7 - RF Description and Troubleshooting

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CMT RF

Top-level description

The RF module performs the necessary high frequency operations of the GSM850/EGSM900/1800/1900 tripleband (EDGE) engine. Both the transmitter and receiver have been implemented by using direct conversion architecture which means that the modulator and demodulator operate at the channel frequency.

The core of the RF is an application-specific integrated circuit, Helgo. Another core component is a power amplifier module which includes two amplifier chains, one for GSM850/EGSM900 and the other for GSM1800/GSM1900.

Other key components include

- 26 MHz VCTCXO for frequency reference
- 3296-3980 MHz SHF VCO (super high frequency voltage controlled oscillator)
- Antenna switch module (ASM)
- Four SAW filters

The control information for the RF is coming from the baseband section of the engine through a serial bus, referred later on as RFBus.

The whole RF circuitry is located on one side of the 8-layer PWB.

EMC leakage is prevented by using a metal cans. The RF circuits are separated into two blocks.

- PA, ASM, LNA, baluns for Rx/Tx and Rx/Tx SAWs.
- Helgo RF IC, VCO + balun, VCTCXO, baluns and EGSM Rx filter

The RF transmission lines constitute of striplines and microstriplines after PA.

RA-2 test point locations

Figure 1: Top view

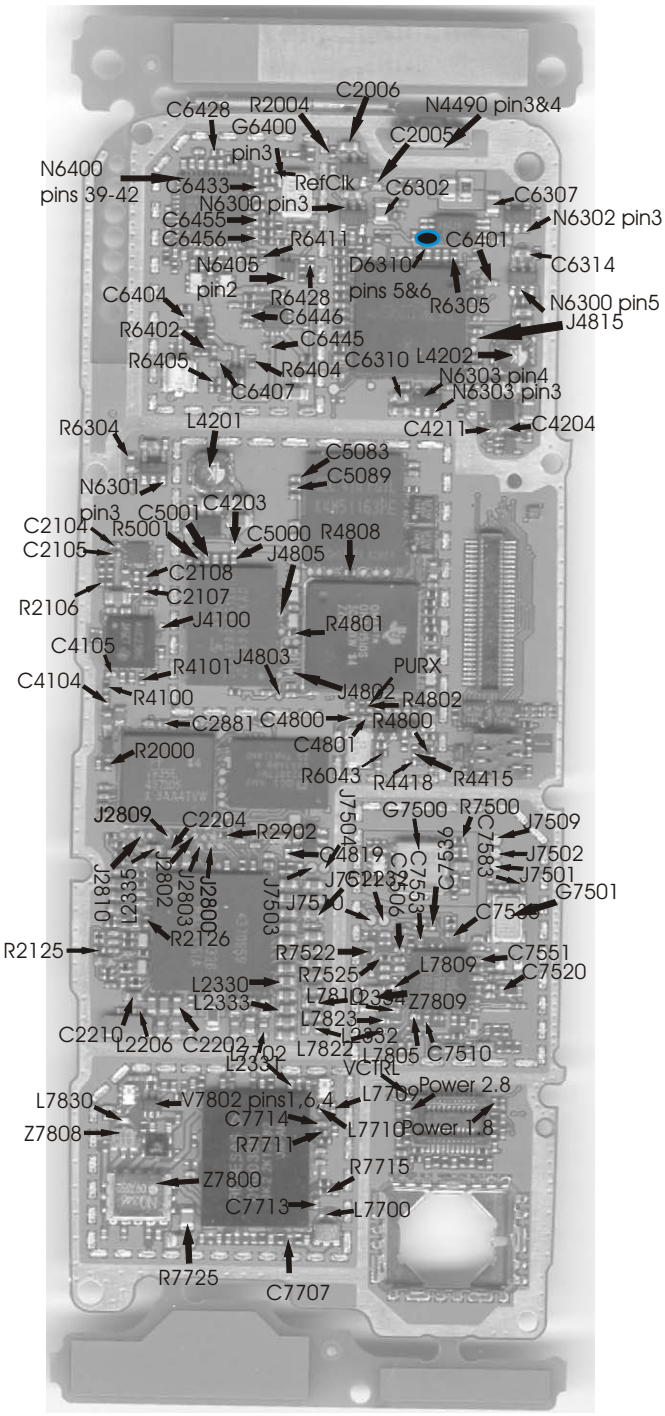
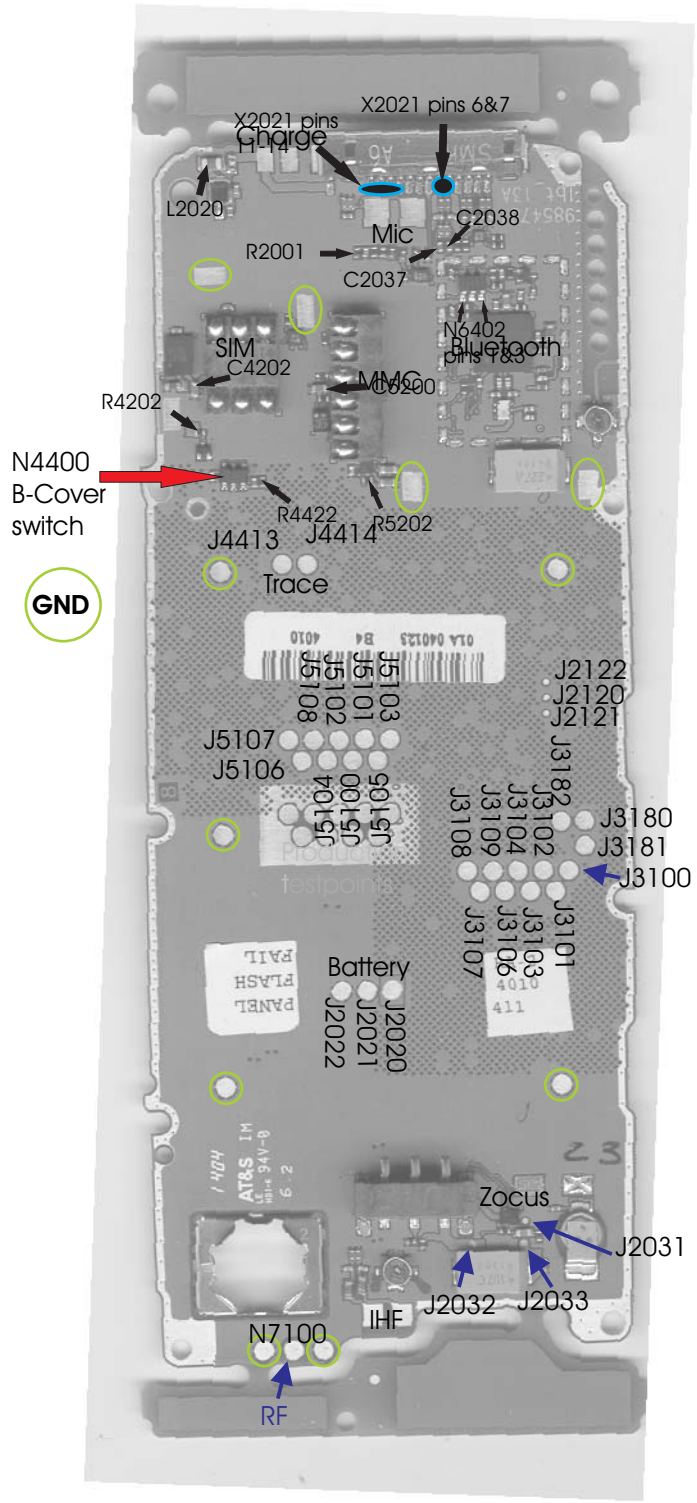


Figure 2: Bottom view



Test points

Table 1: Rx test points

Signal name:	Ref:
LNA_VCC	V7802
LNA_IN	V7802
LNA_P	V7802
RXI	J7510
RXQ	J7511

Table 2: Antenna switch test points

Signal name:	Ref:
VANT_1	Z7800
VANT_2	Z7800
VANT_3	Z7800
GSM_Rx	Z7800
DCS_Rx	Z7800
PCS_Rx	Z7800
TX_IN_EGSM/850	Z7800

Table 3: Helgo serial interface test points

Signal name:	Ref:
RFBusClk	J7501
RFBusEna1	J7502
RFBusData	J7509
Reset	J7503

Table 4: Synthesizer test points

Signal name:	Ref:
VCO_out	G7500
VCTCXO_out	G7501

Table 5: GSM900/850 Rx helgo input test points

	Ref:
RX filter	Z7809
Inductor	L7809
Inductor	L7810

Table 6: GSM1800 Rx helgo input test points

	Ref:
Filter	Z7808
Inductor	L7823
Inductor	L7822
Inductor	L7830

Table 7: GSM1900 Rx helgo input test points

	Ref:
Inductor	L7805

Table 8: Tx PA input test points

Signal name:	Ref:
Rfin_900/850	C7707
Rfin_1800/190	L7702

Table 9: Tx filter/balun input test points

Signal name:	Ref:
RfinP_900	L7700
RfinM_900	L7700

RfinP_1800_1900	C7709
RfinM_1800_1900	C7710

Table 10: PA control signal test points

Signal name:	Ref:
VPCTRL_900	R7715
VPCTRL_1800_1900	R7711
TXIM	C7535
TXIP	C7535
TXQM	C7536
TXQP	C7536
TXC	R7522
TXP	J7504 (test pad)

Table 11: Rx test points

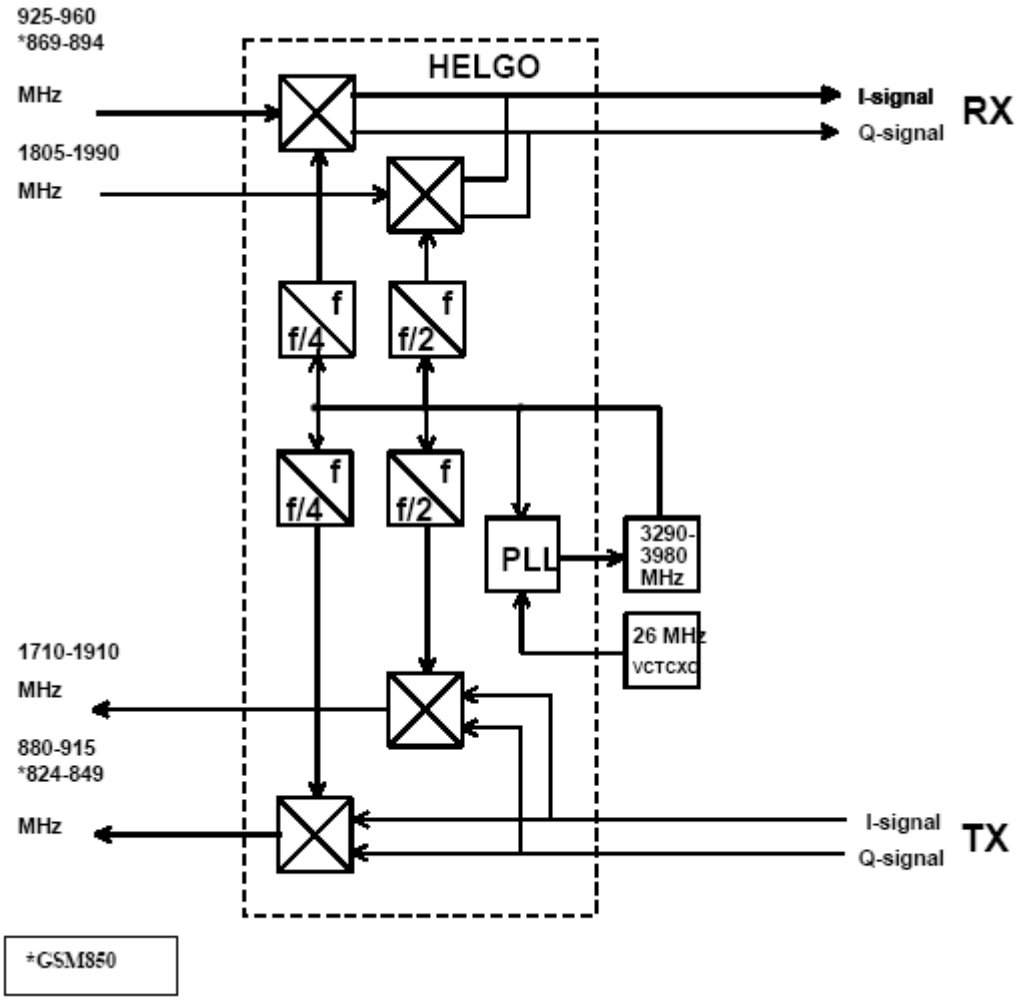
Signal name:	Ref:
VR1	C7551
VR2	C7520
VR3	C7583
VR4	C7510
VR5	C7553
VR6	C7506
VR7	R7500
VrefRF01	R7525
VBAT	C7725
VTXB_900	C7713
VTXB_1800_1900	C7714

RF implementation in RA-2/3

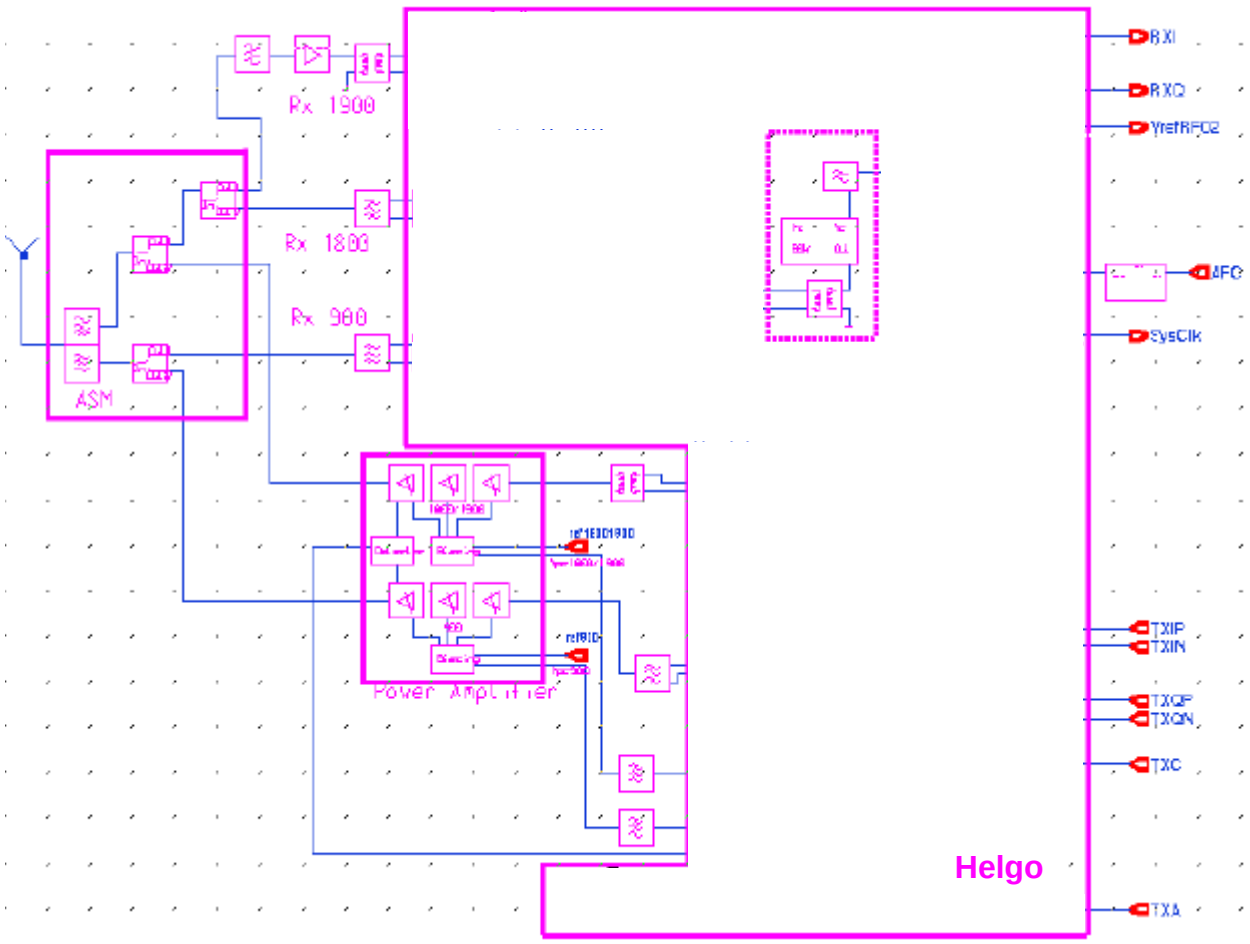
Frequency plan

The RF frequency plan is shown below. The VCO operates at the channel frequency multiplied by two or four depending on the frequency band of operation. This means that the baseband modulated signals are directly converted up to the transmission frequency and the received RF signals directly down to the baseband frequency.

Figure 3: RF frequency plan

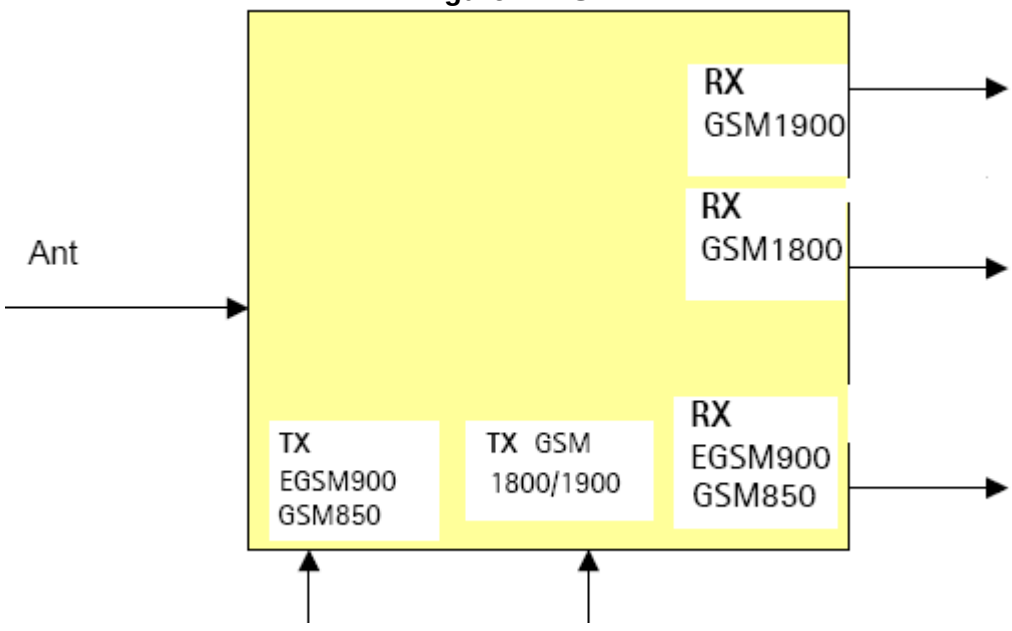


RF block diagram



Antenna switch module (ASM)

Figure 4: ASM



DC characteristics

Regulators

The transceiver baseband section has a multi function analog ASIC, UEM, which contains among other functions six pieces of 2.78 V linear regulators and a 4.8 V switching regulator. All the regulators can be controlled individually by the 2.78 V logic directly or through a control register. Normally, direct control is needed because of switching speed requirement: the regulators are used to enable the RF-functions which means that the controls must be fast enough.

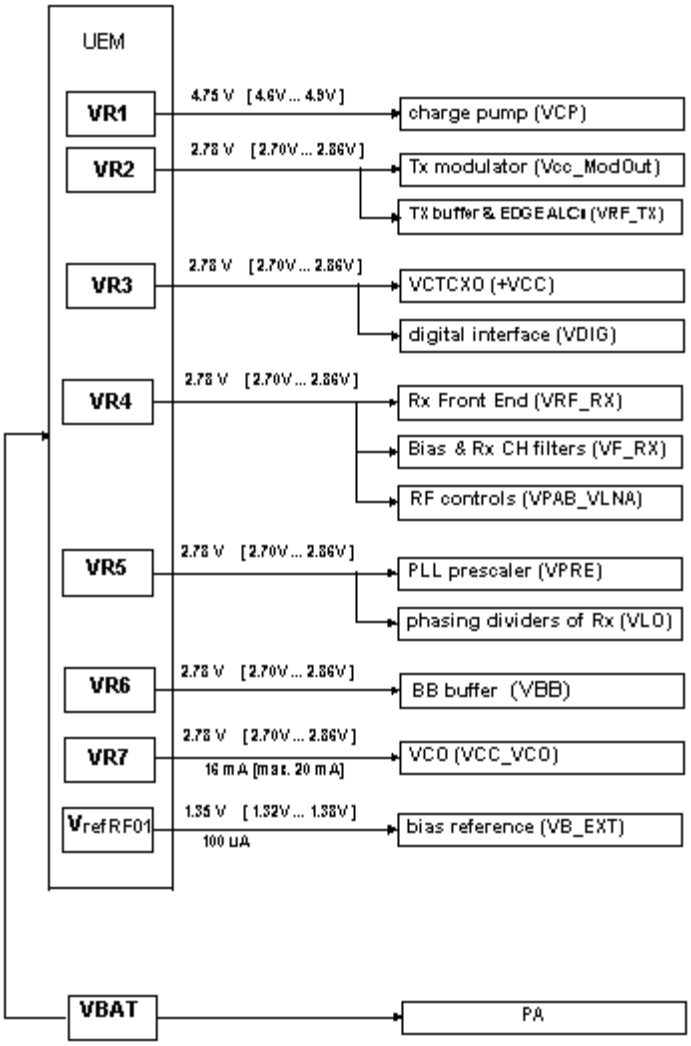
The use of the regulators can be seen in the power distribution diagram which is presented in Figure 6, “Power distribution diagram,” on page 15.

