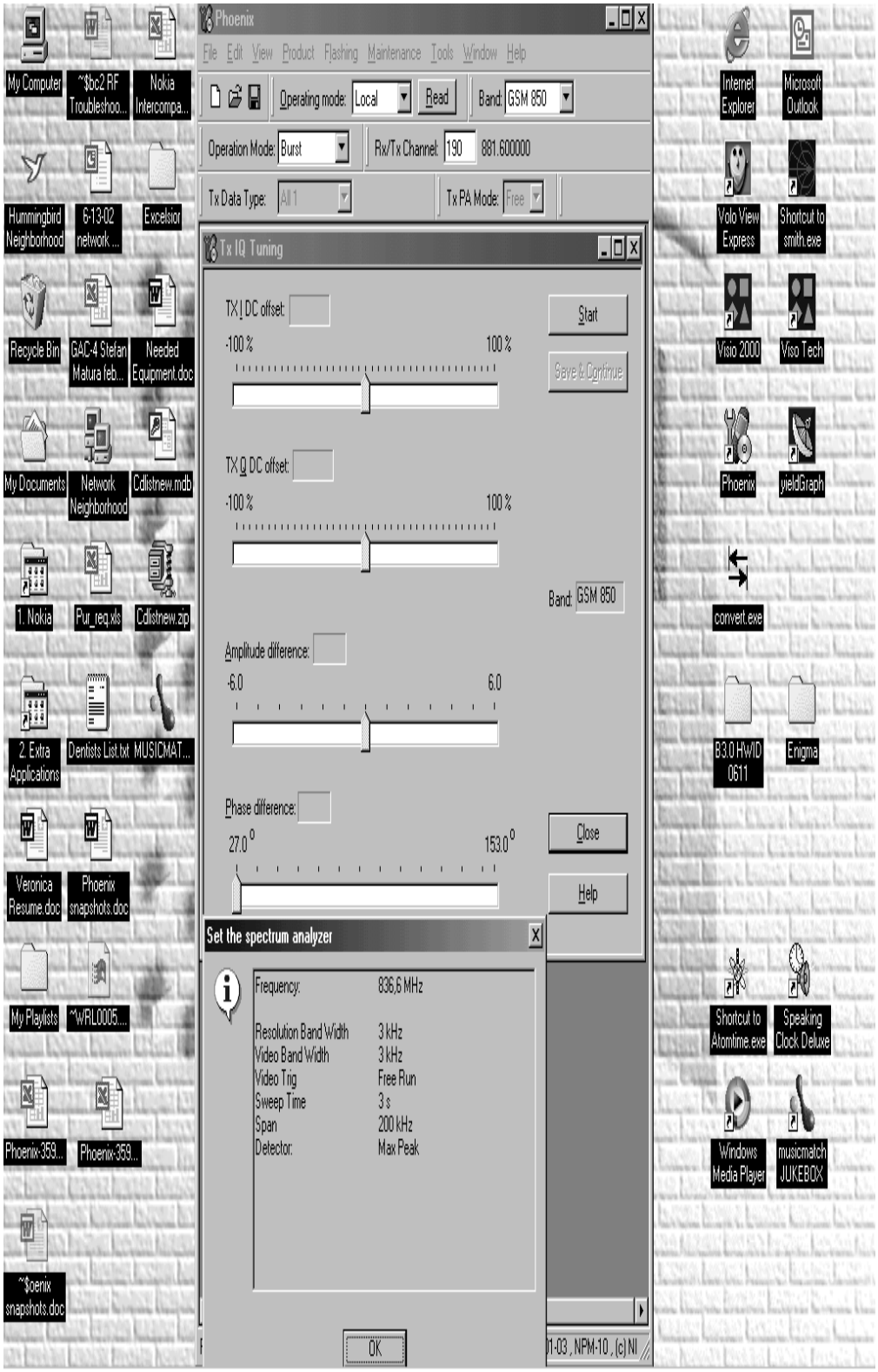

Select where to get values. Normally select Load From Product

Push "Start" soft key.