The seven regulators are named VR1 to VR7. VrefRF01 is used as a reference voltage for Helgo.

The regulators (except for VR7) are connected to the Helgo. Different modes of operation can be selected inside the Helgo according to the control information coming through the RFBus.

DC supply currents

Figure 5: DC power supplies



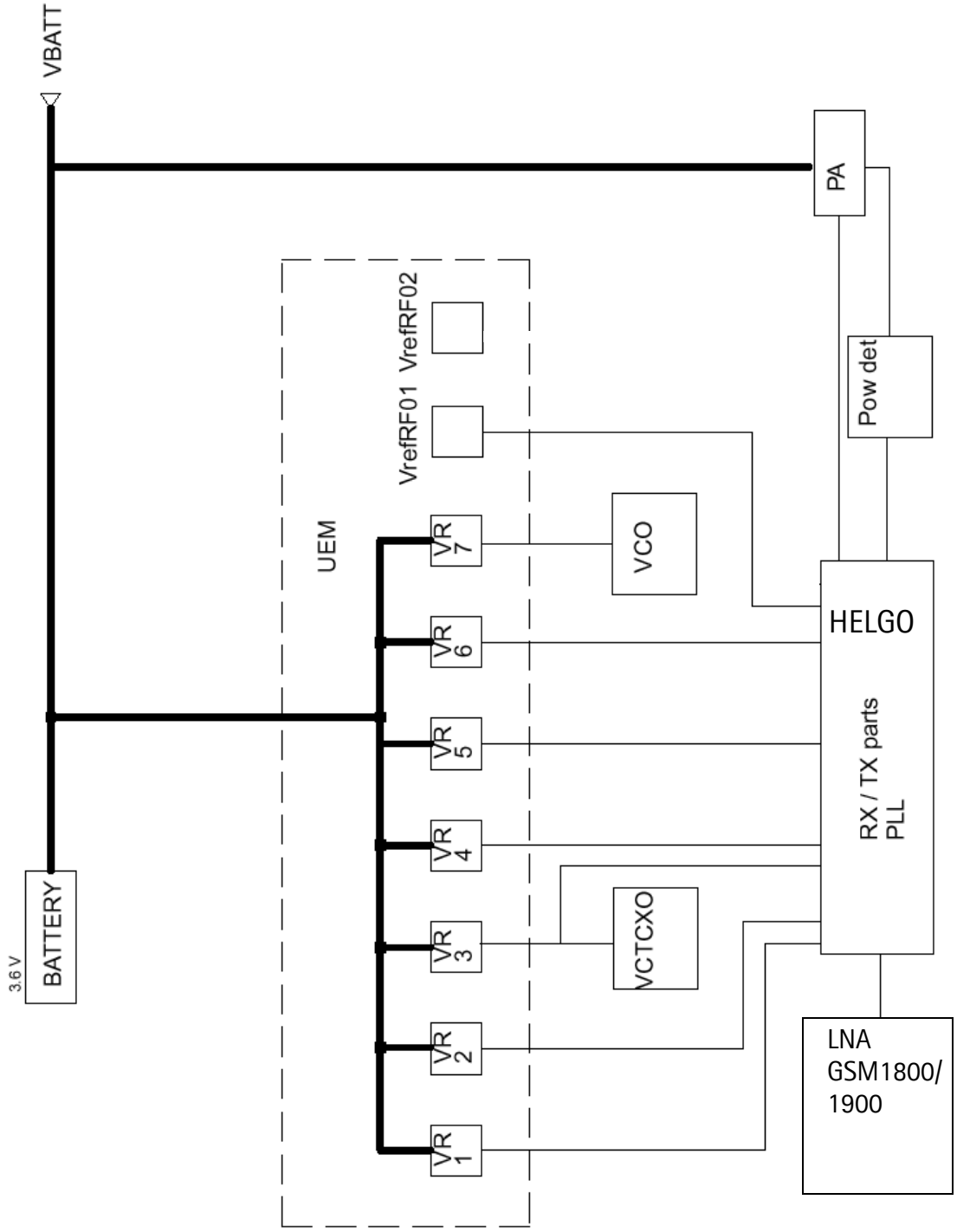
Typical current consumption

The table shows the typical current consumption in different operation modes.

Operation mode	Current consumption	Notes
Power OFF	< 10 uA	Leakage current (triple band PA)
Rx, EGSM900/GSM850	75 mA, peak	
Rx, GSM1800/GSM1900	70 mA, peak	
Tx, power level 5, EGSM900/ GSM850	1700 mA, peak	
Tx, power level 0, GSM1800/ GSM1900	1000 mA, peak	

Power distribution diagram

Figure 6: Power distribution diagram



RF characteristics

Channel numbers and frequencies

System	Channel number	Tx frequency	Rx frequency	Unit
GSM850	128< =n <=251	F= 824.2+0.2* (n -128)	F= 869,2+0.2* (n -128)	MHz
GSM900	0 < =n <=124	F = 890 + 0.2 * n	F = 935 + 0.2 * n	MHz
	975<= n <= 1023	F= 890+0.2* (n -1024)	F= 935+0.2* (n -1024)	MHz
GSM1800	512 <= n <= 885	F=1710.2+0.2*(n-512)	F=1805.2+0.2*(n-512)	MHz
GSM1900	512 <= n <=810	F=1850.2+0.2*(n-512)	F=1930.2+0.2*(n-512)	MHz

RF Troubleshooting

All measurements should be done using a spectrum analyzer with a high-frequency high-impedance passive probe (LO-/reference frequencies and RF power levels) and an oscilloscope with a 10:1 probe (DC-voltages and low frequency signals).

The RF section is build around one RF ASIC (HELGO N7500). For easier troubleshooting, this RF troubleshooting document is divided into sections.

Before changing HELGO, please check that both supply voltages and serial communication coming from baseband to HELGO are OK. Please note that the grounding of the PA module is directly below the PA module, so it is difficult to check or change.

Most RF semiconductors are static discharge sensitive! Therefore ESD protection must be taken care of during repair (ground straps and ESD soldering irons). HELGO and PA are moisture sensitive so parts must be pre-baked prior to soldering.

Apart from key components described in this document there are a lot of discrete components (resistors, inductors and capacitors) of which troubleshooting is done by checking if the soldering of the component is done properly (for factory repairs checking if it is missing from the PWB). You can check capacitors for shortening and resistors for value by means of an ohmmeter, but be aware in-circuit measurements should be evaluated carefully.

Please be aware that all measured voltages or RF levels in this document are rough figures. Especially RF levels vary due to different measuring equipment or different grounding of the probe used. When using an RF probe use a pair of metallic tweezers to connect the probe ground to the PWB ground as close to the measurement point as possible.

Receiver description and troubleshooting

Each receiver path is a direct conversion linear receiver. From the antenna, the received RF-signal is fed to a front end module where a diplexer first divides the signal into two separate paths according to the band of operation: either lower, GSM850/EGSM900 or upper, GSM1800/GSM1900 path.

Most of the receiver circuitry is included in Helgo.

Rx front end

The front end features include:

- Antenna 50 ohm input
- RXs single outputs
- TXs single 50 ohm inputs
- 3 control lines from Helgo

Antenna

The RA-2/3 GSM850/EGSM900/GSM1800/GSM1900 transceiver features an internal antenna. There are two triple-band antennas: one for RA-2 and one for RA-3.

Receiver characteristics

Item	Values, GSM850/EGSM900/1800/1900
Type	Direct conversion, Linear, FDMA/TDMA
LO frequencies	3476...3576/3700...3840 MHz / 3610...3760 MHz/3860...3980 MHz
Typical 3 dB bandwidth	+/- 91 kHz
Sensitivity	min. - 102 dBm (normal condition)
Total typical receiver voltage gain (from antenna to Rx ADC)	86 dB
Receiver output level (RF level -95 dBm)	230 mVpp, single-ended I/Q signals to Rx ADCs
Typical AGC dynamic range	83 dB
Accurate AGC control range	60 dB
Typical AGC step in LNA	30 dB GSM1800/GSM1900 25 dB GSM850/EGSM900
Usable input dynamic range	-102... -10 dBm
RSSI dynamic range	-110... -48 dBm
Compensated gain variation in receiving band	+/- 1.0 dB

General instructions for Rx troubleshooting

To start Rx troubleshooting:

1. Connect test jig to a computer with a DAU-9S cable or to a FPS-8 flash prommer with an XCS-4 modular cable.

Make sure that you have PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply to the module test jig with an FLC-2 cable.

3. Set the DC supply voltage to 3.6 V.

4. Connect an RF cable to the RF connector of the module test jig (MJ-19) and to RF signal generator.

5. Set the phone module to test jig and start Phoenix service software.

6. Initialize connection to the phone. (Use FBUS driver when using DAU-9S and COMBOX driver when using FPS-8).

7. From the File menu, choose "Choose Product".

8. From the list, select RA2/RA-3.

9. From the toolbar, set operating mode to "Local".

10. From the Testing menu, choose "RF Controls".

11. In the "RF Controls" window:

- Select band "GSM850", "GSM 900", "GSM 1800" or "GSM1900" (Default = "GSM900" RA-2, Default= "GSM850" RA-3)
- Set Active unit to "Rx" (Default = "Rx")
- Set Operation mode to "Burst" (Default = "Burst")

For continuous mode:
- Set Operation mode to "Continuous"
- Set AGC to "12: FEG_ON + DTOS_ON + BB_30=Vgain60" (maximum gain setting used in normal mode) (Default = "14: FEG_ON + DTOS_ON + BB_42=Vgain72")
- Set Rx/Tx channel to 190 on GSM 850, 37 on GSM900 band, 700 on GSM1800 band or 661on GSM1900 (Defaults)

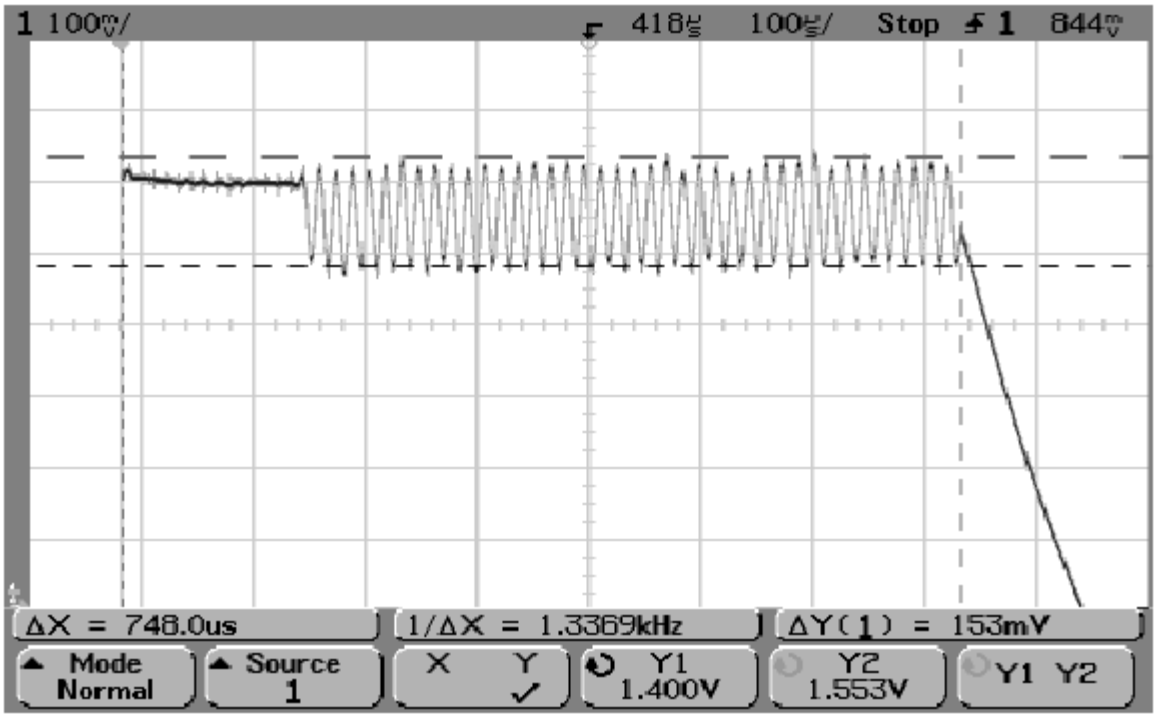
12. Apply

881,6671 MHz (channel 190 + 67,710 KHz offset),
942.46771 MHz (channel 37 + 67.710 kHz offset),
1842.86771 MHz (channel 700 + 67.710 kHz offset) or
1960.06771 MHz (channel 661 + 67.71 kHz) –90 dBm signal

to the RF connector (remember to compensate for cable attenuation).

When measuring with an oscilloscope on "RXI" or "RXQ", you should see the following screens on a working GSM900, GSM1800 or GSM1900 receiver:

Figure 7: Rx I/Q signal, burst mode, input level –90dBm



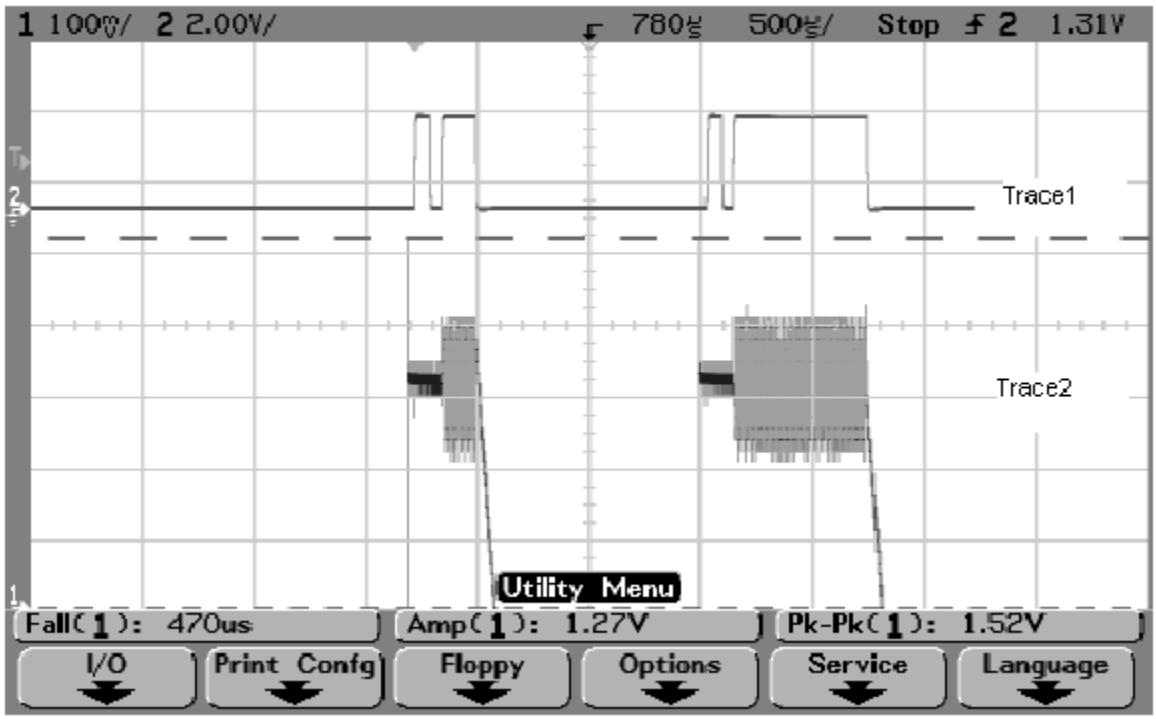
- Receiver I or Q burst mode signal (channel 37) measured from test point RXI or RXQ with 942.46771 MHz signal, input level –90dBm at RF-connector.

  Correct signal amplitudes approximately:

  GSM850~170mVpp
  GSM900~170mVpp
  GSM1800~140mVpp
  GSM1900~160mVpp

  Signal part frequency 67.7kHz sine.
  DC level of signal part is 1.35V. DC level can variate about +/-100mV between

I and Q signals and between different bands as well.

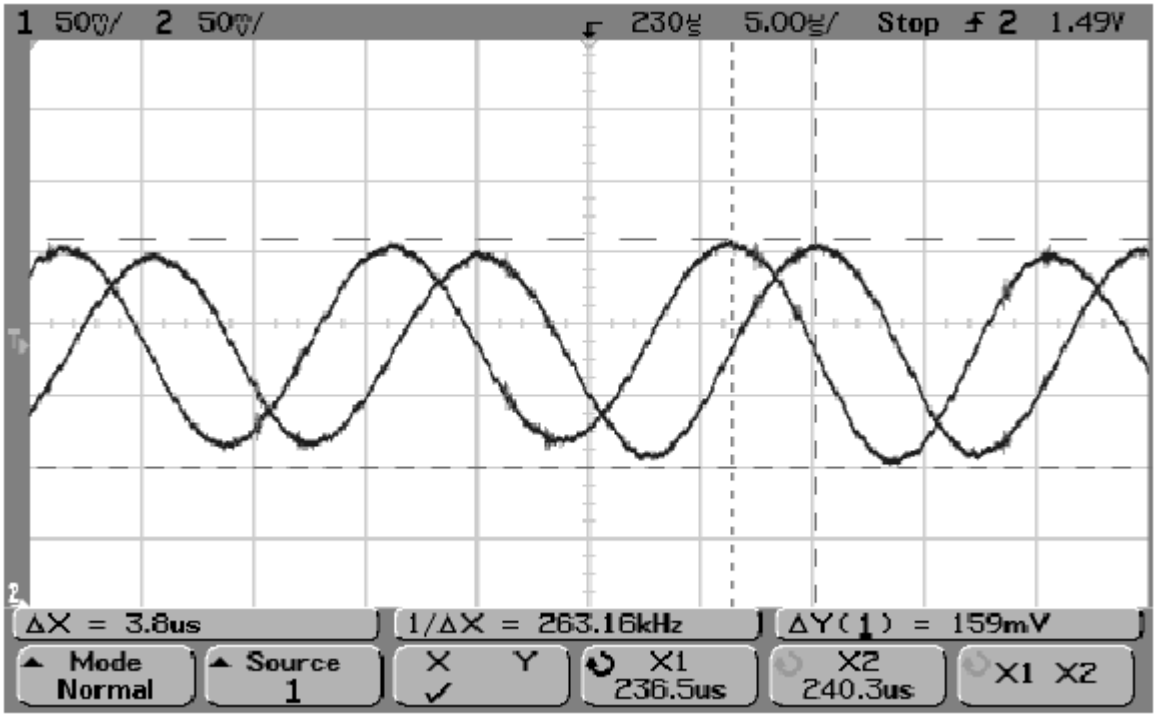


GSM1900 receiver burst mode I or Q signal at ch 661 with input signal 1960.067MHz, level –90 dBm at RF-connector.

Trace2: With wider time scaling both monitoring and own Rx bursts are seen, 1st burst (shorter) is monitoring and 2nd burst (longer) is own Rx burst.

Trace1: External LNA VCC supply voltage at burst mode, input level –90 dBm. Measured from test point LNA_VCC

Figure 8: GSM1900 Rx I or Q signal (trace2), burst mode.



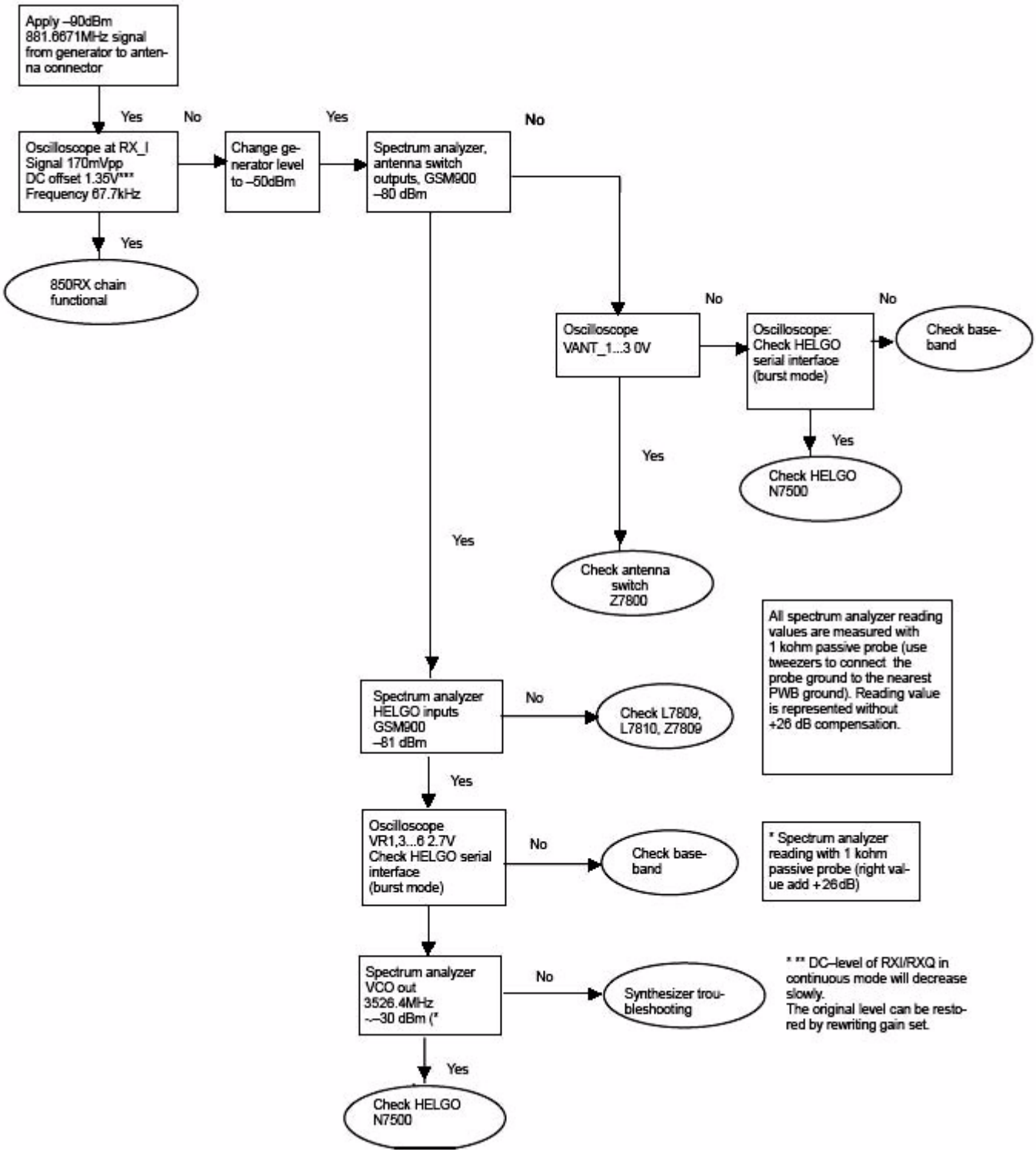
Detailed view of GSM900 continuous mode Rx I and Q signals measured from test points RXI and RXQ simultaneously.

Used channel 37, input signal 942.46771 MHz, level –90 dBm at antenna port, AGC setting 12.

Phase difference should be 90 degrees between Rx I and Q signals at all bands.

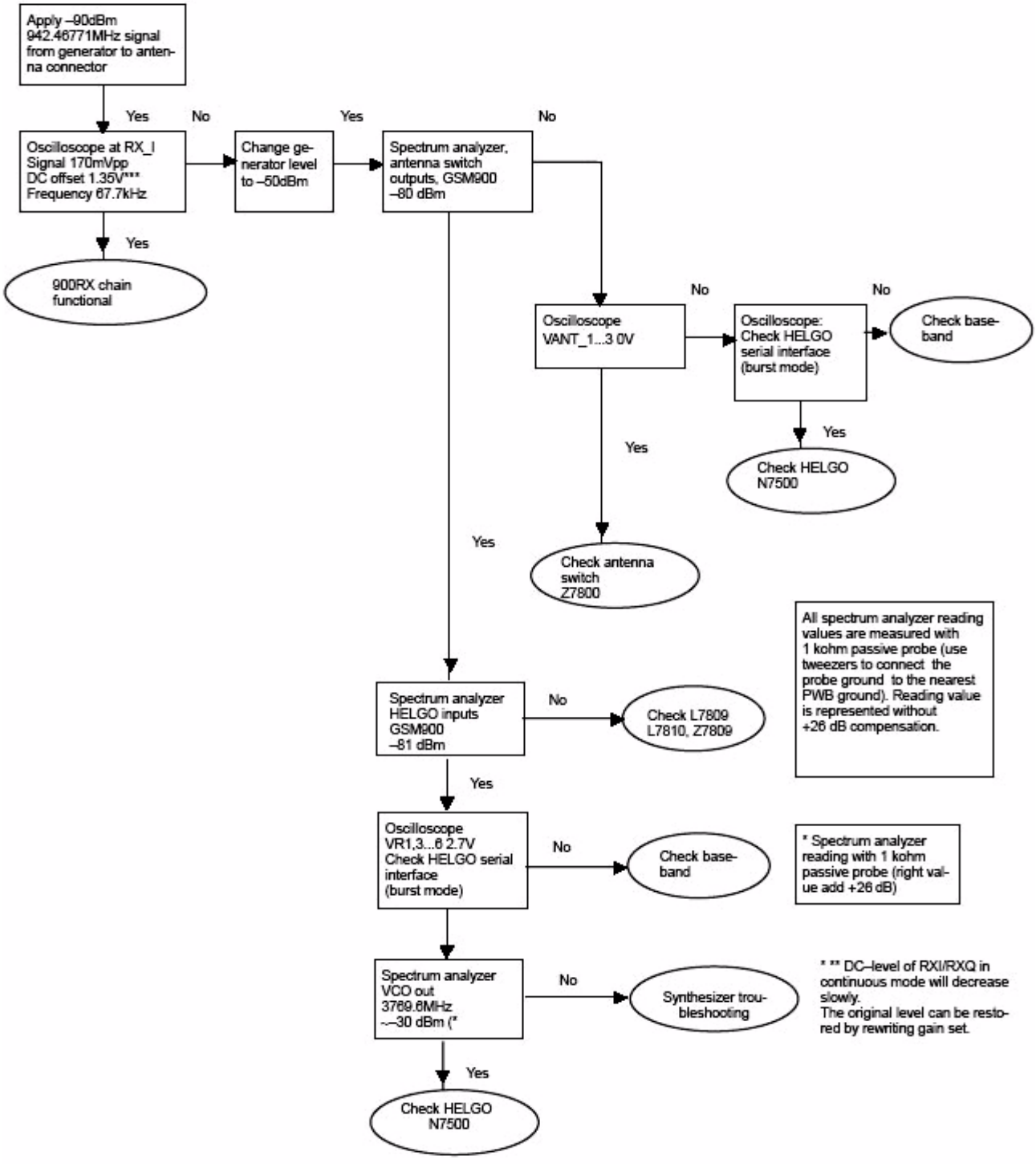
Troubleshooting diagram for GSM850 receiver

Phone in “Continuous” mode, AGC setting “12”.



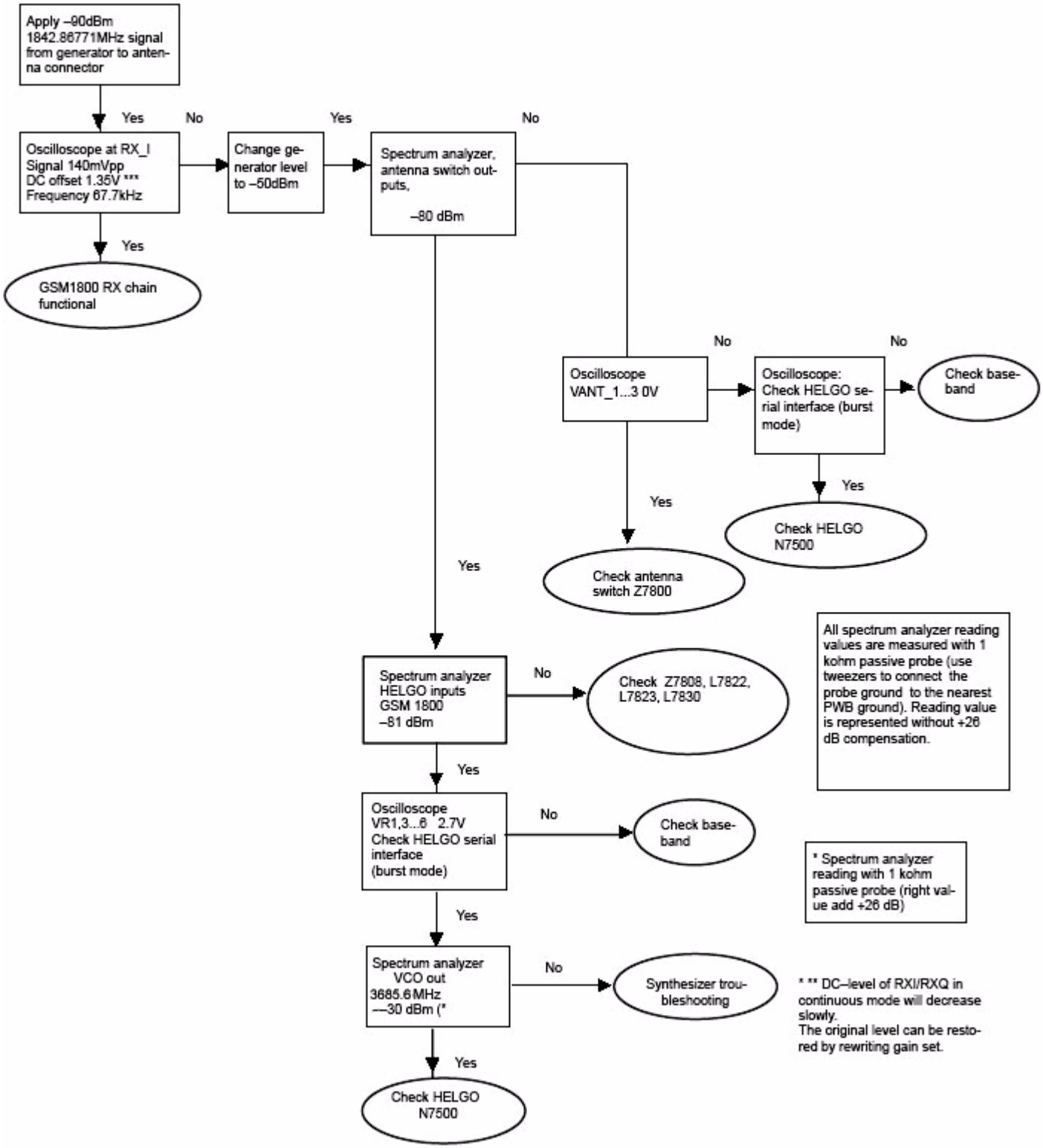
Troubleshooting diagram for GSM900 receiver

Phone in “Continuous” mode, AGC setting “12”.



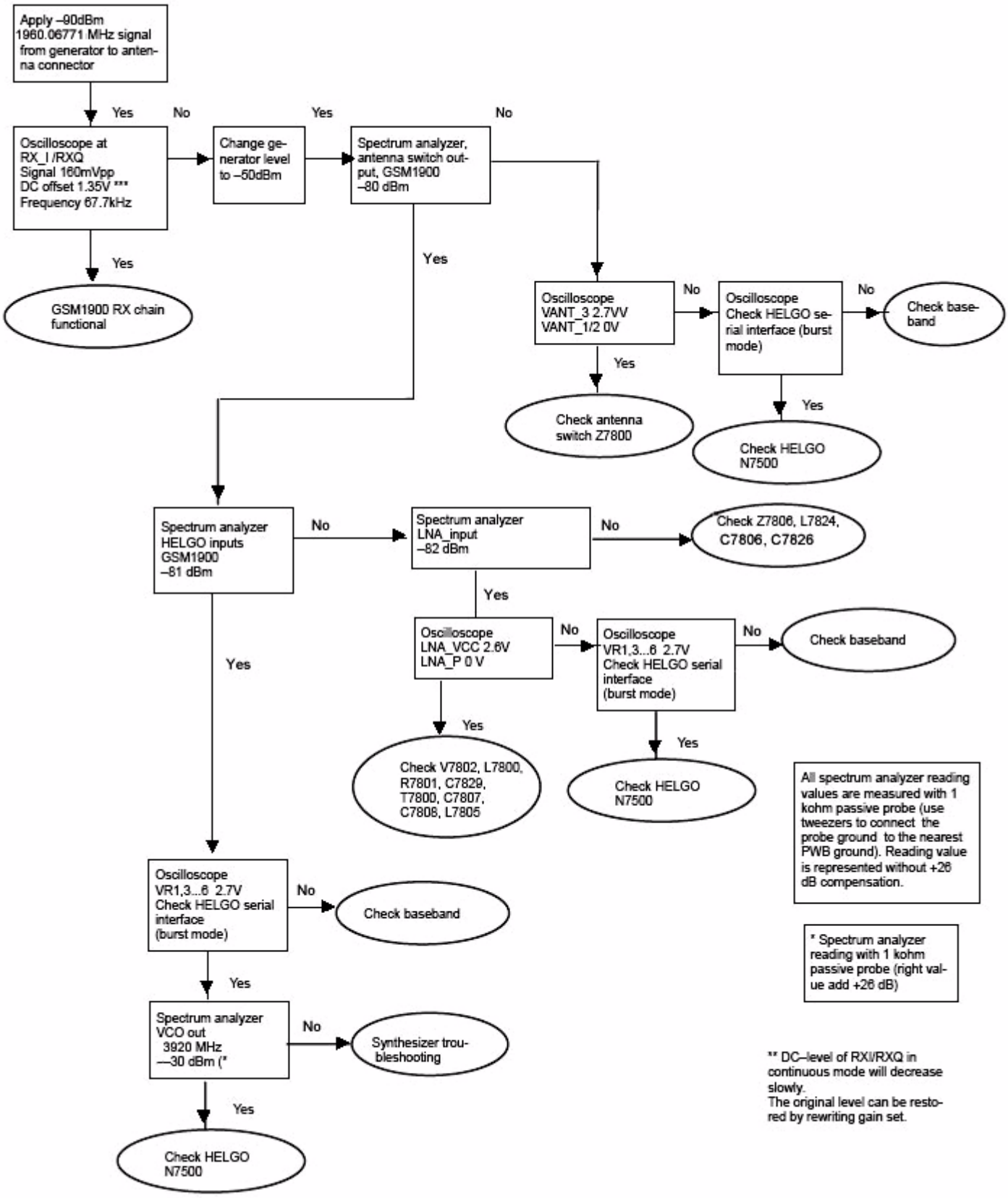
Troubleshooting diagram for GSM1800 receiver

Phone in “Continuous” mode, AGC setting “12.



Troubleshooting diagram for GSM1900 receiver

Phone in “Continuous” mode, AGC setting “12.



Transmitter description and troubleshooting

The transmitter consists of:

- two final frequency IQ-modulators
- two power amplifiers, for the lower and upper bands separately
- power control loop.

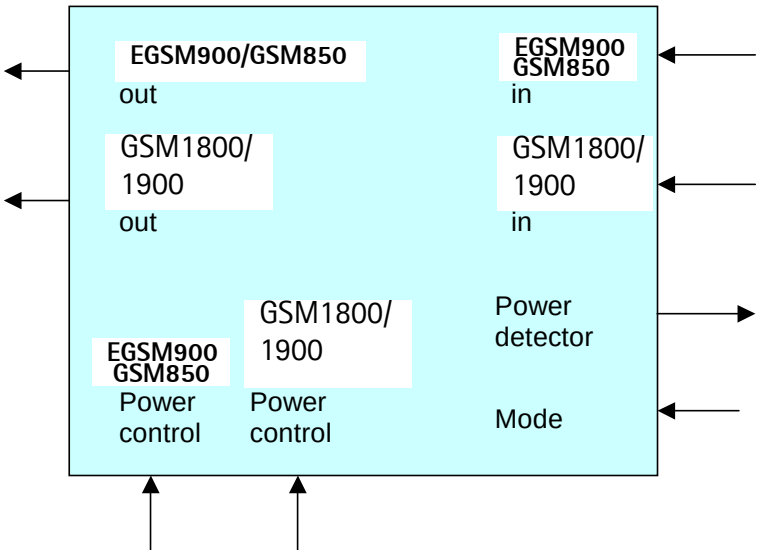
The IQ-modulators are integrated in Helgo, as well as the operational amplifiers of the power control loop. The two power amplifiers are located in a single module with a power detector. In the GMSK mode, the power is controlled by adjusting the DC bias levels of the power amplifiers.

Power amplifier

The power amplifier features include:

- 50 ohm input and output, GSM850/EGSM900/GSM1800/GSM1900
- internal power detector
- EDGE mode

Figure 9: Power amplifier



RF ASIC Helgo

The RF ASIC features include

- Package TFBGA88
- Balanced I/Q demodulator and balanced I/Q modulator
- Power control operational amplifier, acts as an error amplifier
- The signal from VCO is balanced, frequencies 3296 to 3980 MHz

- GSM850/EGSM900 and GSM1800 low noise amplifier (LNA) are integrated.

The Helgo can be tested by test points only.

AFC function

AFC is used to lock the transceiver's clock to the frequency of the base station.

Transmitter characteristics

Item	Values (GSM850/EGSM900/1800/1900)
Type	Direct conversion, nonlinear, FDMA/TDMA
LO frequency range	3296...3396/3520...3660 MHz/3420...3570 MHz/3700...3820 MHz
Output power	GMSK 33/33/30/30 dBm 8-PSK 27/27/26/26 dBm
Gain control range	min. 30 dB

General instructions for Tx troubleshooting

Please refer to section Service Concepts in Chapter 3, Service Software Instructions.

To start Tx troubleshooting:

1. Connect the test jig MJ-19 to a computer with a DAU-9S cable or to an FPS-8 flash prommer with an XCS-4 modular cable.

   Make sure that you have a PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply to the module test jig (MJ-19) with an FLC-2 cable.

   Note: When repairing or tuning the transmitter use external DC supply with at least 3A current capability. Set the DC supply voltage to 3.9V and set the jumper connector on test jig to "bypass" position.

3. Connect an RF cable to the RF connector of the module test jig (MJ-19) and measurement equipment; or at least a 10dB attenuator, otherwise the PA may be damaged. Use a spectrum analyzer as measurement equipment.

   Note: The maximum input power of a spectrum analyzer is +30dBm. It is recommended to use 10dB attenuator on the spectrum analyzer input to prevent any damage.