Tune I and Q DC offset values to reduce the carrier frequency to a minimum. Use Side arrows or +, -. Carrier must be at least –30 dBc. Typically carrier supression is better than –40 dBc.

Tune Amplitude and phase difference to reduce the lowest sideband frequency. The sideband must be reduced at least –35 dBc. Typically sideband supression is better than –40 dBc.

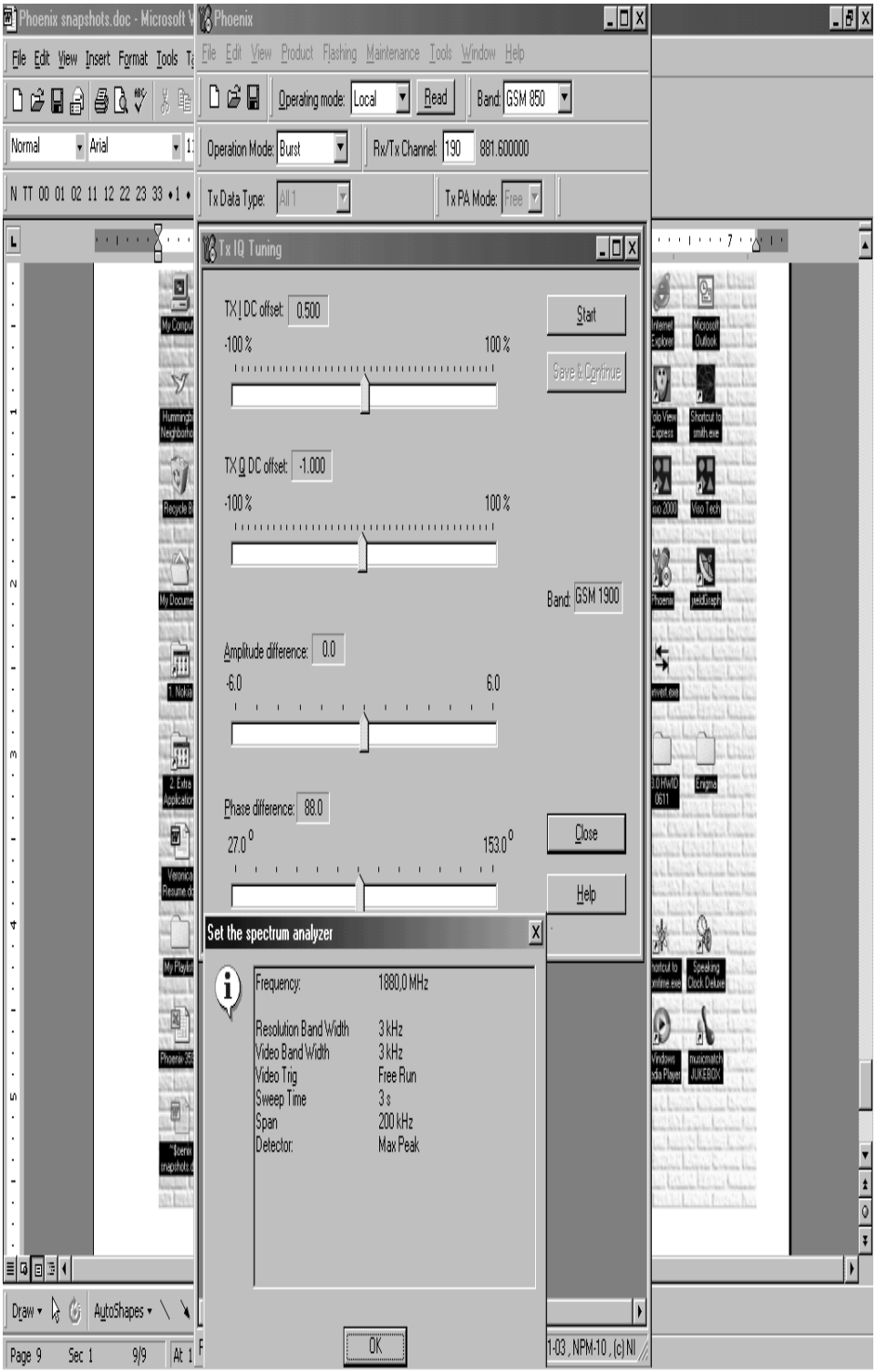
Check the IQ tuning values meet the specifications for both 1 and 0 data types.