4. Set the phone module to test jig and start Phoenix service software.

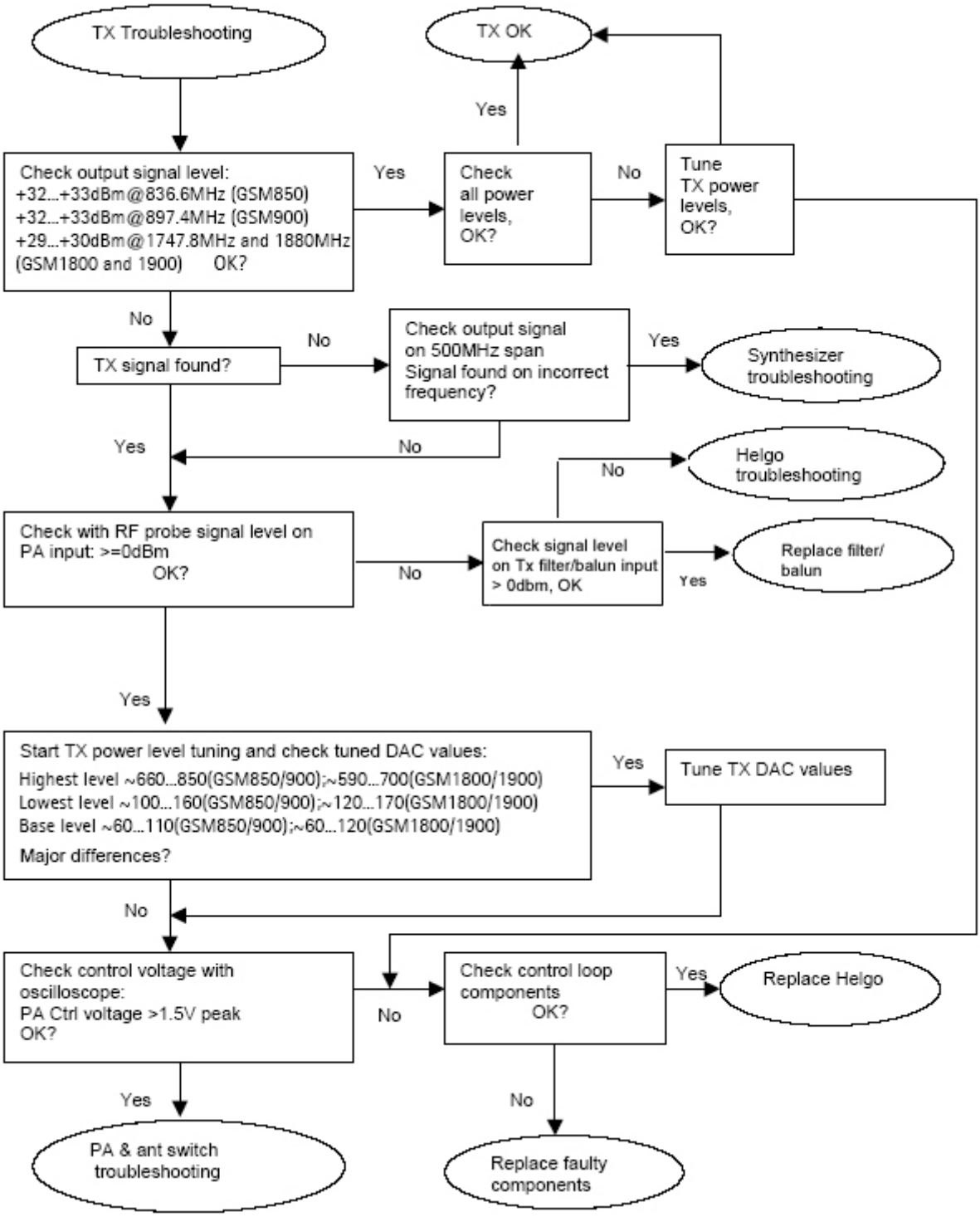
5. Initialize connection to the phone. (Use FBUS driver when using DAU-9S and COMBOX driver when using FPS-8).

6. To choose a product in Phoenix:
   From the File menu, choose "Choose Product" and select RA-2/RA-3 from the list
   or
   from the File menu, choose "Scan Product".

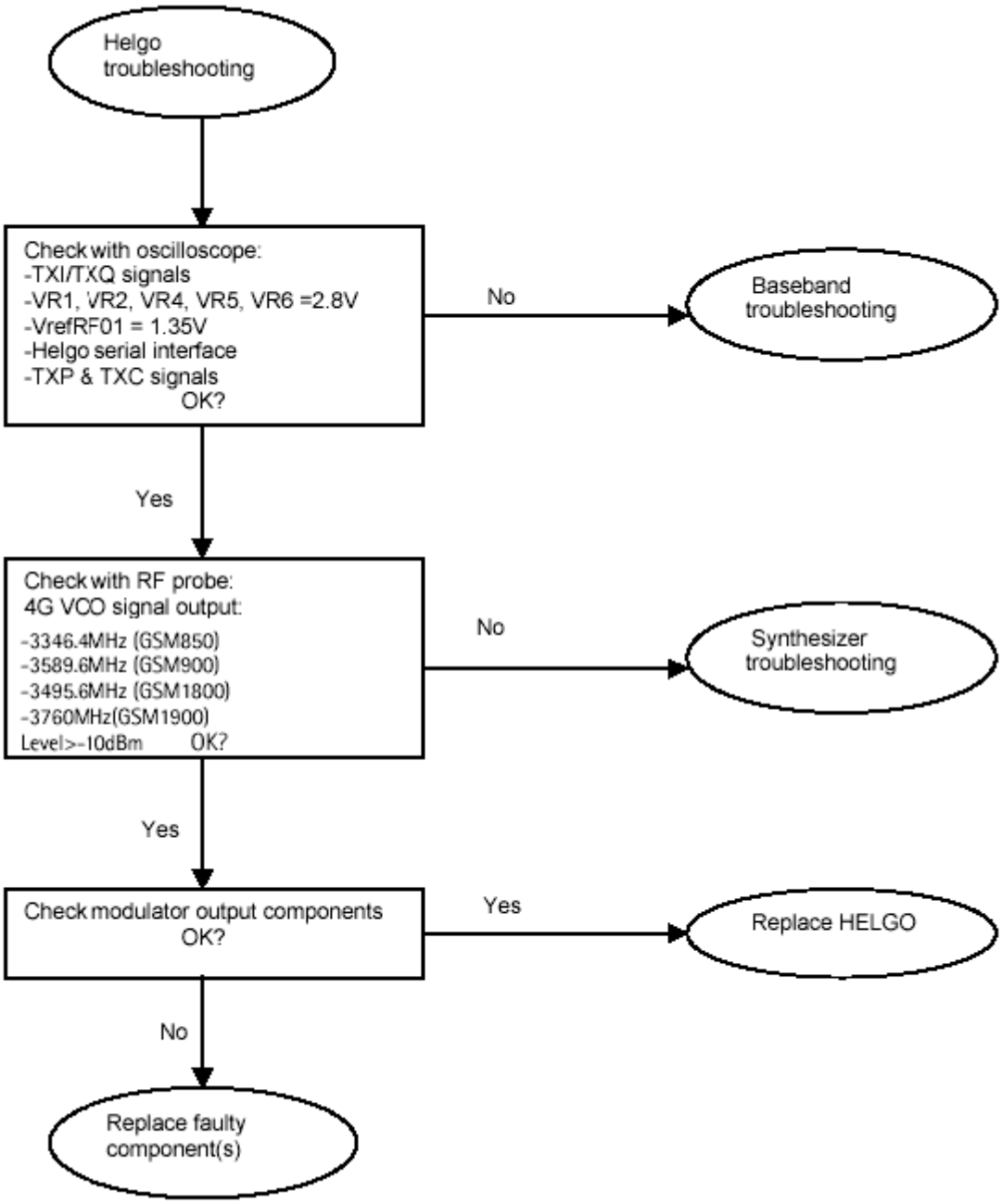
7. From the toolbar, set operating mode to "Local".
8. From the Testing menu, choose “RF Controls”.
9. In the “RF Controls” window:

- Select band “GSM 850”, "GSM900" or "GSM 1800" or "GSM1900" (Default = "GSM900" RA-2, Default= “GSM850” RA-3).
- Set Active unit to "Tx" (Default = "Rx").
- Set Operation mode to "Burst" (Default = "Burst").
- Set Tx data type to "Random" (Default = "All1").
- Set Rx/Tx channel to 190 on GSM 850, 37 on GSM900 band or 700 on GSM1800 band or 661 on GSM1900 (Defaults).
- Set Tx PA mode to "Free" (Default).
- Set power level to 5 (Default = 19) on GSM 850 and GSM900 or to 0 (Default = 15) on GSM1800 or GSM1900.

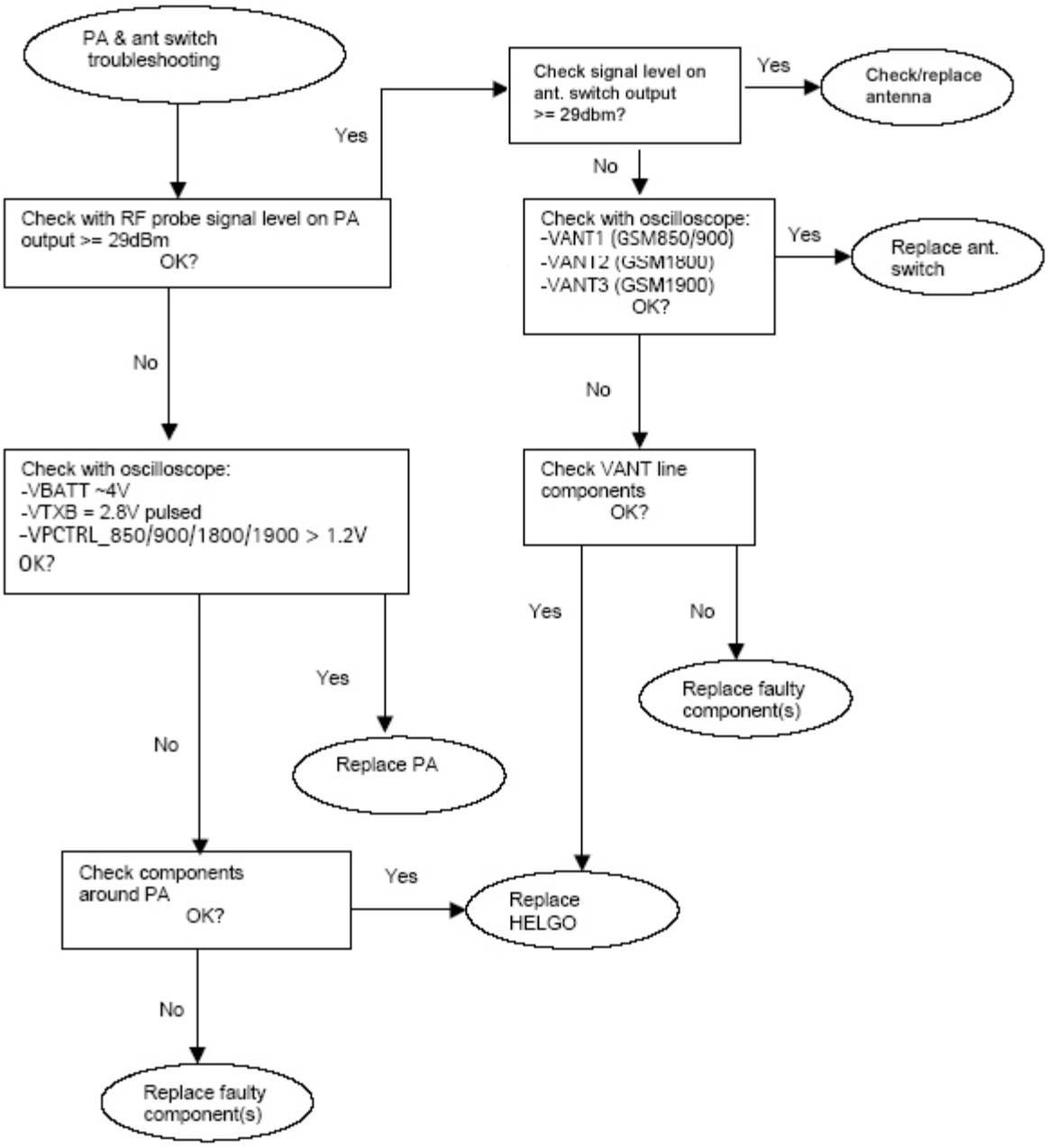
Transmitter troubleshooting diagram



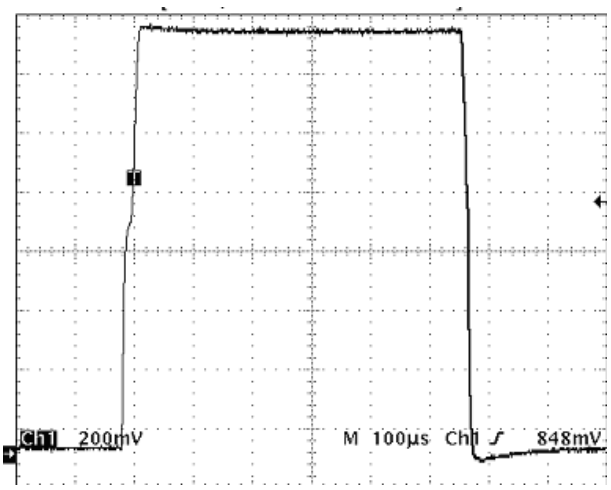
HELGO IC troubleshooting diagram



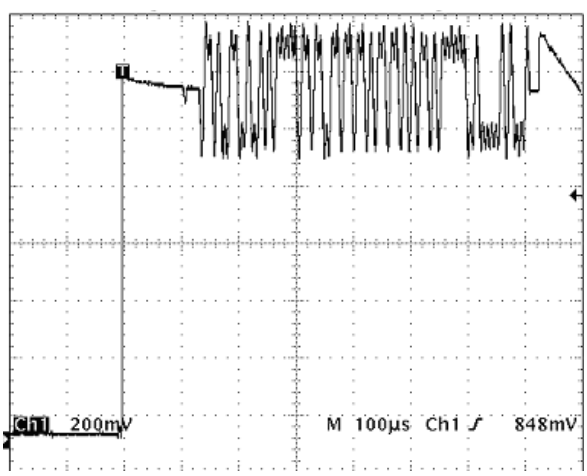
PA and antenna switch troubleshooting diagram



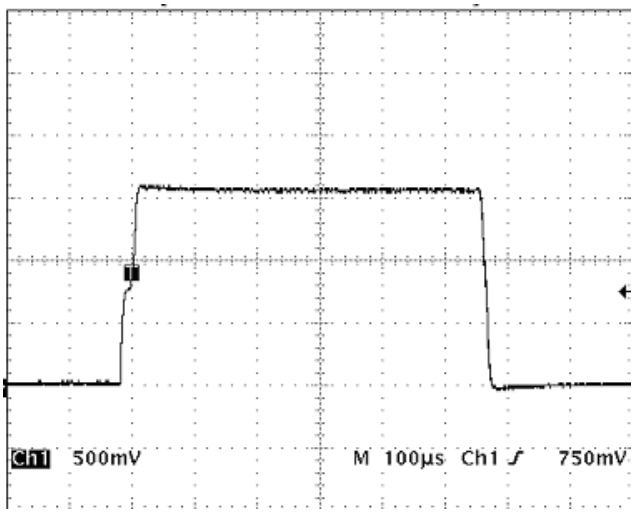
Pictures of transmitter signals



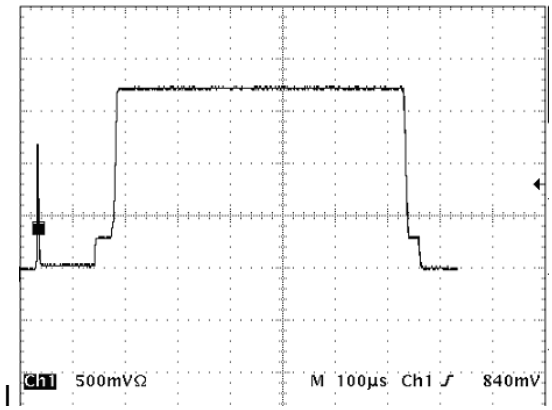
VPCTRL 850/900 power level 5 at R7703/C7703
VPCRTL_1800/1900 power level 0 at R7704/C7704



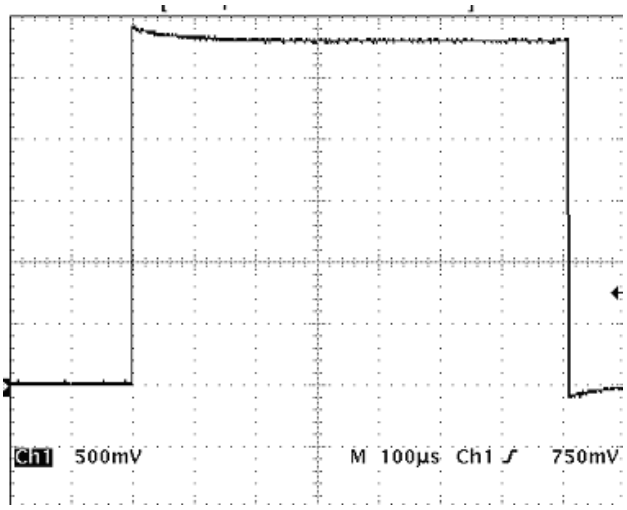
TXI/TXQ TX signals at R7516/R7515/C7535/C7536



VTXB 850/900 at C7713 VTXB_1800/1900 at C7714

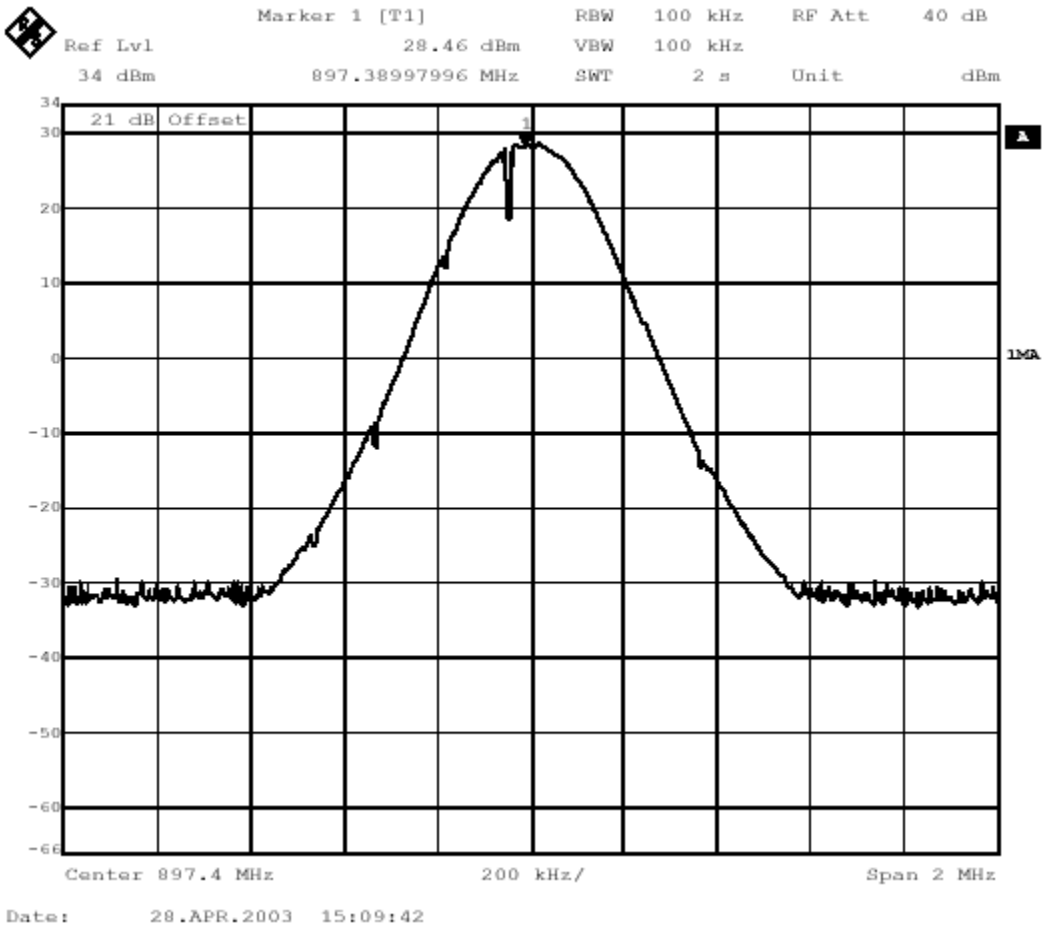


TXC 850/900 power level 5 at R7522



VANT_1 at C7805 VANT_2 at C7804
VANT_3 at C7538

Figure 10: Tx out signal, 900 band burst mode, channel 37



Additional information for EDGE troubleshooting

Note! EDGE mode troubleshooting differs slightly from basic GSM troubleshooting.

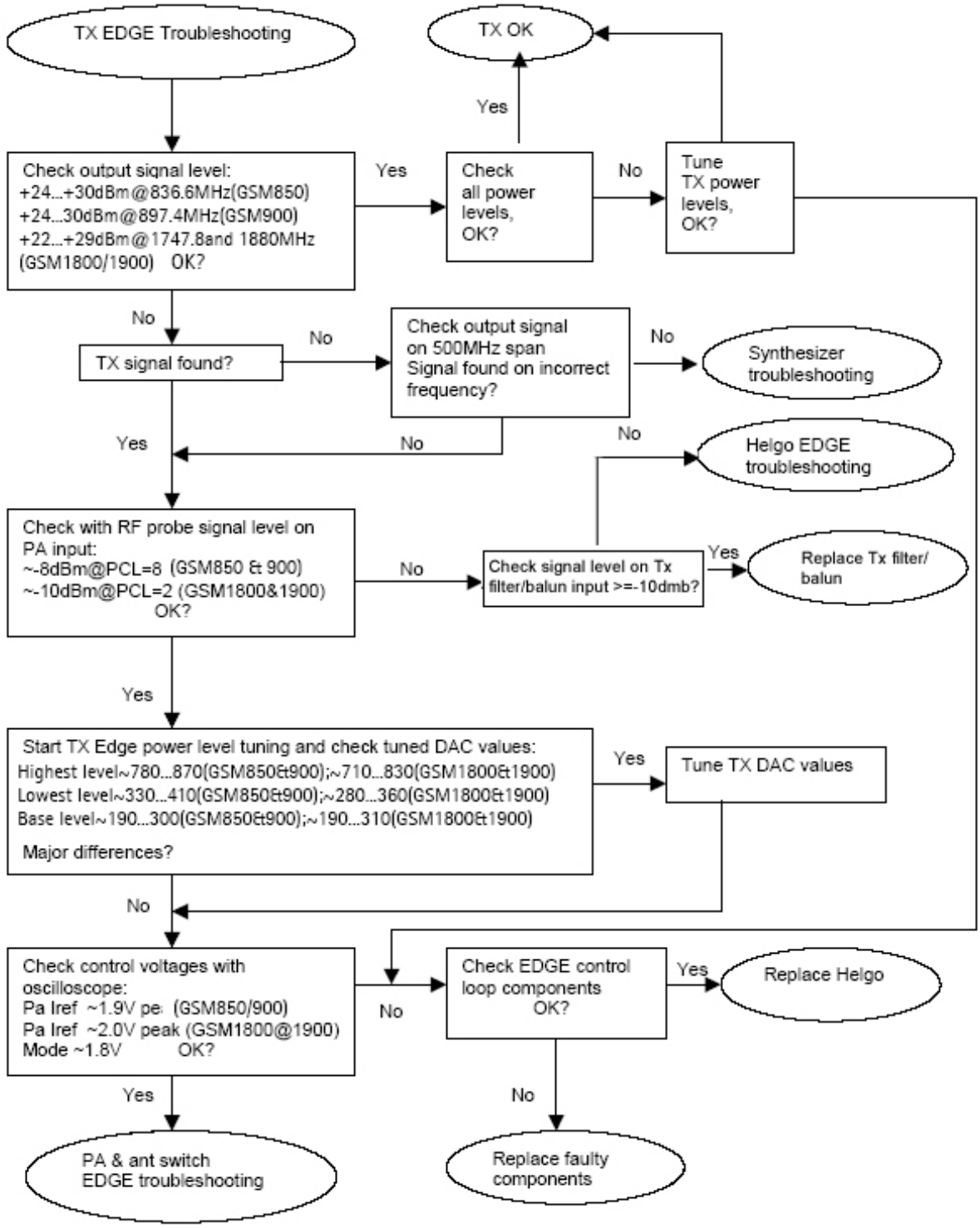
To start EDGE troubleshooting:

1. Initialize a connection to the phone (see GSM850/900/1800/1900 trouble-shooting instructions).
2. To select a product in Phoenix:
From the File menu, choose “Choose Product “and select RA-2/RA-3 from the list
or
from the File menu, choose “Scan Product”.
3. From the toolbar, set operating mode to “Local”
4. From the Testing menu, choose “RF Controls”.
5. In the “RF Controls” window:

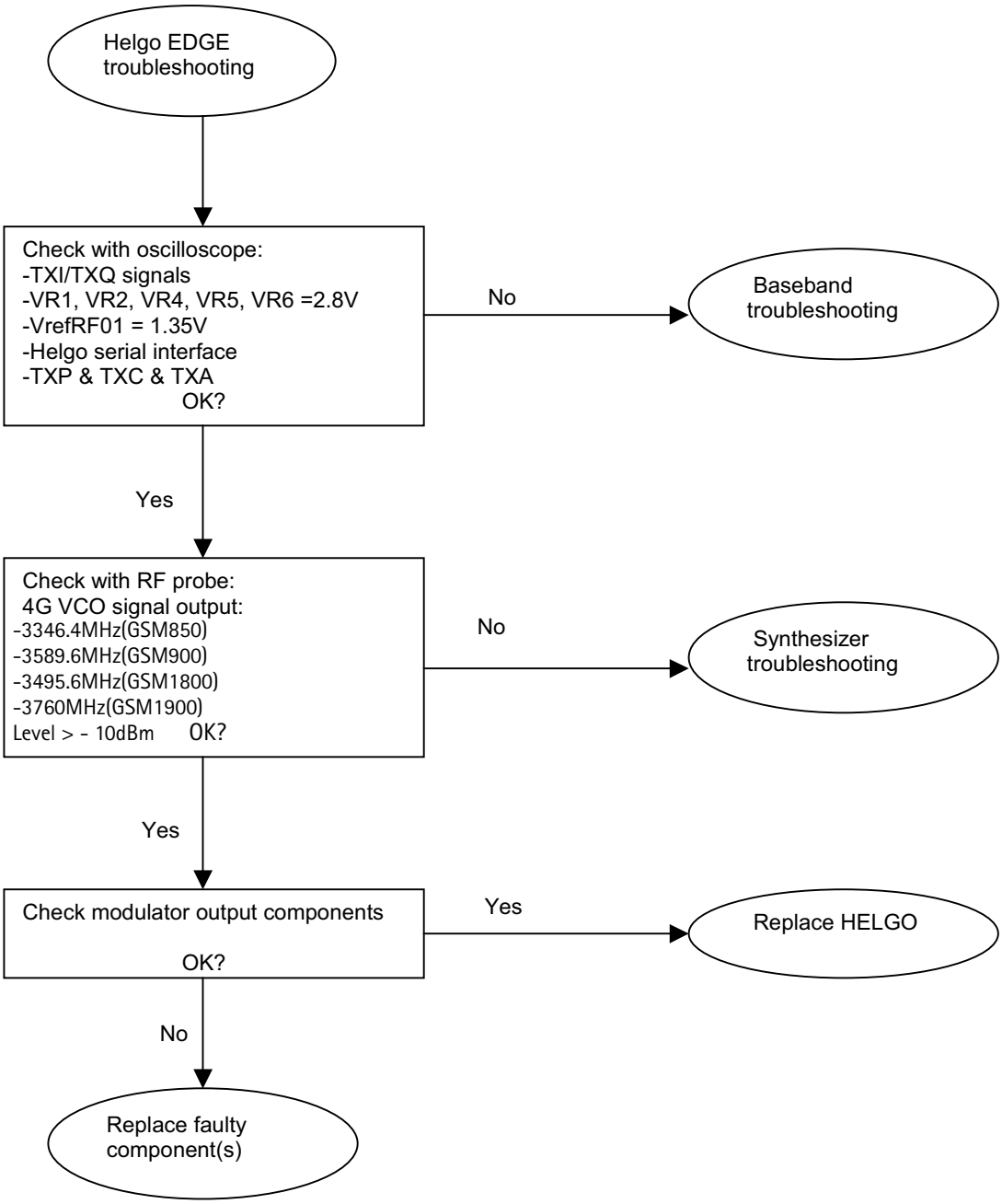
- Select Band “GSM850”, “GSM900” or “GSM1800” or “GSM1900” (Default = "GSM900" RH-30, Default= “GSM850” RH-31).
- Set Active unit to “Tx” (Default=”Rx”).
- Set Edge “On” (Default=”Off”).
- Set Operation mode to “Burst” (Default=”Burst”).
- Set Tx data type to “Alternate PN9” (Default=”All1”).
- Set Rx/Tx channel to 190 on GSM850, 37 on GSM900 or 700 on GSM1800 or 661 on GSM1900 (Defaults).
- Set power level to 8 (Default = 19) on GSM850 and GSM900 or to 2 (Default = 0) on GSM1800 or GSM1900.

Note! For GSM850/900 Edge power levels 5, 6 and 7 are not in use and for GSM1800&1900 Edge power levels 0 and 1 are not in use.

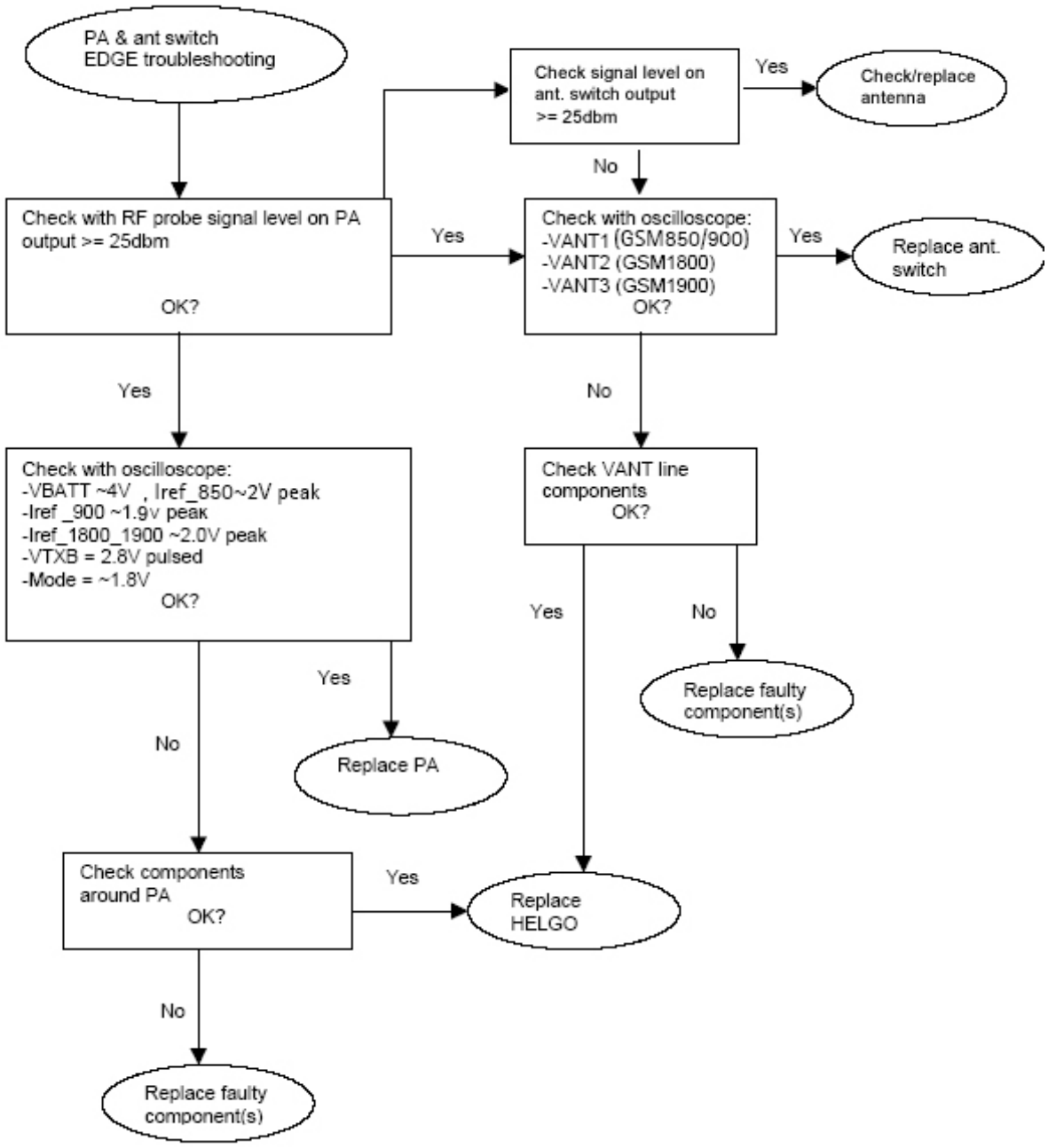
Transmitter EDGE troubleshooting diagram



HELGO EDGE troubleshooting diagram



PA and antenna switch EDGE troubleshooting diagram



Pictures of EDGE transmitter signals

Figure 11: I_ref_1800/1900 power level 2 at R7700/C7700

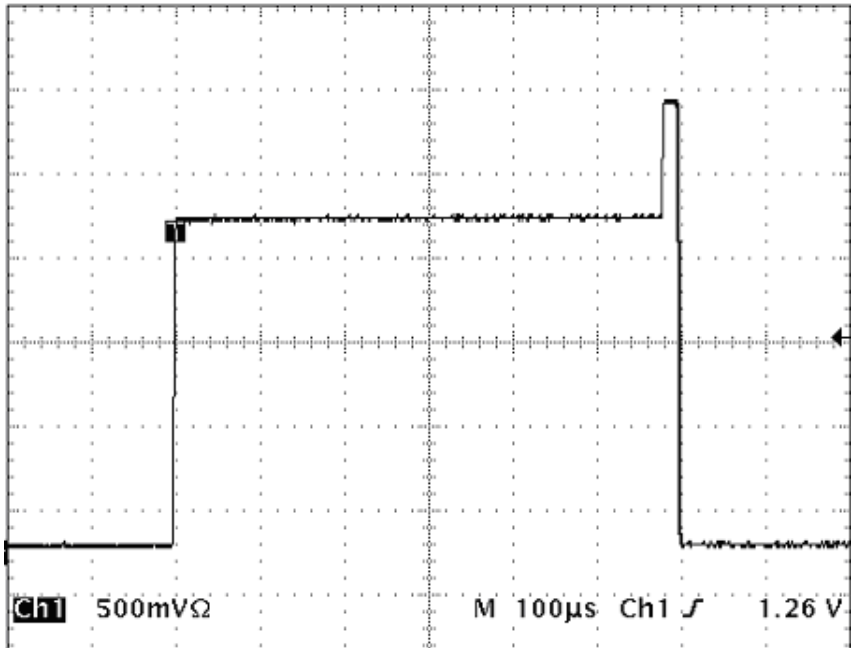


Figure 12: VTXB 1800/1900 power level 2 at C7714

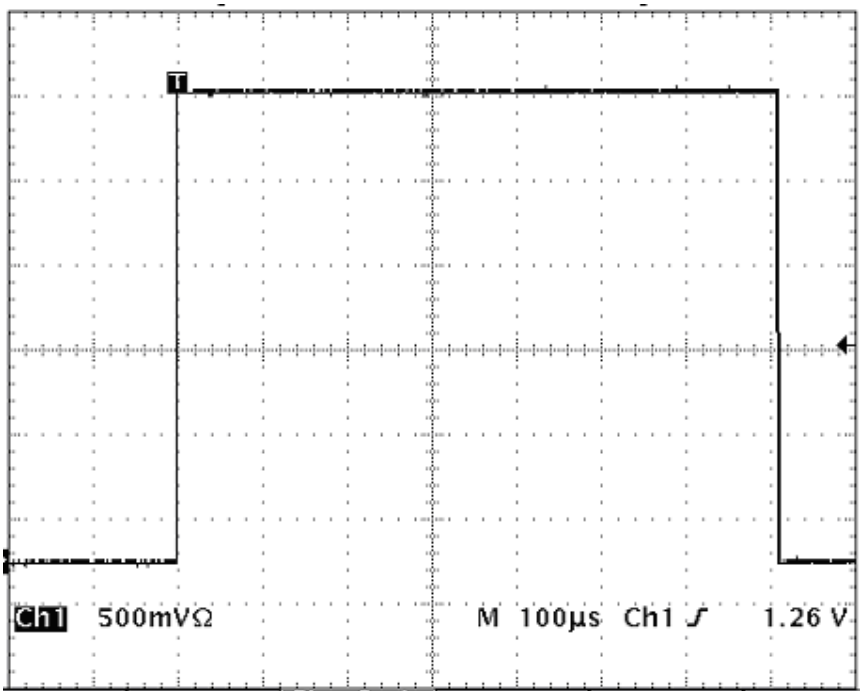


Figure 13: TXI/TXQ signal at C7535/C7536/R7516/R7517

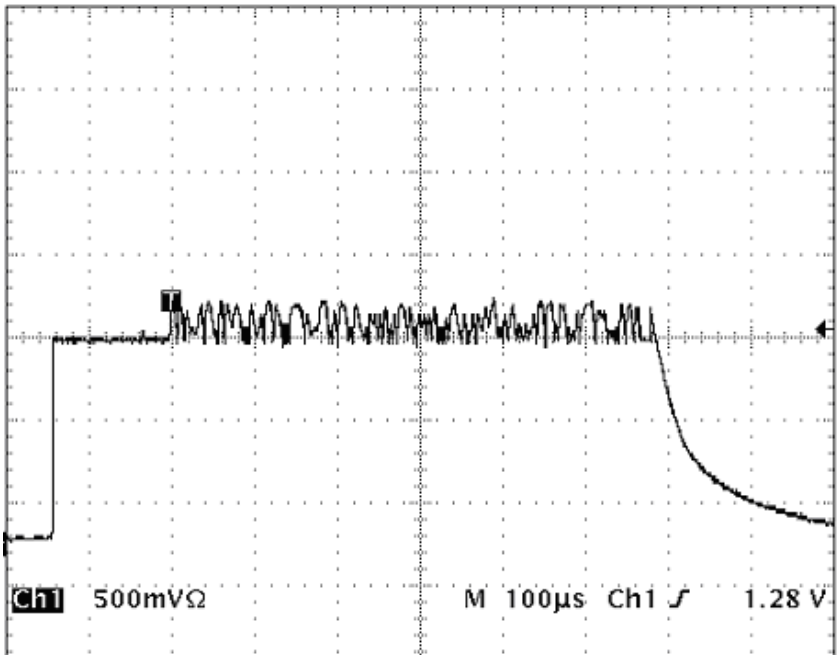


Figure 14: TXA 850/900/1800/1900 at C7538

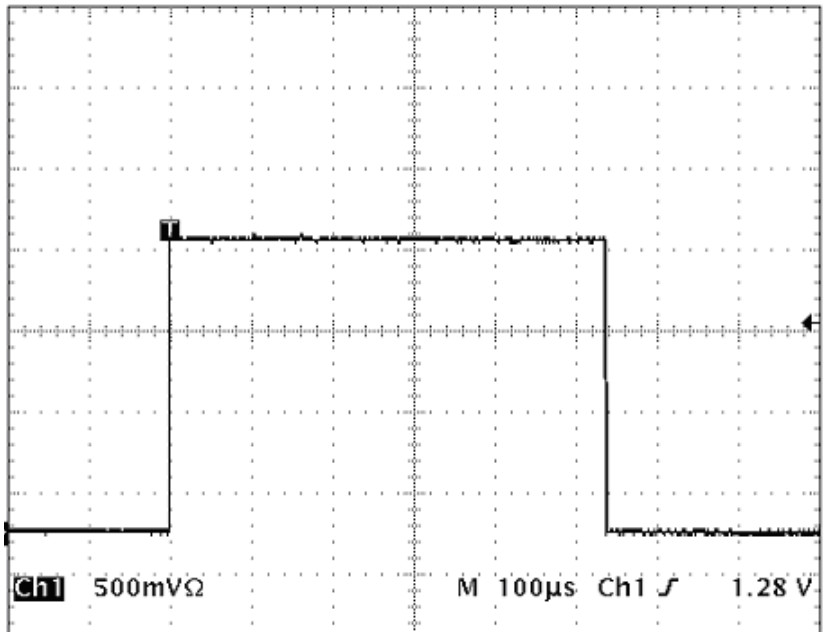


Figure 15: VTXB 850/900 power level 8 at C7713

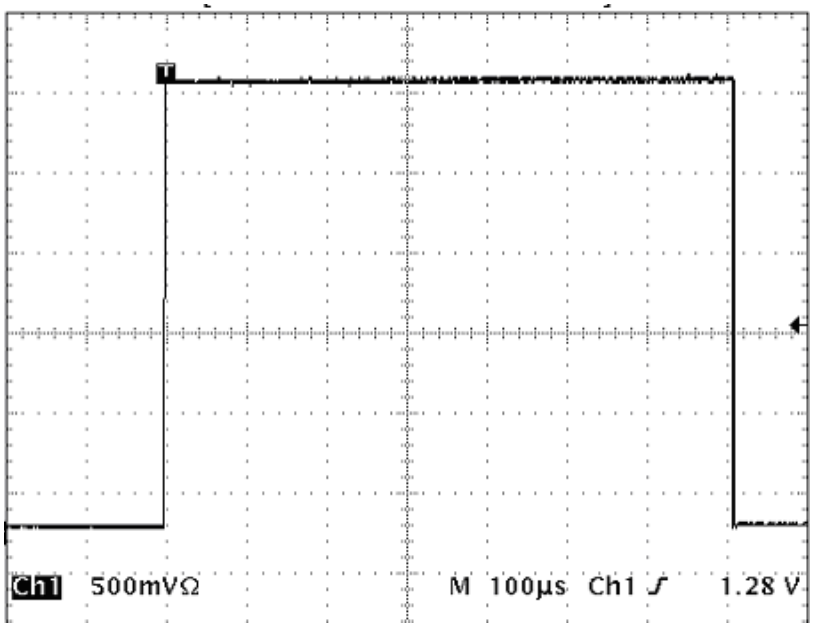


Figure 16: I_ref 850/900 power level 8 at R7701/C7701

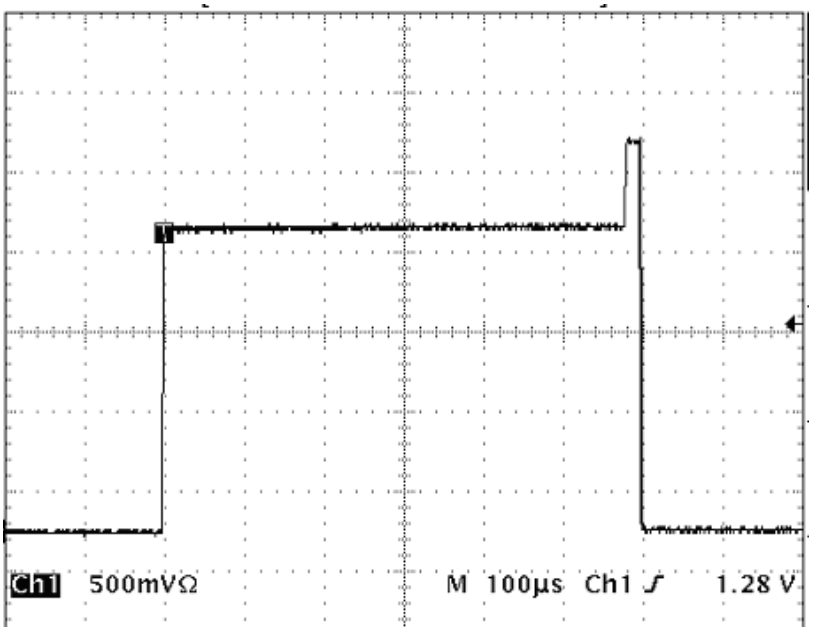
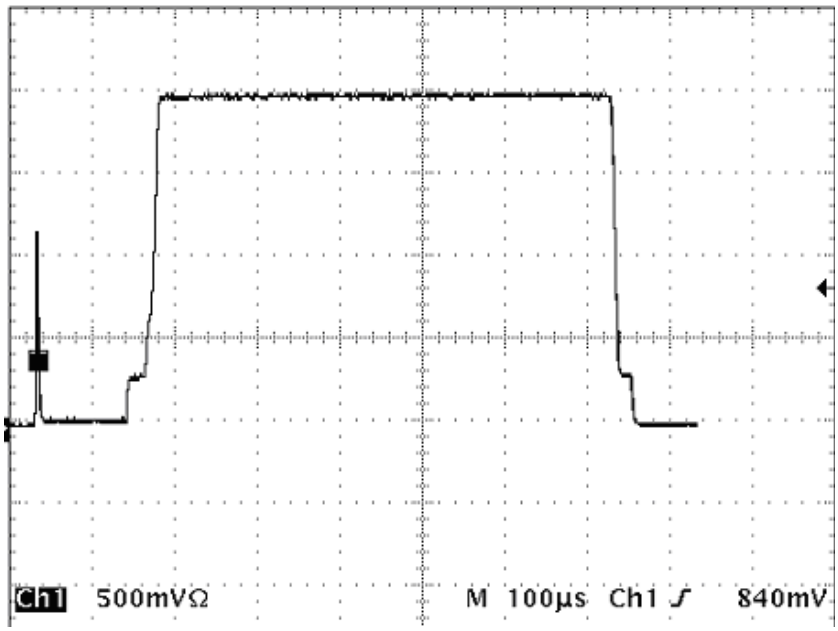