Remember to check the box "Save to Product" if you want to save the tuning values to the phone.

Push "Stop" softkey. This ends tuning and saves the values to the phone if you have selected the "save to product" box.

Same procedure is used for PCS1900 as for GSM. Channel will be 661, as pictured below with some typical tuning values.

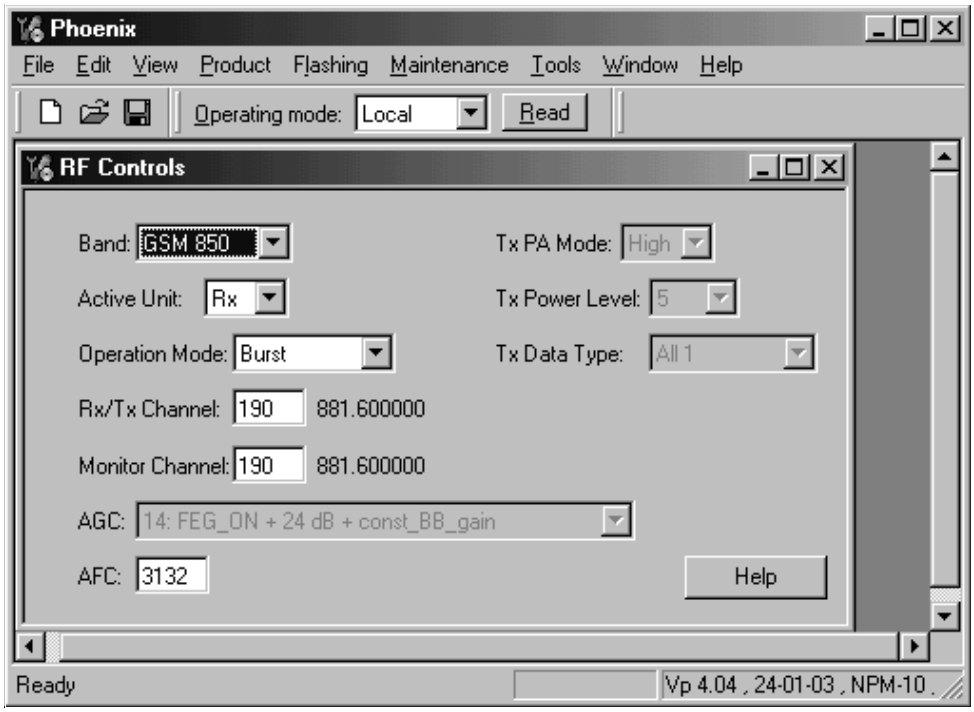


## RF Control

Phoenix menu: Select Maintenance, Testing, RF Controls

It is meant to check the receiver or transmitter without going in a call. It works very much like a call, but you have control via the PC, and not via the tester. The GSM850 TX PA mode should be set to High.

If you want to tune at other channels than the default, then you must select it first in RF control and then start the tuning.




## Call Testing

If all tunings are done, and the phone TX and RX is working, a call is the ultimate test of the phone.

Set the communications tester to manual test. Switch the phone to normal if it was in local mode. Remember to have a test simcard in the phone.

After the phone has registered to the communications tester, a call can be made. It is possible to let the phone answer via Phoenix. In the Autocaller (Maintenance Testing) you can answer by ticking Answer when button pushed and then push the button.