Figure 17: TXC 850/900 power level 8 at 7522



Synthesizer description and troubleshooting

Frequency synthesizers

The VCO frequency is locked by a PLL (phase locked loop) into a stable frequency source given by a VCTCXO which is running at 26 MHz. The frequency of the VCTCXO is in turn locked into the frequency of the base station with the help of an AFC voltage which is generated in UEM by an 11 bit D/A converter. The PLL is located in Helgo and it is controlled through the RFBus.

The required frequency dividers for modulator and demodulator mixers are integrated in Helgo.

Loop filter filters out the comparison pulses of the phase detector and generates a DC control voltage to the VCO. The loop filter determines the step response of the PLL (settling time) and contributes to the stability of the loop.

The frequency synthesizer is integrated in Helgo except for the VCTCXO, VCO, and the loop filter.

General instructions for synthesizer troubleshooting

To start synthesizer troubleshooting:

1. Connect the test jig (MJ-19) to a computer with a DAU-9S cable or to an FPS-8 flash prommer with an XCS-4 modular cable.

   Make sure that you have a PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply or FPS-8 to the module test jig with a PCS-1 cable.

3. Set the DC supply voltage to 3.6V and set the jumper connector on test jig to "bypass" position.

4. Set the phone module to test jig and start Phoenix service software

5. Initialize connection to the phone. (Use FBUS driver when using DAU-9S and COMBOX driver when using FPS-8).

6. From the File menu, choose "Choose Product".

7. From the list, select RA-2/RA-3.

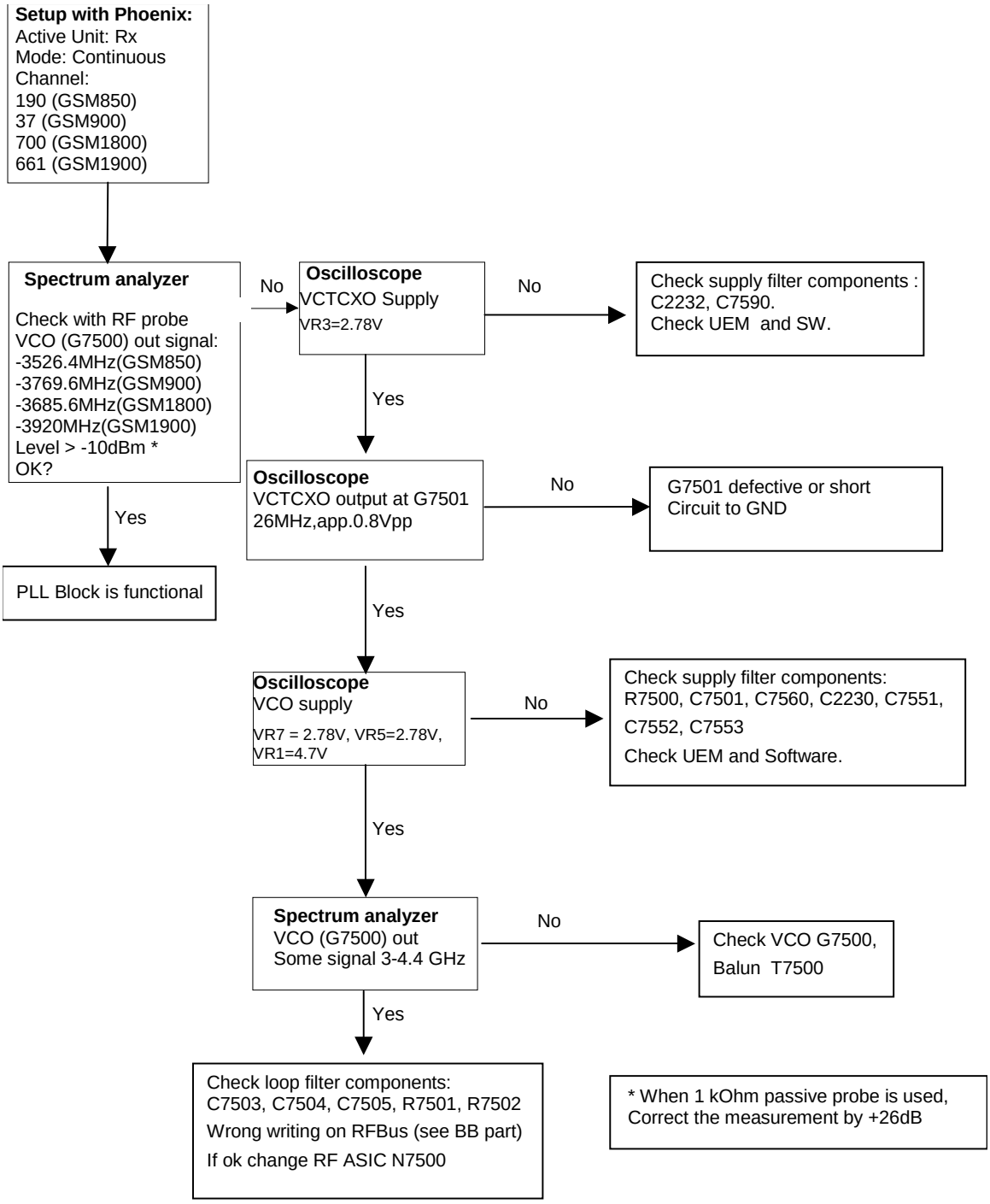
8. From the toolbar, set operating mode to "Local"

9. From the Testing menu, choose "RF Controls".

10. In the "RF Controls" window:

- Select band "GSM850", "GSM900", "GSM 1800" or "GSM1900" (Default = "GSM900" RA-2, Default= "GSM850" RA-3).
- Set Active unit to "Rx" (Default = "Rx").
- Set Operation mode to "Continuous" (Default = "Burst").
- Set Rx/Tx channel to 190 on GSM850, 37 on GSM900 band, 700 on GSM1800 band, 661 on GSM1900 band (Defaults).

Troubleshooting diagram for synthesizer



Pictures of synthesizer signals

Figure 18: 26MHz at G501 pin out

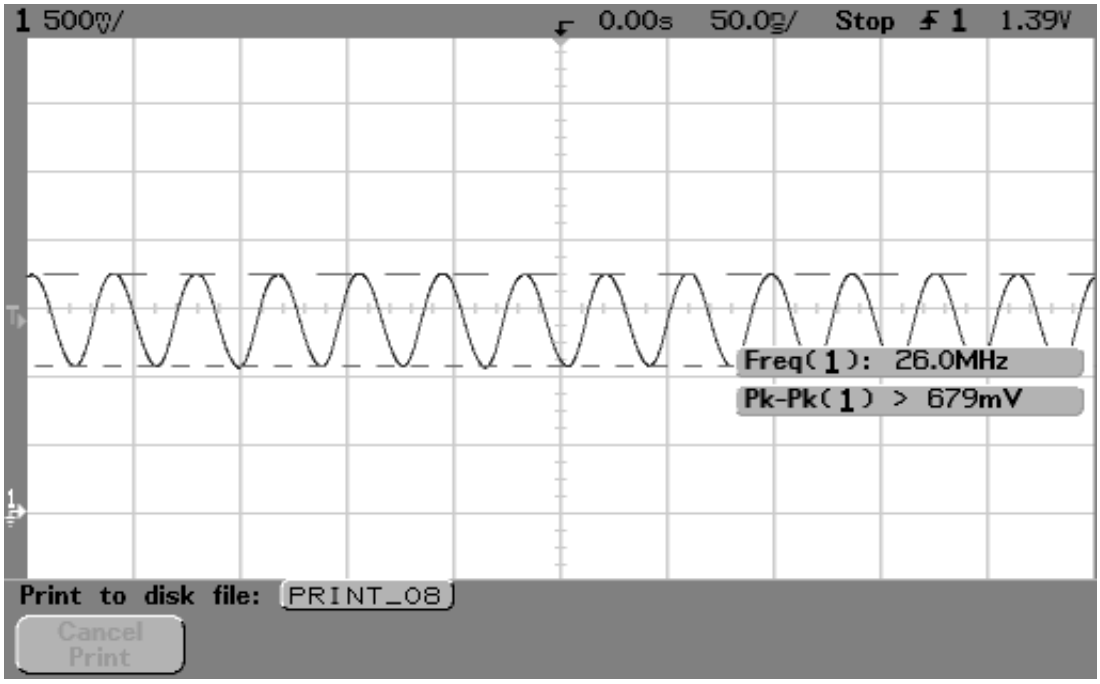


Figure 19: 26MHz RFCLK at R420/C420

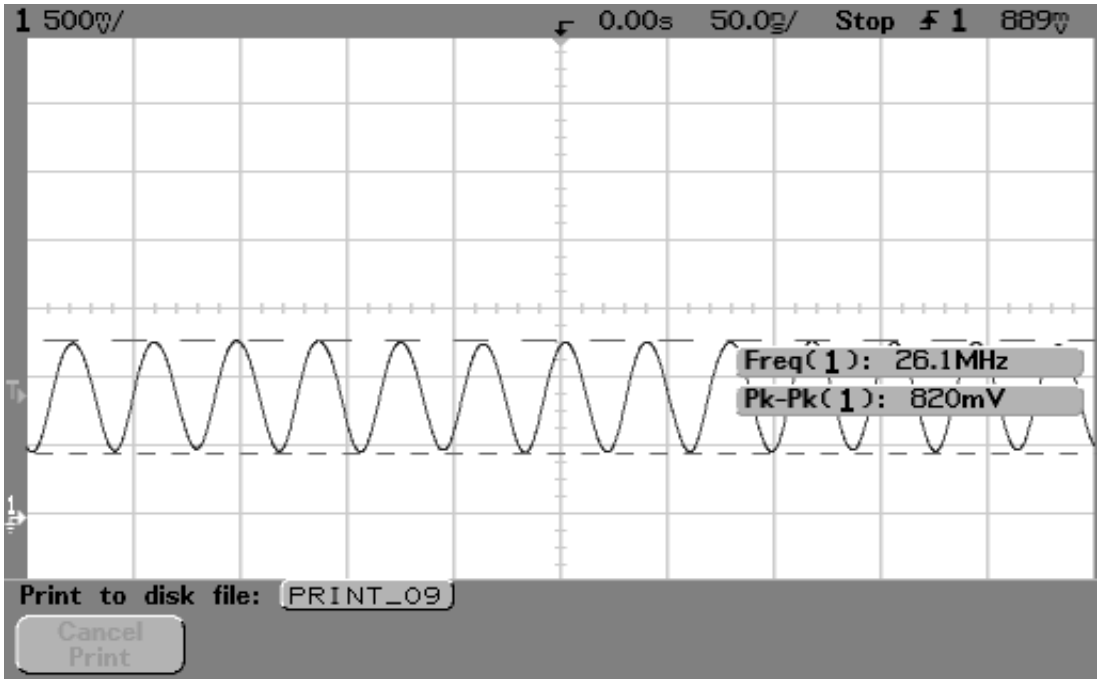


Figure 20: 1800 Tx, channel 512, burst mode

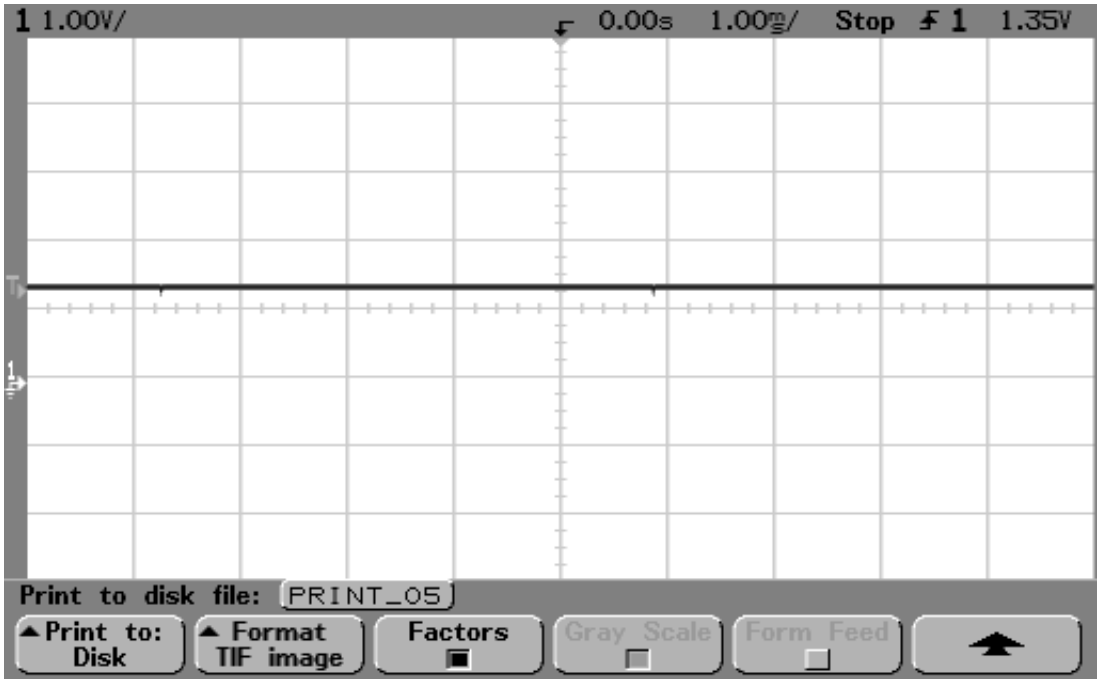


Figure 21: 1900 Rx, channel 810, continuous mode

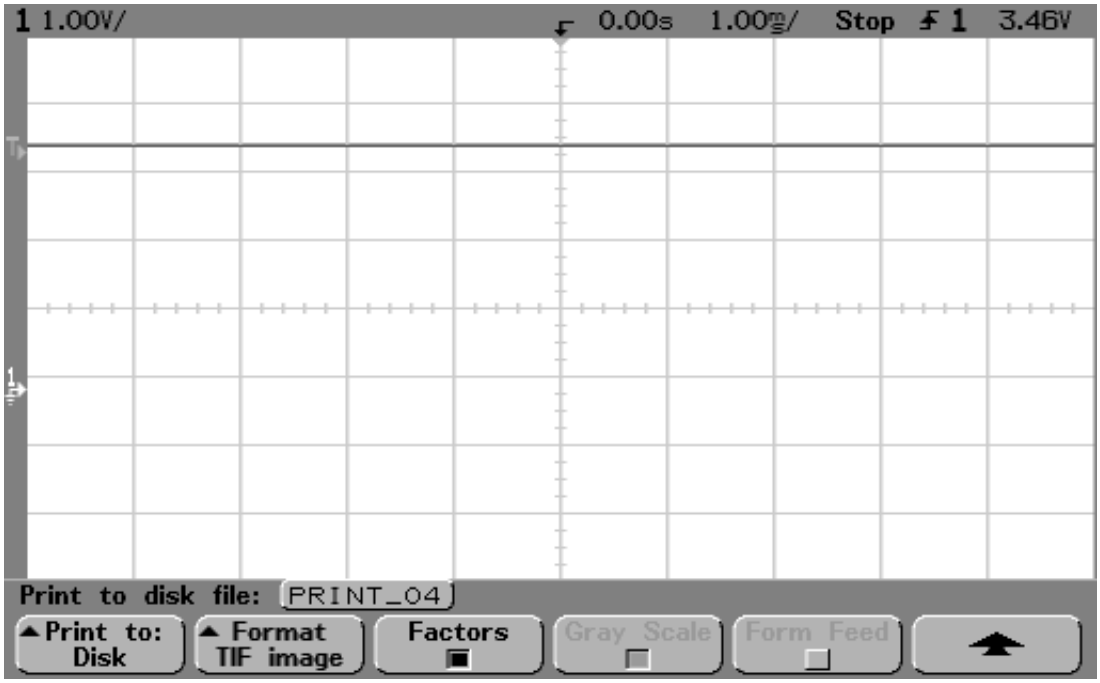
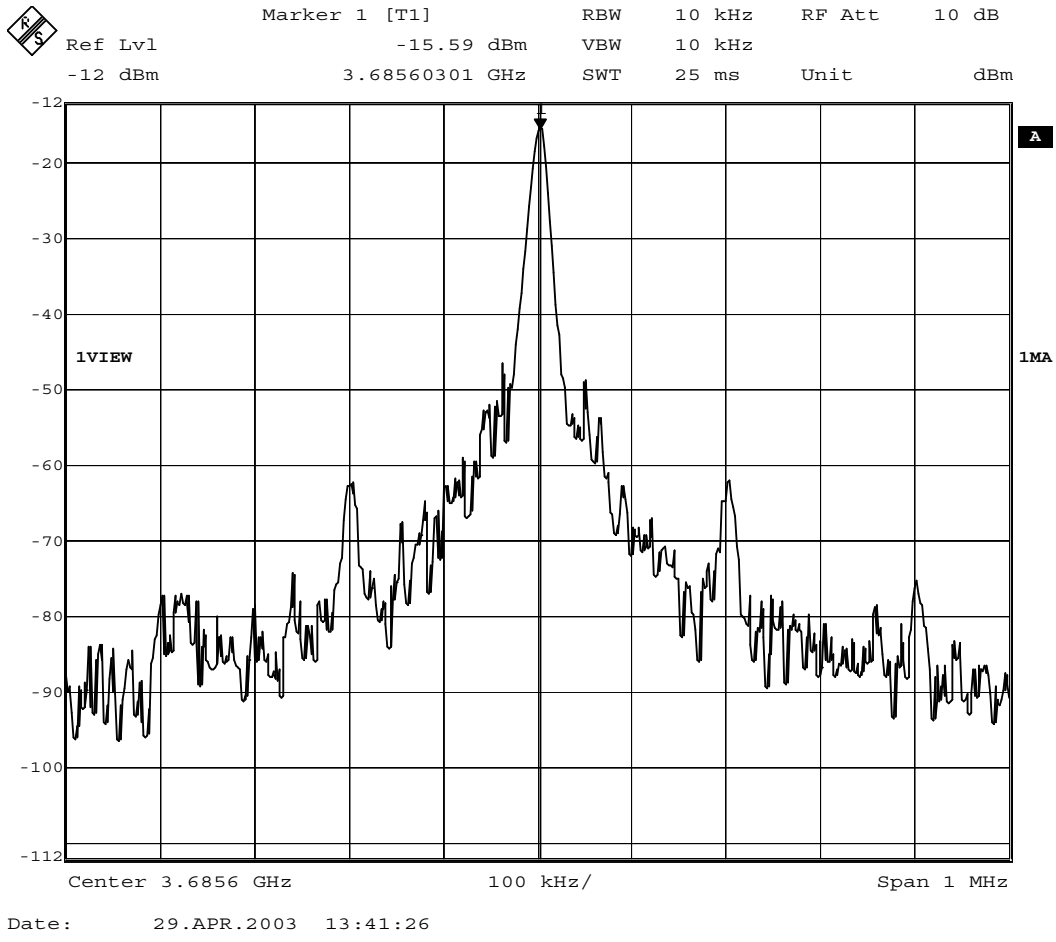


Figure 22: VCO output, 1800 band, ch700, Rx on, continuous output



Frequency Lists

GSM850

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
128	824.2	869.2	3296.8	3476.8	190	836.6	881.6	3346.4	3526.4
129	824.4	869.4	3297.6	3477.6	191	836.8	881.8	3347.2	3527.2
130	824.6	869.6	3298.4	3478.4	192	837.0	882.0	3348.0	3528.0
131	824.8	869.8	3299.2	3479.2	193	837.2	882.2	3348.8	3528.8
132	825.0	870.0	3300.0	3480.0	194	837.4	882.4	3349.6	3529.6
133	825.2	870.2	3300.8	3480.8	195	837.6	882.6	3350.4	3530.4
134	825.4	870.4	3301.6	3481.6	196	837.8	882.8	3351.2	3531.2
135	825.6	870.6	3302.4	3482.4	197	838.0	883.0	3352.0	3532.0
136	825.8	870.8	3303.2	3483.2	198	838.2	883.2	3352.8	3532.8
137	826.0	871.0	3304.0	3484.0	199	838.4	883.4	3353.6	3533.6
138	826.2	871.2	3304.8	3484.8	200	838.6	883.6	3354.4	3534.4
139	826.4	871.4	3305.6	3485.6	201	838.8	883.8	3355.2	3535.2
140	826.6	871.6	3306.4	3486.4	202	839.0	884.0	3356.0	3536.0
141	826.8	871.8	3307.2	3487.2	203	839.2	884.2	3356.8	3536.8
142	827.0	872.0	3308.0	3488.0	204	839.4	884.4	3357.6	3537.6
143	827.2	872.2	3308.8	3488.8	205	839.6	884.6	3358.4	3538.4
144	827.4	872.4	3309.6	3489.6	206	839.8	884.8	3359.2	3539.2
145	827.6	872.6	3310.4	3490.4	207	840.0	885.0	3360.0	3540.0
146	827.8	872.8	3311.2	3491.2	208	840.2	885.2	3360.8	3540.8
147	828.0	873.0	3312.0	3492.0	209	840.4	885.4	3361.6	3541.6
148	828.2	873.2	3312.8	3492.8	210	840.6	885.6	3362.4	3542.4
149	828.4	873.4	3313.6	3493.6	211	840.8	885.8	3363.2	3543.2
150	828.6	873.6	3314.4	3494.4	212	841.0	886.0	3364.0	3544.0
151	828.8	873.8	3315.2	3495.2	213	841.2	886.2	3364.8	3544.8
152	829.0	874.0	3316.0	3496.0	214	841.4	886.4	3365.6	3545.6
153	829.2	874.2	3316.8	3496.8	215	841.6	886.6	3366.4	3546.4
154	829.4	874.4	3317.6	3497.6	216	841.8	886.8	3367.2	3547.2
155	829.6	874.6	3318.4	3498.4	217	842.0	887.0	3368.0	3548.0
156	829.8	874.8	3319.2	3499.2	218	842.2	887.2	3368.8	3548.8
157	830.0	875.0	3320.0	3500.0	219	842.4	887.4	3369.6	3549.6
158	830.2	875.2	3320.8	3500.8	220	842.6	887.6	3370.4	3550.4
159	830.4	875.4	3321.6	3501.6	221	842.8	887.8	3371.2	3551.2
160	830.6	875.6	3322.4	3502.4	222	843.0	888.0	3372.0	3552.0
161	830.8	875.8	3323.2	3503.2	223	843.2	888.2	3372.8	3552.8
162	831.0	876.0	3324.0	3504.0	224	843.4	888.4	3373.6	3553.6
163	831.2	876.2	3324.8	3504.8	225	843.6	888.6	3374.4	3554.4
164	831.4	876.4	3325.6	3505.6	226	843.8	888.8	3375.2	3555.2
165	831.6	876.6	3326.4	3506.4	227	844.0	889.0	3376.0	3556.0
166	831.8	876.8	3327.2	3507.2	228	844.2	889.2	3376.8	3556.8
167	832.0	877.0	3328.0	3508.0	229	844.4	889.4	3377.6	3557.6
168	832.2	877.2	3328.8	3508.8	230	844.6	889.6	3378.4	3558.4
169	832.4	877.4	3329.6	3509.6	231	844.8	889.8	3379.2	3559.2
170	832.6	877.6	3330.4	3510.4	232	845.0	890.0	3380.0	3560.0
171	832.8	877.8	3331.2	3511.2	233	845.2	890.2	3380.8	3560.8
172	833.0	878.0	3332.0	3512.0	234	845.4	890.4	3381.6	3561.6
173	833.2	878.2	3332.8	3512.8	235	845.6	890.6	3382.4	3562.4
174	833.4	878.4	3333.6	3513.6	236	845.8	890.8	3383.2	3563.2
175	833.6	878.6	3334.4	3514.4	237	846.0	891.0	3384.0	3564.0
176	833.8	878.8	3335.2	3515.2	238	846.2	891.2	3384.8	3564.8
177	834.0	879.0	3336.0	3516.0	239	846.4	891.4	3385.6	3565.6
178	834.2	879.2	3336.8	3516.8	240	846.6	891.6	3386.4	3566.4
179	834.4	879.4	3337.6	3517.6	241	846.8	891.8	3387.2	3567.2
180	834.6	879.6	3338.4	3518.4	242	847.0	892.0	3388.0	3568.0
181	834.8	879.8	3339.2	3519.2	243	847.2	892.2	3388.8	3568.8
182	835.0	880.0	3340.0	3520.0	244	847.4	892.4	3389.6	3569.6
183	835.2	880.2	3340.8	3520.8	245	847.6	892.6	3390.4	3570.4
184	835.4	880.4	3341.6	3521.6	246	847.8	892.8	3391.2	3571.2
185	835.6	880.6	3342.4	3522.4	247	848.0	893.0	3392.0	3572.0
186	835.8	880.8	3343.2	3523.2	248	848.2	893.2	3392.8	3572.8
187	836.0	881.0	3344.0	3524.0	249	848.4	893.4	3393.6	3573.6
188	836.2	881.2	3344.8	3524.8	250	848.6	893.6	3394.4	3574.4
189	836.4	881.4	3345.6	3525.6	251	848.8	893.8	3395.2	3575.2

GSM900 (including EGSM900)

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
975	880.2	925.2	3520.8	3700.8	1	890.2	935.2	3560.8	3740.8	63	902.6	947.6	3610.4	3790.4
976	880.4	925.4	3521.6	3701.6	2	890.4	935.4	3561.6	3741.6	64	902.8	947.8	3611.2	3791.2
977	880.6	925.6	3522.4	3702.4	3	890.6	935.6	3562.4	3742.4	65	903.0	948.0	3612.0	3792.0
978	880.8	925.8	3523.2	3703.2	4	890.8	935.8	3563.2	3743.2	66	903.2	948.2	3612.8	3792.8
979	881.0	926.0	3524.0	3704.0	5	891.0	936.0	3564.0	3744.0	67	903.4	948.4	3613.6	3793.6
980	881.2	926.2	3524.8	3704.8	6	891.2	936.2	3564.8	3744.8	68	903.6	948.6	3614.4	3794.4
981	881.4	926.4	3525.6	3705.6	7	891.4	936.4	3565.6	3745.6	69	903.8	948.8	3615.2	3795.2
982	881.6	926.6	3526.4	3706.4	8	891.6	936.6	3566.4	3746.4	70	904.0	949.0	3616.0	3796.0
983	881.8	926.8	3527.2	3707.2	9	891.8	936.8	3567.2	3747.2	71	904.2	949.2	3616.8	3796.8
984	882.0	927.0	3528.0	3708.0	10	892.0	937.0	3568.0	3748.0	72	904.4	949.4	3617.6	3797.6
985	882.2	927.2	3528.8	3708.8	11	892.2	937.2	3568.8	3748.8	73	904.6	949.6	3618.4	3798.4
986	882.4	927.4	3529.6	3709.6	12	892.4	937.4	3569.6	3749.6	74	904.8	949.8	3619.2	3799.2
987	882.6	927.6	3530.4	3710.4	13	892.6	937.6	3570.4	3750.4	75	905.0	950.0	3620.0	3800.0
988	882.8	927.8	3531.2	3711.2	14	892.8	937.8	3571.2	3751.2	76	905.2	950.2	3620.8	3800.8
989	883.0	928.0	3532.0	3712.0	15	893.0	938.0	3572.0	3752.0	77	905.4	950.4	3621.6	3801.6
990	883.2	928.2	3532.8	3712.8	16	893.2	938.2	3572.8	3752.8	78	905.6	950.6	3622.4	3802.4
991	883.4	928.4	3533.6	3713.6	17	893.4	938.4	3573.6	3753.6	79	905.8	950.8	3623.2	3803.2
992	883.6	928.6	3534.4	3714.4	18	893.6	938.6	3574.4	3754.4	80	906.0	951.0	3624.0	3804.0
993	883.8	928.8	3535.2	3715.2	19	893.8	938.8	3575.2	3755.2	81	906.2	951.2	3624.8	3804.8
994	884.0	929.0	3536.0	3716.0	20	894.0	939.0	3576.0	3756.0	82	906.4	951.4	3625.6	3805.6
995	884.2	929.2	3536.8	3716.8	21	894.2	939.2	3576.8	3756.8	83	906.6	951.6	3626.4	3806.4
996	884.4	929.4	3537.6	3717.6	22	894.4	939.4	3577.6	3757.6	84	906.8	951.8	3627.2	3807.2
997	884.6	929.6	3538.4	3718.4	23	894.6	939.6	3578.4	3758.4	85	907.0	952.0	3628.0	3808.0
998	884.8	929.8	3539.2	3719.2	24	894.8	939.8	3579.2	3759.2	86	907.2	952.2	3628.8	3808.8
999	885.0	930.0	3540.0	3720.0	25	895.0	940.0	3580.0	3760.0	87	907.4	952.4	3629.6	3809.6
1000	885.2	930.2	3540.8	3720.8	26	895.2	940.2	3580.8	3760.8	88	907.6	952.6	3630.4	3810.4
1001	885.4	930.4	3541.6	3721.6	27	895.4	940.4	3581.6	3761.6	89	907.8	952.8	3631.2	3811.2
1002	885.6	930.6	3542.4	3722.4	28	895.6	940.6	3582.4	3762.4	90	908.0	953.0	3632.0	3812.0
1003	885.8	930.8	3543.2	3723.2	29	895.8	940.8	3583.2	3763.2	91	908.2	953.2	3632.8	3812.8
1004	886.0	931.0	3544.0	3724.0	30	896.0	941.0	3584.0	3764.0	92	908.4	953.4	3633.6	3813.6
1005	886.2	931.2	3544.8	3724.8	31	896.2	941.2	3584.8	3764.8	93	908.6	953.6	3634.4	3814.4
1006	886.4	931.4	3545.6	3725.6	32	896.4	941.4	3585.6	3765.6	94	908.8	953.8	3635.2	3815.2
1007	886.6	931.6	3546.4	3726.4	33	896.6	941.6	3586.4	3766.4	95	909.0	954.0	3636.0	3816.0
1008	886.8	931.8	3547.2	3727.2	34	896.8	941.8	3587.2	3767.2	96	909.2	954.2	3636.8	3816.8
1009	887.0	932.0	3548.0	3728.0	35	897.0	942.0	3588.0	3768.0	97	909.4	954.4	3637.6	3817.6
1010	887.2	932.2	3548.8	3728.8	36	897.2	942.2	3588.8	3768.8	98	909.6	954.6	3638.4	3818.4
1011	887.4	932.4	3549.6	3729.6	37	897.4	942.4	3589.6	3769.6	99	909.8	954.8	3639.2	3819.2
1012	887.6	932.6	3550.4	3730.4	38	897.6	942.6	3590.4	3770.4	100	910.0	955.0	3640.0	3820.0
1013	887.8	932.8	3551.2	3731.2	39	897.8	942.8	3591.2	3771.2	101	910.2	955.2	3640.8	3820.8
1014	888.0	933.0	3552.0	3732.0	40	898.0	943.0	3592.0	3772.0	102	910.4	955.4	3641.6	3821.6
1015	888.2	933.2	3552.8	3732.8	41	898.2	943.2	3592.8	3772.8	103	910.6	955.6	3642.4	3822.4
1016	888.4	933.4	3553.6	3733.6	42	898.4	943.4	3593.6	3773.6	104	910.8	955.8	3643.2	3823.2
1017	888.6	933.6	3554.4	3734.4	43	898.6	943.6	3594.4	3774.4	105	911.0	956.0	3644.0	3824.0
1018	888.8	933.8	3555.2	3735.2	44	898.8	943.8	3595.2	3775.2	106	911.2	956.2	3644.8	3824.8
1019	889.0	934.0	3556.0	3736.0	45	899.0	944.0	3596.0	3776.0	107	911.4	956.4	3645.6	3825.6
1020	889.2	934.2	3556.8	3736.8	46	899.2	944.2	3596.8	3776.8	108	911.6	956.6	3646.4	3826.4
1021	889.4	934.4	3557.6	3737.6	47	899.4	944.4	3597.6	3777.6	109	911.8	956.8	3647.2	3827.2
1022	889.6	934.6	3558.4	3738.4	48	899.6	944.6	3598.4	3778.4	110	912.0	957.0	3648.0	3828.0
1023	889.8	934.8	3559.2	3739.2	49	899.8	944.8	3599.2	3779.2	111	912.2	957.2	3648.8	3828.8
0	890.0	935.0	3560.0	3740.0	50	900.0	945.0	3600.0	3780.0	112	912.4	957.4	3649.6	3829.6
					51	900.2	945.2	3600.8	3780.8	113	912.6	957.6	3650.4	3830.4
					52	900.4	945.4	3601.6	3781.6	114	912.8	957.8	3651.2	3831.2
					53	900.6	945.6	3602.4	3782.4	115	913.0	958.0	3652.0	3832.0
					54	900.8	945.8	3603.2	3783.2	116	913.2	958.2	3652.8	3832.8
					55	901.0	946.0	3604.0	3784.0	117	913.4	958.4	3653.6	3833.6
					56	901.2	946.2	3604.8	3784.8	118	913.6	958.6	3654.4	3834.4
					57	901.4	946.4	3605.6	3785.6	119	913.8	958.8	3655.2	3835.2
					58	901.6	946.6	3606.4	3786.4	120	914.0	959.0	3656.0	3836.0
					59	901.8	946.8	3607.2	3787.2	121	914.2	959.2	3656.8	3836.8
					60	902.0	947.0	3608.0	3788.0	122	914.4	959.4	3657.6	3837.6
					61	902.2	947.2	3608.8	3788.8	123	914.6	959.6	3658.4	3838.4
					62	902.4	947.4	3609.6	3789.6	124	914.8	959.8	3659.2	3839.2

GSM1800

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	794	1766.6	1861.6	3533.2	3723.2
513	1710.4	1805.4	3420.8	3610.8	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	795	1766.8	1861.8	3533.6	3723.6
514	1710.6	1805.6	3421.2	3611.2	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	796	1767.0	1862.0	3534.0	3724.0
515	1710.8	1805.8	3421.6	3611.6	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	797	1767.2	1862.2	3534.4	3724.4
516	1711.0	1806.0	3422.0	3612.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	798	1767.4	1862.4	3534.8	3724.8
517	1711.2	1806.2	3422.4	3612.4	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	799	1767.6	1862.6	3535.2	3725.2
518	1711.4	1806.4	3422.8	3612.8	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	800	1767.8	1862.8	3535.6	3725.6
519	1711.6	1806.6	3423.2	3613.2	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	801	1768.0	1863.0	3536.0	3726.0
520	1711.8	1806.8	3423.6	3613.6	614	1730.6	1825.6	3461.2	3651.2	708	1749.4	1844.4	3498.8	3688.8	802	1768.2	1863.2	3536.4	3726.4
521	1712.0	1807.0	3424.0	3614.0	615	1730.8	1825.8	3461.6	3651.6	709	1749.6	1844.6	3499.2	3689.2	803	1768.4	1863.4	3536.8	3726.8
522	1712.2	1807.2	3424.4	3614.4	616	1731.0	1826.0	3462.0	3652.0	710	1749.8	1844.8	3499.6	3689.6	804	1768.6	1863.6	3537.2	3727.2
523	1712.4	1807.4	3424.8	3614.8	617	1731.2	1826.2	3462.4	3652.4	711	1750.0	1845.0	3500.0	3690.0	805	1768.8	1863.8	3537.6	3727.6
524	1712.6	1807.6	3425.2	3615.2	618	1731.4	1826.4	3462.8	3652.8	712	1750.2	1845.2	3500.4	3690.4	806	1769.0	1864.0	3538.0	3728.0
525	1712.8	1807.8	3425.6	3615.6	619	1731.6	1826.6	3463.2	3653.2	713	1750.4	1845.4	3500.8	3690.8	807	1769.2	1864.2	3538.4	3728.4
526	1713.0	1808.0	3426.0	3616.0	620	1731.8	1826.8	3463.6	3653.6	714	1750.6	1845.6	3501.2	3691.2	808	1769.4	1864.4	3538.8	3728.8
527	1713.2	1808.2	3426.4	3616.4	621	1732.0	1827.0	3464.0	3654.0	715	1750.8	1845.8	3501.6	3691.6	809	1769.6	1864.6	3539.2	3729.2
528	1713.4	1808.4	3426.8	3616.8	622	1732.2	1827.2	3464.4	3654.4	716	1751.0	1846.0	3502.0	3692.0	810	1769.8	1864.8	3539.6	3729.6
529	1713.6	1808.6	3427.2	3617.2	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	811	1770.0	1865.0	3540.0	3730.0
530	1713.8	1808.8	3427.6	3617.6	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	812	1770.2	1865.2	3540.4	3730.4
531	1714.0	1809.0	3428.0	3618.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	813	1770.4	1865.4	3540.8	3730.8
532	1714.2	1809.2	3428.4	3618.4	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	814	1770.6	1865.6	3541.2	3731.2
533	1714.4	1809.4	3428.8	3618.8	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	815	1770.8	1865.8	3541.6	3731.6
534	1714.6	1809.6	3429.2	3619.2	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	816	1771.0	1866.0	3542.0	3732.0
535	1714.8	1809.8	3429.6	3619.6	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	817	1771.2	1866.2	3542.4	3732.4
536	1715.0	1810.0	3430.0	3620.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	818	1771.4	1866.4	3542.8	3732.8
537	1715.2	1810.2	3430.4	3620.4	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	819	1771.6	1866.6	3543.2	3733.2
538	1715.4	1810.4	3430.8	3620.8	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	820	1771.8	1866.8	3543.6	3733.6
539	1715.6	1810.6	3431.2	3621.2	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	821	1772.0	1867.0	3544.0	3734.0
540	1715.8	1810.8	3431.6	3621.6	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	822	1772.2	1867.2	3544.4	3734.4
541	1716.0	1811.0	3432.0	3622.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	823	1772.4	1867.4	3544.8	3734.8
542	1716.2	1811.2	3432.4	3622.4	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	824	1772.6	1867.6	3545.2	3735.2
543	1716.4	1811.4	3432.8	3622.8	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	825	1772.8	1867.8	3545.6	3735.6
544	1716.6	1811.6	3433.2	3623.2	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	826	1773.0	1868.0	3546.0	3736.0
545	1716.8	1811.8	3433.6	3623.6	639	1735.6	1830.6	3471.2	3661.2	733	1754.4	1849.4	3508.8	3698.8	827	1773.2	1868.2	3546.4	3736.4
546	1717.0	1812.0	3434.0	3624.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	828	1773.4	1868.4	3546.8	3736.8
547	1717.2	1812.2	3434.4	3624.4	641	1736.0	1831.0	3472.0	3662.0	735	1754.8	1849.8	3509.6	3699.6	829	1773.6	1868.6	3547.2	3737.2
548	1717.4	1812.4	3434.8	3624.8	642	1736.2	1831.2	3472.4	3662.4	736	1755.0	1850.0	3510.0	3700.0	830	1773.8	1868.8	3547.6	3737.6
549	1717.6	1812.6	3435.2	3625.2	643	1736.4	1831.4	3472.8	3662.8	737	1755.2	1850.2	3510.4	3700.4	831	1774.0	1869.0	3548.0	3738.0
550	1717.8	1812.8	3435.6	3625.6	644	1736.6	1831.6	3473.2	3663.2	738	1755.4	1850.4	3510.8	3700.8	832	1774.2	1869.2	3548.4	3738.4
551	1718.0	1813.0	3436.0	3626.0	645	1736.8	1831.8	3473.6	3663.6	739	1755.6	1850.6	3511.2	3701.2	833	1774.4	1869.4	3548.8	3738.8
552	1718.2	1813.2	3436.4	3626.4	646	1737.0	1832.0	3474.0	3664.0	740	1755.8	1850.8	3511.6	3701.6	834	1774.6	1869.6	3549.2	3739.2
553	1718.4	1813.4	3436.8	3626.8	647	1737.2	1832.2	3474.4	3664.4	741	1756.0	1851.0	3512.0	3702.0	835	1774.8	1869.8	3549.6	3739.6
554	1718.6	1813.6	3437.2	3627.2	648	1737.4	1832.4	3474.8	3664.8	742	1756.2	1851.2	3512.4	3702.4	836	1775.0	1870.0	3550.0	3740.0
555	1718.8	1813.8	3437.6	3627.6	649	1737.6	1832.6	3475.2	3665.2	743	1756.4	1851.4	3512.8	3702.8	837	1775.2	1870.2	3550.4	3740.4
556	1719.0	1814.0	3438.0	3628.0	650	1737.8	1832.8	3475.6	3665.6	744	1756.6	1851.6	3513.2	3703.2	838	1775.4	1870.4	3550.8	3740.8
557	1719.2	1814.2	3438.4	3628.4	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	839	1775.6	1870.6	3551.2	3741.2
558	1719.4	1814.4	3438.8	3628.8	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	840	1775.8	1870.8	3551.6	3741.6
559	1719.6	1814.6	3439.2	3629.2	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	841	1776.0	1871.0	3552.0	3742.0
560	1719.8	1814.8	3439.6	3629.6	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	842	1776.2	1871.2	3552.4	3742.4
561	1720.0	1815.0	3440.0	3630.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	843	1776.4	1871.4	3552.8	3742.8
562	1720.2	1815.2	3440.4	3630.4	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	844	1776.6	1871.6	3553.2	3743.2
563	1720.4	1815.4	3440.8	3630.8	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	845	1776.8	1871.8	3553.6	3743.6
564	1720.6	1815.6	3441.2	3631.2	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	846	1777.0	1872.0	3554.0	3744.0
565	1720.8	1815.8	3441.6	3631.6	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	847	1777.2	1872.2	3554.4	3744.4
566	1721.0	1816.0	3442.0	3632.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	848	1777.4	1872.4	3554.8	3744.8
567	1721.2	1816.2	3442.4	3632.4	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	849	1777.6	1872.6	3555.2	3745.2
568	1721.4	1816.4	3442.8	3632.8	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	850	1777.8	1872.8	3555.6	3745.6
569	1721.6	1816.6	3443.2	3633.2	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	851	1778.0	1873.0	3556.0	3746.0
570	1721.8	1816.8	3443.6	3633.6	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4

GSM1900

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1850.2	1930.2	3700.4	3860.4	606	1869.0	1949.0	3738.0	3898.0	700	1887.8	1967.8	3775.6	3935.6	794	1906.6	1986.6	3813.2	3973.2
513	1850.4	1930.4	3700.8	3860.8	607	1869.2	1949.2	3738.4	3898.4	701	1888.0	1968.0	3776.0	3936.0	795	1906.8	1986.8	3813.6	3973.6
514	1850.6	1930.6	3701.2	3861.2	608	1869.4	1949.4	3738.8	3898.8	702	1888.2	1968.2	3776.4	3936.4	796	1907.0	1987.0	3814.0	3974.0
515	1850.8	1930.8	3701.6	3861.6	609	1869.6	1949.6	3739.2	3899.2	703	1888.4	1968.4	3776.8	3936.8	797	1907.2	1987.2	3814.4	3974.4
516	1851.0	1931.0	3702.0	3862.0	610	1869.8	1949.8	3739.6	3899.6	704	1888.6	1968.6	3777.2	3937.2	798	1907.4	1987.4	3814.8	3974.8
517	1851.2	1931.2	3702.4	3862.4	611	1870.0	1950.0	3740.0	3900.0	705	1888.8	1968.8	3777.6	3937.6	799	1907.6	1987.6	3815.2	3975.2
518	1851.4	1931.4	3702.8	3862.8	612	1870.2	1950.2	3740.4	3900.4	706	1889.0	1969.0	3778.0	3938.0	800	1907.8	1987.8	3815.6	3975.6
519	1851.6	1931.6	3703.2	3863.2	613	1870.4	1950.4	3740.8	3900.8	707	1889.2	1969.2	3778.4	3938.4	801	1908.0	1988.0	3816.0	3976.0
520	1851.8	1931.8	3703.6	3863.6	614	1870.6	1950.6	3741.2	3901.2	708	1889.4	1969.4	3778.8	3938.8	802	1908.2	1988.2	3816.4	3976.4
521	1852.0	1932.0	3704.0	3864.0	615	1870.8	1950.8	3741.6	3901.6	709	1889.6	1969.6	3779.2	3939.2	803	1908.4	1988.4	3816.8	3976.8
522	1852.2	1932.2	3704.4	3864.4	616	1871.0	1951.0	3742.0	3902.0	710	1889.8	1969.8	3779.6	3939.6	804	1908.6	1988.6	3817.2	3977.2
523	1852.4	1932.4	3704.8	3864.8	617	1871.2	1951.2	3742.4	3902.4	711	1890.0	1970.0	3780.0	3940.0	805	1908.8	1988.8	3817.6	3977.6
524	1852.6	1932.6	3705.2	3865.2	618	1871.4	1951.4	3742.8	3902.8	712	1890.2	1970.2	3780.4	3940.4	806	1909.0	1989.0	3818.0	3978.0
525	1852.8	1932.8	3705.6	3865.6	619	1871.6	1951.6	3743.2	3903.2	713	1890.4	1970.4	3780.8	3940.8	807	1909.2	1989.2	3818.4	3978.4
526	1853.0	1933.0	3706.0	3866.0	620	1871.8	1951.8	3743.6	3903.6	714	1890.6	1970.6	3781.2	3941.2	808	1909.4	1989.4	3818.8	3978.8
527	1853.2	1933.2	3706.4	3866.4	621	1872.0	1952.0	3744.0	3904.0	715	1890.8	1970.8	3781.6	3941.6	809	1909.6	1989.6	3819.2	3979.2
528	1853.4	1933.4	3706.8	3866.8	622	1872.2	1952.2	3744.4	3904.4	716	1891.0	1971.0	3782.0	3942.0	810	1909.8	1989.8	3819.6	3979.6
529	1853.6	1933.6	3707.2	3867.2	623	1872.4	1952.4	3744.8	3904.8	717	1891.2	1971.2	3782.4	3942.4					
530	1853.8	1933.8	3707.6	3867.6	624	1872.6	1952.6	3745.2	3905.2	718	1891.4	1971.4	3782.8	3942.8					
531	1854.0	1934.0	3708.0	3868.0	625	1872.8	1952.8	3745.6	3905.6	719	1891.6	1971.6	3783.2	3943.2					
532	1854.2	1934.2	3708.4	3868.4	626	1873.0	1953.0	3746.0	3906.0	720	1891.8	1971.8	3783.6	3943.6					
533	1854.4	1934.4	3708.8	3868.8	627	1873.2	1953.2	3746.4	3906.4	721	1892.0	1972.0	3784.0	3944.0					
534	1854.6	1934.6	3709.2	3869.2	628	1873.4	1953.4	3746.8	3906.8	722	1892.2	1972.2	3784.4	3944.4					
535	1854.8	1934.8	3709.6	3869.6	629	1873.6	1953.6	3747.2	3907.2	723	1892.4	1972.4	3784.8	3944.8					
536	1855.0	1935.0	3710.0	3870.0	630	1873.8	1953.8	3747.6	3907.6	724	1892.6	1972.6	3785.2	3945.2					
537	1855.2	1935.2	3710.4	3870.4	631	1874.0	1954.0	3748.0	3908.0	725	1892.8	1972.8	3785.6	3945.6					
538	1855.4	1935.4	3710.8	3870.8	632	1874.2	1954.2	3748.4	3908.4	726	1893.0	1973.0	3786.0	3946.0					
539	1855.6	1935.6	3711.2	3871.2	633	1874.4	1954.4	3748.8	3908.8	727	1893.2	1973.2	3786.4	3946.4					
540	1855.8	1935.8	3711.6	3871.6	634	1874.6	1954.6	3749.2	3909.2	728	1893.4	1973.4	3786.8	3946.8					
541	1856.0	1936.0	3712.0	3872.0	635	1874.8	1954.8	3749.6	3909.6	729	1893.6	1973.6	3787.2	3947.2					
542	1856.2	1936.2	3712.4	3872.4	636	1875.0	1955.0	3750.0	3910.0	730	1893.8	1973.8	3787.6	3947.6					
543	1856.4	1936.4	3712.8	3872.8	637	1875.2	1955.2	3750.4	3910.4	731	1894.0	1974.0	3788.0	3948.0					
544	1856.6	1936.6	3713.2	3873.2	638	1875.4	1955.4	3750.8	3910.8	732	1894.2	1974.2	3788.4	3948.4					
545	1856.8	1936.8	3713.6	3873.6	639	1875.6	1955.6	3751.2	3911.2	733	1894.4	1974.4	3788.8	3948.8					
546	1857.0	1937.0	3714.0	3874.0	640	1875.8	1955.8	3751.6	3911.6	734	1894.6	1974.6	3789.2	3949.2					
547	1857.2	1937.2	3714.4	3874.4	641	1876.0	1956.0	3752.0	3912.0	735	1894.8	1974.8	3789.6	3949.6					
548	1857.4	1937.4	3714.8	3874.8	642	1876.2	1956.2	3752.4	3912.4	736	1895.0	1975.0	3790.0	3950.0					
549	1857.6	1937.6	3715.2	3875.2	643	1876.4	1956.4	3752.8	3912.8	737	1895.2	1975.2	3790.4	3950.4					
550	1857.8	1937.8	3715.6	3875.6	644	1876.6	1956.6	3753.2	3913.2	738	1895.4	1975.4	3790.8	3950.8					
551	1858.0	1938.0	3716.0	3876.0	645	1876.8	1956.8	3753.6	3913.6	739	1895.6	1975.6	3791.2	3951.2					
552	1858.2	1938.2	3716.4	3876.4	646	1877.0	1957.0	3754.0	3914.0	740	1895.8	1975.8	3791.6	3951.6					
553	1858.4	1938.4	3716.8	3876.8	647	1877.2	1957.2	3754.4	3914.4	741	1896.0	1976.0	3792.0	3952.0					
554	1858.6	1938.6	3717.2	3877.2	648	1877.4	1957.4	3754.8	3914.8	742	1896.2	1976.2	3792.4	3952.4					
555	1858.8	1938.8	3717.6	3877.6	649	1877.6	1957.6	3755.2	3915.2	743	1896.4	1976.4	3792.8	3952.8					
556	1859.0	1939.0	3718.0	3878.0	650	1877.8	1957.8	3755.6	3915.6	744	1896.6	1976.6	3793.2	3953.2					
557	1859.2	1939.2	3718.4	3878.4	651	1878.0	1958.0	3756.0	3916.0	745	1896.8	1976.8	3793.6	3953.6					
558	1859.4	1939.4	3718.8	3878.8	652	1878.2	1958.2	3756.4	3916.4	746	1897.0	1977.0	3794.0	3954.0					
559	1859.6	1939.6	3719.2	3879.2	653	1878.4	1958.4	3756.8	3916.8	747	1897.2	1977.2	3794.4	3954.4					
560	1859.8	1939.8	3719.6	3879.6	654	1878.6	1958.6	3757.2	3917.2	748	1897.4	1977.4	3794.8	3954.8					
561	1860.0	1940.0	3720.0	3880.0	655	1878.8	1958.8	3757.6	3917.6	749	1897.6	1977.6	3795.2	3955.2					
562	1860.2	1940.2	3720.4	3880.4	656	1879.0	1959.0	3758.0	3918.0	750	1897.8	1977.8	3795.6	3955.6					
563	1860.4	1940.4	3720.8	3880.8	657	1879.2	1959.2	3758.4	3918.4	751	1898.0	1978.0	3796.0	3956.0					
564	1860.6	1940.6	3721.2	3881.2	658	1879.4	1959.4	3758.8	3918.8	752	1898.2	1978.2	3796.4	3956.4					
565	1860.8	1940.8	3721.6	3881.6	659	1879.6	1959.6	3759.2	3919.2	753	1898.4	1978.4	3796.8	3956.8					
566	1861.0	1941.0	3722.0	3882.0	660	1879.8	1959.8	3759.6	3919.6	754	1898.6	1978.6	3797.2	3957.2					
567	1861.2	1941.2	3722.4	3882.4	661	1880.0	1960.0	3760.0	3920.0	755	1898.8	1978.8	3797.6	3957.6					
568	1861.4	1941.4	3722.8	3882.8	662	1880.2	1960.2	3760.4	3920.4	756	1899.0	1979.0	3798.0	3958.0					
569	1861.6	1941.6	3723.2	3883.2	663	1880.4	1960.4	3760.8	3920.8	757	1899.2	1979.2	3798.4	3958.4					
570	1861.8	1941.8	3723.6	3883.6	664	1880.6	1960.6	3761.2	3921.2	758	1899.4	1979.4	3798.8	3958.8					

RF tunings after repairs

The following tunings have to be performed after repairs:

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

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

WLAN RF Description

WLAN RF has functionality required for IEEE802.11b 2.4 GHz high-rate WLAN. The radio is half-duplex with no frequency duplex. Transmission and receiving is on the same frequency.

Transmission times are determined by running a distributed medium access control protocol leaning on clear channel assessment and back-off procedures. The protocol is known as CSMA/CA, Carrier Sense Multiple Access / Collision Avoidance.

EMC leakage is prevented by using a metal can. Heat generated by the circuitry is conducted out via the PWB ground planes and a metallized shield.

Table 12: General transceiver characteristics

Parameter	Value
Frequency range	2412 – 2462 MHz (US bands) 2412 – 2472 MHz (EU bands)
Channel spacing	5 MHz
Number of channels	11 channels in US 13 channels in EU 13 channels in France
Frequency accuracy	± 25 ppm
Modulation	11 Msymbols/s BPSK/QPSK
Data rates	1 Mb/s BPSK Barker spreading 2 Mb/s QPSK Barker spreading 5.5 Mb/s and 11 Mb/s QPSK and CCK coding

RF operating modes

The MAX2821 has four primary modes of operation: shutdown, standby, receive active and transmit active. The modes are controlled with RF_ENA, TX_ENA and RX_ENA signals.

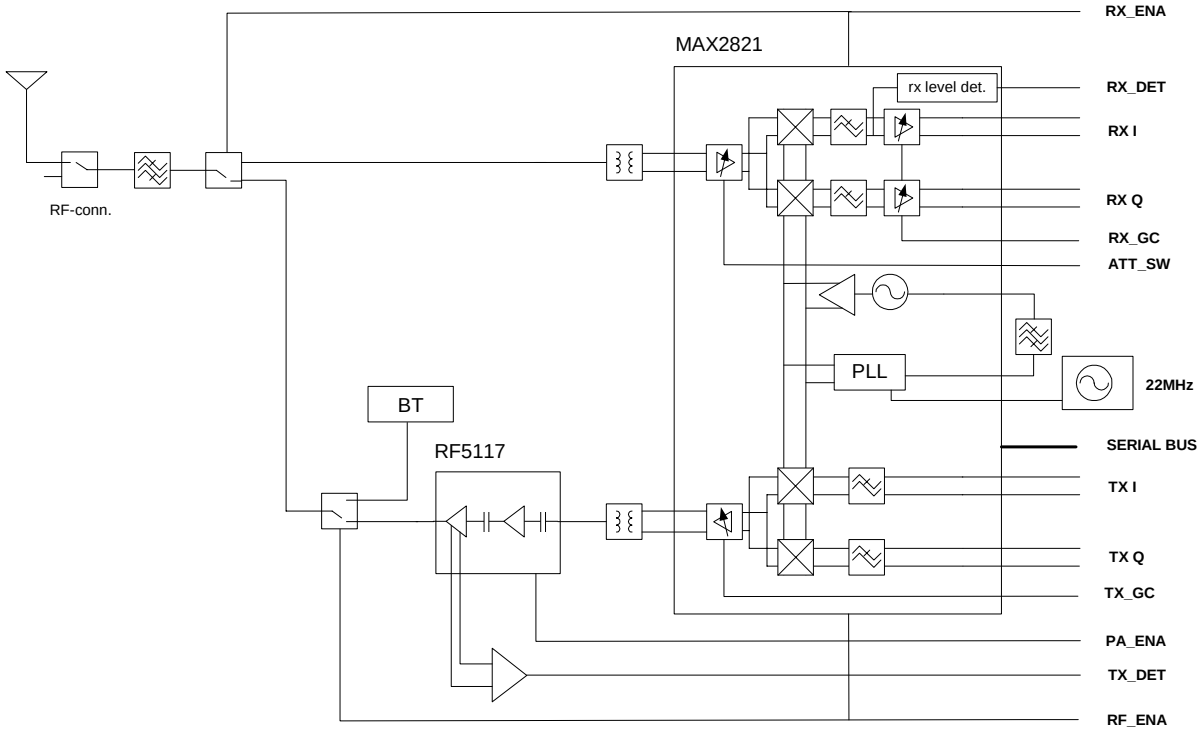
Table 13: RF operating modes

Mode	/SHDN	Tx	Rx	Note
Shutdown	0	X	X	
Stand-by	1	0	0	PLL on
Receive	1	0	1	
Transmit	1	1	0	

Transmitter

The RF block diagram is shown in the figure below:

Figure 23: WLAN RF block diagram.



The transmitter section of MAX2821 contains integrated baseband filter, IQ-modulator and a driver amplifier with a variable output power. Balanced output of MAX2821 is converted to single-ended with ceramic balun. The PA RF5117 amplifies the signal to the desired output level. Decreasing or increasing of the transmit power is by applying the output signal from DAC (TX_GC) to the driver amplifier VGA. This way the Tx output power level is constant regardless of process or temperature variations. The accuracy of the detector is ±1 dB. TX_GC setting is updated to DAC output only at the start of the transmission. The signal goes after the PA to the Bluetooth selection switch and from there to Tx/Rx switch and the RF band pass filter. The RF filter attenuates the transmitter wideband noise to a level where it does not interfere GSM re-

ceiver. The transmitter harmonics are attenuated at the RF filter to a required level. The Tx/Rx switch, BT/WLAN switch, RF filter, RF test connector and antenna are common to BT and WLAN in RA-2/3.

Table 14: Transmitter characteristics

Parameter	Value
Typical output power (mean power)	17.5 dBm (conducted), Maximum output power 100 mW (EIRP)
Min output power (mean power)	3 dBm
Output spectrum	ACPR1 _ -33 dBc, ACPR2 _ -53 dBc
Modulation accuracy	<35%
Carrier Suppression	>15 dBc

Receiver

The receiver is a direct conversion receiver based on a single chip RFIC. The received input signal is filtered with a ceramic band pass filter after which the Tx/Rx switch selects the receiver branch..

Table 15: Receiver characteristics

Parameter	Value
Typical 3 dB bandwidth	7.5 MHz (I and Q channels)
Sensitivity, 2Mbps (1024 byte frame)	-90 dBm
Sensitivity, 11Mbps (1024 byte frame)	-85 dBm
Max. Rx voltage gain (from antenna to Rx ADC)	102 dB
Typical receiver output level	500 mVp-p
Typical AGC dynamic range	100 dB
Usable input dynamic range	-10 dBm…-92 dBm
RF gain step	30 dB, typical

Synthesizer

The PLL synthesizer with VCO is integrated into RFIC, only the loop filter is needed outside the RFIC.

Antenna

Antenna is located in the corner of the engine PWB. Antenna interface is single ended 50 W.

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